Thesis
on the
Spinal Cord
and its relation to
Muscular Contraction
by
Henry Steele
Preface.

When I began to read with a view to writing a thesis, Epilepsy was the subject on which I proposed to discourse. It soon became evident, however, that to do so satisfactorily would be impossible without having first of all obtained an acquaintance with the minute anatomy of the nervous system; and it became equally plain that this was an acquaintance which it would require a short time to form. I was therefore obliged to abandon the idea of writing on Epilepsy, and having begun at the beginning the present Essay is the result. Even yet I cannot flatter myself that I have adopted the major

sine dicta materiam portis, per probitas Aquan

Visibus"
But I think it only fair to myself to state that, in composing this thesis, I have laboured under considerable disadvantages. The Senate Academicians permitted me to pass my examinations for the degree of M.A. last year, and now I am placed in a situation where the want of a library is a serious bar to progress. It will perhaps diminish the surprise which may be felt at the small number of authors whose works I have been able to consult, when I mention that, with one exception, every book I procured was through the rather expensive channel of purchase.

In the following pages the opinions of others have been freely canvassed. I trust I shall always be found to have borne in mind the high talents of those whose views I was discussing, and even when dissenting never to have spoken disrespectfully.

Braun's Hospital, Elgin,
17 June 1861.
Conjectures have not been wanting as to the path which the fibers of the spinal cord pursue; their relation to the ganglionic cells; and the functions of both. Search any other subject has given rise to such flat contradictions as to what are and what are not facts; and to such endless differences of opinion as to how what are admitted facts ought to be interpreted. Anatomy, pathology, and experiments, have done a great deal to enable us to advance from the stage of hypotheses to that of theory. But while much has been learned, so much still remains unknown as much of what
ought to be matter of fact, still remains matter of con-

ely, that no theory can be accepted to be perfectly just.

Consideration however, the very rapid progress which has been made of late years in this

field of inquiry there is no cause for despondency;

but rather for believing that the night is far spent,

and the day at hand. Several things contributed to

prolong the darkness, and it brooded more thickly

than ever the mechanism of reflex actions.

They were commonly regarded as the results of anas-
tomoses through the sympathetic. They induced

some to imagine that the 'latent principle' was

diffused through the future body, and others, more

naturally, that it resided partly in the spinal
cord. Wight, after producing several instances of dia-
static actions, and proving that they cannot be ac-
counted for by 'any union or anastomosis of the nerves'

temselves, concludes that 'all sympathy must be

referred to the brain itself and spinal marrow.'

The most convincing proof of the whole he conceives to

be this, that when any of the muscles of the legs of a

frog are excited, most of the muscles of the legs and

thighs contract soon after putting off its head, if the

spinal marrow be left entire: but when that is destro-

ed, although the fibres of the stimulated muscle are
affected with a weak tremulous motion, yet the neighbouring muscles remained perfectly at rest. "In many sympa-
thetic muscles, both in a sound and diseased state, we can plainly perceive a power: potentia"; but "these
motions are to be referred to that power which
animates the whole frame, and which endeavours,
at all times, to free the body from whatever occasions
pain or unpleasantness." Whewell therefore opposed the doctrine
of nervous anastomosis, believing in the existence of mo-
tions which were involuntary, but did not believe in
the existence of motions which were independent of the
mind. Yet there were physiologists who long ago recog-
nized a class of actions, excited by external impressions, which
never became sensations. Of these physiologists Whewell was
one. He was aware, indeed, that nervous and motor fi-
bres were distinct from one another as such, and put them
equal regard to their peripheral distribution. They are," he says,
"identical in structure, and only differ in their local
relation. Each nerve may be either the one or the other ac-
cording to its distribution; and each motor nerve is, at
the same time, endowed with the properties of the sen-
sory." He thought, too, that an impression applied to
the extremity of a sensory nerve could quite a sympathetic
nerve-action through its own section branches alone;
and this idea, which may vague also as to where reflex
can took place. The 'optimal impression,' proceeded up towards the brain, and 'as it reached there,' was the same what wrote paper on which it might turn back so as to operate like an 'optimal impression.' He assigned to conductional impressions a peculiar range. However, he admitted that they might spread from nerve to nerve through the medium of ganglia. Still, though without a clear understanding of how a reflex movement was affected, without indeed concerning that the cord was implicated in its accomplishment at all, he had quite realized the fact that such movements did occur. He knew moreover that in some instances what was at one time a reflex might, at another be a voluntary motion, and that both reflex and voluntary motions might exist together.

Rutherford distinctly perceived the influence of the spinal cord and of the ganglia in producing reflex actions; he pointed out how they might be excited without consciousness, or with it, or sometimes even against the will; and he observed with Wright, that their object was the preservation of the individual from injurious impressions, and the maintaining of him in such conditions as might be agreeable. People like the others believed the same 'pneum-a most unsatisfactory and indefinite word—to be at once
...and motor—plastic, when an impression was applied to its peripheral, motor, pole applied to its central extremity.

Waller would seem to have been acquainted with a class of movements due to the influence of the cord, in fact with reflex movements, for he distinguished between movements due to the inherent irritability of muscle, and movements which take place after removal of the brain, remarking that the latter may "continue to manifest themselves as long as the spinal cord and medulla oblongata remain uninjured." But that his notion must have been obscure is evident from the following statement of his own, quoted by Dr. Charles Bell—"I know not a nerve which has pliant tissue, without producing motion also; the nerve which gives feeling to the finger is that which moves the muscles; and the first nerve of the brain branches to the epiphysis of the tongue." His opinions as to reflex actions were on the whole much the same as those of Waytto.

With regard to researches into more remote antiquity, while the brain and its functions afforded an extensive field for antiquarian zeal to explore, it is quite otherwise with the spinal cord, on which our more distant ancestors bestowed small attention, and which received from them a scanty literature. Conserved until less...
than thirty years ago as a mere appendage of the brain, or differently branded by any part no clear conception of its functions, and no conception whatever of its structure, it was rescued from its obscure position by J. Marshall Hall, who, whether his ideas be altogether correct or not, has at least the distinction of having been the first officially to refer reflex actions to the cord—"the true spinal cord"—to point out distinctly a path which he considered the impressions producing those reflex actions to traverse, for a road to originate the idea which opened the way to subsequent discoveries. The merit of that discovery, without which those of J. Hall would have been impossible, belongs to Sir Charles Bell. A man who first introduced order among the chaos, by demonstrating that sensory fibres are, from beginning to end, distinct from motor, and, of course, vice versa; and by starting practically proving the theory which Magendie succeeded in proving wholly true, that the posterior roots are sensory and the anterior motor. Plentiful objections were raised against the doctrine at the time, and, although a quarter of a century at least has destroyed the blare of novelty, it has gone perfectly, however. Perhaps we shall ere long see that Bell's earlier opinions as to the track pursued by impressions from the posterior roots through the cord, to the
brain-process far correct, not altogether wrong, as Dr. Brainseghard would make them out, and as Dr. Clarke himself supposed them to be.

I propose to describe the cord from a physiological point of view, because while petting some repetitions it is the only method which enables one either to ponder on the masses of facts, or bear them in memory, or embrace a sufficiently wide range in forming a judgment. To this end I shall describe 1 the mechanism of sensation; 2 that of voluntary motion; 3 that for the so-called reflex, physical, or brain-stimulated motion. I am aware that in this arrangement it will not be possible to discuss any one subdivision entirely apart from the others, and particularly that the last will be pretty fully treated in the examination of the two preceding. The arrangement at all events will cause neither precon- science nor obscurity; as I intend to have as people in breaking through it, whenever anything is to be gained by doing so. Strain it shall carefully shun, and therefore premise a few remarks on the broader anatomy of the cord.

The spinal cord is nearly divided by the anterior and posterior median fissures, of which the former is perfectly pre- sent, and found a division between the anterior columns through out the entire length of the organ; the latter is visible only in the
cervical and lumbar regions, where tissue is narrower than the former, and in the back is quite indiscernible. Posteriorly standing here, as elsewhere, the posterior columns are not entirely separated from each other by blood vessels and connective tissue, which penetrate as far as the central gray matter. The borders of the cord are linked together by means of two commissures, the anterior and the posterior or gray, both the one and the other, however, being essentially composed of fibers, although in the one, they may be chiefly tubular, in the other, chiefly of axons, made up of connective tissue. Vault Clarke indeed denied the existence of a "preferred transverse commissure" either to the anterior or the posterior columns.

With regard to the posterior, there is a partly perforating mass of fibers on the other side, reduced by Rollier, and then by Schwalbe. Based, with regard to the posterior, viewed in the light of these being as direct communication, his statement may be true; for the argument he advanced in support of it, viz., that the posterior fibers extend down to the gray matter, and pass from the column past across through that matter to the opposite side, would not show that they do so pass. Instead, I find no more telling witness against his views than himself, for to proceed farther at present would involve repetition. Rollier remarks that the anterior commissure is proportionate to the
the thickness of the motor roots. The posterior, as Clarke has shown, is broad (not large, however) where the core—

spreading canals are small and confluent; narrow where they increase and become separate. Traversing the cord I am basing Clarke's observation— and situated more or less near the posterior surface of the gray matter, according to the breadth of the commissure, is the spinal canal. It is continuous with the fourth ventricle, and is prolonged into the film terminals; it is lined with ciliated epithelium, according to Holzknecht, which Clarke also states to be cylindrical; and according to both it receives support from a substance which is not nervous. This substance, the former with Pieckow, consists of the hypoderm of the spinal canal, which of the same structure as that of the fourth ventricle. It is composed of a simple layer of epithelium below which a layer of connective tissue is constantly developed. It appears to the later B. Carus, if an extremely fine circular band of fibrous tissue. Stelling, whom he quotes, believed the fibers surrounding the canal are gray—hence that they constitute the gray commissure of the cord.

On, and near, the film terminals, the posterior column having coalesced constitute a mass of gray matter, while the substantia gelatinosa crossed uninterruptedly from side to side. Ascending towards the lumbar site, the sub-

stantia gelatinosa divided, and the fibers of the posterior...
commissure and forwards, both narrowing that commissure and marking off the posterior horns. These become exceedingly broad in the middle of the bulby and are thus equally covered by the posterior columns. The cornea diminishes in size from this point to the middle of the back, where the substantia gelatiosa again crosses as below the bulb. In their ascent from the core the posterior bands of the transverse commissure are drawn as it were gradually backwards, becoming at the same time, less curved, so that the space between them and the spinal canal is now correspondingly increased. Proceeding forwards the changes are reversed, and attain their consummation in the cervical bulb, where the posterior comissure are large once more, though not so large as in the lumbar bulb but are separated by a greater quantity of white matter. Still higher these comissure are thinner, and narrow and compressed upon by a network of vessels below the substantia gelatinosa, and by bundles of fibres from the lateral columns. All these alterations in size and shape have been minutely described and figured by Clarke. Judging from the drawings of other authors his representations do not appear correct, as far as the comissure never coalesce, and the substantia gelatinosa is never divided. Judging from what I have seen myself I am very much disposed to think the substantia gelatinosa extends right across.
why Clarke shows it in the form of a straight line: it certainly has a considerable fall towards the middle line. The anterior cornua, likewise, exhibit a fall marked changes in different regions of the cord. They dilate and decrease along with the posterior but they never are combined, moreover, they are shorter and thicker than the others, and are quite otherwise constructed. Of the anterior, and in the roots of the posterior, ganglionic nerve cells abound; elsewhere in the latter, these pedicles are few, and in the S. lateralis a cell is quite. Here the only cells to be met with are of a much similar to those of the cerebral convolutions, that is, they are small, spherical, not ganglionic, and isolated. They are common too, throughout the rest of the posterior horns, and are numerously scattered among the ganglionic cells and fibres of the anterior. Clarke observes that many of them are doubt nerve cells, but that many others are the cells of a common fibrous plasma. With respect to the ganglionic cells, it is further to be observed, that "they increase in number in direct proportion to the size of the nerves with which they are associated" (Clarke) and not only so but become most grouped together where the greatest quantities of nerve fibres are given.

They are largest, as well as most plentiful in the anterior horns, where according to Van Elst Krabbe, this chief...
groups are placed. A prey essential group; whose connec-
tions he has assigned with much precision, and which had
received special notice from Clarke under the name of the "Poten-
tior Visceral Column", and from Holikin, is situated in
the radiation of the posterior commissure. There is an
other group in the middle of the gray matter between the
Anterior and Posterior cornua; and this is a fourth at
the base of the latter. This numerical order coincides with
the comparative importance attached to them by Van
den Hoef; an author from whom I take the opportunity
of saying I have received more aid in studying the minute
anatomy of the cord than from any other. He believes with
Clarke, the groups to be arranged in columns which in
turn are not independent of one another, but all more or
less intimately connected. A fifth group is mentioned by
Mr. Clarke as being situated at the outer border of the gray
substance between the anterior and posterior cornua;
consisting of small, regularly shaped, caudate cells; be-
coming distinct in the upper part of the dural en-
largements; increasing in the cervical region; dimin-
ishing in the cervical enlargement; increasing in the
epigastric cervical region; where it forms the principal
part of the nucleus of the spinal accessory nerve.

The nerve tubes in the gray matter are very numerous,
constituting according to Holikin fully half its substance,
according to Van den Holth, existing almost alone in the posterior commissure; and according to Lockhart, Clarke, partly alone (though of course with reference to other fibres) in the substantia gelatinosa. They are also very small—Lockhart stating that they have decreased by half from pole to pole in passing into the cord; Clarke that he has seen them 10,000 in a section in a tract that had been sectioned; they are perfectly distinct from the grey fibres with which they have frequently been confounded. There are found also with the tubular fibres, but are scanty in the whole posterior commissure, and in the gelatinosa panchus. A vertical section through those commissure reveals a multitude of parallel white fibres, between which other white fibres run transversely (Van den Holth). Clarke seems to take notice, as well as Van den Holth, of the marginal band of fibres encircling the ganglia commissurales, and to give all definiteness and the latter alone has assigned to them an important significance. In the anterior commissure besides the white fibres, there are many grey fibres, processes of the Gans type cells passing to connect them with each other. They ultimately break up into very fine transparent fibres, which form a most intricate mesh-work, and some of which pass a short distance into the anterior commissure, possibly to be continued as the angioblasts of some of the tubes. The fact of their passing out has not been recognized by Holth, who assumes they all
the posterior half of the cord proceed on the supposition that it constitutes a semi-circle, which is very nearly the exact truth.

Let \( A \) represent the posterior portion of the cord in the Superior Cervical region; \( B \) in the Cervical Bulb; \( C \) in the Dorsal region; \( D \) in the Lumbar Bulb.

- \( A \)'s diameter is \( 7\frac{1}{4} \) lines
- \( B \)
- \( C \)
- \( D \)

<table>
<thead>
<tr>
<th>Cervix</th>
<th>Cervical Plexus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Breadth</td>
</tr>
<tr>
<td>3</td>
<td>( \frac{3}{4} )</td>
</tr>
<tr>
<td>4</td>
<td>( \frac{3}{4} )</td>
</tr>
<tr>
<td>2(\frac{1}{2} )</td>
<td>( \frac{1}{2} )</td>
</tr>
<tr>
<td>2(\frac{1}{2} )</td>
<td>( \frac{1}{4} )</td>
</tr>
</tbody>
</table>

Area of White substance around the Cervix:

- \( A = 39.55 \)
- \( B = 53.74 \)
- \( C = 23.75 \)
- \( D = 35.058 \)
Proportion of White to Central Grey Matter. Proportion of White to Both Corners.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3712</td>
<td>100</td>
<td>1759</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2534</td>
<td>100</td>
<td>1791</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2375</td>
<td>100</td>
<td>1900</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1752</td>
<td>100</td>
<td>1121</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Proportion of White & Central Grey Matter + the Corners:

- A: 1111 to 100
- B: 1048 to 100
- C: 1041 to 100
- D: 608 to 100

Let the same letters represent the same parts in the anterior portion of the cord.

Area of A = 11
Area of A's horns = 1 1/2

B = 10 1/2

C = 8

D = 9

Area of A = 11
Area of A's horns = 1 1/2

B = 10 1/2

C = 1 1/2

D = 1 1/2

Proportion of white matter horns on A: 633 to 100
B: 460 to 100
C: 433 to 100
D: 200 to 100

Rolleri's measurements agree on the whole; Parrot's plates, being all magnified twenty diameters linear, cannot be...
The comparison with the other is stated to have been made with the same degree of accuracy as those of Todd and Arnold. Otherwise inferred, the amount of white matter in the superior cervical region, this is no difference of importance, physiologically speaking, between any of them. Dollken would make the larger quantity of white matter in the superior cervical region than in the cervical bulb, while according to all the other, their relation is exactly the opposite. Van der Horst says that Arnold's plates show in the superior divisions of the spinal cord the posterior & postero-lateral columns to be much increased, and in that case it is certainly mistaken if the plates are correctly copied into Dandy's anatomy. The white matter on those columns therefore appears more abundant in the cervical bulb, less in the superior cervical region, still less in the lumbar bulb and least in the spinal region. The posterior comes in largest in lumbar bulb, increased in the neck, of considerable size in the cervical bulb and much smaller in the lower part. In its proportion to its size, the gray matter diminishes from the back to the upper part of the neck than the white cord, and the one to the other greater in the lumbar bulb, less in the cervical, least in the back and superior cervical region. The anterior and antero-lateral columns are not as large as the posterior; their size also is more uniform, but they nevertheless are different.
changes precisely similar to those which this other mineral.

The horn also had like those behind them, but had a
much higher proportion to the white matter than the posterior
white matter. Consequently, the remarks made with reference to the rela-
tive quantities of gray and white matter in the posterior half
of the cord, are equally applicable to that organ in its
entirety. These are extremely important facts, and have
strong bearing upon the subject question. These impres-
sions are transmitted through the cord, for which
reason I have dwelt upon them somewhat at length.

From the future surface of the corona transversa fibres
of a ray, more numerous at the situation where the nerves
merge than in those interweaving, and most numerous where
the nerves are thickest, pass into the white columns.
This nature has been much disputed, and is told 'ad
judice.' It would seem certain that blood vessels from the
gray matter & the corona fun. alongside the rays, but it
seems equally certain that they are more than mere blood-
vessels. Clarke concludes them to be processes from the cells,
particularly from those near the margin of the gray matter, pen-
etrating the white matter, by the fibers which contain the
vessels. Toldt thinks them processes of gray matter of the same
structure & color as the central mass; while Van der Holst's
plates make them appear to be white tubular fibers. Po-
Sally the grayness may be owing to the vessels which are situated beside them. This relation to the cells, to the nerve roots, and to the white columns, will be considered hereafter, in accordance with the plan I have already indicated.

The vessels of the cord pass into it from the Perineurium. This membrane does not into the anterior or posterior fissures, by means of which, of the nerve roots, and of the spina, the vessels are conveyed to the gray substance; whereafter having distributed branches to the polite, and "without having become narrower to any considerable degree", they form a minute network. Rollier says that where they enter the cord, they are partly arranged in series. The first at the bottom of the anterior fissure, one in the posterior, "and other not infrequently correspond to the roots of the nerve, and the attachment of the ligamentum denticulatum." Clarke describes them, observing that pouched the margin of the canna they constitute a network of loops, that round the spinal canal also vessels from the bottom of the two fissures, and the posterior white columns pass on; while other branches pass out through the canna and join the peripheral loops. They are expressively like the nerve fibers and hard to be distinguished from them. Besides being strengthened by the vessels, the median of the cord, according to Rollier, receive support from a quantity of connective tissue distributed throughout it in laminae.
are the plasma cells which have been formerly adapted to.

Now only remains to say a few words concerning the roots of the nerves before proceeding to follow them into the cords. The posterior are thicker than the anterior—the sum of the transverse sections of the former being more than double the sum of the transverse sections of the latter. While thicker, however, as a whole, their individual nerve tubes are finer by nearly a half so that the number of fibres passing in Belz's is almost four times as great as the number entering in part, though on pulling adrenin the cord the posterior roots may adhere rather to the posterior column of the lateral column, than to the posterior column itself. Besides, it is wrong to say that they are therefore exclusively attached to the former. Nor can follow them as stiff without perceiving that some fibres pierce the one, and others the other. If those roots are now admitted by every one to be purely sensory—just at all events, and as the arguments which till contrariwise have been so fully explained away, there is no occasion for saying much more about them. I merely remark, therefore, that I was led to think they were formed of fibres supplied to the skin alone. This part, it is believed, to be centrifugal, but centrifugal also, serving as a way to convey tactile and other impressions to the centres and to produce those cutaneous movements to which it is needless to observe are due to the action of muscles and the nerves supplying them.
As respects the anterior parts he held them to be the distributed 89 muscles alone, and to suffice both for causing their contraction, and for informing the mind of their condition. Brown Seaward has a certain amount of faith in this doctrine because frogs can move nearly as well after as before all their posterior parts have been divided. But when it is borne in mind that, although so near an operation has been performed and that path for impressions cannot cross, the mechanism for grouping together and harmonizing muscles in their actions has not been interfered with, that further most of the voluntary movements of which a frog is capable have been so frequently repeated that groups of nerve cells, if not already ready made at birth, must be formed in consequence of being pressed many times combined. To combine in their turn the muscles necessary for effecting these movements, that the tendency of these groups is of course always to act together; that by eventually harmonized motions may be accomplished without any appreciation by the mind of the state of the muscles; when these facts are borne in mind, the views of Arnold do not derive much weight from the experiment mentioned. Indeed it is only by believing that there are different nerve fibres for different impressions (an hypothesis which I take to be very far from proven) that Brown Seaward can accompanying Arnold so far as he does. For he has observed that no pain is caused
by the application of a galvanic current to muscles, the post-
erior roots of whose nerves have been divided. Consequently
this sort of impressions travels through these roots, and
not through the anterior. But the singular thing is that,
after all, both sorts of impressions turn out to be the same;
for a few pages before I read him saying that muscular
contraction produces sensation by a "change in the
galvanic state of the muscle." As Menard asserted
that a current from a battery gives rise to an impression
which constantly passes by the posterior root, and that
a current from a muscle gives rise to an impression
which constantly passes by the anterior root. His own
proof I know of nothing which can prove the existence
of other than motor fibres in the anterior root.

My further task is to decide what the course of the
feeder of the nerve roots pursue after having entered the cord.
Beginning as proposed with the posterior roots—do the fibres
which conduct these impressions that proceed to the brain,
pass directly thither, or do they terminate in the gray matter
of the cord? If they terminate in that substance do the im-
pressions travel upwards in it or do they emerge to travel by
the posterior and postero-lateral columns (like the pinnae)
and the afferent fibres identical or different? These are questions
which it is as necessary as difficult to answer.

There can be no doubt that part of the fibres of the posterior
roots pass into the posterior columns, with which princep Clarke\footnote{Clarke, 1774} affirms that they are alone connected. Holliker's observation, however, that they not only penetrate the posterior columns, but the region also joins the posterior and posterolateral columns as equally, seems to be the more correct. He thinks that the fibres proceed to the gray matter both in an ascending and a horizontal direction, but he takes no notice of those which assume a descending course. Yet although they have been overlooked by him, as well as by Van der Holst, who purely represents the portion of the post at bend, my view is that the gray matter to pursue a straight course upward to the brain, and another portion as passing directly to the gray matter of the cord, such fibres progressively split. They appear to have been first pointed out by Mr. Clarke, who remarks that the bundles which pierce the lamina may be traced into small roots, above, below, and on the same plane forth, themselves. The presence of descending fibres has been confirmed experimentally by Brown's reagent. He found that in dividing the anterior from the posterior part of the cord, in a longitudinal direction, and in cutting through the posterior part thus isolated, in a section at the middle of and in a line at right angles to the longitudinal section, the lower portion still retains its sensibility, provided a few fibres of the roots and some little parts of the poste-

ior gray substance remain attached. It would seem however that these fibres neither pass very far before they enter the posterior matter, for he represents a spinal cord divided in its
posterior columns at two heights, with five pairs of posts between the sections, and he states that in posts so placed sensibility for cuts, while it is lost to a pair post the section immediately above and another below them. Thus for the apparent pain produced by irritation of the central segment in the first experiment may be owing to reflex action. I do not rely on the mean time to prove the phenomenon which occur, whether voluntary or physical, from at all equal what Clarke says to the true, that there are fibers which enter the gray matter at points lower than those at which they enter the white.

While traversing the columns the posterior radical fibers from a definite point parallel to those very minute fibers that radiate in the corona. A drawing of Van der Kolk's diagram with this fiber display also terminates nerve fibers which lighter in color than the rest of the column ascend between the transverse bundles. Apart from the question relating to no fibers pass to the brain from those which originate from the cells of the cord, it is now generally admitted, as was indeed at the outset asserted by Hering, that these ascending fibers enter the gray matter farther on in the column for an assertion which Hering puts the case of Todol, Wagner and Wundt, who hold that all the nerve fibers terminate in the spinal substance. Van der Kolk too now agrees with Hering having recanted his first belief, and adopted the doctrine that the passing fibers pass into the gray matter.
It is to be presumed of course that since he had come to regard the ascending as efferent fibres, he believes them also to enter the cornea. When Holstein otherwise described the whole of the fibres of the posterior plexus as entering the cornea, while Clark's description is thus far to the same effect, except that he conceives some fibres being lost to view in the posterior columns that they may ascend directly to the brain and when physiology had proceeded any other position plausibly, it is impossible to deny evidence to a fact so attested.

How the fibres compact themselves in that gray matter to which they have now been traced, has been a point in a bone of much contention among physiologists, especially leading my author inability. We may try to throw some light of the subject, this to receive a good deal of what has been said by others. In experimenting, my failure has been in a more lamentable, and any want of success in making the sections I desired in the cords, when I berries separated from their bodies, having been completed I was not disposed to torture creatures without any prospect of obtaining an adequate result. It would afford me great satisfaction, and would the breaker in its possibility could I see the cord so divided for instance, that while the posterior column shall be left perfectly untouched, the posterior cornea shall be entirely cut through. On entering the gray matter...
the posterior fibres of the posterior roots take different directions, some passing up and others down immediately in front of the substantia gelatinosa, some passing forwards between the longitudinal fibres. Although Kohler seems to think that the longitudinal fibres remain longitudinal throughout, partly passing into the posterior and lateral columns, partly passing back again into the corner, Clarke's opinion that this sheet of tubercular matter gives off fine bundles of fibres which proceed forwards, is much more probable. With these fibres are joined from roots at various heights, other fibres which pass horizontally at once. Bundles of these, having penetrated almost as far as the basis of the anterior corpus, break up and interlacing with each other, constitute a network on whose meshes lie ganglionic cells, those, namely, which form the posterior peduncular columns. Between the fibres and the cells Clarke has observed no union take place. But though it is not certain whether the existence of a cellular connection between the fibres of the anterior and posterior roots is assured, that latter proceeding in bundles, directly into the former. As was Stilling's opinion, as quoted by him, much other for he thought a connection between the pores was maintained without the intervention of cells, and solely through the medium of gray fibres. According to Clarke, many of the fibres
from the posterior roots pass out also into the anterolateral & anterior columns; some pass between the spinal canal and the anterior median fissure—that is, I would say, they form part of the anterior commissure—into the same columns. On the other side, lastly, as what he has named “posterotransverse fibers” come into the gray commissure, and passing in large numbers the limit of the spinal canal, diverge on each side into the anterior and posterior gray masses, and extend into both the posterior and lateral white columns.” Rollinder puts the facts succinctly and says, that these fibers “are finally lost in the anterior horn, in the gray & white mass, and the anterior commissure.” They would pass, therefore, if Clarke’s views were correct, into the anterior roots, and the antero-lateral columns (including the anterior) of the same side; and into one of the columns on the opposite side. It is needless for me to point out how irreconcilable these opinions are, both with the varying size of the cord, and the results of experiments. As far as the conduction of sensitive impressions is concerned, I would now again beg to remark that from such statements correct we could find a division of the cord into half the cord, partial pinsonian paralysis on the whole body, instead of what actually is found, complete pinsonian paralysis on the opposite side.
But the theory of Van den Hoff is by no means open to the same objection, and seems to me untouched by any argument he has adduced. The only part of it that will substantially be his subdivision of the fiber into sensory and motor sets—an hypothesis combated both by Todd and Wagner. Were the two distinct, we should certainly find the occurrence of sensation along with diastaltic action much less frequent, seeing that according to himself, both sets of fibers must with cells thus ought to be special groups for either function; whereas the same group receives all the fiber, the difference in the mode of operation being that, for the production of sensation, the stimulus passes from the cells to the apparatus to the opposite side, and thence to the brain; for the production of a diastaltic action, it passes from the same cells to a group on the same side, with which the symphonic fibers are connected. This arrangement evidently of sets with a view to the preservation of the individual, for if the stimulus for such an action crossed over and caused the limb of the other side to move, it would prove no good purpose whatever. Although he cottonizes Brown-Squard's experiments to require time to condense B.A. plus, these fibers which he previously considered effector, it does not follow, unless the two sets had been first of all clearly proven distinct, that what he thought sensory must therefore
become empty. Since they have not been proven distinct, this circumstance makes it more probable that they are identical, showing at least nothing in the state of the nerves themselves, to prevent the one set from performing the functions of the other, and of course depriving all weight to the contrary statement which he urges as an objection against the opinion of Wagner. By the der Hof's aon showing the ascending fibers must enter the cells before they can execute their reflex function, and while it is probably true that this function pertains to them, there is no reason why they should not be sendy as well as the more directly transverse which enter the same cells. Hence I think that one half of either pretension is correct, the other half incorrect, neither the ascending nor the transverse fibers are merely 

fibra nor simply sensory, but each fiber in both divisions carries (in the case of the pretension which may develop) a sensation in another a reflex action. Leave this subject for the present as I shall have occasion to refer to it again when speaking of the mechanism for effecting the last named action. Meantime it may suffice to state that the object accomplished by the division of the post seems to be the affording of a larger communication with the peripheral matter to a more limited part of the body than could otherwise be accomplished—a fact which, along with other things, to explain the much more frequent persistence of sensibility.
city than the power of voluntary motion, after extensive injuries to the cord.

The posterior fibers, having traversed and perhaps assisted to form the marginal band, which girdles the posterior cornu, pierce the substantia gelatinosa, and arrive at the group of cells situated on the radiation of the gray commissure. Of this group they are lost and with it in all probability they unite; but their extraordinary minuteness has prevented van der Holst's being able to decide on this point with perfect certainty. These neurons are not the only fibers which disappear in this ganglionic group. The marginal band which is chiefly derived from the rays not only encompasses the cornu but also extends to its base, and thus enters the same group. It likewise transmits fibers to, and receives fibers from, the opposite pole of the cord, and finally it is connected with those fibers already noticed which pursue a longitudinal course in the posterior cornu. Indeed that the whole of these fibers pass, or their continuations, pass from one half of the cord to the other, has been affirmed by many anatomists and rendered certain by the investigations of J. Bonn. Lequard. He finds that on dividing the cervical enlargement bilaterally the possibility of this anterior link is lost, probably because these fibers are cut through. He further finds that the posterior fibers which are
hyposesthesia. 2) After the operation will each of them lose its sensibility on the opposite half of the cord being divided. It therefore follows that the impression, which has arrived at those cells in its onward progress, transmitted across the cord; and as the fibres which convey it do not pass out of the gray matter, but unite with the corresponding gray of cells on the other side, that becomes the next stage of the impression’s journey. These cells Van den Burch thinks are arranged in groups—be speaks principally, indeed of the cells in the anterior columns, but neglecting, if what I have now is partly, regard to the disposition of the sensory fibres, the same remarks apply to the cells generally under consideration, each of which groups he conceives may be looked upon as typically connected with the brain by only a single fibre, and really by very many fewer fibres than those which enter the group.

The next link in the chain is formed by the pons which are composed of fibres emerging from the groups surrounding the cornua, piercing transversely the posterior and posterolateral columns, and continually leading up to run longitudinally in these columns and their continuations, until they reach the brain. An experiment related by Baro de Segura, in which the whole cord above the posterior columns was divided, showed them also to be capable of conveying impressions, though very feebly.
the brain; and showed too. I may remark, by way of analogy, how probable it was that when sensory fibres emerged from the gray matter in one situation, they should emerge from it in another as well. The conductors for purposes herefore according to this theory, ultimately almost entirely the posterior and postero-lateral columns, and from exceedingly small extent the anterior columns, and as doubtless that part of the lateral columns which is usually conjured with them in function. This theory is not opposed to the fact that stimulation may manifest itself although all the conductors have been cut across in any particular column, or some of them in every column. In this regard, every small portion of the conducting grey in a lateral half of the spinal cord contains conductors of sensations proceeding from all the parts of the body in the opposite side, which are behind the place of this small portion. Since then the posterior column is destroyed, the posterior-lateral will cause sensations to the brain. Opposite persons, and when portions of both are destroyed, the remaining will to a certain extent perform the functions of the whole. But the theory is most decidedly opposed to the statement that, including the faint influence of the anterior white matter, possibility remained much less is increased, in the parts behind a portion of both posterior and postero-lateral columns. Rather it ad-
parts that sensibility diminishes from a part, should the corresponding part of the posterior vesicular columns be destroyed, even if the whole columns should continue intact. A destruction of the gray matter does not deprive the parts behind the injury of sensibility, while destruction of the white matter has that effect, saving that, above the injury these are fibers from parts behind the injury which have a communication with pots by conducing the pain-interrupted course upwards to the brain. It is the only theory which is in harmony with the varying size of the cord in its different parts, at different heights, which is at all in keeping with the opinions of other anatomists, and which while it is not entertained by his affirmers, enables the difficulties of that advanced by Brown-Squard.

Of the many obstacles against which the experimenter had to contend, the danger of mistaking between sensation and voluntary motion on the one hand, and motion from reflex action on the other, is not the least. From but the only signs of pain are the movements they make, and these being directed to the skin and at times which take place through the medium of the cord alone—the withdrawal, namely, of the body from whatever is debilitating—are identical with them. In the one case, the animal's safety is seen to be itself; in the other, it is provided for independently of the mind; but in the one case, and in the other, precisely the same means are employed to attain the same object. Thus do the actions
If a decapitated frog would suppose them to be performed otherwise than by the influence of motion, and joints could distinguish what is voluntary from what is merely physical? It has been well observed, too, by Van der Holtz, that if the brain be cut off above the pineal body and the fifth pair of nerves be strongly stimulated, the animal will cry out, although without consciousness, without perception, and without the feeling of pain. Writing, in fact, and the other vocal modifications which are commonly supposed to denote pain, are nothing more than reflex actions. It will be necessary therefore in order to support this theory which has been advanced, to find instances of "articulate speaking men" who have lost the posterior and postero-lateral columns of their cords destroyed, and yet have retained their speech, or who have lost the sensibility of all the parts behind the part of an injury to the gray matter—the channel of communication through the white matter being uninterrupted.

The theory Brain leaped on proposes is this, that impressions, with the exception of those which enter the anterior white substance, ascend to the brain in the central gray substance. He endeavors to establish it by proving, in the first place, that they do not ascend in the posterior nor in the lateral columns nor in both combined, nor in the same columns associated with the posterior column; and, in the second place, by showing positively that they do ascend in the locality he mentions. The method he adopts is the following:—he divides the posterior columns and
finds hyperesthesia; 2) of the parts behind the posterior, he acts similarly on the lateral columns and with a similar result. He divided all the cord save the posterior, and all the cord save the lateral columns, and in similar cases the result is the same, viz.: loss of sensibility in the parts behind. He divides all the columns of the cord in the dorsal region, each section being at a different depth from the others, and he finds that sensibility still remains. He divides the anterior half of the cord, and he divides the posterior half of the cord, and in both instances the so-called sensibility is preserved. The most telling cases he brings forward in support of his that the posterior white matter does not take up impregnation are two of Dr. Schultze's. One of them, and the other is the Dr. X. is as follows: A man, aged 23, after having had cramps, paresthesia and weakness in the lower limbs and paralysis of the upper limbs for a long period, was admitted to Bellevue. The patient was bedridden everywhere. On the evening of the 4th November he was able to walk but not held by some one. Sensibility continued everywhere to the last moment before his death on the 5th November.

Autopsy. Encephalus normal. There was in the duration of the spinal cord from its upper extremity to the third dorsal vertebra, and from the fifth dorsal vertebra to the upper extremity. The tissue of the cord in those parts being cut was found nothing like for certain, hard and difficult to be crushed. The gray matter was also a little darker than normally, but of its usual colour. The anterior posterior
post seemed normal. In the space between the 5th and 6th
discal vertebra the cord was soft, soft, soft, resembling
a whitish, a rather yellow, yellow, punctuated in some places.
When placed in water many parts became disintegrated, and
formed a kind of emulsion. This alteration affected only in the
white substance, the gray on the contrary seemed to have pre-
erved its normal consistence. The microscope showed that
the gray matter in both the softened and the indurated parts
contained normal cells and fibres and normal blood-
vesels, while the white substance, in the softened region, con-
tained but rare fibres which were altered, containing a oily
matter and granulations. There was also a quantity of granu-
lated corpuscles of inflammation, with many Capillaries,
oily drops and Annemarcn matter in the indurated white
substance, there was no alteration, and the fibres were more
normal and numerous. — Case 22. p. 82. Now we are told
that sensibility existed everywhere. But since this was the case,
when so large a portion of the cord was damaged, the sensory
fibres passing into the gray matter cannot have been all
destroyed, and this fact renders it unnecessary for us to
believe that all the fibres passing out from it to the brain
were destroyed either.

The rest of the evidence, B. Readall looks is compre-
henient to show that the posterior column may be destroy-
ed and sensibility continue, but it is not competent to
show that when posterior and posterior-lateral columns are destroyed together, the sensibility continues. The final case intended to demonstrate positively that the gray matter is the channel by which stimuli reach the brain, although how it does so in the way least, I cannot perceive. It is short, and I will quote it. "A gentleman suddenly lost all sensation and power of motion in the lower half of the body. Twenty-four hours afterwards there was a feeling of numbness in the hands, and imperfect power of using them. No right movement. Autopsy. Two small clots of blood amounting together to a little over a dram were found in the interior of the medulla, occupying about an inch and a half in extent, and situated between the origins of the second and third pairs of spinal nerves. The substance of the cord around the clots was somewhat soft; the medulla was more or less infiltrated and stained with blood from the site of the clots upwards, as high as the third cervical vertebra, and downwards as low as the last dorsal." Case 27, p. 86. Phys. Clin. 1871, seq. What does the case teach? Simply this, that stagnation of blood into the interior of the medulla deprives the parts behind of sensibility. If statements be properly made, can have any effect whatever, they disprove, rather than prove, the supposed thing. Maybe it is clear that hyperesthesia exists in man after an injury to one of the columns. Certainly there is no iota of proof that it exists after both have been destroyed.
Taking Case 77 as an example of the others we have a man suffering from paralysis along with acute pain in the lower limbs and abdomen, and the post mortem examination reveals a tumour two inches long, Stiff lined, wide, pressing against the left and posterior part of the cord, which was replaced in situ at the seat of pressure only, with her feet below it seemed after this excised. But what of this? There is no mention of softening higher up, and the tumour irritates the healthy cephalic end of the compressed pyramidal fibres which convey impressions from the parts below, and when subjected to a stimulus in the cord reflexes (causes the most reflex action) to those parts, the painful impression.

On examining in the light of clinical and anatomical facts the deductions which he draws from his experiments, they will, I believe, be found unwarranted. Possibly after dividing the posterior or lateral column, there may be suppression without although sensory fibres have been cut through, owing to the fibres which are left having been thrown out to the spinal cord by the operation. But I am now inclined to think that the supposed hyperesthesia is to be accounted for by the circumstance that when the path to the brain has been broken up, the impression is not from being an electric agent but because the cut fibres do not have any means of discharging the current, which enters it, and partly becomes charged to the utmost, passes the cells situated at the meeting of the anterior and
posterior column, travels upwards & downwards in them, and makes itself felt by the motor roots, causing disturbing sensations &
the other phenomena which are regarded as shooting pain.
The greater the number of emerging sensory fibres divided,
the more will the reflex phenomena manifest themselves.
Hence the mistake that when both the posterior and lateral co-
lumns are cut through hypnæsthesia is far more increased
than when one only is divided, and hence why no similarity of
a case can be made with clinical or post-mortem observa-
tions on man. This explanation likewise applies to the ex-
periment where all the columns of the cord were cut in the
dorsal region, and the posterior column seemingly retained
sensibility. Voluntary movements of course are stopped by
the section of the descending fibres, but as the injury to the
directly motor fibres is purely local, reflex movements con-
tinue. When the anterior half of the cord is divided, there
is no reason why sensibility should be diminished; when
the posterior half is divided, the apparent effects of an-
sibility are the actual effects of deafferent action. With re-
ference to this dividing all the cord in one case save the lat-
eral and in another save the posterior columns, and finding
that in neither sensibility was lost, I have to remark first
that the correctness of the statement is disputed; se-
condly that when a little grey matter is left individual sen-
sibility remains, and that it is an utter impossibility
And I pray in the holy name of communicants—
against whom some persons
may—
for any human being to divide all the gray matter of the cord and leave any one of the columns intact, and think of that when all the gray matter (of which there must be a considerable distinction from ephemeris) all the anterior, all the lateral, and part of the posterior columns have been cut through. It is small wonder that irritation is changed for shock, and that sensibility should no longer appear. These, then, are the means by which Brown-Séquard proposed to overthrow the theories of other people; I do see how this new thing stands the test of anatomical facts.

All agree that the gray matter is in a direct ratio to the quantity of white matter passing into it from the nerves. Now were the thing we are examining true, the gray matter should be found increasing as we ascend in the body, disproporionately to the size of the nerves which enter, since it had not only to receive impressions from them, but to convey up impressions received at a lower point. It cannot be that impressions received in the superior part of the cord ascend by those cells which receive impressions higher up, for that irremovable confusion would be introduced by every impression causing a sensation to be felt in the whole body above the situation of its entering the gray matter. Therefore gray matter must be provided for carrying onwards, as well as for receiving impressions, and this would make the proportion of that substance to the white
much greater on the high, than in the low regions of the cord. But what is actually the case? Referring to the measurements given on a former page we find exactly the reverse holding true; we find indeed the white matter decreasing considerably in quantity in the back, and again in the superior cervical region, but we find the gray matter in these regions decreasing to more than a proportionate extent. The decrease of vital substance is evidently owing to the presence of minute sensory fibres, a circumstance which also explains the small quantity of vascular matter, it being always directly proportionate to these, while the proportionate increase of white matter in the back, and in the upper part of the neck, is the consequence of the many additional ascending fibres from the cells of the lumbar and cervical bulbs. These remarks are equally true whether the comparison be held as instituted between the white and central gray matter, or between the former and the latter of the gray matter of the conus. In fact the two are physiologically coalesced, and any attempt at a separation being purely artificial, can serve no good purpose.

It is proper to observe that in a diseased state cells seem capable of stimulating those both above and below them. But the result is the feeling of sensations in the parts to which the stimulated cells correspond. I have lately seen this circumstance illustrated by a case of ulcer of the stomach,
where painful sensations were felt over the whole left side of the chest and abdomen. They were stopped, acting in the suggestion of Dr. Todd by the application of ice along the spine. When the cells of the posterior vascular columns thus operate upon the latter (more or less protective), the result, when the cells between the anterior and posterior columns, move a less plectial sheath, acting take place; when the cells of the anterior column cannot be limited to the performance of any particular movement. It cannot then be admitted that the gray matter is the medium for conducting impressions to the brain. It follows that that medium effect on the white matter, and it is plain that the parts of the white matter so employed are almost exclusively the posterior and posterior-lateral columns.

The theory I have adopted shows well the analogy existing between the portion of the cord designated as the vehicle for impressions, and that as the vehicle for action. The proportion of white matter to gray varies in the same manner in front as behind. In both cases we see on the back a very large increase of white matter over gray for the reason already given; in both the proportionate increase in the cervical bulb is not as great in the first ascending fibers from the back as those, the entering fibers are many and the gray matter is sufficient; in both there is another considerable increase in the superior cervical region, because there...
are added.

Many new ascending fibres are, because the roots of the upper cervical nerves being smaller than those of the lower cervical nerves, (Stirn) the quantity of grey substance in the former situation diminished.

The anterior nerve roots pierce the cord in bundles without forming any intercalament in the white matter. After having penetrated a band of fibres which encircles the anterior horns they pass, according to Mander and Koch, into cells situated thus. At their place of entrance several cells are to be seen sending off filaments into the roots; other fibres again can be traced to more remote cells, and others from the thinness of a sector have their connection with cells cut off. Although the great distribution of collateral impressions does not take place in the cord, some fibres cross from side to side from the group of cells into which the fibres pass, thus leaving, which proceed to the opposite half and in that situation partly running along the pole of the anterior fibres turn up into the anterior columns, partly entering the grey matter mingle with the fibres of the rays, and with them pass into the longitudinal columns. Brown eyripand says "there is always pain in mammals, after a transverse section of the whole of a lateral half of the cord, at least some appearance of voluntary movements in the side of the injury and always also a diminution of voluntary movements in the opposite side, so that in animals there seems to be
in the spinal cord, a discussion of a few of the voluntary motor conductors. The decussation anteriorly as well as posteriorly occurs before the conductors of the impressions have commenced to travel longitudinally in the cord. In the one case the decussation required to take place in the one skull of Cognatar in the other where the sensory fibers enter the gray matter. Anteriorly as well as posteriorly the cays form the medium of connection between the cells and the brain; and, anteriorly as well as posteriorly, the cells are arranged in groups, each of which Van der Rolk thinks a single fiber might be able to change with nervous force, although he does not think it probable that nature would entrust its important animal to one single delicate filament. Yet while the number of filaments from the brain are so few as to render the means of communication unsafe, they are few enough to account for the size of the anterior white matter at its various heights. B. Magendie's experiments seem to show that the number of conducted in the different columns of the cord vary disproportionately at varying heights, but it cannot be easy to decide on so delicate a subject. Van der Rolk further conceives that there are anatomically distinct groups of cells for each distinct movement, and that this circumstance explains the cause of its being impossible to act on some muscles less when combined with others. He urges this hypothesis
his as an objection against the opinion of Hollkne that the fibres pass directly from the brain stem. As far as this individual matter only is concerned, the proofs could with equal probability be conceived to issue from the brain as from the body. And, even as it is, the mind must concentrate its influence on some particular brain cells, before it can impart a stimulus to the fibre which is to convey the impression to the group of cells in the end. I cannot help doubting, however, whether there be anatomically distinct groups of cells at all. And I am disposed to agree with those who believe that any ultimate separation is the effect of an educational process initiated by the frequent applications which we are compelled to make in order that our purposes may receive fixation. But will give rise in the long run to artificial groups.

Hollkne conceived that the fibres of the pons to the gray matter, having reached the gray matter, pass chiefly in two directions. One proceeds backwards and somewhat inwardly along the pons, the front part of the anterior commissure passes through a group of cells, but without forming any communication with them. Arrived at the anterior commissure, it enters, crosses over, and finally ascends in the anterior column of the opposite side. The fibrous spread backward and direction of the anterior root to the thalamus posterior, as lost in the intricate network. The second set passes backward and outward through a group of cells into the an-
two lateral columns of the same side and ascend first to the brain. Helvétius admits that fibres also exist which originate in the cells of the coral. Clarke states that on reaching the gray matter, the fibres break up into smaller bundles and then assume different directions. Some pass inward partly to enter the anterior column of the same side, and partly to cross over and enter the opposite anterior column; some pass outwardly partly to enter the anterior lateral column and partly to cross over in the posterior commissure; some pass backwardly, but these it is impossible to trace. As the objections to these opinions are very similar to what have been already advanced with regard to the posterior root, it is unnecessary to repeat them now.

I may mention however that with the all-important exception of their doctrine as to cell connections, the views of Dr. Clarke and Van der Stelk are not incapable of being reconciled as far as the distribution of the radial fibres is concerned. The former, for instance, says that fibres of the posterior root cross directly in the transverse commissure; the latter that they first of all are united with cells, the former that other fibres pass directly to the anterior root and to the anterior and lateral columns; the latter that fibres pass to cells which give off fibres that proceed to other cells whence the motor nerves originate, and from which rays penetrate into the columns Clarke has mentioned. If so,
I have already stated what I believe to be the mechanism of diastaltic action, and I have also stated reasons why there should be no difference between the muscular nerves which develop such actions, and those which develop sensations. The fact that all the nerve fibres are inserted in the gray matter of the cord is a strong proof that the two sets are identical. Their being separate could be of no advantage, as every diastaltic action is capable of being performed without any need of such an arrangement. Yet, and really, in a case of this sort "ceci n'est pas un pipe" is an argument which may be used with propriety. Dr. Marshall Hall seems to have been upon his guard against asserting that there was any anatomical distinction, and to have confined himself to arguing for a physiological distinction between the sets. Now, although a sensation of diastaltic and paralytic are two different things, yet if they be produced through the medium of the same fibres, those fibres can scarcely be that account be said to be physiologically distinct, unless indeed the sets of stimuli conveyed be different in the two cases. Thus, Dr. Hall considered that the stimuli were different, he considered that the stimuli which passed along the incident nerve to evoke a reflex action was identical with that which passed along the spinal, i.e. it was a motor stimulus which ran along a cen-
trijetal nerve fibre. But this hypothesis is not called for; it is opposed to all analogy, and it is totally unproven. Moreover it is an inconvenient hypothesis to hold, for the fibres must be conceived either to be or not to be the same. If they are the same then one fibre is both a sensory and a motor; if they are not the same then there is no occasion for any reasoning about anatomy or physiology, and the preceding remarks become applicable. We have seen, however, that unless the stimuli be distinct we cannot admit the fibres to be physiologically distinct, without being anatomically distinct also. Since those who believe in the one doctrine must likewise believe in the other, Dr. Carpenter and Mr. Newport have tried, but not successfully, to show that in insects the two sets of fibres are separate, and to argue from the circumstance that they are separate in man. It is sufficient to refer without mentioning it, to Dr. Todd's reputation of their opinions. There are two other objections which he advances against the theory, namely the influence of certain or paralysed limbs, and Paralyses of the Eosphinetic Ani, in certain cases of brain disease, where the influence of the cord or other muscles is not interfered with. For these reasons then I adhere to the view that the ephipo-motor nerves are identical with those which develop
a plasmaton and respose to the stimulus of motion.

Such then is the power which the cold possesses over muscular contraction. But there resides in muscles a power of contracting altogether independent of the nervous system—a power which, when too much lost sight of in disease, I shall hereinafter describe in propositions on this subject, without attempting to prove them correct, deferring this for an opportunity when I shall have more time to do so satisfactorily. They are as follow—

1. That muscle naturally tends to contract—witness the approximation and parings of incisions by Dr. C. B. Radcliffe.

2. That it is prevented from passing into a state of contraction in the living body by the heat developed in the nutritive changes.

3. That, through the nervous system, we are furnished with a means of imparting a stimulus to muscle more potent for causing its contraction than heat its expansion.

4. That the more rapid nutritive changes attendant on contraction produce the subsequent relaxation.

5. That defective nutrition, independently of the nervous system, is capable of causing muscular contraction and that this, many of the phenomena of disease are to be explained.

6. That when the influence of the nervous system
is withdrawn, muscles pass into a state of contraction that this is the consequence of defective nutrition and that thus many of the convulsions occurring in coma are to be explained.

7. That the more a muscle contracts, the greater is the opposing passive development, and that therein is an example of the vis medicatrix naturae.

8. That treatment in such cases should consist of a copious supply of nutritive material, and a further stimulus to the contracted muscles to assist in overcoming definite nutritive changes.

[Signature]

[Handwritten Signature]