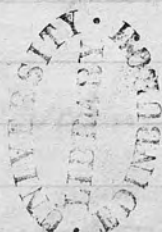


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An Enquiry into certain points
Connected with the
Physiology and Pathology
of the
Cerebellum.

by
Edward Livingston French.
(Edin. Univ. & King's Coll. Lond.)



Voyez donc beaucoup, observez
par vous-même, car il faut
posséder des notions personnelles
pour comprendre et utiliser
celles que les autres ont
acquises.

(J. Troussau.)

Prefatory Remarks.

It must have appeared evident to most persons, who have at one time, or another turned their attention to scientific or intellectual pursuits; that Facts regarded as Facts alone do not constitute a science. We may very well conclude that man ever since his first appearance in the world must have eaten and drunk and moved and had his being in much the same manner as we do at this present hour and yet a hundred years ago the science (the physiology) of life was not much better understood than it had been two thousand years before. And indeed

We know that to establish facts as the points
 and landmarks of a science is something else
 than the mere statement is necessary: they must
 be reduced into systems and formulae expressive
 of mutual relation, and the crude and concrete
 phenomena of nature, to be apprehended by the
 intellect, must be analysed, compared and
 interpreted, and so recognised not as mere
 empirical manifestations, but as appointed
 means employed by an all wise nature for a
 definite end and purpose.

Regarding the course of events then in such a light as
 this we shall be better able to appreciate the past
 working of science, and to predict her future course.

Prompted by the implanted principle of Curiosity, if not by higher motives, zealous workers in the study of medicine, as well as in other intellectual pursuits, have been always found; and at first sight it might appear somewhat remarkable that so much time and labour should have been spent on such subjects and so small a result obtained; and yet the solution of this is not difficult when we once reflect on the process that has to be submitted to prior to the establishment of any single link in the hard chain of science: when we consider that all the operations of the human mind are more or less relative to some known standard, and that all our ideas upon subjects

moral, scientific, or otherwise are formed by a
 process of comparison, so that heat and cold, light
 and darkness, anger and affection, are none of
 them entities but all comparable statements: and
 through experience enabled each observer to attach
 in his own mind some meaning to each of such
 states; yet there being no fixed point by which the
 observations of one might be compared with those
 of another, each man struggled on in his course
 unaided and unaiding, and as life was short
 and science infinite, the tardy growth of anything
 fixed or definite out of that vast wilderness
 will - I say - be no longer a matter of any
 surprise to us.

On the other hand as soon as some definite
 starting points were established, as was done in
 the physical sciences
 by the propagation of such facts as the fixed
 boiling and freezing points ^{of water}, and the grand
 Newtonian laws of gravity, why then the advance
 of all these Sciences became as rapid as before
 it had been tardy. The analogy is complete
 as applied to medicine, for centuries its sluggish
 waters rolled on in their narrow channel receiving
 few additions to their bulk; and but little impetus
 to their progress, commencing as an art it
 bid fair to die one. Would-be-engineers of an
 engine, the machinery of which they were ignorant,
 looking upon Life as a 'Pox' or 'an animating

principle' ~~and~~ something which pervaded the organism independant of, and yet directing, its various functions; and upon Disease likewise as an Entity, an enemy to the economy, something vicious in its intent, a something which must be driven and purged away; the success of the disciples of medicine was - to say the least - very limited, and we ^{may} well suppose that medicine as a science gained but little by their efforts.

But as the light of Physiology, in its truest and widest acceptation, rising above the horizon on the Medical world, began to disperse the dark clouds of ignorance in which medicine had been so long and profoundly wrapped, it was evident that

that a brighter and more glorious era was at hand, that shaking off much of its cloak of art and assuming its rightful toga of science, Medicine, founded on a true conception of that most wonderful of nature's products - the living body - was destined to take her stand by the side of the sister sciences, and rear for herself a monument as grand and imperishable as any.

What was known of the Anatomy and physiology of the Nervous system fifty or sixty years ago? why simply nothing: it is within this time that much, of what was before an unknown territory ^{has} been opened up, and the way paved for future

investigation - it is only within this time that the very rudiments of a nervous physiology have been pointed out by such men as Bell, Magendie, Marshall Hall and others; and though we have at length obtained some surer footing for our future endeavours, still the debatable ground is very extensive, and our ignorance on many points very manifest; and for proof of this we need go no further than to the organ which forms the subject of our future consideration; and this results from no lack of enquirers for few parts of the brain have been so carefully investigated both by experiment and by clinical observation, there must then have been something wrong either in the mode in

which it was investigated, or in the deductions
 drawn from the results obtained - it too often
 happens that men set about researches with already
 deeply-rooted preconceived notions as to the results which
 will probably be obtained; and a theory once being
 conceived facts with a little straining are easily
 made to suit: I allow however that a theory of
 some kind is generally necessary in our work, but
 then that theory must always be made subservient to
 even the smallest opposing fact "Les idées préconçues"
~~says Claude B.~~
 says Claude Bernard "sont nécessaires, indispensables;
 on ne fonde rien sans elles; il faut savoir
 seulement les abandonner lorsqu'elles n'ont plus
 de raison d'être. à ce moment, si l'on s'y rattachait

Elles cesseraient d'être idées préconçues pour devenir idées fixes, et constituer une véritable infirmité de l'esprit. L'idée préconçue est toujours interrogative; c'est une question adressée à la nature. Il faut écouter froidement la réponse et cesser de faire la question, quand la réponse, quelle qu'elle soit, a été donnée. Les hommes à idées fixes n'interrogent que pour la forme; ils ont fait d'avance la demande et la réponse. Semblables à ces gens qui, bien décidés sur ce qu'ils doivent faire, vous demandent des conseils qu'ils ne suivront pas, s'ils sont contraires à leurs idées, car au fond ils cherchent une approbation et non un conseil.

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Guided by such a spirit of enquiry as Bernard
would here uphold I have chosen this subject
of the Cerebellum for my consideration - entering
upon the enquiry with no theory on the subject
whatever, and having no great confidence in
any that have as yet been suggested I may
as it were conclude without being able to offer
a better. My object is not to find a theory
so much as to examine into all the facts
that have been brought ^{forward} ~~before~~ - both by physiological
experiment and by bed-side observation - and see
how far they are compatible, or not, with the
various theories that have from time to time been
advanced, and then having all the facts ^{before us} we may perhaps

be able to form some reliable standard on which to ground our opinion.

With regard to clinical observations I have collected from various sources 100 cases of disease of the Cerebellum, ~~and~~ as far as it was possible excluding all cases in which there was a lesion affecting ^{any} ~~some~~ other portion of the nervous system, and recorded the symptoms observed in each, and the accompanying lesion. In making this use of the numerical method no one can be more fully aware than myself of the many fallacies to which any deductions drawn from it are liable. and yet they need not be so great to those who like myself do not in any way expect to reach the whole truth through them

but in reality merely a fraction of that which lies behind them, and which the present state of our knowledge does not yet allow us to express: we must remember however that that fraction, whatever it be, is as valuable as information obtained in any other scientific manner - and may indeed at length lead us to that path by which we may discover the whole truth: on the other hand I shall endeavour, as far as lies in my power, by analogy and induction to give a fair and impartial examination, and where possible explanation to all the facts which in the course of the ~~present~~^{evening} may be brought before us.

With regard to one other point viz, Experimental

physiology - I would say that I am at present
 very sceptical as to exact importance to be attached
 to many of the results obtained from it. When we
 consider how closely connected the Cerebellum
 (by means of its commissures) is with all the other
 divisions of the Centro-spinal system - with the
 Spinal Cord - Medulla Oblongata - Pons Varolii,
 ganglia at the base of the Cerebrum and the
 hemispheres themselves, we shall easily under-
 -stand how injury here, severe and sudden as it
 always is, would be very likely to cause serious
 functional disturbances of the whole economy.
 The results therefore of vivisections I shall accept as
 evidence, only, with caution and a limited confidence.



Physiological Anatomy.

Von Baer's law of the progression from the general to the special in the animal Kingdom, is nowhere better illustrated than in the development of the nervous system.

In the lowest forms of animal life, where the existence of the creature is so nearly vegetable that to draw a distinct line between what is truly vegetable and what animal is often nearly impossible, the nervous system exists either in a very rudimentary condition, or is altogether absent; thus in the Protozoa no definite trace of a nervous system has as yet been made out, but as we mount the ladder of the animal series

ascending from the mere esophageal ring
 found in the higher Radiata, until we reach
 the vast and complex cerebro-spinal and sympathetic
 systems of the Vertebrata, we can trace the gradual
 growth of structural complication, and coincident
 acquisition of increased functional importance;
 the complexity and extent of the psychical endow-
 -ments of each species bearing a direct relation
 to their influence over the vegetative life, so that
 in man organic life would seem destined for little else
 than to serve for the maintenance of the animal
 functions.

The first definite trace of a cerebellum commences
 with the vertebrate series, and is confined at first

as in the reptilia to a mere thin lamina of nervous matter covering in the fourth, or as it has been sometimes wrongly called the cerebellar, ventricle. This rudimentary structure is supposed to represent the median lobe in the higher stages of development; and some physiologists have gone so far as to state that it exerts an independent function to that of the lateral lobes, this to say the least is very doubtful.

However this may be, it suffices at present for us to state that there does exist a certain portion of the nervous system representing a cerebellum in all the vertebrate, and without tracing its development through the various classes, I shall at once pass on

to the consideration of the organ as it exists in man. Accepting as my foundation, the general anatomy of the part as given by Solley (for to go into this would be beyond the scope of this thesis) I am content to state that the cerebellum is divided into a median and two lateral lobes and that it is associated with the rest of the nervous system by means of three tracts or commissures, which respectively connect it with the sub-cerebral ganglia, the Dors. Veroles, and Medulla-Oblongata. Its grey matter like that of the Cerebrum is external, and its surface, which is not convoluted is traversed by numerous curved furrows which correspond to the intervals between the laminae of which

which its exterior is composed.

The grey matter of the cerebellum which presents many peculiarities has been carefully examined by most histologists, the following description of it is given by Kölliker in his work on Microscopic Anatomy: the grey matter he states exists both in the Nucleus Dentatus and on the surface of the organ, in the former we perceive greyish-red lamellae containing a considerable number of yellowish pigmented nerve cells of a medium size, furnished with from two to five processes, which are not directly connected with the numerous nerve-fibres passing between them from the white centre of the nucleus into the white substance of the hemispheres.

With regard to the grey substance on the surface, this consists of two layers viz an inner or rust-coloured, and an outer or grey layer; except in the farrons where the inner layer is generally thicker. These are nearly of an equal thickness the one with the other. The rust-coloured layer contains nerve fibres and a large collection of free nuclei the former having a tendency to break up into numerous fine bundles variously interwoven with each other: in the meshes of these fibres an immense number of dark round corpuscles are situated which appear to be free cell nuclei: the fibres themselves diminished in diameter pass outwards into the grey layer which may be divided

into two (not sharply defined) sub-layers, of
 which the inner contains nerve-fibres and beautiful
 large nerve cells, and the outer merely a finely
 granular pale substance (which in truth is more or less
 distributed throughout the whole of the grey layer) and
 small nerve cells with delicate processes, besides
 which there are some large cells (discovered by
 Purkinje) of a round pyriform or ovoid shape
 with finely granular colorless contents, found only
 at the innermost parts of the grey layer bordering
 on the rust-colored substance, they possess two or three
 long branched processes, the thinner directed inward.
 The thicker outward the latter are at their roots finely
 granular or delicately streaked, gradually becoming more and

more homogeneous.

From this cortical substance, which we have just described, the fibres of the white substance emerging, converge more or less towards the central stem of each hemisphere, in which is situated the peculiar nucleus of vesicular substance already noticed as the corpus dentatum or Rhomboidium the ganglion of the cerebellum, whether each passing fibre is connected or no with this nucleus is doubtful a late observer[†] remarks "Toutes les fibres blanches cérébelleuses, quel que soit leur point d'émergence, se dirigent comme des rayons vers un amas de substance grise placé au centre de chaque

[†] D^r J. Luys Archives Générales de Médecine Oct 1864.

hémisphère cérébelleux pour se mettre en rapport avec les cellules nerveuses qui s'y trouvent.

cet amas de substance grise (corps dentelé) joue, vis-à-vis les fibres blanches cérébrales" and a

little further on he states that from this central point

the fibres again diverge, many of them decussating,

and then split up into three tracts known

as the peduncles of the cerebellum. The inferior

tracts pass downward to the sides of the Medulla

oblongata, where they are termed corpora Restiformia

though not truly continuations of the posterior columns

of the spinal cord, yet the fibres become here fully

intermingled with each other, but I believe there is

here no fusing of fibres nor any direct communication

Established between the two sets - the corpora
 Restiformia then descending in the Medulla Oblongata
 are directed from above downwards and from behind
 forward, and crossing the antero-lateral spinal
 columns resolve themselves into transverse fibres
 which in such great numbers pervade the M.O.
 many of these fibres lose themselves in the olivary
 bodies of the opposite as well as the same side.
 and Luy adds "Les fibres qui émergent
 des corps olivaires paraissent se disséminer
 au milieu des interstices des fibres spinales
 ambiantes".
 Next the middle peduncles connect the opposite
 hemispheres of the cerebellum forming in their

course the part known as the Pons Varolii;
 in the so-called Pons two fasciculi of transverse
 fibres exist a superficial and a deep. Through
 which the pyramids, split into four principal
 columns, pass: these various fibres passing in
 opposite directions are in the Pons probably intimately
 connected by the agency of the vesicular neurine
 in which Pons Varolii abounds and which they
 probably help to form.

And lastly the superior peduncles known otherwise
 as processus ad testes connect the Cerebellum
 and Cerebrum proper through its subadjacent ganglia.
 Solley divides these ^{last} tracts into three divisions
 First. Fibres passing from Cerebellum to Tubercula ad nigra.

Secondly Fibres passing from Cerebellum to Optic Thalami
(and thence diverging into the hemispheres)

Thirdly Fibres descending and interlacing with fibres
of the sensory tract.

Lugy states that the cerebellar nerve fibres assist
in forming a very intimate plexiform network
of fibres and cells (all ovoid, and many containing
large quantities of pigment) which stretches from the
Corpora Striata to the Medulla Oblongata, and in
this space a process of fusion goes on between the
cerebellar and spinal fibres "La fibre cérébelleuse
une fois fusionnée avec la fibre spinale ne l'
abandonne pas ainsi; elle s'attache à elle comme
une tête visible, et la poursuit jusqu'à son

arrivée au contact des grosses cellules de la
 substance grise du corps strié".

Retrospective Statement of Cerebellar Physiology

With this brief statement of the relational anatomy of
 the cerebellum, which it is very necessary, in our future
 discussions, ~~that~~ we should bear in mind; we may proceed
 to enquire into the present state of our knowledge with
 regard to the functions of the part, or in other ~~words~~ ^{words} to its physiology.
 We may remark that during the last 30 or 40 years
 numerous different theories have been advanced, many
 of them by eminent physiologists - some of whom
 arguing from the same facts and observations have
 arrived at different conclusions, while others looking
 at

at the subject in another light have in their turn
 arrived at a conclusion adverse to that of any of
 their predecessors. To say that the observations and
 deductions of these men were all erroneous, would
 not merely be presumptuous but most assuredly false:
 for the facts themselves have been confirmed by too
 many observers to admit of any doubt as to the
 correctness of their statements; but as to the deductions
 they drew from these facts, and the theories they built
 up on them, this is entirely a different question - and
 the theories crude and unsifted as they often are, not
 infrequently when tried at the furnace of experiment
 and of further observation; have been found wanting.
 and yet they probably contain some vein of the truth

though thin behidden and obscured by some glaring accompanying errors "The value of a theory" it has been remarked "is that of a key that it shall unlock doors which shut us out from hitherto unexplored chambers of knowledge; and its test is the same, that it shall accurately fit all the ward of the lock, which here are the facts of the case".

Though we cannot always expect to arrive at once at the utopia in science, yet we cannot have ~~no~~^a doubt that in most instances a careful and scientific investigation of all the facts of each case will lead us to a very close approximation to the real truth. Bearing this in mind; and knowing that no one theory has as yet been firmly established

as the true one, though many hopeful foundations have been laid, I should neither be doing justice to the subject nor would the argument be complete if I did not (briefly at least) pass in review such facts and statements as have already been disclosed to us both by experimental physiology and pathology.

First and foremost amongst the number stands the theory of Gall, still acceptable to the phrenologist though deserving of a very limited confidence from the physiologist. The evidence on which the theory, that the Cerebellum is the central organ of Physical Love - Attractiveness - or Instinct of procreation, rests has been shown by numerous physiologists to be deficient in so many respects and indeed often

directly opposed to facts that I think it no longer merits any lengthy consideration at our hands. the following facts amongst others are hostile to it.

- 1 In the case recorded by Combette of congenital (!) absence of the cerebellum the sexual passion was early and strongly developed.
- 2 In the gelding the cerebellum is heavier than in the stallion.
3. Such affections of the genital organs as described by Galt in Cerebellar disease, are more generally observed both in diseases and experimental irritations of the Medulla Oblongata and upper part of the Spinal cord.
- 4 Comparative anatomy & physiology are opposed, no proportion exists between the size of the cerebellum and the development of the sexual appetites.

5 Symptoms referable to the genital organs, or sexual passions are the exception and not the rule in cerebellar disease.

6 The Sexual instincts cannot be separated from the emotions.

Rollando's theory that the cerebellum is the source of all muscular activity is negatived by the fact that animals move very briskly even when the whole organ is removed.

The views of Flourens are those adopted by many teachers of physiology down to the present hour, and hence will merit in this thesis our careful attention. They are however too well known for us to dwell on them now;

In 1822 M. Flourens read a paper before the Academy of Sciences on the properties of the different parts of the nervous system and his observations on the Cerebellum amounted to this that upon its removal in animals

"La volition, les sensations, les perceptions persistaient.
 mais la possibilité d'exécuter des mouvements d'ensemble
 persistait aussi; mais la coordination de ces mouvements
 en mouvements de locomotion, réglés et déterminés
était perdue". and the well-known conclusion he drew
 from these observations was that the Cerebellum was
 the coordinator of all voluntary movements which originated
 in other parts of the cerebro-spinal system, whether the
 movements had reference to locomotion or other objects.
 Brownell, Longet, and others have noticed the same
 results follow the extirpation of the Cerebellum as Flourens
 did, and have arrived at similar conclusions.
 Wagner adds that ~~from~~ his experiments he noticed
 that superficial injuries did not cause these disorders

movements, and that they only occurred when the deep parts were injured; he also noticed that after a few days the affects passed off when the animal survived the operation.

Magendie also instituted an extensive series of similar experiments but arrived at a somewhat different result. The principal phenomena ~~are~~ observed by him were described in a memoir read to the French Academy of Sciences in 1825, and his conclusions were as follows

1. Injury to the cerebellum caused retrogression
2. Injury to the Medulla Oblongata had a similar effect
3. after dividing one peduncle of the Cerebellum "l'animal se met à roller latéralement sur lui-même, comme s'il était poussé par une force assez grande; la rotation

rotation se fait du côté où le pédoncule est coupé, et
quelquefois avec une telle rapidité, que l'animal fait
plus de soixante révolutions dans une minute."

and the same effect was produced by all vertical sections
of the cerebellum, the rotation being more rapid the nearer
the pons varolii was approached; and the same effect
was also produced by cutting the pons varolii itself to the
side of the median line. Fodina, Horsrus, Longet and others
accept all Magendie's statements as correct except that
which connects associative inquiry to the cerebellum with
retrogressive movements as at all constant phenomena;
Horsrus obtained a similar result only 5 times in 18
experiments: and M. Lafargue states "Aucune
de mes dix expériences sur le cervelet n'a
produit

produit le mouvement de recul; d'où il suit que le mode de locomotion observé par d'autres, à la suite des mutilations de cet organe, n'est pas ~~assez~~ assez constant pour justifier l'hypothèse du M. Magendie". And I may add that only once in the 100 cases of cerebellar disease collected by myself was there noted any tendency to retrogression.

Budge in 1842 recorded that irritation of the cerebellum caused movements of the stomach and intestines, and that the same result was obtained by irritating the anterior columns of the spinal cord, he noticed also that irritation of one hemisphere of the cerebellum caused retraction of the limb on the opposite side of the body, and he demonstrated a similar connection

between the cerebellum and the uterus and its appendages the consideration of these and other phenomena led him to attribute to the organ in question a power which he termed "Hemmungskraft" in other words a power which restrained or counteracted the action of the nervous centres on the muscles.

Foville and more recently Lussanna have performed experiments similar to those of Horsens with a like result, but the deductions they draw ^{from} them are different, for the disordered movements supposed by Horsens to indicate a want of coordinative power, they ascribe to a want of muscular perception or sense; and in accordance with this view they hold that the cerebellum is the central organ for the perception

of the muscular condition: by this muscular sense is intended a sense and appreciation of resistance a sense quite different from that of ordinary sensibility the tactile sense which resides in the skin - and the distinction is evident for two bodies may be placed on a table before us and we may exert all our five senses without being able to distinguish between them, but if we call into play our sixth, as this sense is now sometimes called, and lift them up the distinction is at once made for one is heavier than the other. the muscular sense say, Loman^{*} is far excellence the coordinator of voluntary movements. (so in reality these last agree with Florens.).

* Journal de Physiologie (Brown. Legend) Vol V.

of the existence of such a sense as we just been referring to, no one can have any doubts but whether we are to conclude that its central organ is the Cerebellum or no is a more difficult question and one which will merit our future consideration.

I may add here that Lussanna's views on the functions of the Cerebellum are summed up in this "sens musculaire et peut-être sens érotique voilà les véritables usages du cervelet."

Dr Dickenson* Pathologist St George's Hospital London, both from physiological experiments and pathological observations arrived at certain conclusions with regard to the functions of this organ

* Proceedings of the Royal Society April 7. 1864.

- 1 That the cerebellum exerts a voluntary motor power, producing habitual ~~than~~ rather than impulsive movements.
 2. That, distinct from the above, it possesses a coordinating power over voluntary movements.
- and becoming more minute he adds the former property resides in the outer part of the Cerebellum - and the latter in its inner layers.

Another observer Mr J. S. Pridoux* drawing his conclusions from comparative anatomy and physiology believes that the median lobe serves as central ganglion to the nerves of muscular condition and resistance. While the lateral lobes form the

* Report of Physiological Section. British Association Sept 1864.

ganglia of the cuticular system of nerves.

To support his first statement he traces the existence of a definite ratio between the amount of muscular power possessed by an animal and the size of the median lobe of the cerebellum - the cerebellum relatively large to the cerebrum accompanying greater locomotive power and vice versa. e.g.

Crow. (slow and inelegant motion) Cereb^{ll} : Cerebr: :: 1 : 1½

Gull (Graceful movement) " " :: 1 : 4½

Swallow (swift, graceful strong wing) " " :: 1 : 4

And to exemplify his second point he instances the

Cetacea and the bird. the former he states possess

a peculiar system of nerves distributed to the blubber

by which their sensibility is rendered very acute

and their cerebellum : Cerebrum :: 1 : $2\frac{1}{2}$

while in birds with the horny beaks, feathers and callous skins the average proportion is as 1 : 13.

Dr. Luys whose observations on the anatomy of the cerebellum I have already referred to, concludes as to its physiology that the cerebellum working in a manner isolated from and independent of the other departments of the central nervous system *élaborait, en vertu d'une véritable autonomie fonctionnelle, l'influx moteur qu'il déversait incessamment à l'aide de ses peduncules vers les régions antérieures de l'axe spinal*" but whilst he believes that its influence is specially connected with the voluntary movements of animal

life, he also thinks it probable that the various muscular actions ministering to the maintenance of the organic life such as the heart and diaphragm are also included in its influence. He conceives that the cerebellum generates a nervous force 'sui generis' in a continuous stream which is carried to the motor tract, as he says "Il peut donc être considéré comme une source d'innervation constante, et provisoirement, comme l'appareil dispensateur universel de cette force nerveuse spéciale, qui se dépense en quelque point que ce soit de l'économie, chaque fois qu'un effet moteur volontaire ou involontaire est produit" and that special force "est cette force surnuméraire 'Sthenique'."

Thus according to Day, the cerebellar influence
 is exerted on the intensity rather than on the regularity
 of motor action. He goes further however and traces
 an intimate connection between the cerebellum and
 the sphere of mental activity. The specific force he says
 of the cerebellum accumulates in the corpora striata
 in a state of permanent tension and so the fibres
 radiating from these ganglia to the cortical portion
 of the hemispheres ('centre perceptif) would convey "la
 notion du degré auquel la tension de l'innervation
 cérébelleuse est arrivée au sein du deux corps
 striés, et lui fournir ainsi l'appréciation recurrente
 de la quantité d'influx moteur sthenique dont il peut
 disposer, pour l'accomplissement des actes volontaires qu'il

"à provoquer": and in this way he believes a rational
 explanation may be offered of ~~the~~ the various temperaments
 as boldness, self-reliance, cowardice & timidity; in the one case
 the battery (corpora striata) being well charged with this sthenique
 the mind becomes conscious of its power and acts accordingly:
 while in the opposite condition the supply being small a
 corresponding mental impression results and a general
 state of asthenia is produced. In conclusion Luss traces
 the course of a motor act as follows: The "ordre psychique"
 starting from the peripheral grey matter of the brain is
 transmitted direct to the cells in the corpora striata
 here it undergoes a transformation and starts again to
 reach the motor cells of the spinal axis, and here
 the cerebellar influence comes into play and adds to

This force developed above la durée et la continuité.

And lastly we have recorded the views of Professor Laycock⁺ who seeing that the cerebellum is directly brought into connection by the corpora Restiformia with the lateral or pathetic substrata of the spinal axis concludes that it exerts over these tracts a central regulative function. and besides this it appears anatomically from a study of embryological anatomy, and the course of development, that the cerebellum is a differentiation of the intervertebral system, so that whilst the hemispheres and their subservient ganglia are the organs of External relation proper; the cerebellum on the other hand, presides over all those vital processes.

⁺ Laycock, Mind and Brain. Vol ii.

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which are involved in coordinated visceral function,
and in the relations of the blood to the viscera and nerve centres
generally: it is thus constituted the centre of vegetative
life, and of all the processes of the organic appetites
and instincts. In its convolutions an infinite
variety of internal afferent changes are coordinated
and reflected on the hemispheres, and thus it forms
a link in the great afferent or sensory tract: but
is only indirectly brought into relation with the
periphery through the sympathetic and intervertebral
systems, and their coordinated structures in the spinal
cord and medulla oblongata. and we may thus under-
-stand how by changes occurring in the cerebellum
the cerebral organs of the propensities, sentiments and

and faculties are excited into activity under the influence of the generative glands. The mode of action appears to be as follows. An impression is conveyed by the sympathetic ganglia and their plexuses to the spinal substance & thence by the medulla oblongata and Restiform tracts to the cerebellum, where it undergoes a change and may then pass in either of three directions. 1st by the cerebro-cerebellar commissure to the Tabercula Quadrigemina and Optic Thalami; or 2nd by the descending fibres of the same commissure - interlacing with fibres ascending to the brain; or 3rd back by the restiform tracts to the anterior columns and olivary ganglia. All pathemic phenomena being objects of consciousness, the results of the downward action of

the cerebellum, manifested in the peripheral organs, will be perceived, and transmitted back again along the spinal sensory tract to the cerebral hemispheres.

Besides the above, affirmative impressions reach the cerebellum through the medium of the cerebral nerves as appears certain with the auditory, and probably the optic and olfactory.

Pathological Considerations.

Having thus passed in review, as briefly as was

compatible with a fair statement, the various views

and theories that have been put forward by different

observers on the subject, we are more at a loss than

ever to know which is the true one, or if any altogether

merits that denomination. And the difficulty is

a peculiar one, for instance three observers (Horsano

The cerebellum, manifest in the peripheral regions,
will be perceived, and transmitted back again along the
spinal sensory tract to the central hemispheres.
Besides the above, afferent impulses reach the cerebellum
through the medium of the cerebral nerves as follows:
Certain with the auditory, and probably the optic and olfactory.

Pathological Considerations

Having thus far seen a review, we briefly now

considerable with a fair statement, the various cases
and theories that have been put forward by the
What was the character of their cases? were they examined
after death? the brains taken?
seen to know which is the true one, or if any addition
might that demonstration, and the difficulty is
apparent, for instance, these theories of the

Lurana. and Luys) perform the same experiments, with the same results, and yet receive different impressions as to their cause - while the first part of their proposition then is 'fact', the last is 'theory': and as experimental physiology fails to settle the point which theory is right we must bring them all to the touchstone of Pathology; for what is true for the physiologist will assuredly be so for the observer at the bedside and in the dead house.

We will therefore examine into the symptoms during life, and the lesions found in 100 cases of disease of the cerebellum taken indiscriminately (the advantage of working with 100 cases is obvious, as at a glance not only do we obtain the exact number for our tables, but also the average per cent.) In order that we may arrive at some definite idea

with regard to ^{the} nature of the symptoms recorded, it will be convenient to class them under four heads (as has been done by Dr R. Reynolds in discussing the symptomatology of epilepsy) viz. (1) Mental. (2) Sensational (3) Motorial (4) Organic. and it will then be easy to collate on each head. Thus by glancing at the Table below we see a general statement made as to number of times symptoms were noted under each head

Act: No.	Mental.	Motorial	Organic	Sensational.
42.	—			
61		—		
80			—	
83.				—

Table 1

Granted that this statement does not explain many points it does however unequivocally tell us one thing viz that the symptomatology of cerebellar disease is very extensive:

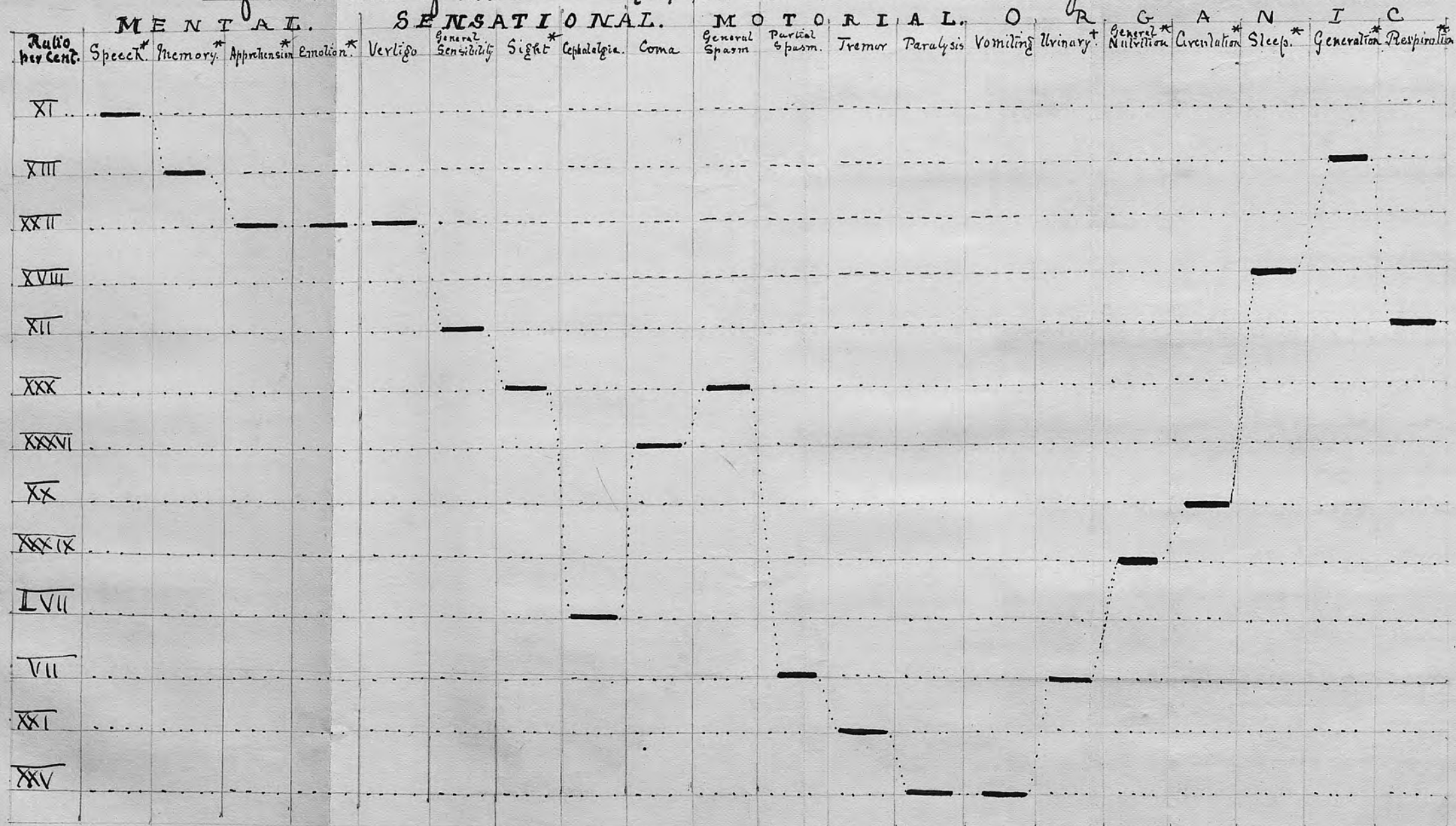
and this is one point which we must always bear in mind, the diversity of the symptoms in cerebellar lesion; there is a want of definition about its pathology which we are unaccustomed to meet with in diseases of other parts of the nerve centres: given a hemorrhagic clot in one corpus striatum and we might at once infer that during life there had been hemiplegia of the opposite side of the body; and nearly the same exactitude is now being exerted in lesions affecting the spinal cord. but it is very different with the organ we are considering: supposing hemiplegia with hemorrhage into the cerebellum - we cannot say for certain in which lobe we should find the clot, as we can in cerebral disease - and so with a great many other instances - and it is only by considering a large

Table II.

face page 53.

Stating the frequency

of occurrence of the various symptoms noted, in 100 cases of Cerebellar Disease.



†. * The organ or function affected.

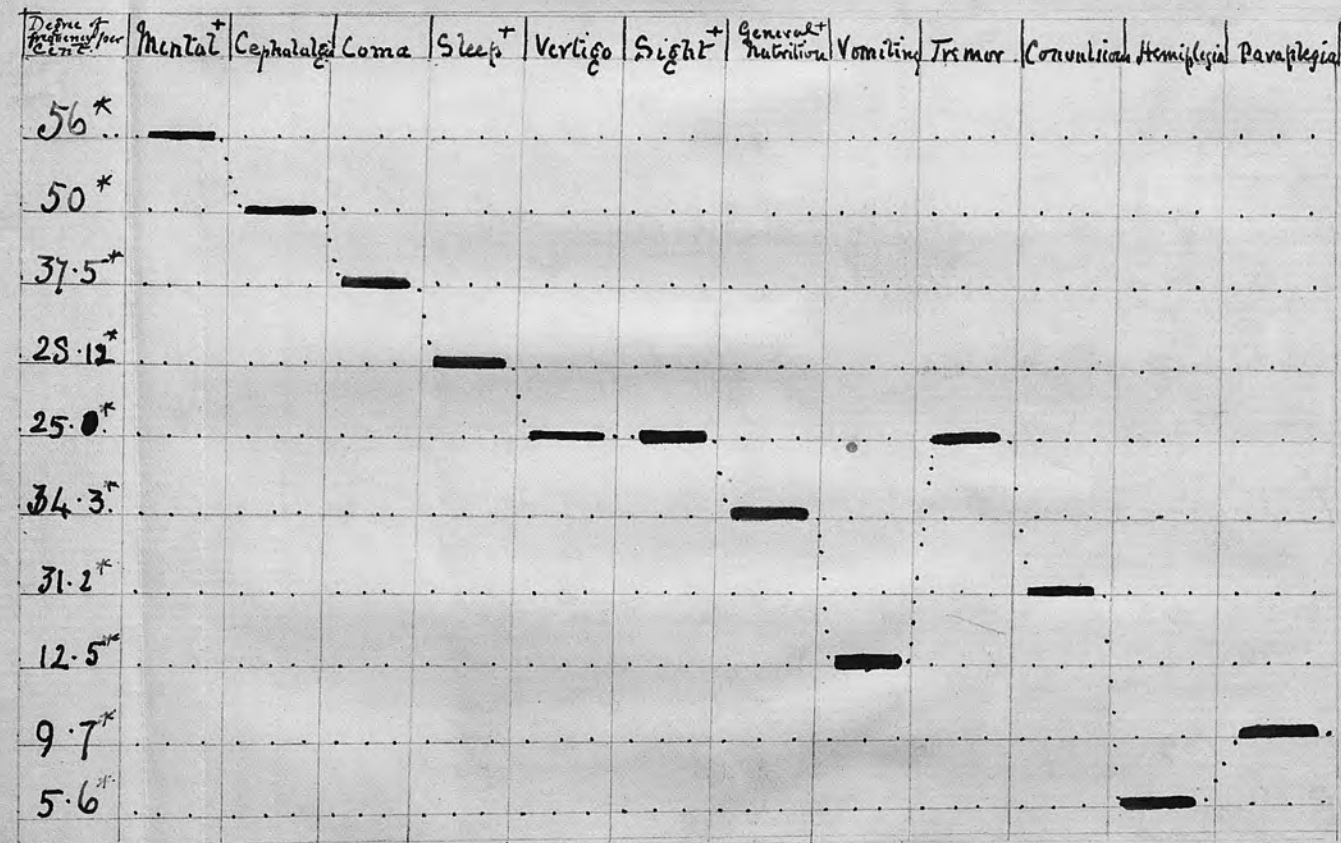
number of cases that we can even hope to be in a position to generalise at all.

So let us now turn our attention to a more extended table of the one just given above; and this I have endeavoured to display in Table ii. here we have stated with more precision the Kind of Mental, Sensational or Motorial etc Disturbance with its relative frequency. And we will first consider briefly (for it does not offer much ground for a long discussion) the Mental phenomena of Cerebellar Disease - we might have termed them 'Cerebral' phenomena but rather than use any term which would imply a theory I simply term them mental. and I again find Dr REYNOLDS subdivision useful, not that it is not difficult in some cases to draw the line so as to be able

to state with precision where one form of mental derangement ends and another begins, but waving these points the general statement is still useful. The 4 subdivisions of mental phenomena as appear in the table are classed as (1) changes affecting the Memory & Attention (2) those affecting the Apprehension and Ideation (3) those the Control of Emotions. and (4) those affecting the Speech⁺. Next with what frequency to these symptoms occur, it appears that the memory was affected thirteen times in the 100 cases, this would not give much value to defective memory as symptomatic of cerebellar disease: but we should not expect the

+ Dr. Luys would here find fault with the classification as he looks on defective powers of speech as entirely referable to changes in 'motorial' powers - but irrespective of theory I place what certainly is a mental act amongst mental phenomena in my symptomatology.

Table III.
Symptomatology of cases of
Softening of the Cerebellum.
N^o of cases 31.



* approximately

+ Disturbances affecting

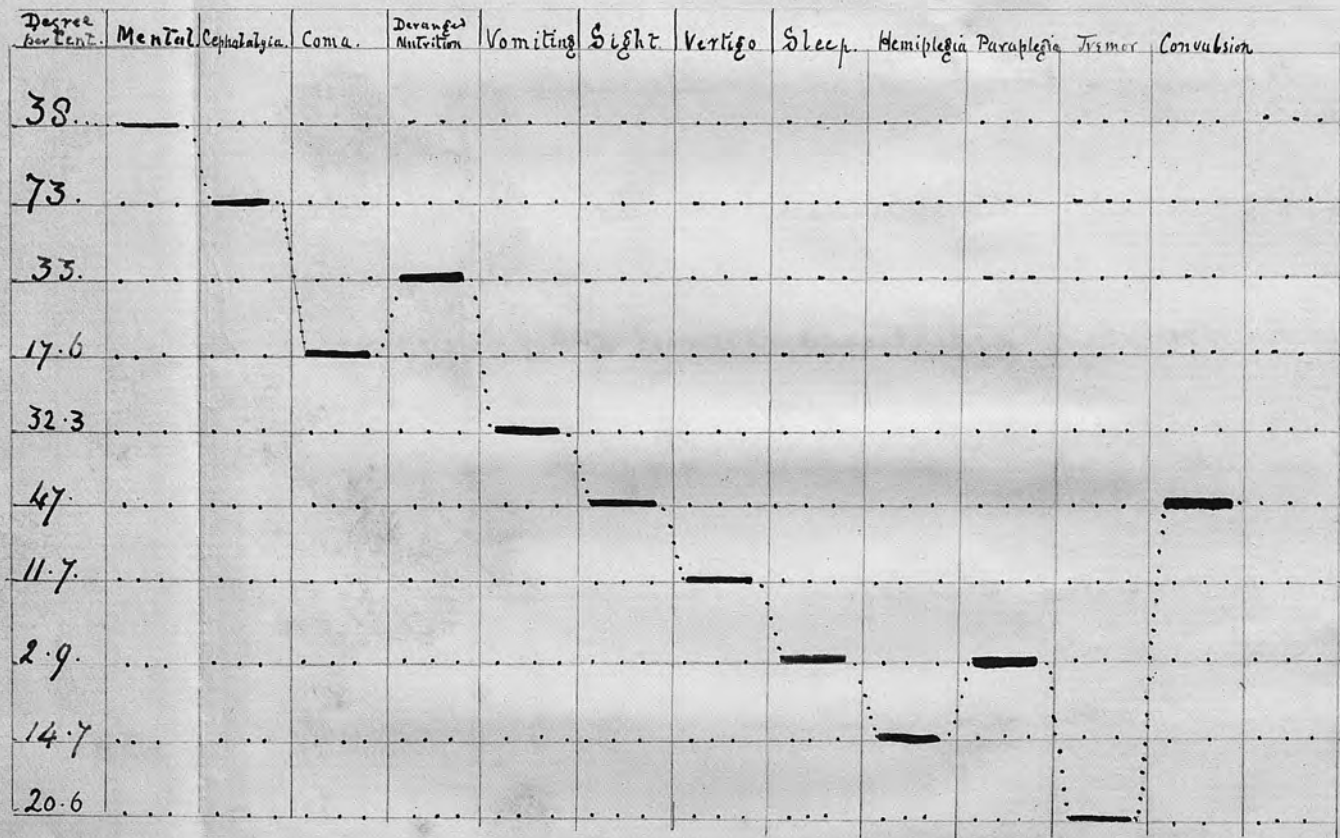
memory to be affected except in very chronic cases
and even then so entirely a secondary affection as to
be a symptom of no value for diagnostic purposes.

and what is said of memory applies to a great extent to
mental derangement generally in this class of cases.

We see stated in Table ii; that in more than half the
cases of softening of the cerebellum there will be some
derangement of the intellectual powers; and to a less
extent in cases of tumour or abscess (Tables iv. & v.)
(pages 56, 57)

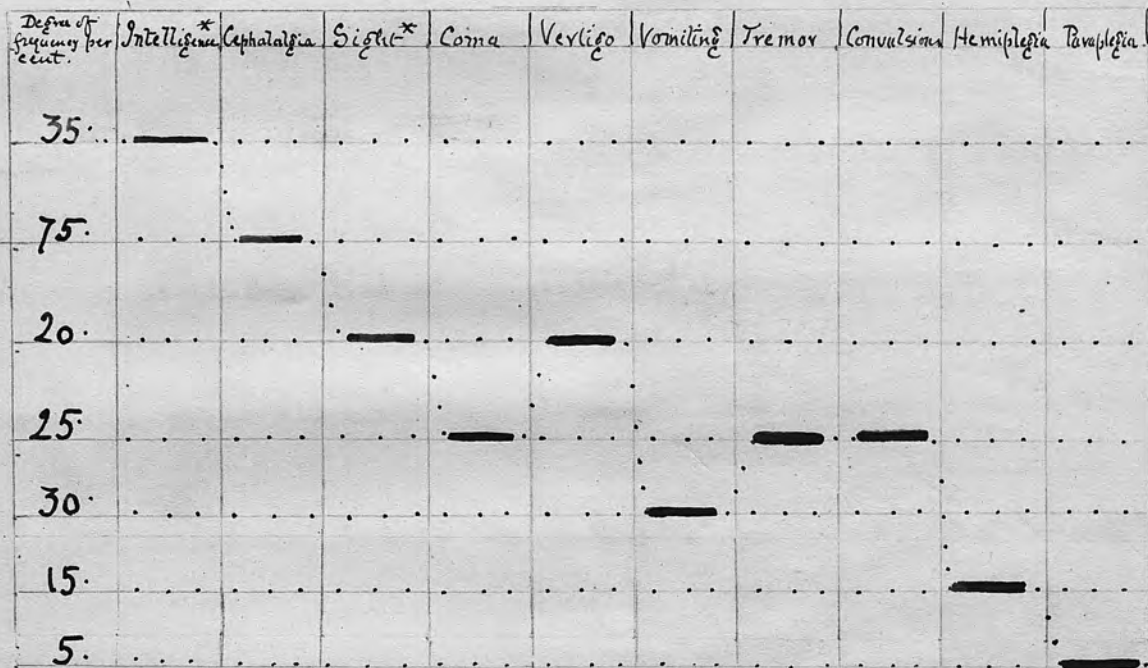
but we must not be misled by these statements;
such tables afford us no index as to extent of mental
disturbance to be expected, in all standard works
on the subject it is constantly stated that in Cerebellar
disease the mental powers are clear and unaffected

Table IV.
Relative Symptomatology.
in cases of Tumour of the Cerebellum.
No of cases 34.



This I believe to be only partially true, the peculiarities
 and idiosyncrasies of individuals often render
 it a difficult matter to arrive at a very
 definite conclusion whether a patient has or has
 not all his 'wits' about him, and if not in what
 he fails. what has struck me is that though to
 a casual observer the patient's mind appears clear
 yet that very often in these cases there is so to
 speak a 'mental slackening' the patient is rather
 obtuse than otherwise - his memory for trifling
 recent events often fails him, this is doubtless
 partly owing to a want of attention, or maybe a
 defective state of the powers of apprehension, thus
 in 22 patients this deficiency was noted, and it

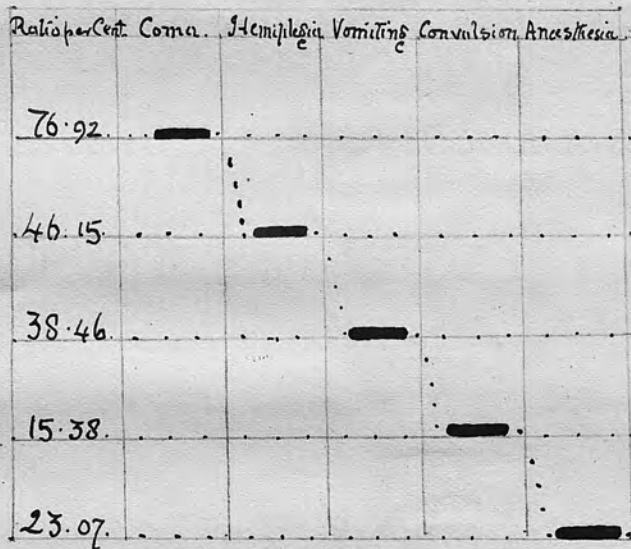
Table V.
Symptomatology in 20 cases of
Abscess of Cerebellum.



* Disturbance of.

of a peculiar nature - the patient has a dull
 and rather vacant expression, often betokening weariness
 and a desire to be let alone, and here we encroach on
 the phenomena connected with the control of emotions which
 we therefore pass into - as manifested by Depression of spirits,
 a melancholy or irritable frame of mind; or the patient
 may be very excitable and occasionally Delirious -
 a thickness of the speech like that of intoxication has too
 been noticed in a few cases - the speech may be slow and
 measured or there may be total inability to speak
 at all: and thus in conclusion we may say
 that though ideation is seldom affected the
 apprehensive faculties are not infrequently
 blunted rendering the person slow and rather stupid.

Table VII.
Symptomatology in 15 cases of
Cerebellar Apoplexy.
(Lateral Lobes).



2 cases of
Apoplexy into
the Median
Lobe.

Case i. Vague sensations, temporary coma. Sudden death.

Case ii. Sudden coma, convulsions, death.

No palsy in either case.

~~but~~ we shall not stay here to offer explanations for this it suffices to say that they are probably entirely secondary to, and only indirectly associated with, cerebellar lesions.

Sensational disturbances[†] will next invite our attention and these naturally divide themselves into two classes the General and the Special sense derangements on the head of the first would come pain, vertigo, coma (though it is doubtful how far the last is rightly placed): and under that of the second blindness, deafness etc.

Sensational changes are as we should expect very

† Under this head I have ^{not} included the 'Muscular Sense' though strictly I should. it more conveniently comes under head of Motorial phenomena - one

common, and indeed it is rather difficult to conceive a case of cerebellar disease without some sensational change first or last; pain of course, nature's cry of distress, occurs very frequently and is not rarely of considerable diagnostic importance. Vertigo also is a condition fraught with a special interest in association with the cerebellum; we shall consider separately each of these symptoms.

Cephalalgia was remarked in 57 per cent of all cases and by a reference to Tables iii. iv. v we may note the relation its frequency bears to the nature of the lesion it being most common in cases of tumour of the cerebellum (73 per cent of cases). and ^{occurring} in about half the cases of softening of the organ.

In cases of organic disease of the brain the pain, which is usually present, is generally more or less fixed in position. The seat of the pain may either correspond in position to the existing lesion, or may be referred to some remote part of the head; authors have too dogmatically laid it down that in cerebellar disease ~~the~~ the pain is occipital, it just happens from coincidence that in three cases of this kind that have come under my notice during the past 12 months the seat of pain in each has been the frontal region, and we must therefore be careful not to allow this seeming contradiction to throw us off our guard when forming a diagnosis. Unfortunately in many cases the precise seat of the pain has not been recorded; and we must therefore

be content to state the result of those cases in which it was noted. Thus by glancing at the table below

Seat of Pain.	Actual No	Per Cent.	
Not Noted	27	47.	approximately
Occipital	16	28.	"
Frontal	14	24	"

in which we find that the seat of pain was recorded in 30 cases in nearly half i.e. 14 the pain was frontal: and this is quite in accordance with what is recorded of cases of organic disease, specially tumours, affecting the upper part of the medulla oblongata or Pons Varolii the pain being usually frontal. The character of the pain varies it may be constant or only paroxysmal - it is usually the former in cases of abscess, whilst in cases of tumour and softening the latter character is more frequent. Some

Brewers have stated that when the pain is paroxys-
 -mal it depends on variations in ^{the} force and regularity
 of the circulation - and constant pain I presume
 they would explain as a state of constant irritation,
 though I should imagine that in a case of abscess of
 the conchellum the circulation would be as liable to vary
 as in any other form of organic disease. Pain it appears
 to me must always necessarily be associated with the
 circulation, the generation of pain is a process of
 nutrition, abnormal it is true, a sensory nerve cell
 has no more action without blood than has a liver cell,
 so that irritating a nerve not supplied with blood would
 have no effect. all pain I believe is paroxysmal the
 interval in one case being longer than that in another;

now patients often do not distinguish between active
 pain and soreness or tenderness the result of it - in
 cases of so called constant pain the active pain has been
 so severe as to leave tenderness so great that the interval
 of rest does not appear to the sufferer to be one at all.
 Cerebellar Disease is very often, as we see, associated with
 pain perhaps more often than is Cerebral, this may
 be partly owing to the fact that in the former case the
 consciousness and general sensibility are less blunted
 than is usually the case in the latter. one word as
 to cessation of pain this often occurs unaccountably
 and indeed usually is noted for some hours before the
 patient dies even in cases where it has been continuous
 throughout the rest of the Disease. this receives some explanation

is the fact that when effusion occurs to any great extent into the ventricles pain diminishes or ceases. The explanation of the fact is not so evident, it may be the result of pressure on the subcerebral ganglia.

In connection with this part of the subject too I may mention that Magendie and Longet came to the conclusion from the experiments, that the Corpora Resiformia, the posterior or inferior surface of the Pons Varolii and the Superior crura cerebelli were the most sensitive parts of the brain, the slightest touch causing (apparently) violent pain. I add the word apparently because the value of such experiments is always very doubtful by irritating some parts of the Medulla Oblongata the animal shrieks while yet it probably suffers

no pain, the shriek being merely automatic: however
 apart from speculations these parts are closely connected
 with the sensory tracts and the conclusion probably is to a
 great extent true.

Pain in cerebellar disease occasionally occurs elsewhere than in
 the head, as in the neck and back or in some of the limbs
 specially those whose motorial powers are affected the latter
 pains are probably often due to what has been termed
 painful muscular contraction, in fact 'cramp'.

Vertigo. (or giddiness) is the next ocular phenomenon
 which will engage our attention. and it divides itself
 into two classes viz vertiginous sensation and vertiginous
movement; in discussing the latter class we shall
 encroach rather closely on the boundaries of motorial

disturbances; but in considering these phenomena they must be taken together.

First as to vertiginous sensations generally; it is stated in Table ii that they were noted in 22 per cent of the cases this is probably rather below the mark - giddiness as a symptom is often overlooked by both patient and physician, the former not paying much attention to slight attacks of it - and the latter putting it down as 'all stomach'. The relative frequency of vertigo in the ^{various} morbid states find a place in Table vi.

Ratio per Cent*	Softening	Tumour	Apoplexy ⁺	Abscess	Gen ^l Infl.	Hernia Cerebri	Vertigo.
68..	—	—	—	—	—	—	
22	—	—	—	—	—	—	
4	—	—	—	—	—	—	

Table VI.

* approximately. + shortly preceeding the attack.

Vertigo as we are aware may be symptomatic either of some peripheral irritation as sometimes affects the abdominal viscera or of organic or functional disturbance in the nervous centres themselves - an irregular circulation either tending to plethora or anaemia - or a toxic blood, as the uraemic condition, which would necessitate an abnormal supply of 'food' to the nerve centres. particular impressions on nerves of special sense as the optic and auditory, all are capable of producing the vertiginous state.

We shall follow Ruchel Regnier's example and divide vertiginous sensations into 'objective' and 'subjective' the difference being in the one case surrounding objects appear to revolve while in the other to be in some kind of motion, while

in the other the person feels as if he himself were moving.
 and the causes may be similarly subdivided into 'internal'
 and 'external' or 'centric' and 'eccentric', we have
 many examples of each an external or eccentric cause
 is found in the movement of the sea, the surface of
 which presents to the visual sense the appearance of
 shifting lines and this is not an uncommon cause of
 vertigo: as a centric or internal cause we might
 instance a tumour in the cerebellum. I have mentioned
 one visual impression causing vertigo but this is not a simple
 case as other causes are here brought into
 play - but the same thing is noticed in some persons
 who attempt to follow with the eye rapidly revolving
 machinery. an impaired muscular sense is also

a cause of vertiginous sensation, perhaps the following is an example of such a cause acting it is the case of a man quoted by M. Sandras[†] who "ne pouvait pas marcher sur les trottoirs d'asphalte sans éprouver des vertiges bien caractérisés". The senses as we are all aware are frequently exposed to ~~being imposed~~ the imposition so to speak of various delusive effect thus in rapid railway travelling either by closing the eyes or when passing through a tunnel the motion appears sometimes reversed and it requires some mental effort or external object to correct the delusion: the self consciousness and volitional powers usually suffice for this, and one sense aid in correcting

†. Traité pratique des Maladies nerveuses Tome i. p 306.

another, but in the intoxicated person the vertiginous
 sensation, resulting from visual impression, or
 depraved muscular sense, or a complicated disturbance
 of all his senses, not being corrected by the volitional
 powers his consciousness not permitting him to distinguish
 between the real and the fanciful, the supposed movement
 is converted into real motion and he frequently falls.
 In organic as well as functional disturbance of the brain
 we may note that the position of the body and head
 frequently determines the direction of the vertiginous
 sensation: thus a patient ^{in one case} "Quando sedet, patat
 inferiorem truncum antorsum et retrorsum
 moveri, Quando decumbit, moveri videtur Caput
 solum hoc modo" (Weffer.) and many patients who

in the erect posture suffer from rotatory sensations
 in the recumbent feel themselves sinking bodily down
 into the earth. From an absence of all data I am
 unable to draw any conclusions as to the direction
 assumed by the vertiginous sensation in the different
 cerebellar lesions. we might perhaps be inclined
 to conclude from experiments that as in the one case
 rotatory movements are induced so in the other
 rotatory sensations might be expected - these have
 been occasionally noticed; ~~but rarely~~; a sense of
 falling forward I believe to be more common - but
 we shall require further observation on this point - it is
 not enough merely to specify 'giddiness' as a symptom
 in recording a case; - the exciting causes - the direction,

of the sensation - and the effect of position - closure
 of eyes and passing objects, on it ought all
 to be stated. The body naturally is in a condition
 of sensori-motor equilibrium and is maintained in that
 condition only by the functional integrity of all the
 senses being preserved, ~~so that~~ a rupture of one link
 in the chain suffices to derange the whole machinery
 in certain cases. So that there really is no necessity
 of us to go much further in our search for a cause
 for the cerebellar vertigo, but in many cases
 special derangements being very evident we may
 consider that these at least are partly the cause
 whereby the Equilibrium has been disturbed.
 I have already noticed the effect visual impressions

power of causing vertigo, and in connection
 with this it is not uninteresting to note that
 in 35 cases of organic disease of the nervous
 centres with vertigo (including our 22 cerebellar cases)
 'imperfect vision to a greater or less extent'
 was noted in 22, or in other words imperfect
 vision is associated with vertigo in ^{62 per cent of the} cases of organic
 disease of the brain.* and knowing that impressions
 upon the organ of sense are themselves stimuli
 of sensation, and action, we may safely conclude
 that the vertiginous sensations were in some cases
 due to a disturbed sensori-motor equilibrium the result

* Taking the 22 cases of cerebellar disease separately there was
 imperfect vision was present in 12 (at a rate of 54.09 percent)

of imperfect visual impressions.

In from 81 to 82 per cent of these cases of vertigo there was noted disturbance to a greater or less extent in the motorial powers - it would have been an interesting point to have determined how often the staggering gait and like phenomena were due to the giddy head - in some cases they both probably are due to the same cause viz a defective muscular sense. Rhombert indeed explains all cases of vertigo as dependant on hyperaesthesia of the sensitive muscular nerves, but this theory must be dubious in all cases, and certainly not applicable to many. Some observers have explained the vertiginous sensations which often arise in the inexperienced when standing on the top of a tower, or crossing a chasm or a plank, as

the result of a change in the integrity of the muscular sense; but the more obvious and natural explanation is probably to be found by regarding the sensations produced as the result of an unusual impression on the visual organs operating directly on our motor power of equilibrium. *Vertigo nocturna* is comparatively rare I presume it is entirely dependant on morbid condition of muscular sense function - if this be the case and Foville and Lamanon's theory of the cerebellar function be correct *Vertigo nocturna* ought to be carefully enquired for in such cases.

In some cases of cerebellar disease the vertiginous sensations are constant in others only occasional; in the former case they probably depend on some change affecting the

integrity of the nerves of the muscular sense. now it
 is difficult to imagine cases of defective muscular sense
 apart from vertiginous sensations and yet 22 in a
 100 is not a large proportion by any means - cases of
 very extensive disease of the cerebellum have been
 reported and yet no symptoms of vertigo, neither
 Forville nor Lussanna offer any explanation of this
 fact, and it is to my mind a very tough fact for
 those gentlemen and their followers to explain, especially
 when we consider what has been said above as to the
 great dependence on external impressions, that we
 exhibit in the maintenance of our sensori-motor equilibrium.
 Lastly as regards these sensations what explanation
 is offered for their much greater frequency in cases of

Note

+A (fr 77. line 9) It may appear to some that in discussing the question of vertiginous sensations, and specially with reference to their cause, that I have laid little or no stress on what they may think is the only cause of vertigo, certainly a very common one - I refer to changes in the circulation; and I feel that to some extent I must plead guilty to the charge, and state at the same time that it was intentional: for though I with them recognise vertigo frequently associated with slight changes in the circulation - as that associated with the state of syncope; yet I feel convinced that this is only one class of cases, and one which does not include all cases of giddiness, we must look sometimes for something more than mere functional disturbance, and this especially when the vertigo is what I may call 'definite' i.e. with the same direction, and character, whether it be subjective or objective, rotatory or lateral movement. And when we consider that the circulation of nervous influence is as definite in its direction as that of the blood, the inference appears perfectly natural, that by interrupting the course of the stream at definite points, we may expect definite sensations to result and therefore I repeat that while fully recognising mere functional giddiness, we ought not to omit an organic variety, usually definite in nature, the exciting cause of which may sometimes be referred to

cerebellar softening (Table VI page 66) than in other lesions a rapid process of softening is probably a more irritating affection than the slow deposition of a tumour - indeed a tumour frequently excites no symptoms until a softening process commences around it: or is it that in these cases there is slight general tendency to defective nerve nutrition throughout, however it may be the fact remains and future clinical observation must throw more light on this part of the subject. (vide A. 9. 10. 11.)

Secondly I must briefly allude to vertiginous motion, where the fancy is converted into a reality and motion usually rotatory in character results. This peculiar kind of movement was first observed in the lower animals, specially sheep

changes in the circulation, while the primary or predisposing cause is organic change in the nerve tissue. and I think it more than probable that a close examination into the variety of vessels present, may at no very distant date afford us a considerable aid in the diagnosis of central neural affections.

affected with hydatids in the brain.

Pourfour du Petit in 1766 was the first person to demonstrate that section of the cerebellar peduncles on one side gave rise to "rotatory movements"

Mr Serres in 1819 recorded the case of a man who, shortly before an attack of apoplexy (into the cerebellum) "lui semblaient qu'il tournait lui-même" and shortly after began à tourner réellement sur lui-même". I need not say any more with regard to Magendie's experiments as they have already been referred to (p. 34)

M. Giron de Buzareingues in 1825 in a paper reported to the French Academy of Sciences stated that he had observed in cases of hydatids of the cerebellum causing vertiginous

* Recueil d'observ: et anat: et de chir: p. 121.

movements, that loss of sight was a constant co-phenomenon.
 Longet, Lafargue, Schiff and more lately Brown-Sequard
 have confirmed the statements of their predecessors, so that it is
 certain that injuries produced in certain parts of the nervous
 centres including the space between the Optic Thalami and
 lower part of the Medulla Oblongata (taking in the cerebellum)
 will under certain circumstances give rise to rotatory movements
 and more rarely to a retrogressive tendency: but in
 addition to injuries applied direct to the centres
 impression exerted on the peripheral distribution of certain
 nerves for example the Optic and auditory produce
 sometimes a similar effect. In connection with these
 movements spasm of certain muscles, commonly in
 the neck, has been noticed, but it is of no long duration

while on the other hand the rotatory movements often
 last a considerable time. Now in rotatory movements
 the result of injury to the cerebellum or its peduncle
 what is the explanation? Some observers say it is
 due to the production of hemiplegia and the animal
 in struggling to move continually falls toward the
 side affected and so rotates. - in the first place
 does hemiplegia ever occur in animal this is more
 than doubtful and has been denied by many physiologists
 (paraplegia on the contrary is common). Again no one
 can doubt that the movements may occur and there
 yet be no paralysis, and it is equally certain that
 hemiplegia may occur and no rotatory movement,
 and lastly does hemiplegia produce any tendency to

this kind of motion, or is it possible that an animal which is hemiplegic could revolve 60 times in a minute as some of Magendie's animals did? and we must raise the same difficulties to those who ascribe the rotatory movements to a loss of muscular sense on one side and more than this the animal instead of revolving sometimes runs backward? can a hemiplegic animal or one deprived of its muscular sense over one side of its body go backward though it cannot go forward? the answer is evident, the explanation does not suffice.

It is not difficult to understand how in animals, irritation applied to the optic or auditory nerves might, as it does, cause rotation, a modified circus

movement' may be sometimes produced in an animal
 whose eyes look transversely, by the removal of one
 and irritation about the corpora quadrigemina
 and optic tracts would have an analogous
 effect. The influence exerted by the power of vision
 over the movements of the body is as we all know
 very great: a person with good sight, if
 blindfolded is unable to walk for any distance
 in anything like a straight line and his movements
 are all characterised by a diffidence and want of
 directing energy; "we lean on our eyes like crutches"
 says Mayo. We may therefore conclude that in some
 of these experiments referred to it is not improbable the
 result was due to an unilateral disturbance of the visual function.

Now what explanation can we offer for the fact that vertiginous or rotatory movements are so rarely accompaniments of lesion of the cerebellum in the human subject. I am driven to this conclusion that the attempt to distinguish between vertiginous sensation and vertiginous motion is impossible, that they are not separate conditions, dependant on separate causes, and that vertiginous or rotatory movements in the animals experimented on or those affected by disease are not dependant on spasm, or hemiplegia or unilateral loss of the muscular sense; but in reality ^{represent} ~~is~~ a giddy sensation, the result of disturbed sensori-motor equilibrium, a sensation of the same nature as

that noticed in the human subject, subjective or Objective as the case may be, a sensation which suggests the feeling of rotation or retrogression, an erroneous and delusive sensation which, and herein lies the point, in the case of the one is checked and corrected by the inherent self-consciousness and volitional powers of the individual, whilst in the other the ~~animal~~ discrimination of the fanciful from the real, and its correction by actively bringing into play other senses; neither being so exact nor so complete and the animal not being capable of weighing the exact value of the impression, the suggestion passes into action, the fanciful sense becomes a reality ~~and~~ in fact the vertiginous sensation becomes a

vertiginous movement. The animal moving in the direction indicated by the sensation - In the case already quoted given by Serres the man was in a seminecliptic condition and perhaps in addition a man of impulsive disposition and easily affected by external impressions so that he allowed the sensation uncorrected to become a reality: at any rate there is nothing in that case which militates in any way against the explanation of vertiginous movement offered above.

We must however now hurry on to the next symptom viz Ammaurosis (and I would first remark that I use this term in its widest acceptance, as expressive of a symptom, and not of any special form of ~~that~~ disease. I use it, whatever

the ultimate explanation of the disease may be, merely as expressive of a defect, slight, serious, or total. ⁱⁿ the visual function). as stated in Table ii occurs in about 30 per cent of all cases of cerebellar disease, this at first is rather a startling statement when we remember that cerebellum neither forms a part of, nor does it intervene between, the optic centres or their external apparatus, and it necessitates our enquiring more carefully into the pathology of the affection.

Does it occur more frequently with one form of lesion than with another. I believe we may say it occurs most frequently in cases of tumour - the tumour or tumours may affect one or both of the lobes or the central and a similar effect produced, the following

the ultimate explanation of the disease may be, namely,
 an exposure of a defect, slight, serious, or fatal. If the
 animal function (as stated in table it occurs in
 about 50 per cent of all cases of cerebellar disease,
 this at first is rather a startling statement when we
 remember that cerebellum is the former a part of,
 and that it is the former between, the other cerebellum a part
 of the cerebellum and it is the cerebellum a part of
 the cerebellum. What cause - where are they - What was the kind & extent of
 the tumour - ?
 How it occurs more frequently with one form of brain
 than with another. I believe we may say it occurs most
 frequently in cases of tumour - the tumour a tumour
 may affect on a little of the cerebellum
 central and a similar effect probably, the following

table expresses the relative frequency of this symptom in connection with different lesions in our hundred cases, showing a considerable preponderance

Ratio per Cent	Tumour	Softening	Abscess	Apoplexy
47	—	—	—	—
25	—	—	—	—
6	—	—	—	—

in favour of the cases of tumour - before 180

further I cannot help again lamenting our wanting of accurate information with regard to these cases,

can we conclude for certain that in all of them the

defect in vision depended on the cerebellar or indeed

on an internal lesion at all? it is impossible in

many instances to be certain on this point - the retina

was but seldom examined, and until we know the

condition of the external apparatus we are very often not in a position at all to hazard any opinion as to 'the cause' of the deficiency - a disease of the optic disc, as displayed on the retina, may precede, accompany or be the result of the internal disease, incipient at first - it may when some internal lesion arises, rapidly progress merely from an indirect connection with the central affection; for the future then is all chronic (it often is not possible in acute) affections of the nervous centres attended with amaurosis to a greater or less extent, we ought to examine the retina with the ophthalmoscope, and until we do this our diagnosis can never be complete, nor indeed in any way reliable.

In the cases that I have collected both eyes have more frequently been affected than one (here again I in no way feel certain that there may not be some fallacy in the statement; practitioners so often omit to try each eye separately and patients often do not find it out and will go on for a long time with one eye nearly useless without detecting it) then both eyes were affected in 16 cases of tumour of the cerebellum: 6 of these were cases of permanent dimness, 6 of complete blindness, and the other 4 exhibited temporary alterations in their vision. Having said enough to show the frequency of the symptom the next point is to decide the connection which exists between the diseased organ and the symptom. ~~and~~

in other words the pathology of the affection.

I presume the explanation one would offer would depend, on the opinion held with regard to the physiology of the part in question, given its influence which it exerts on the part & function in health and the pathology would follow as a matter of course. So that I suppose Flourens and his adherents would explain the symptom as resulting from a loss of co-ordination power in using the muscles of the eye. and Linnæus would tell us that in the adaptation and accommodation of the eye for the inspection of objects at various distances the muscular sense of both the extrinsic and intrinsic muscles of the eye played an essential part, destroy this and you impair the function to

a greater or less extent. Dr Luys states the motor nerves of the muscles of the eye and eye-ball being deprived of the necessary 'sthenique' and 'duree' no longer are capable of maintaining a healthy action and either Amblyopia or complete blindness results. And we might accommodate the physiological theory of D'Arny for an explanation of the pathological condition, but as he makes no reference to this point specially I will not suppose a theory. At any rate we see from the opinions of those I first quoted that believing in some definite function of the cerebellum the explanation to their mind is complete - yet how, if the cerebellar influence is essential for correct muscular action in the eye and ball, do they explain the fact that in the case

already alluded to. of complete absence of the cerebellum
sight is reported as being unaffected. The muscles according
 to some observers must have accommodated themselves
 in a definite manner at the bidding of the impressions made
 on the retina by the image, in spite of all loss of coordination
 and of the peculiar muscular sense which at one time we are
 told by the same observers to be essential to the act - the
 point comes to be, which is the more correct their
 physiology or their pathology or can we rely in this
 case on either? I think we shall obtain an answer as
 our enquiry proceeds.

Brown-Sequard in speaking on this subject says*

(A) Amaurosis is often present in one eye while the

* Journal de Physiologie N° XIX. (July 1862)

disease may affect both halves of the cerebellum.

(B) Amaurosis may effect one eye and the disease exist only in the corresponding half of the cerebellum.

(C) Amaurosis may effect one eye and the disease exist only in the opposite half of the cerebellum.^F

(D) Amaurosis may affect both eyes and the disease be in one or other half of the cerebellum.

(E) Amaurosis may effect one or both eyes and the disease exist only in the middle lobe of the cerebellum."

In considering the meaning of the above statement, and also what follows, it will be necessary for you to try and separate symptoms indirectly resulting from irritation in other parts of the nervous system, and

^F This was the case in the majority of the cases of one eye affection collected by myself.

* But an analysis of the 100 cases on the principle of Brown Sydenham might have shown something -

and those which are the direct result of some loss of function - to attempt an explanation of these facts mentioned by Brown-Sequard - by any of theories recorded above would be labour in vain - for the thing on the face of it appears impossible.†

To illustrate the next point I will quote a case which recently occurred in the Royal Infirmary† the history was briefly as follows ~~as reported in the case books.~~

James Kellock 15. admitted Dec 12. 1864. Fifteen months previous to his admission he was in perfect health, when he began to work as a baker's boy carrying the bread about on his head, his work was hard and he lived badly, after he had been so employed

† recorded by the permission of P Bennett under whose care the case was.

for 6 months he began to suffer from occasional, aching pains across the forehead and occasionally down his back; 4 months later (i.e. 5 months before his admission) his sight began to fail him and it got gradually dimmer until he was left quite blind with his left eye, and very dim with his right. The above symptoms continued so till his admission when it was noted that no paralysis existed that he could walk well, and grasp objects firmly but exertion was soon attended with fatigue and feeling of languor. Common sensibility was perfect there was external strabismus of the left eye, pupil dilated, insensible to light - quite blind - right eye, pupil dilated, moderately sensible to light - myopic and amblyopic. Hearing dull. He suffered from frequent

and severe paroxysms of frontal pain, lay in the intervals in a heavy state unless disturbed - P72 - tongue covered with a dirty white fur.

He improved very much for the first few days and was up and about the ward but the pain shortly returned attended with vomiting and from that time until Dec 24th he varied being one day better and the next day worse - on the noon of the 24th getting out of bed he fell down and on being raised was quite rigid and unconscious - soon began toretch violently - 3.0 p.m. extreme strabismus of right eye semicomatose. 4.0 p.m. spoke and complained of the pain in his head - he then lapsed into a drowsy condition and died quietly at 6.45 in the evening. On examining the head 42 hours after death. Surface of

the cerebral convolutions rather flattened, dry; with
 slight thickening of the arachnoid over the cerebellum
 ventricles dilated - contained five ounces of serum,
 lining smooth. In the cerebellum there was a mass
 of cheesy tubercle formed by a superposition of
 eccentric layers, surrounded by a gelatinous like
 portion of altered brain substance, the mass about
 the size of a large Brazil nut was situated in the
 posterior part of the median lobe extending for a considera-
 -ble distance into both lateral lobes (especially the right & con-
 -siderable portion of the interior of which was replaced by
 the tumour). In some clinical remarks on the case
 Dr Bennett stated that the amaurotic affection probably
 depended on effusion of serum in the ventricles, exerting

pressure on some parts of the optic tract, the effusion being perhaps more extensive in one ventricle than the other, so that dimness only resulted in one eye but complete blindness in the other - Dr Brunnell however laid no great stress on this opinion in this case but rather mentioned it as the probable explanation of some of these cases if not of this one. as no one is so ready as Dr Brunnell to allow his pupils all licence in the acceptance and discussion of theories I shall take this opportunity of expressing my opinion on this theory. There are I know some observers who explain all cases of disturbed vision accompanying cerebellar disease as the result of pressure exerted by serum in the ventricles: and supposing that in all these

cases of cerebellar amaurosis effusion in the ventricles
 was constantly present, it might not be an easy matter
 to deny the truth of their explanation - but when we
 meet with many of these cases in which no fluid
 exists in the ventricles at all such Dogmatists must
 be rather staggered for ~~any~~ explanation - now it
 just so happens that in one half of my cases
 the ventricles did not contain any excess of fluid, on
 the contrary were sometimes specially noted as being
 dry, while in the other half they did contain
 excess of fluid, and this, to say the least, indicates
 that serum in the ventricles is not an essential
 condition for
 a ~~part~~ of the loss of sight; this being the case would
 it be safe to further and deny that it has anything

at all to do with ^{the affection} ₁, but as most sweeping propositions in
 Medicine are erroneous, we will be content with our
 first statement. Now in the case of Kellock
 when the left eye was quite useless and the right
 very dim the fluid in the two ventricles was about
 equal in quantity and it seems to me more difficult to
 believe that permanent blindness should exist in one
 eye for months caused by pressure of fluid in the ventricles
 (which to begin with we have no proof was there) and
 that the other eye should not for a long period be affected
 at all, and then very gradually grow dim, than to
 believe that the fluid in the ventricles had nothing to do
 with the visual deficiency; not to mention the gratuitous
 assumption that more fluid existed in one ventricle than

in the other, which this theory would require - No. I

think we must seek some other explanation which though it may not be so mechanically easy of ~~comprehension~~ will yet admit of a wider application.

Can we suppose that the cerebellum exerts any influence which is directly essential to the process of vision? I think not for, not to mention Combe's case, the cases of extensive disease of the cerebellum unaccompanied by any loss of visual power are too numerous to allow us to place much confidence in such a theory: then if there be so its influence must be exerted indirectly. Now we are very well acquainted with many instances of cases of reflex amaurosis i.e. amaurosis dependant on some irritation transmitted from a distance: take for example any of the cases of

sympathetic ophthalmia, so called, where disease in one
 eye, such as glaucoma, or a painful stump, following
 removal of the front part of eye, is gradually as it were
 transmitted to, and affects the other, beginning with pain
 and dimness of sight and proceeding to total destruction
 of the eye unless the cause of the irritation such as the
 glaucomatous globe or painful stump be removed. When the
 sympathetic disease is immediately arrested. Dimness
 of sight again is not at all uncommon in
 cases of supraorbital neuralgia. If in these cases the
 eye at an early stage be carefully examined there is often
 no organic change at all discoverable but it certainly
 follows after a while if the irritation which is causing
 the functional disturbance be continued.

With such facts as these before us does it not seem probable that some of the cases of cerebellar ataxia might admit of a similar explanation - and in this way we could understand the progressive amblyopia ending in complete blindness, the irritation probably at first affecting only the ganglionic portions of the optic apparatus such as the geniculate or quadrigeminal bodies, at which stage the retina examined by the aid of the Ophthalmoscope might appear quite healthy, but later the irritation being propagated along the optic nerves, the peripheral papilla or disc undergoes organic alteration and the affection becomes permanent, I say permanent but here I may be wrong for in some cases even supposing distinct structural change has

taken place yet if the irritation be removed the tissue
may as it were undergo a renovation.

† a Lady at 33. stated that when she was twenty she suffered
for some months from headache and catamenial irregularities
a year later she experienced an epileptic seizure which recurred
daily, under treatment they were reduced to one every two or three
weeks and this continued for eleven years, at end of which
time her sight began to fail her and as it appeared to
be progressing she applied to an Ophthalmic Surgeon who
found that it was only with difficulty that she could read
No 10 of Girard-Toulon's types and on further examination
the optic discs were found to be white and cupped
(they did not however present that ivory white appearance

† 'The Lancet' Jan'y 7th 1865.

met with in cases of total atrophy) the veins were full and tortuous; the indication being to treat the Epilepsy, as he looked on the eye affection as past hope. he ordered the application of ice to the ciliary region of the spinal cord in the hope of improving the nerve nutrition through the sympathetic - the fits rapidly diminished both in frequency and severity and the sight at the same time rapidly improved, so that she could read No 4 of the types - and on examination the Optic discs were seen to possess their natural paleness & state here though the capping remained. The facts related in this case are of great interest - both therapeutically, pathologically and physiologically. The fact that Epilepsy should cause structural alteration of the Optic

dise is explicable only on the reflex theory. Whether it
 act through the circulation, or directly by some way
 affecting the nerve cells I do not intend to be
 dogmatic however either to affirm that the cerebellum
 acts in this way or not. I do not however think
 that we have much valid evidence in favour of
 the view held by some physiologists viz that the cerebellar
 influence is exerted through the circulatory apparatus:
 at any rate not to any great extent. We must remember
 however that the optic tracts are closely connected with
 the sensory & motor and so is the cerebellum, and what
 is of the greatest importance is the direct connection between optic
 centres and the cerebellum, the latter receiving from them afferent impressions

and in this way we may have a direct communication between the two though the cerebellum itself plays no essential part in the perfecting of the visual function. Once discover however a connection between the two, and we shall be at no loss to understand how, what affects one may easily affect the other.

thus what I mean is that though the nerve influence sets from optic centres to the cerebellum, yet that disease in the cerebellum may so affect the functional activity of those centres as to impair if not destroy their function altogether.[†]

Deafness requires but short notice atoms handed in only 2 per cent of the cases was it remarked. it is possible that some influence may be exerted on the auditory function through a filament described by some as having its

[†] vide appendix. C. page. 196.

origin from the flocculus: or on the other hand it may have been owing to some pressure exerted by the diseased cerebellum on the medulla oblongata affecting the integrity of the root of the fifth nerve. or lastly the deafness may merely have been a coincidence and in no way connected with the cerebellar disease.

Anaesthesia, & Hyperaesthesia. Changes in the general sensibility are noted as having occurred in 12 per cent of the cases, but the evidence is not at all conclusive that in any one of these cases the cerebellum was only part involved and indeed in some the evidence of pressure from tumours in the organ on the Pons Varolii was pretty conclusive. Dr Luys comes pretty much to this conclusion for he states that he has never

noticed any alteration in the general sensibility when the cerebellum alone was involved - and this is not without its interest - when we remember that most of our hand-books tell us that ^{many of} the sensory fibres of the spinal cord passing upward by the posterior columns and grey matter on arriving at the medulla oblongata, assist to a great extent in forming the Restiform bodies and so are prolonged into the cerebellum, supposing this true we should expect more often in cerebellar lesions to meet with some alteration in the general sensibility, but such does not appear to be the case. The following case bears on this point

* J. B. Sailor at 23 was stunned by a blow on the

* Proceed: Roy: Med: Chi: Soc: April 20th 1863.

Side of the face, as soon he recovered from the first effects, he walked without assistance to the hospital (a considerable distance) on arriving he complained of slight vertigo, his articulation was slightly impaired, was unable to swallow, was troubled with hicough, face dusky. Respiration quiet; Pulse 100 regular. Slight palsy of right side of the face, arm, and leg. But he could raise the limbs if he wished: the temperature on that side was slightly raised, as compared with the opposite side: sensation on both sides good. if any difference slightly less acute on the right side. he died suddenly 24 hours later.

On examination post mortem. No cranial fracture

sinuses full of blood; cerebrum natural.

There was slight superficial laceration of the under surface of the right lobe of the Cerebellum; also slight extravasation of blood on the right side of the Medulla Oblongata, in connection with a laceration of the nervous substance there; on close examination two transverse lacerations connected by a vertical one were noticed; the superior cut involved the right Restiform body about its middle, extending, nearly to the median furrow of the fourth ventricle behind, and in front to the line of origin of the roots of the eighth nerve: the lower laceration was just below and to the right of the rib of the Calamus scriptorius dividing the posterior pyramid and tract outside it, it stopped behind ^{at} the

Median fissure, and did not extend in front beyond the line of attachment of the posterior roots: these two were connected by a vertical laceration extending along the inner side of the restiform body.

Now without alluding to the paralytic symptoms some of which were due to an implication of the facial, ~~and~~ the 8th nerve being implicated, or discussing the question whether the slight hemiplegic symptoms were ~~not~~ due or not to the loss of cerebellar function on one side; the point which strikes us at once and for which I quoted the case is that the Restiform Body on one side was completely divided and little or no alteration in the general sensibility of either side resulted; now Brown-Sequard has

shown by experiments on animals that hyperaesthesia rather than anaesthesia is the result of dividing the arborescent body, but we have not even that symptom here - and in fact we may conclude that whatever impressions are conducted by the arborescent bodies, sensory ones are not to be enumerated amongst them.

Coma. in the majority of cases when it occurred, it was merely that suspension of consciousness which frequently precedes death, and which may be due to the circulation of imperfectly aerated blood through the brain and in no way characteristically associated with cerebellar disease; in other cases it might have been owing to effusion into the ventricles. or in others it accompanied the sudden shock of haemorrhage into

the cerebellum in these cases the coma was not so
 deep as that accompanying cerebral apoplexy, the
 patient being rather very drowsy than comatose - so that
 he could be aroused to answer questions but soon lapsed
 into the semiconscious state again. and lastly
 there were some instances of a truly occasional
 and temporary coma the patient being liable to
 occasional attacks of loss of consciousness. we might
 compare this condition to that form of epilepsy
 termed 'le petit mal' and very likely it is owing
 to a similar cause, some sudden change in the
 circulation of the brain caused by irritation of its
 vaso-motor system: which irritation might have
 propagated from the cerebellum.

Organic Functions, were not unfrequently deranged in some form or other, and we have arranged them as seen in Table ii under various heads.

Generative Function for reasons already stated (p. 31) I shall content myself with a very few remarks on this point: alteration in some form or other was noted in 13 percent of the cases and this included four of the cases related by Gall in support of his theory, one of which I will quote as I think it shews on what slight evidence he was willing to rest his opinion.

A man. 32. intoxicated, during the act of coition in the street fell suddenly insensible, he was removed to one of the Parisian hospitals, where it was noted that his face head and neck were hot and red. Pulse strong and

frequent. Respiration slow and intermitting - extremities cold, he experienced occasional convulsive attacks - and during the 6 hours he lived he had constant priapism. on examination post mortem, hemorrhagic clot in the superior vermiform process and extending into the superior crus cerebelli on one side. I really don't see how this case proves anything except that drink was probably the predisposing, and coition the exciting cause of the apoplexy - in the condition he was then in that the priapism should have remained constant is just what we should have expected if the hemorrhage had occurred into any other part of the brain.

The following list comprises the various forms of disturbance of the function under consideration noted in the 13 cases

Priapism (5 cases), Masturbation (4 cases), Erotomania (2 cases) Loss of

Veneral desire (cease), Great congestion of uterus and ovaries (noticed after death) (cease).

General Nutrition. In estimating the amount of influence exerted by any diseased organ on the general health, it is always a difficult matter to decide how much of the effect is to be attributed to the local affection and how much to the general constitutional condition which may have preceded the local manifestation. Now though in Table I I have set down a certain number of cases in which some marked symptom of failure in the general nutrition was noticeable, yet I do not in any way mean to assert that they were all or any of them wholly dependant on the cerebellar disease, ~~may~~ be this however as it may, we cannot I think deny

a direct influence in some of the cases. The following were some of the forms of mal-nutrition or assimilation: Loss of animal heat (3 cases), diminution in the vitality of the skin (8 cases), Diabetes (2 cases), General wasting (7 cases), more or less anoxia and general derangement of the visceral functions (8 cases). These derangements were usually associated with chronic cerebellar affections. A great many of these cases were of scrupulous habit; now according to Dr Laycock's views we ought to expect considerable changes in the performance of these vegetative functions, but I do not think his theory obtains much support from our cases. The fact of glycosuria being noted in two cases is interesting, but the same fact of its only being noted in two, renders it

improbable that the cerebellum in any way
 influenced it, and such a conviction would be
 strengthened when we remember the close proximity
 of the fourth ventricle and Bernard experiments
 on it. and lastly in one case of complete softening
 of the cerebellum the general nutrition was unimpaired.
Vomiting as a symptom was noticed in about 25 per cent
 of the cases, but was most frequently associated with
 cases of tumour in 32 per cent of which cases it was present;
 vomiting however is not characteristic of cerebellar disease,
 as it often accompanies disease in other parts of the nervous
 centres, but still I think it may be said that it is more
 frequently noticed in connection with disease in the cerebellum
 than in any other part of the brain. associated with the

vomiting, or independant of it, we often have nausea more or less constant, the appetite however in spite of the vomiting is frequently voracious. With regard to the cause of these symptoms, we might with fairness conclude that they were the result of irritation propagated to the cells at the origin of the vagus, or to cells in connection with the sympathetic system of nerves. or if we like to both.

Circulation & Respiration, with regard to these two functions nothing characteristic is noticeable - the rapid asphyxia, which frequently follows cases of cerebellar apoplexy, is due probably to pressure on the medulla oblongata - and it is in this way that many of the cases of tumour appear to terminate.

Sleep, in a few cases marked disturbance of this function

is recorded, unusual wakefulness being more common than the opposite state, this is probably owing to the neighbouring irritation keeping up a state of excitement in the circulation and consequently cerebral congestion, which is just opposed to the state conducive to sleep which appears to be one of cerebral anaemia†.

Motional Function. inasmuch as the cerebellar influence has been, by nearly all physiologists, associated with this department, it now merits our careful consideration. There was marked motional disturbance in about 61 per cent of the cases. and under this heading to Table if we have the following sub-heads or rather more exact specification of the kind of disturbance remarked; and it is as

† Durham in Guy's Hosp' Reports Vol vi. 3rd Series

follows.

(In the various lesions taken together)

General Spasm or convulsion noticed in 30 percent of the 61 cases

Partial do do " " 7 " " "

Paralysis (partial or general) .. 25 " " "

Tremor and Muscular debility .. 21 " " "

In the special lesions the tables iii. iv. v. vii state that

(A). Softening of Cerebellum.

Spasm or convulsion . occurred in. 31 percent of cases

Hemiplegia 5

Paraplegia 9

Tr

Tremor 25

B

In cases of Tumours

Spasm occurs in 47 percent of cases

Hemiplegia " 14

Paraplegia .. 2 " " "

Tremor .. 20 " " "

(C) In cases of inflammation or Abscess.

Spasm or convulsion -	in	25	per cent of cases.
Hemiplegia	..	15	— — —
Paraplegia	..	5	— — —
Tremor	..	25	— — —

D In cases of Apoplexy.

Spasm	in	15	per cent -
Hemiplegia	..	46	.. ..

In the first place we will consider the symptom designated as Spasm or convulsion. For convenience sake we may divide it into 3 classes. 1st convulsions generally associated with coma directly preceding the death of the patient. 2nd. The epileptic form of convulsion. and 3rd occasional or permanent Spasm (general or partial) not attended with loss of consciousness.

Convulsions of the first class require no notice here being

in no way characteristic of cerebellar disease - but dependent usually on a morbid condition of the blood as the result of an accumulation of carbonic acid with.

2nd Epileptic attacks. Pathologists of the present day have pretty uniformly come to the conclusion that the central seat of these affections is to be looked for in the Medulla Oblongata. And there appears to be much that is favorable to such an opinion, though we cannot look upon it yet as an established fact; we have to ask ourselves next the question whether these epileptic seizures were merely coincident with, but independent of, the cerebellar disease or whether they were the result of it - it is impossible to answer such a question with any certainty, for that it might be a coincident we cannot deny, and on the other

And from the little that we know of epileptic aura's
 and the conduction and reflection of afferent impressions toward
 from the nervous centres we can see nothing improbable
 in the idea that an 'aura' might start from the cerebellum
 when in this state of irritation engendered by the softening
 process or by a tumour, or again the cerebellum may exert
 some influence over the physiological working of the Medulla
 Oblongata, which being deranged or removed would reduce that
 portion of the spinal system to a condition favorable for the
 production of epilepsy: and I am inclined to an opinion something
 of the nature of this last suggestion. Epilepsy is ^{at least secondarily} ~~primarily~~
 if not primarily ~~a motorial disease~~ a motorial disease⁺ (including the vaso-motor
system), the Medulla Oblongata is the great centre of motor
 action: the cerebellum is specially connected with this system

+ Vide Appendix .p. 178.

and it requires but a slight imaginative (yet really inductive) stretch to connect the one with the other. viz cerebellar influence and Epilepsy.

3^d Convulsion or Spasm unattended by loss of consciousness:

and the question for consideration is, what is the connection between the cerebellar affection and such motorial phenomena.

In the first place whatever it be we may safely conclude that

it operates through the spinal system, and that no direct

connection exists between the Cerebellum and the muscles

themselves: for after all we must remember that spasm or

convulsion is simply muscular contraction usually involuntary,

and irregular. Spasm and rigidity of certain detachments

of muscles was not unfrequently noted in our cases. muscles

of the extremities being usually those to suffer - the following

will serve for examples.

- A. In the case of a woman with tumor in the cerebellum there was weakness in the lower extremities with permanent contraction of the soles of the feet.
- B. In the case of a physician who had suffered for 6 years from headache, vertigo, etc. it was noted that his upper extremities began gradually more & more contracted and ended in permanent contraction of the arms on the arms - there was a large tumor in one lobe of the cerebellum.
- C. Girl at $3\frac{1}{2}$ - ill for 18 months restless - pitiful gradual stiffening of all the limbs, which were extended with a spasmodic force her mind gradually became imbecile, and she died after remaining stiff for a whole year. there was found general softening of the cortical portion of the cerebellum

with entire softening of one corpus dentatum and the medullary substance around it - slight softening of Central cortex - spinal chord firm.

D. A.H. at XI . ill for 5 mos. it commenced with ^afit - became dull, face wore an aspect of pain, her left leg became gradually colder than the opposite one, stiff and firmly extended; right leg affected to a less extent, no loss however of sensibility, the muscles of the back were stiff - right forearm gradually followed in same way and became contracted firmly on arm - the eyeballs were permanently drawn to the left side. After death - a few scattered tubercles ^{were} found on the surface of the brain - and a large mass occupied the position of the left corpus dentatum and cerebellar hemisphere -

I might mention two other cases also in which paralysis of

one or the limb existed with permanent contraction
 the limbs affected being on the opposite side to the seat of
 the lesion.

Brown-Sequard in his lectures
 on the physiology and pathology of the nervous system, alluded
 to certain tracts of nerve substance situated in the subcentral
 and upper spinal systems, which possess the power of producing
 persistent spasm in certain muscles, which constitute a
 different system to that employed either in the transmission
 of sensitive impressions or of the orders of the will to
 the muscles, these tracts are situated chiefly in
 the lateral and posterior columns of the Pons Varolii
 and Medulla Oblongata, many of their fibres do not
 decussate - these columns contain most of the fibres
 of the vaso motor nerves, and play an important part

in most convulsive phenomena - when irritated they specially tend to produce spasm of the muscles of the neck. A similar property is supposed by some to attach itself to the salivary bodies which when irritated were said to produce permanent spasm of certain sets of muscles. but I do not think these last opinions have been sufficiently well established to admit of any direct application in our present enquiry; let us therefore go if possible to the root of the matter, and enquire into what is known of the 'ratio' of muscular contraction; and it is a curious fact that though volumes have been written on spasmodic and convulsive diseases, yet the first question in the whole enquiry viz the cause of muscular contraction has as yet not been decided.

"Whatever" write Todd & Bowman "is capable of inducing contraction in the muscles, when either naturally or unnaturally applied to them, is termed a stimulus. In the living body, the muscular fibres are in most instances made to contract by the immediate influence of the nervous tubules distributed among them; and this influence however called into play, should be styled the nervous stimulus, or the *vis nervosa*.....

.. of the nature of this, and of the mode of its production we are as completely ignorant, as we are of the nature of all those other conditions of the nervous system on which the manifestation of its various phenomena depend". Although these authors profess their ignorance of the nature or mode of action of this stimulus or *vis nervosa*, yet they imply the belief that some addition of force or stimulus necessarily

accompanies muscular contraction, and is the cause
 of it. and this is the general belief. On the other hand
 "There is reason to believe" writes Dr Radcliffe[†] "that the
 power of muscular contraction is inversely related to
 the amount of nervous influence supplied to the muscles
 from the great nervous centres" which is diametrically
 opposed to all our previous notions, but Dr Radcliffe
 does not content himself with mere theories, he
 brings forward a number of most interesting facts to support
 or I should rather say on which the theory was founded amongst
 others he quotes two experiments performed by Brown Sequard
 in the first* a scale was fixed to the paw of one of ^{the} hind

† Lectures on Epilepsy, Pain and Paralysis. London 1864.

* Complete Reader. 16 Mar: 1847.

legs of a frog and the animal suspended by its fore-limbs so as to raise the scale to a convenient height; weights were then gradually added to the scale until it was a trifle heavier than could be raised by the contraction, which was produced in the limb by pinching; the spinal cord was then divided immediately below the insertion of the nerves supplying the fore-limb, and the power of contraction was again tested and the result was as follows

The limb raised BEFORE division of the cord.		Grammes
		60
AFTER		
.. ..	.. immediately	20.
.. ..	.. in 5 minutes	45.
.. ..	.. 15 "	60.
.. ..	.. 25 "	80.
.. ..	.. 1 hour	130.
.. ..	.. II "	140.
.. ..	.. 24 "	150.

and the power would remain stationary for 6, 10 or 20

days when it gradually declined until in 6, 7 or 8 months it had passed to a third or fourth of its original value before the operation; much of this loss might be prevented by exercising the palsied limbs by electricity: the second experiment was of a similar character with this addition that the principal nerve of the limb as well as the cord was divided with the effect of still farther increasing the 'power' of the muscular contraction in that limb.

It is a recognised fact that venous blood (which certainly is not nourishing and cannot tend to the development of an increased (i.e. nervous) circulating through the nervous centres predisposes strongly to convulsions i.e. muscular contraction of an irregular and involuntary character.

and we recognise another instance in the convulsions produced by profuse haemorrhage. And what of the cases which I have related above; for instance case C. in which we recorded gradually progressive spasmodic contraction involving the whole system and keeping it so bound for 12 months: the child was evidently in a low and feeble condition instances in other ways than by the softening of the grey matter. Dr Bright who record this case specially notes the absence of palsy I presume he must intend prior to the rigidity; though on the other hand there is no difficulty in associating the two conditions together - muscles may be rigid and yet the person be not paralysed. Rigidity supervening in paralysed limbs Dr Todd says depends on a slow and lingering irritation, attendant on the cicatrization of brain substance which may have

been destroyed by hemorrhagic extravasation, which
 is propagated to the muscles and excites in them a
 corresponding gradual contraction, to explain this same
 phenomenon by Radcliffe's theory we should offer an exactly
 opposite suggestion and so under the contraction the effect
 of cutting off of the supply to a great extent. contraction
 usually, when present, is associated with paralysis, the flexors
 overpowering the extensors, but in case C. both extensors
 and flexors are in a state of rigidity, in, we might say a
 condition of living 'rigor mortis'. Next is there any uniformity
 of flexion associated with this condition, the Corpus Dentatum
 it is true was destroyed in every case, on one side at least, and
 if we bear in mind the analogy I mentioned which exists
 between the Dentate body and the Corpus Olivace - and the

property which has been assigned to the latter body (p. 130)
 we might be inclined to hazard some plausible theory, that
 the same power was attached to the analogue, the dentate body:
 but the corpora dentata have been frequently involved
 with the rest of the hemispheres, or at least portions of them,
 without spasm being produced - one is certainly tempted
 to apply Redcliffe's laws of muscular contraction to the present
 case, and to look upon spasm associated with cerebellar
 disease as an indication of a deranged electrical condition
 of the nervous centres which supply the muscles involved, and
 secondarily of the muscles themselves, by which the static
 electrical condition of the nerves and muscles is preserved,
 and either the supply of nerve influence is very limited
 or it is supplied in a irregular manner: and it really

does not seem altogether improbable, but that the cerebellum might exert some regulating and controlling influence over the electrical condition of the motor tracts.

In discussing this last symptom I have throughout been obliged to speak vaguely and hypothetically, we know so little of the cause of even the simplest act and what I have said must be looked upon rather as suggestive than as the statement of any definite opinion.

Paralysis as a symptom of cerebellar disease - its occurrence here is rare as compared with that in disease of the subcerebral ganglia - and indeed I have my doubts whether complete paralysis, hemiplegic or otherwise ever occurs when the cerebellum alone is implicated.

In our 100 cases palsy in one form or another was noted in

in 24 instances and the following Table expresses the varieties.

Ratio per Cent.	Hemiplegia on opp. side to lesion.	Hemiplegia on same side.	Paraplegia	Gen. Paralysis
62...	————	.....	.....	.....
12	.....	————	.....	.....
20	.....	.....	————	.....
4	.....	.....	.....	————
Actual No.	15	3	5	1

Thus we see hemiplegia occurs in only about 18 percent of all cases of cerebellar disease; it is noted more frequently in association with one lesion than with another. I think so, apoplexy of the cerebellum is the lesion which most frequently gives rise to it, and this is not that more substance is destroyed for such is not the case, but it is that the shock is more sudden the system has not had time gradually to accommodate itself to the change which it does in cases of chronic disease. Some authors have

stated that hemiplegia always occurs on the side of the body opposite to that on which the lesion is situated, but we see from our tables that in at least 12 per cent of the cases it occurs on the same side, and there was nothing to be remarked at the post mortem examination which indicated any difference in the lesion in these cases - from what in another case caused hemiplegia of the opposite side - again it is a curious fact that we see many cases of very complete disorganisation of the cerebellum and no hemiplegia at all; we cannot then suppose that the cerebellar influence passes in any way directly to the muscles or hemiplegia would be expected more frequently - therefore it must act through the motor tracts by acting on them in some way, and the question is how, we shall however have occasion to allude to this in the

conclusion (Proposition ~~IX~~) No doubt spare repetition here -
 I would only mention that Dr. Luys says that hemiplegia
 the result of cerebellar disease is always accompanied by
 anaesthesia; but to this I would say that in 6 cases of hemiplegia
 with cerebellar hemorrhage there was no anaesthesia at all in
 three of them, and I have a conviction that in the other three
 cases it was merely the result of pressure on the sensory
 tracts in the Pons Varolii.

Paraplegia, complete very rare - 5 times in 100 cases
 there was considerable (nearly complete) loss of power over
 the legs, but Brown Sequard denies that paraplegia ever
 results from cerebellar disease alone. and it is not stated
 in these cases, what was the condition of the spinal cord
 so that I shall not say any more about it here than just

word the fact as stated in my notes.

And lastly in our symptomatological discussion we have to consider the pathology of those cases where ^{there was} ~~was~~ considerable disturbance of the motorial powers, but not amounting to a real paralysis. There may merely be trembling of the hands or more frequently an unsteady gait - or the patient may scarcely be able to stand at all though when lying down he can move all his limbs - The statement in Table ii that Tremors were remarked in 21 per cent of the cases is probably a good deal under the mark - many of my cases were only admitted into hospitals when in extremis and were consequently confined to their beds - again slight trembling is often not noted or else they are assigned to some other cause and the true explanation is overlooked.

Trembling is undoubtedly pathognomonic, in some form or other, of weakness, whether mental, organic or otherwise. Thus tremors characterise frequently the late stage in a case of fever, or the cachexia produced by chronic mineral poisoning in various shapes, specially Mercury; or the declining health of the drunkard, or merely mental exhaustion; they are in fact merely the external manifestation of an internal depression, always of the innervation though not necessarily primarily so. all this then is granted, that with a low and enfeebled state of the general system we may get tremors; but do we on the other hand meet with tremors in conjunction with a robust general health? we may I think answer this in the affirmative, and

conclude in such a case that they depend on some local change in the nervous centre, engendering a functional derangement in its action: and it is

of little moment whether the lesion be a tumour, or a blood clot or a patch of softening, abnormal nutrition will nevertheless be going on around it;

activity of function is only synonymous with a healthy
 nutrition

and nutritive changes which are below the standard

of health cannot be associated with a maximum functional power - Cerebellar Disease, as well as

all other morbid conditions, then is synonymous with

a state of functional depression; before we go further on

this point, let us first consider another question.

Are tremors necessarily associated with any loss of

of coordinative power. such an influence as
 Flourens ascribed to the cerebellum - certainly not,
 we must distinguish between the two powers expressed
 by the words Coordination and control; though
 the converse would probably hold viz that where-
 -ever the coordinative power was defective, there would
 probably be trembling. and so the same reasoning
 applies to the 'Muscular Sense'; tremors are in no
 way pathognomic of a defective muscular sensibility;
 though a person whose muscular sense was deficient
 would probably tremble more or less in his movements
 they being to a great extent guided by our appreciation
 of the relation we bear to external objects, which
 appreciation operates through the muscular sense.

Again do tremors imply a want of 'sthenique'
 such as Luzz would have the cerebellum supply?
 as I have already indicated muscular tremor is
 associated with vital depression, and implies asthenia
 to some degree either of nerve or muscle. but asthenia
 of what? it may be of the directing mental powers;
 or of the conducting properties of the white fibres;
 or of the cell action in the spinal cord; to say then
 that a trembling condition of the muscles implies
 asthenia is as much as to say that disease implies
 a want of health; and we are in no way led to
 conclude at once, that Luzz's theory is right. the
 'sthenique' influence, if it can be looked upon as an entity
 having its origin in any one spot in the nervous centres

which to say the least is doubtful, might have its origin in some of the subcerebral ganglia or in the Pons Varolii or Medulla Oblongata, who shall say - I have said enough already about the inseparability of functional activity and healthy nutrition, and may only add that all those conditions which have been termed functional disorders imply nevertheless organic change in some form, microscopic though it be sometimes - and a functional disorder which is continually recurring will at length give very manifest indications of structural change. I have already insisted strongly enough too on the doctrines of non-organic paralysis - to enable us putting these two points together to comprehend perfectly

how even supposing some centre for the formation
 of nerve sthenique existed (not being the cerebellum)
 disease at a distance, say in the cerebellum, could
 cause a derangement in the supply and action of its
 influence. Of all the motor disturbances tumor
 is the one most likely to show itself first, a slight
 peripheral irritation sufficing for its production -
 so that we have only to suppose that the cerebellum
 is in any ^{way} connected with the nerve supply regulating our
 motor acts and we have at once ample explanation of
 the association of tumors with cerebellar disease, without
 making that organ the centre of such an indefinite and
 doubtfully separable force as 'sthenique'.
 But as I think any opinion we may form of

The cerebellar function can only be arrived at by a general and comprehensive view of all the facts that have been brought forward, not laying too great stress on any one symptom or condition. I shall, to make our case more complete, subjoin two further cases of disease of the cerebellum, the first of them being the well known case recorded by M. Combelles. (The only cause for regret about this case is that the girl had not been more carefully and for a longer time watched during life.)

A Girl at XT - her intellectual faculties were of these she answered questions slowly and with difficulty - her countenance was expressive of stupidity - the power of movement was defective in her lower

extremities as she frequently fell down — her gait was irregular and unsteady — ordinary sensation perfect, special senses entire, circulation and respiration not notably disturbed, constitution generally weak and delicate, generative organs well developed, she practiced masturbation, she suffered from progressive loss of locomotive power till at length she was unable to move at all even when lying on her back, epileptiform convulsions supervening she died in one of the attacks.

On examining the head the cerebellum was found to be entirely wanting, a sac filled with serous fluid replacing it attached on each side to modified corpora Restiformia; commissural fibres ~~from~~ ^{from} Pons

Parotid wanting - the rest normal. (Revue Medicale 1831)

The following case is also worthy of our attention.

a man at 44, deformed, by an antero-lateral curvature of the spine, with both legs contracted and drawn up on to the thighs, right forearm partially contracted on the arm, subject to epileptic attacks which were ushered in by severe headaches, he never started a conversation, but answered simple questions rationally, could use his arms, very passionate, practiced masturbation, the bodily deformity had gradually increased with his growth - died at length exhausted with bed-sores. On examining the head post mortem a large quantity of fluid was found in the cerebral ventricles, the ganglia on the left side

being so expanded as to be scarcely recognisable,
the central lobe and left hemisphere of the cerebellum
were altogether absent.

The points which still remain untouched upon, are
still very numerous, but it ~~is~~ impossible with the
little time at my present disposal for me to pursue
this very (to me at least) interesting enquiry further
and I must therefore now sum up any conclusions
at which I may have arrived at from the study of
the preceding facts and statements and for the
sake of convenience and conciseness I shall
arrange them in the form of propositions making
comments where necessary endeavouring as
far as possible to avoid repetitions.

Proposition 1. There is reason to believe that the Cerebellum
is not the centre of intellectual or mental acts of
any kind.

This proposition is I think established by everything
we know of the history and symptomatology of cerebellar
disease in the human subject, no one intellectual
faculty being with any constancy implicated
and more frequently none at all — at the same
time a condition of greater or less stupidity
a slackening as it were of the mental tone, was
too frequently noticed in long standing cases of disease
of this organ not to have attracted our attention.
Therefore while agreeing with the general book
statement of intellect unimpaired, I should qualify

it by adding that though no marked deficiency occurred in any one of mental faculties specially; yet that there undoubtedly existed a general ~~obtuseness~~ obtuseness of them all in some cases. and so

Proposition II. We may conclude that the Cerebellum does influence the intellectual faculties indirectly in some way ~~or~~ or other.

This must follow as axiomatic after what has just been said, for if an organ influences a faculty and not directly, why then it must do so by some indirect means. and the next question is what are ~~the~~ means by which it acts? the nutrition and functional activity of the cerebrum is we may suppose regulated by a Sympathetic System as well as the rest of the general

system, and whatever deranged that controlling system
 would affect the integrity of the function of the part
 supplied, now I believe Dr Laycock entertains, or
 did, a notion that perhaps the cerebellum acts
 in some way as vaso-motor or sympathetic centre
 to the cerebrum amongst other parts, and I must
 confess that when I first began to think on
 the subject that I entertained some such idea
 myself, but further investigation has shaken
 my belief in such theory, and I now think
 that if these disturbances be due to a deranged
 action of the sympathetic system, that the
 cerebellar influence is then exerted indirectly
 through this system, which it could easily do as

it is undoubtedly connected with the sympathetic in the cervical region; * we know that some poisons act by causing minute alterations in the grey nervous matter or axis cylinder and if this may occur from the direct influence of some poisonous matter in the blood, it seems not improbable that changes might also result from some morbid impression being transmitted from a distance and interfering with the minute molecular changes necessary for the healthy performance of its function by the part - and so the chain would run from cerebellum to sympathetic and sympathetic to brain. On the other hand much of our mental acuteness depending on our susceptibility to external impressions, supposing this blunted or

* vide appendix. p. 178.

interrupted in some way. ~~in this function~~ ~~activity~~

owing to a derangement, the result of cerebellar disease, affecting some of the channels by which our minds become cognizant of our external relations, and we have here another suggestion & explanation of Prop. ij.

Proposition iii. We may conclude that the cerebellum is in no way connected with the functions of common sensibility or sensation.

This proposition after what has preceded it will I think find no opposition: we saw that anaesthesia seldom if ever resulted from simple cerebellar lesion and that when it did occur it was probably owing to pressure on the neighbouring parts. I cannot help just alluding here to the notion that sensitive impressions

conveyed by the posterior spinal columns passed ~~the~~
 through to a great extent the Restiform bodies and
 consequently the cerebellum, that this was an error I
 think there can be no doubt, we ought anatomically,
 not to mention physiologically, to regard the Restiform bodies as
 continuations from the cerebellum to the spinal system, and
 not the reverse - on the whole then I am not inclined
 to give Mr. J. S. Prudden's theory (the lateral lobes of
 the cerebellum are the ganglia of the cuticular system forming
 any support.

Prop iv. There is reason to believe that that the cerebellum
 may exert some influence over the functions of the organic life.

I think the fact must be admitted, whatever the
 explanation may be, and the idea is a new one,

for it was a theory adopted by many old medical writers.
 in later times Gall applied the idea to a special
 division of those functions viz the generative and more recently
 Dr Laycock has revised the action of its extended influence
 over all the departments of the organic life - changes
 in the nutrition of the skin, amounting to a state which
 has been termed 'Cuti auserina', have been noticed;
 and various degrees of irritation affecting the genital
 organs - Vomiting, anorexia, defective assimilative
 powers, constipation, have all not infrequently
 occurred - glycosuria too has been remarked - patients
 affected with chronic cerebellar disease generally become
 considerably emaciated; allowing the facts then some
 weight, what is the explanation - again we have the

choice, between an indirect and a direct mode of
 action, either the cerebellum is in direct communication
 with the sympathetic system or it merely influences it indirectly
 according to D. Laycock's view the cerebellum is to be regarded
 as a differentiation of the intervertebral system of ganglia, a
 chain of ganglia which bear the same relation to the contents of the
 cranio-spinal cavity, as the sympathetic system does to the
 contents of the visceral cavity. the intervertebral ganglion is in
 connection by means of the sympathetic chain with the viscera
 and internal surface of the body, as well as with the skin
 the special nerve of touch and common sensibility passing
 through it; the afferent nerves of the skin being merely
 channels by which external impressions are transmitted
 to the intervertebral ganglia, thence to be deflected either upon

the motor roots or sympathetic ganglia, by which
 means channels for the excitation of both nutrition
 and motion are provided for. Now says Dr. Laycock
 the cerebellum is a differentiation of this system, connected
 with it by the corpora Restiformia, so that while
 the cerebral hemispheres and their subservient
 ganglia are organs of external relation proper, the
 cerebellum presides over all those vital processes which
 are involved in coordinating visceral function, and
 in the relations of the blood to the viscera and nerve
 centres generally; it is in fact the centre of vegetative
 life and of all the organic appetites and instincts - let
 us analyse this statement more closely; and first
 with regard to the intervertebral ganglion. A spinal ganglion

+ i.e. a pure motor nerve, for we must distinguish between this and the motor element found in the sympathetic system.

We may remind ourselves is a compound ganglion
 composed of two parts, the grey cell and nerve, and
 the impressional nerve, and so it differs from a
 sympathetic ganglion which is made up of three
 parts, the grey cell and nerve, the impressional nerve
 and the motor nerve; and 2^{ndly} a spinal ganglion
 is never connected with a motor nerve⁺; and 3^{rdly} that
 every spinal ganglion is connected by ^{grey} filaments with
 adjoining sympathetic ganglia; and lastly the
 spinal ganglia influence the nutrition of the cord centrally
 - ally. This last assertion appears to be proved by Dr Waller's
 experiments (quoted by Bernard in his *Leçons*) who
 divided the spinal cord and then a few days later examined
 it ~~and~~ and he found that whilst the anterior horns of grey matter
 and nerve roots were disorganised below the section. When the posterior were sound,
 the reverse held above the section for here the posterior were disorganised
 and the anterior healthy. the spinal ganglia influence only the posterior)

And now that we understand ~~with~~ what system it is
 with which it is proposed to class the cerebellum,
 do the facts with which we are acquainted bear us out
 in such an opinion. There is at once evident, one marked
 distinction to be drawn between the two, for whereas the spinal
 ganglia are in special connection with our common
 sensibility, the cerebellum we have concluded has no
 connection at all with it, and secondly if the cerebellum
 was the centre of the entire vegetative life we should most
 assuredly be able clinically to trace a closer connection,
 than we can, between the two; when we remember the intimate
 connection between the cerebellum and the Ciliary spinal
 region one of the starting points of the sympathetic, we shall
 recognise ample means of communication by which, ~~it~~

The cerebellum might when diseased or irritated influence these functions, through the sympathetic. so that

Proposition V We may conclude that in whatever way the cerebellum affect the functions of the vegetative life, it does so altogether indirectly by first ~~disturbing~~ ^{affecting} the sympathetic.

Proposition vi There is no reason to believe that the cerebellum is the central organ of the 'muscular sense'.

In spite of what Forville Lussanua and others have said on this point I do not think the result of our enquiry points to such a conclusion as these physiologists would have us adopt. The specific nerves of muscular sense Lussanua tells us spring from the cerebellum, and pass to the voluntary muscles with the 5th pair and with the filaments which leave the posterior roots of the spinal marrow.

reaching them by passing down the Restiform bodies -
 if the posterior root of a spinal nerve be cut both the
 common sensibility and the muscular sense of the parts
 supplied are lost, remove the cerebellum and only
 the latter disappears (says Mazzucchi) ergo the cerebellum
is the seat of the muscular sense. and he goes on to prove
 the loss of the muscular sense by the experiments with which
 we are all familiar: Supposing for the sake of argument
 we grant that the symptoms produced in animals by
 removal of the cerebellum are the effect of defective
 muscular sense, for this is entirely inferential on his part,
 and will require confirmation in the human subject before
 it can be admitted as fact: I say, supposing this point,
 why even then the fact that removing the cerebellum ~~appears~~ is

† The Author says nothing as to how far the junction portion
of the Crinoid, was included in his case. —

associated with the loss of this sense is no proof that the cerebellum is the central organ of that sense - it only proves that the presence of the cerebellum is essential for the completion of the circle which is made up of, the impression produced on a muscle by some external object the transmission of this to the nervous centre and its appreciation by the mental faculties, and the motor or consequent act produced. I may say the same here as I did above if the cerebellum was the central organ for such a function as the muscular sense, we should clinically recognise more frequently and more easily changes in it.

Proposition VII. There is no reason to believe the cerebellum essential to the coordination of locomotive actions.

I say locomotive, and not merely muscular, actions because I wish to include all such acts leaping, swimming etc. frogs though decapitated can perform both these acts perfectly - fishes swim well though deprived of their brains en masse, or merely their cerebella - in fact there can be no doubt that ample means for coordinating muscular acts are provided for in the spinal cord itself by the numerous ganglionic and connecting cells and filaments which Van der Kolk has, since Horrocks wrote, shown us pervade the spinal system.

Proposition VIII. We may reasonably conclude that the cerebellum is intimately associated with the motorial functions.

This view I think be granted by all, for disagree as

observers do on nearly every point connected with the physiology of the cerebellum; they with few exceptions, one and all agree in opposing anyone, who may doubt this essential point, even Brown-Sequard who in his writings, excluding theory after theory and scare, it appears, allowing any function at all to the cerebellum, was that there is one symptom which may be the direct result of impaired cerebellar function - and this is a general muscular weakness.

Proposition IX There is reason to believe that the cerebellum controls and regulates both the nutrition and action of the motorial division of the nervous system, the influence which it exerts over it being in many ways, analogous to that exercised by the intervertebral

gaining over the sensory division.

To prove such a statement as this would be exceedingly
 difficult with our present ^{knowledge,} but closer observation
 in future will doubtless throw great light on the subject.
 As such an opinion opposed to any physiological
 or pathological facts that have been brought forward.
 I do not know of any such: the muscular weakness
 the tottering, staggering gait and the other various forms
 of defective control over the muscular movements, would
 all, by it, receive a fair explanation. the gradually
 increasing asthenia ending at length in extreme cases
 like that recorded by Combelte would be explained by
 such a view, when it could receive none from either
 that of Florence or Foix. if according to Florence the

removal of the cerebellum only implied loss of coordinative power, how do we explain the creeping asthenia ending in paralysis. To go through all the arguments against the other theories and to show that the view held in Proposition ix. answers all our cases would be to rewrite much that I have already done and I must trust to anyone who may read this paper to look upon this view as ~~an article~~ the expression of all the arguments that have occupied this paper. I shall not therefore say any more on the point here.[†]

Proposition x We may assume that the cerebellar influence is exerted on the motorial apparatus in a definite direction.

This only seems to follow naturally in accordance with

[†] Vide Appendix B. page 183

all we know of the action of nerves in general; and
the only question for us to determine is, what is the
channel along which this influence operates? frequent
allusion has been made to the muscular sense, and
this with reason for we must admit the very intimate
connection which necessarily exists between it and
the nerves and centres of motion; bearing in mind
the fact mentioned above, that, division of the posterior
spinal nerve root has the effect of cutting off the
transmission of the muscular sense from the part supplied
we may assume that the nerve fibres which convey
that influence do enter the spinal cord there, and
thence the impression is conveyed upwards to the
sensorium through the medium of the posterior grey

matter, thus far Lussanna might agree with us
 but now he would trace it through the corpora Restiformia
 into the cerebellum, but here I do not agree with him for
 reasons already mentioned, and I rather hold that passing
 along the sensory tracts it reaches the corpora
 Quadrigemina and Optici Thalami (and it is these latter
 ganglia that I regard as the special centre for the
 reception of the 'muscular sense' impressions) here it
 undergoes a change and is reflected on to the cerebral
 convolutions where the mind takes cognizance of it;
 from whence starts a new impression of the order of the
 will which is propagated to the corpora Striata
 and Optici Thalami, and two impressions now pass
 downwards one the order of the will descends to the

anterior spinal columns, the other passing along the superior crura cerebelli excites the action of the cerebellum, which emerges by means of the middle and ^(Especially the) inferior peduncles attached to it, and arrives at the very heart of the motor apparatus, the medulla oblongata, ready to play its part in the motor act whatever it be, without the aid of which the integrity ~~both~~ of the nutrition and action of the motor function cannot be maintained.

Dr Waller's experiments have proved an intimate relation between the nutrition and functional activity of nerve cells & fibres and a controlling influence derived from neighbouring ganglionic centres: they have also shown that nutrient forces of nerves and

+ With reference to the controlling ganglion.

nerve centres, operate in the line of the direction of
 the transeunt forces (the vis nervosa), and as the influence
 of the central controlling ganglion diminishes in
 perfection and activity, it gradually dies out in
 a centrifugal direction - and we must remember that the
 direction of the vis nervosa is reversed in the
 anterior and posterior spinal columns, or have
 already alluded to the frequency with which the lower
 extremities tend to be first affected in changes affecting the
 cerebellum, the unsteady gait being frequently one of the earliest
 symptoms, this doubtless is partly owing to the peculiar
 function discharged by the lower limbs viz supporting
 the weight of the body, and partly to their greater distance from the trophical
 centre: because as yet we are not able to express the definite manner in

which one kind of nerve cell affects the nutrition and action of another, it is no reason that we should reject such a theory all together, the fact is too well established to admit of such a course, and we must be content to take it as a fact and wait for further advance in science to explain to us the *modus operandi*.

I would notice one other point in connection with our subject, we are continually meeting with cases of cerebellar disease where there were no symptoms during life indicative of it. but let us note this is only the case in chronic forms of disease nature has time to adapt herself to the change other cells probably are formed to assist in carrying

on the work, or very often it happens that the perfection and activity of a function being very gradually deteriorated, alterations in its performance are very liable to ~~not~~ escape detection, until some sudden excitement lights up the whole disease, and severe and sudden changes result, for instance there may have been a slight a very gradually progressive weakness in all muscular action going on for months without attracting attention, say the result of a tumor in one lobe of the cerebellum. when owing to some change inflammatory softening sets in around the mass. and then marked feebleness perhaps of one side is produced, maybe, amounting to paralysis; and

on death ensuing we are surprised to find extensive disease assuandly of long standing, when the symptoms had only been of recent date, the explanation is, as I have stated.

Doubtless this is one of the reasons why the diagnosis of cerebellar affections is often so obscure, but a careful examination into the history of the case may be expected often to throw much light on its nature.

Though, in concluding, the many shortcomings of the above force themselves upon me, yet I trust and feel that the work has not been altogether in vain limited as it at first appeared, each page might soon have been made the starting point for some independant research; but unmindful of the allurements, which beset me by the way I have throughout endeavoured to keep the object with which we started always in view; and though at

times the discussion of some points may have appeared at first right irrelevant, yet I think it was only by considering many of these points that we have been enabled to arrive at the conclusion which we have. The task at times has appeared wearisome for here as in every step which is made in science towards a wished for goal - the horizon of our observation is continually widening, new facts, new wonders, new sources of doubt, mixed however with new incentives to action, continually rise before us, until the goal itself seems to be almost hidden from our view; and when at length we gain the summit of our first ambition, we find that is but a starting

point for further action, and it is only when we have attained such a summit that we are capable of appreciating ~~of~~ the vastness of the unknown; this at least I have gained from my enquiry; and I feel that as a beginning and starting point for myself in the work that lies before me, it may not be altogether useless.

and when we gaze back upon the past, and trace the progress of letters, and arts, the invention of great mechanical powers, and the evolution of many a grand scientific discovery, and reflect how each of these was till then an impossibility to man's understanding; we may in the words of Dr Daniel Wilson ask ourselves 'What are they, but glimpses of what is yet to be revealed, stimulants to exertion, encouragements to hope, and also fresh proof of man's immortality, since time is so inadequate for the study of the universe of God'.

Finis.

Appendix.

A (refer to pages 125. and 156.)

Professor Laycock in a clinical lecture lately delivered (Feb. 1865) on Epilepsy pointed out to the class that by considering it as essentially a motorial affection they might be led into great error both in prognosis and treatment - and that it should rather be considered as indicating sensorial changes and reminded them how frequently mental and emotional ~~causes~~ impressions were the cause of the disease, and that it not rarely ended in insanity; he next drew an analogy between sleep and epilepsy; in both there was more or less sudden abolition of consciousness, usually followed by motorial phenomena in the one case convulsion, in the other paralysis.

(general relaxation); sleep was he reminded then associated with an anæmic condition of the brain, so too an epileptic seizure was preceded by a flagging of the pulse and other phenomena indicative of a depressed state of the circulation which state we might conclude was affected by the circulation in the brain. and bearing in mind the influence exerted over the blood vessels by the vaso-motor system the question came to be if epilepsy is caused by a cutting off of the supply of oxygen brought by the blood to the brain where is the centre which regulates the supply? and this added the Professor is to be looked for in the cerebellum. and as such an opinion as this if true would seriously affect our views of the function of the cerebellum. I wish here to take advantage of the licence of an appendix and add something which I have already said on this point. I cannot go into the question

of epileptic phenomena as it would be beyond the limits I have
 set myself: but simply this does the evidence which has been
 brought before us support such a conclusion. by dividing the
 vaso-motor nerve attached to any part we denude the
 circulation in that part and if it be agland we are able
 to trace alteration in function from changes evident in
 its secretion; now the same must hold with regard to the cerebrum
 by separating it from its vaso-motor centre we should expect
 that alteration in its functional powers would ~~be~~ necessarily
 follow, supposing the cerebellum to be this centre has this
 effect resulted from its abolition by the knife or disease. Flourens
 says of an animal from which he had removed the cerebellum
 he could see the instrument raised to threaten him with
 a blow, and would make a thousand contortions to avoid it.

Volition and sensation were not affected.

In the case recorded by Combelte the special senses were entire though there was some obtuseness in the intellect.

Again mental aberrations are by all physicians stated as rarely accompanying cerebellar disease. In not one half even of the cases of cerebellar lesion are the functions of the hemisphere interfered with. Epilepsy is only rarely associated with these lesions. That cerebral disturbances do accompany diseases of the cerebellum I have already indicated, and such disturbances too as would just correspond to a lesion of its vaso-motor supply; but then the probability is that, as this centre must almost necessarily be seated somewhere close to its base, or the upper part of the spinal system; ~~that~~ it might frequently be affected secondarily by disease

existing in the cerebellum. At any rate our present knowledge
 with respect to the cerebellum points to other conclusions;
 we have many arguments negative to such a theory - few
 in favour of it: no part of the nervous system is so readily
 affected by small extent of disease as the sympathetic is.
 and it seems hardly probable that the Cerebellum can be
 thus connected with the cerebrum; when as I have stated
 pathologists in relating cases of disease of that organ, in the
 vast majority of them affirm the unimpairment of the cerebral
 hemispherical function. And on the other hand we have
 innumerable arguments in favour of its being connected with
 other portions of the nervous system.

to the physiological action of the cerebellum, and in this
 shows that the majority of them form a true inference

Appendix B. to Prop IX. page 166.

This proposition being the turning point in our enquiry, I have thought it necessary to add a few further remarks on the theory there put forth. Dr Laycock is I believe on the right track when he states that the cerebellum is a 'trophical centre', but in the application of this idea he has I think gone too far, indirectly, the cerebellum may affect the functional activity of many organs of the body, owing to the close connection into which it is brought with the sympathetic in the neck (the ciliary region of the cord)

In the earlier part of this thesis I directed attention to the various theories which have been promulgated with respect to the physiological action of the cerebellum; and we then saw that the majority of them found their origin in inferences

derived from a consideration of the effects produced by a
 more or less complete removal of the organ in question - the
 correctness of these experiments is established by the fact that so
 many separate observers have met with precisely the same
 result, I have therefore tested the opinion which our facts
 have drawn us to this recognised touch-stone. and I at any rate,
 think with the most satisfactory result - carefully distinguishing
 them between the occasional and the essential phenomena; what
 did we find to be the cardinal symptom? undoubtedly
 motorial disturbance; and in what form? not paralysis,
 nor convulsion, but irregular, indecisive, generally feeble
 action. as Horner expresses it universal agitation. all this
 the last named physiologist explains as the result of a loss
 of the power of coordinating the voluntary movements which originate

in other parts of the cerebro-spinal centre: one can only
 conclude that Flourens merely regards the cerebellum as
 a vast commissural centre - acting between the cells on
 the same side of the motor tract as well as combining the action
 of those on opposite sides - but I have already stated that
 I do not consider this explanation sufficient for our wants
 it will not meet all the pathological nor even all the
 experimental phenomena with which we are acquainted in these
 cases - it will ^{not} explain the creeping asthenia ending in
 the worst cases in complete paralysis - nor indeed
 do observations in the human subject affected with cerebellar
 affection lend any support to the theory - it is weakness
 and not a want of co-ordination from which they suffer.
 From the present state of our knowledge it is difficult or

even impossible to explain the mode and process by which motor force is generated and elaborated by the nerve centres - that it is in some way & for some we must take for granted, and we must also take for granted that the action of the parts employed in generating that force is under the influence of other nerve centres.

The motor force then is generated and elaborated by the cells included in the motorial division of the cerebro-spinal centres. and the operation is regulated and directed by the Cerebellum and so indirectly, in fact secondarily the cerebellum does coordinate motor actions but not in the way Horner implied in his writings. Motor force is being continually and uninterruptedly generated by the nerve cells set apart for that purpose; and as constantly it is being

transmitted therefrom by the help of the nerve tubes;
 and stimulus whether volitional, emotional, reflex,
 mechanical, or otherwise, acts not by causing an
 evolution of force de novo, but by affecting ~~the~~ rather the
 direction or amount of that already in operation:

We may as I have stated above compare the function
 of the liver with that of the brain; the bile is we know
 formed by the action of certain cells from material
 contained in the blood, and so is all nerve force,
 and whatever other constituent of the blood may be necessary
 for its generation. Oxygen at any rate seems an essential
 ingredient. The secretion of the bile both as to its quality
 and quantity is under the control of nerve influence
 as Bernard's experiments on the 4th Ventricle have shown;

I instance the liver, but the same holds with the kidney
 parotid, intestinal glands and indeed every gland in the
 body, and are we to suppose that a different
 law operates when nerve force is the question, it
 certainly would be opposed to all we know of the working
 of nature if such was the case, for everything in
 connection with the subject both in physiology and
 pathology, ^{with} the *modus operandi* of which we are al-
 all acquainted, points to the inevitable conclusion
 that the nervous gland (for such it is) is as much under
 the control of the nervous trophical centres as either liver
 or kidney; it can be no speculation - it must be
 accepted as a fact, and one the full importance
 of which has as yet not been recognised.

Of course the influence of the trophical centre is not everything - when we come to the ultimatum, or rather the prime agent in the process we are involved in the theory of 'Life' and if asked how the motor force is generated we can only answer that it is the result of a vital power inherent in certain particles of matter - but given the vital force the rest of the process may in many cases be traced and not the least important agent is the controlling nerve.

What directs the energy of the sensorial or mental departments does not affect this enquiry - definite centres must somewhere exist for that purpose - and indeed we recognise such in the intervertebral ganglia. all that is necessary for us here to have indicated is

That there must exist somewhere such an agent to regulate the motorial system of cells, and secondly that the cerebellum appears to be that centre.

I have now only to add a word on diagnosis of cerebellar disease; the difficulty experienced in diagnosing these cases has become almost proverbial; and the reason of this is I think now evident. We have all along been struggling to find out the exact function of the organ, I mean some definite function as some people are inclined to call such as loss of the muscular sense; something the absence of which would be patent to everybody; and as everybody knows we have never found this definite function, depend upon it if the cerebellum had any such we should have

Discovered it long ago: and the reason why we have
 not discovered it, is simply that it does not possess any
 such, its work, so to speak, can only be traced in the
 workings of other portions of the nervous centres, the function
 of which we may chance to know, and so when the cerebellum fails we recognise
 we imagine, some failure in the activity of function attached to those last named
 tracts, and maybe by the time we recognise disease organic changes
 have then indeed taken place in them, so that we are partly
 right, but the real & and primary seat of the mischief, must
 in reality be sought for further back in the circle of organic life, it lies
 not within or that tract but in its trophical centre, it is the guiding principle
 and not the mere mechanism of the machine which is at fault. The principle invites
 and would well repay a more exact and careful attention from us all
 the materials are such that they require but the systematizing study
 of the physician to make them as readily appreci-
 -able to our senses, and as easily applicable in our

practice, as the most recognisable phenomena of motion or sensation. I could imagine some Feejee islander deposited in a factory room where machinery was in motion, concluding naturally and at once that the whole was before him both impeller and performer, and whatever vague idea he might have as to the reason of the movement he would never doubt one thing viz that the power whatever it was existed with the machinery visible, the idea of any agent acting out of sight would probably never strike him - so that when it started or when it stopped the cause was to be sought for in some change affecting the cylinders and wheels.

We wiseacres smile at the simplicity of the poor Feejee, and yet it appears to me that we often make the same mistake in our neurological pathology; we speak of disease

But the conclusion is also composed of more than one element,
 & the author gives us no indication as to what part or parts
 were applied in his case —

of this or that nerve or tract when the real disease is affecting
 not that nerve but the nerve ganglion which regulates its action.
 And I especially with the cerebellum^x. Various symptoms have
 been recognised affecting the motor system and others, and been
 referred to the spinal cord or Brain and the like when the post-
 mortem examination has perhaps revealed lesion of the cerebellum.
 and I own that such cases are extremely puzzling even
 to those on the guard, but it is nothing uncommon, take the
 different organs of the animal economy why we may produce
 all the symptoms of diseases to which they are liable by merely
 acting on their corresponding nerves - Deprive a muscle or
 a bone of its nerve supply and in the former we shall
 get perhaps 'fatty degeneration' and in the latter Rickets.
 Though I have laid stress on the fact that the cerebellum is

essentially in respect to its function connected with the motorial system, yet when it is diseased we must not expect only to get motorial phenomena developed. for partly from sympathy, and partly from effects the result of continually of texture - or from pressure etc we shall usually meet with many collateral phenomena. e.g. pain affections of vision, vomiting and the like. and these symptoms are only valuable in diagnosis when taken in conjunction with one another and the motorial disturbances. We may say that gradual loss of power is pathognomonic of cerebellar disease specially if it ^{be} connected with some of these symptoms which experience teaches us are frequently associated with such disease. and if there be nothing in the case which directly opposes such a view. Loss of power with anaesthesia is I believe I may say

never the result of simple cerebellar disease - though it may occur
 as the result of pressure exerted by a tumour or the like on the neighbouring
 sensory tracts in the pons varolii. Again a case may be complicated
 by cerebral symptoms owing to excessive dropsy of the ventricles from
 pressure on the imbibent veins by some cerebellar swelling. therefore
 in some cases the diagnosis will be extremely difficult, still a careful
 consideration of all the facts of the case will, I have not the least
 doubt ~~in~~ in the majority of cases, result in a correct and scientific
 diagnosis; or at any rate when we fail, we shall not be
 at a loss to explain in the dead house the phenomena observed
 during life.

Appendix .C. to Section on Cerebellar Ataxia . p. 107.

Regarding the great importance and interest both physiological and pathological which attaches itself to this question I have considered that a few more explanatory remarks on the pathology of the affection might not be altogether useless now that we have seen the relation borne by the cerebellum to many other divisions of the nervous tract, especially those relating to the muscular sensibility - and the motional function. Mayo, as I think I have already said, lays great stress on the connection existing between sight and motion, so that we lean on our eyes like crutches, and I think this very significant remark demands our attention when the question of cerebellar ataxia is before us. It is I presume granted that we are

to a very great extent dependant in our movements
on the impressions received by the muscular sensibility;
and also in addition as just shown on some received
through the medium of the special senses and
especially that of sight. Now I have already (page 170)
indicated the relation and mode of action subsisting
between the muscular sense impressions and the cerebellum
how they are reflected on to the cerebellum then exciting
its action which is essential to a perfect motorial function:
And it appears in many ways possible to trace a moderately
close analogy between this sense and that of
sight, the one informs us of the relation in which
we are placed to objects in contact with ourselves, whilst

The other performs the same, or a similar function
 with regard to objects at a distance from us
 however small or however great that may be. And
 it appears but natural that if we admit the relation
 between the muscular sense and motorial function
 to be as I have indicated, that we cannot deny
 the probability of a similar connection existing
 between the visual and the motorial. As yet
 the physiology of sight is far from being in a perfect
 condition and though we are accustomed to talk
 of the reception of impression on the retina, their trans-
 -mission to the optic centres and the perception of them
 by the mind, there is still much about this that is very

vague, and the probable intimate relation that exist between the Optic centres, and those for the various animal functions, amongst them - motion - is too often forgotten or not understood - we must then always bear in mind that sight is not merely a mental phenomena, but in addition a guiding sense brought into immediate relation with the central organs for motion through the cerebellum - for visual impressions like those of the muscular sense operate through and by means of the cerebellum though the central ganglia for neither of them are situated in that organ - how then would removal of the cerebellum affect these functions, it would certainly

not destroy, nor even may be impair, the power of vision
 but it would arrest that reflex ~~or~~ activity which subsists
 between sight and motion, a principle of action, of which we
 are not mentally conscious; yet we can guide our movements
 by sight without the intervention of a cerebellum, but how is
 this? it operates then through the mind entirely, and each
 movement as far as it is guided by sight, is altogether depen-
 -dent on a mental effort and only indirectly on the visual
 impression - this last point however is dubious, for
 I am not altogether sure but that all guiding power
 may be lost, when the cerebellum is removed entirely
 further observation will be necessary.

Accepting this then as our physiological expression of the

fact - the explanation of pathological phenomena may
 be induced - with so intimate a connection subsisting
 between the Optic & Cerebellar centres we cannot be surprised
 to find that Disease in one affects the functional
 activity, if not the organic entirely, of the other.

This view at least has this recommendation that there are no
 physiological or pathological facts which oppose it, whilst by it we
 are enabled to unravel many of the mysteries heretofore
 attached to the question of cerebellar amaurosis.