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with Mr. Spence's Test. Vagus

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AN INQUIRY
INTO THE
ANATOMY OF THE PAR VAGUM AND SPINAL
ACCESSORY OF THE EIGHTH PAIR OF NERVES.

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THE *par vagum*, or pneumogastric division of the eighth pair, has hitherto presented a kind of anomaly in the physiology of the nervous system; for whilst this nerve has two true ganglia on the upper part of its course, numerous experiments prove that it sends off motor, as well as sensitive branches. Arnold, Scarpa, and Bischoff attempted to explain this by conjecturing that the motor filaments of the vagus were derived from the spinal accessory, which they believed stood in the same relation to the *par vagum* that the anterior roots of the spinal nerves do to the posterior. Bischoff was further strengthened in this opinion by an experiment; for, having cut the spinal accessory within the cranium of a goat, he found, that, as the roots of that nerve were divided, the voice became gradually weaker, and was lost entirely when the nerve was completely divided; from this he concluded that the motions of the larynx were dependent on the filaments derived from the accessory—a conclusion by no means warranted, however, when we consider how many other causes were present which might have produced this effect, such as the loss of blood and the protracted sufferings of the animal during the preliminary steps of the operation.

In 1837, a most elaborate dissertation on the functions of the various branches of the eighth pair, the result of numerous conclusive experiments, was published by Dr John Reid in the Edinburgh Medical and Surgical Journal. The results of these investigations as regards those branches of the vagus, the anatomy of which I am about to consider, may be briefly stated as follows: 1st, that the pharyngeal branches of the vagus are purely motor. 2d, that the superior laryngeal branch is sensitive, giving rise to no movements of any muscle of the larynx except the crico-thyroid. 3d, that the recurrent laryngeal is a purely motor branch, supplying all the muscles of the larynx except the crico-thyroid. Dr Reid having satisfied himself as to the functions of these branches of the vagus, next proceeded to investigate what were the functions of the spinal accessory in relation to its motor branches. His experiments on this point were performed by first depriving the animal of sensation, then opening the cranium rapidly, and irritating the origins of the nerves; he found that on irritating the spinal accessory no movements of the larynx could be perceived, although there were strong contractions of the Trapezius and sterno-mastoid, and in most cases, of the pharyngeal muscles also; but on irritating the origin of the vagus distinct contractions of the muscles of the larynx took place. From these experiments Dr Reid presumed that the vagus contained motor filaments independent of the filaments derived from the accessory. In 1841, M. Longet published a memoir on the same subject; and, although apparently unacquainted with the previous investigations of Dr Reid, his experiments and their results bear a strong resemblance to those of Dr Reid, with the exception of that regarding the relation of the accessory to the motor branches of the vagus. For M. Longet found that, on irritating the accessory within the cranium, distinct movements of the laryngeal muscles were produced, whilst no such effect followed on irritating the origin of the vagus; hence he is inclined to believe the conjecture of Arnold, Scarpa, and Bischoff, that the motor branches of the vagus depend upon its connection with the spinal accessory. I believe, however, that I can show from the anatomy of these nerves, that the results both of Dr Reid's and M. Longet's experiments might take place, and yet that these results are by no means subversive of each other, nor so contradictory as may at first sight appear.

At the commencement of last winter session my attention was particularly directed to the anatomy of the vagus and accessory, by a request from the late eminent and justly lamented Sir Charles Bell, to examine the ganglia on that nerve, as he was then engaged in writing a dissertation on its functions, which has since been published. Sir Charles was of opinion, that what is generally termed the inferior or second ganglion of the vagus, might, per-

haps, be merely a plexiform arrangement of its fibres with those of the spinal accessory which join it immediately above that point, and that thus we might account for the vagus giving off both motor and sensitive branches in the subsequent part of its course. Whilst engaged in dissecting the pneumogastric in a recent subject, I was struck by the fact that its trunk appeared to consist of two distinct portions, one white and cord-like, the other and larger portion of a grayish colour. This was particularly the case near the lower ganglion, and on removing the neurilema, the white filamentous portion could be traced over this ganglion, a little above which it seemed to be formed by the internal root of the spinal accessory, and a small flat and white filament which I traced up over the superior ganglion of the vagus, but as the *medulla oblongata* had been removed, I was unable to determine its actual point of origin. I, however, showed the dissection to the late Sir Charles Bell, Dr Alison, Dr Allen Thomson, and Mr Mackenzie.

Some time elapsed before I could procure a subject fit for my investigations, as the majority of the subjects received had been previously opened, and the brain and *medulla oblongata* removed; but I repeated this dissection on two other subjects as far as I could, and with similar results.* Having at length obtained a subject with the brain and *medulla oblongata* entire, I commenced my dissection by tracing upwards the white nervous filament which I have mentioned as joining the internal root of the accessory. I found that, by careful dissection, I could trace it over the superior ganglion of the vagus, and found that it took its origin along with the other filaments forming the vagus from the groove between the olivary and restiform bodies; and here I also observed what I then considered filaments from the vagus passing back to join the spinal accessory within the cranium. I then traced the filament, of which I have been speaking, downwards, and found that, immediately below the first ganglion of the vagus, it was joined by the internal root of the accessory, the junction of these two forming a white firm nervous cord, which, after giving off the pharyngeal branch of the vagus, could be traced over the inferior ganglion on that nerve, and continued to descend parallel to and within the same neurilema as the greyish portion or trunk of the vagus; but unfortunately I was again prevented from obtaining anything conclusive as to the connection of this portion of the nerve with the recurrent laryngeal, owing to the vagus having been divided higher up than where it gives off that branch.

Whilst engaged in prosecuting this dissection, I, for the first time,

* Sir Charles Bell at the same time offered a prize to the anatomical students for the best dissection of the eighth pair. This prize was afterwards awarded to my friend Dr Malcolm of Belfast, then a student at this university. His very beautiful dissection is now in the possession of his nephew, Dr Bell, and corroborates in a great measure the dissections which I am about to describe.

became acquainted with the investigations of Bendz, from a footnote in Dr Reid's paper on the vagus. It was there stated, that "from these dissections it is concluded that both in man and animals the *nervus pharyngeus* of the *par vagum* is derived in a great part from the filaments of the accessory, and that the *nervi laryngei*, superior and inferior, and the œsophageal plexus also receive a few filaments from this nerve. He also observed the accessory in man furnish a few filaments to the second ganglion of the *par vagum*. Into this second ganglion of the *par vagum* all the filaments of the vagus do not enter. He has even seen in the rabbit some of the filaments of the vagus pass the superior ganglion placed on this nerve, without entering into its formation." As it seemed from this that the dissections of Bendz were precisely similar to those which I had made, I wrote to Dr Reid for further information regarding them, as I could not myself get the original thesis of Bendz. Dr Reid in his answer says, "I suspect it is not correctly stated in my paper on the eighth pair, that Bendz had traced part of the filaments of the vagus past its superior ganglion in the rabbit, for on looking at the original it appears pretty clear that he means the inferior ganglion, so that if you are correct in supposing that you have traced filaments passing over the superior ganglion, your dissections differ from those of Bendz."

That there may be no doubt as to Bendz meaning the inferior ganglion, in the passage allude to, I subjoin the quotation from the original now before me. He is describing the anatomy of the nerves in the rabbit. "In quinque circiter linearum distantia a ganglio radice nervi vagi, fibræ hujus nervi in gangliolum ovale $1\frac{1}{2}$ longum et $\frac{5}{4}$ " crassum, colore griseo-rubicundo intumescit. Nonnullæ fibræ a vago venientes formationis hujus ganglioli participes non sunt, sed immediate in nervum laryngeum superiorem transeunt, qui majore ex parte hisce formatur." I may also state, before proceeding further with the description of my own dissections, what were the actual results of the investigations of M. Bendz, so that I may not be suspected of laying claim to what he had previously described. Bendz described the spinal accessory as formed of two distinct sets of roots—one set, that usually described arising from the *medulla spinalis* and lower part of *medulla oblongata*—the other set of filaments he described as arising close to the lower filaments of the vagus joining the first mentioned set of nervous fibres within the cranium, and afterwards forming the internal root of the accessory,* which joins the *par vagum* a little below its upper ganglion. He states that this internal root, after sending a few filaments to the second ganglion of the vagus, can be traced distinct from the other portion of the vagus trunk

* These seem to be the same fibres which I mentioned as appearing to pass from the vagus to the roots of the accessory within the cranium.

along its whole course in the neck, until it enters the chest, where these filaments seem to be lost in the recurrent laryngeal nerve and the œsophageal and cardiac plexus. In speaking of the fibres of the accessory which arise close to those of the vagus, he says, "Proxime posteriorem radicis nervi vagi marginem radiculæ nervi accessorii Willisii incipiunt, quæ ad formam et tractum a fibris radicis nervi vagi valde differunt." I have been able in all my dissections to confirm the statements of Bendz, except as regards this difference in appearance and course between the upper filaments or roots of the accessory and those of the vagus. In the representation accompanying his thesis they certainly appear very different, but in my own dissections they have always seemed both to myself, and others who examined them, so exactly to resemble the roots of the vagus both in situation and appearance, as to incline me to describe them as fibres of that nerve passing to join the spinal accessory before it leaves the cranium, and this is well shown in the accompanying plate. Having now given an account of the principal points discovered by Bendz, I shall very briefly describe the anatomy of the vagus and spinal accessory, as regards the points in question, from my own dissections, particularly that from which the accompanying plate was taken, and which is preserved in the Anatomical Museum of this University.

When a section of the cranium and spine similar to that represented in the plate has been made, and the posterior roots of the spinal nerves divided near their ganglia and reflected, the spinal origins of the accessory can be readily traced, commencing generally about the root of the fifth cervical nerve, and gradually forming a flattened cord which ascends into the cranium through the *foramen magnum*. It is there joined by some fibres from the lower part of the *medulla oblongata*; there then intervenes a small space from which no filaments arise; but higher up again, and close to, or I should rather say from, the filaments forming the vagus, there pass back two or three filaments which join the accessory at an acute angle just as it is leaving the cranium.

Almost immediately after passing out of the cranium, the accessory divides into an external and internal portion. The external, after communicating with the spinal nerves and sympathetic, passes through the sterno-mastoid, to which it sends branches, and is finally distributed to the Trapezius. The internal root of the accessory, which seems principally formed by those filaments which arise beside the origin of the vagus, joins that nerve a little below its superior ganglion. If we carefully remove the neurilema from the vagus at the point where this junction takes place, a small flat white nervous filament is seen to pass down to the internal root of the accessory. This filament I have in all my dissections been

able to trace up over the superior ganglion of the vagus into the groove between the olivary and restiform bodies. Retracing it downwards to the point where it is joined by the internal root of the accessory, these two filaments will be found to coalesce and form a white nervous cord, the pharyngeal branch of the vagus being given off from the point of junction of the two filaments. The white nervous cord so formed can be traced down over the inferior ganglion of the vagus to which it sends* one or two delicate filaments. It then continues to descend parallel to, and within the same neurilemal sheath as the grayish or ganglionic part of the vagus to the lower part of the neck, where, after receiving fibres from the ganglionic portion of that nerve, it seems to pass principally into the formation of the recurrent laryngeal; some filaments, however, still continuing to pass down with the trunk of the vagus into the chest, but these I have not yet been able to trace to their final destination. To this white nervous cord I would be inclined to give the title of the motor column of the vagus, as from it seemingly the motor branches of that nerve arise, for whilst we can distinctly show that the pharyngeal and inferior laryngeal do so, it may also be presumed that the œsophageal filaments might also be traced to the same origin. Indeed, the dissections of M. Bendz already quoted seem to bear me out in this supposition; for he states that he has traced fibres of the internal root of the accessory along the vagus into the œsophageal plexus, as formerly mentioned.

From these anatomical details, I think it may be concluded that the *par vagum*, like the third division of the fifth pair, is composed both of motor and sensitive filaments; that its motor column, as I have termed it, is formed partly by intrinsic non-ganglionic fibres, and partly by filaments from the internal root of the spinal accessory. This anatomical disposition of the vagus would perfectly account for all the phenomena witnessed in the experiments referred to at the commencement of this paper; and makes good my assertion, that the results of the experiments of Dr Reid and M. Longet, as to the effects produced by irritating the origins of the vagus and accessory within the cranium, are not so contradictory as they might at first appear to be. For that effect, which forms the positive portion of the experiments of each, (viz. the movements produced in the laryngeal muscles by irritating the vagus, in Dr Reid's experiments, and similar motions resulting from irritating the accessory in those of M. Longet,) is fully borne out by the anatomy, whilst the mere absence of the effect, or what may be termed the negative part of these experiments, which gives rise to the apparent contradiction, might, and doubtless did de-

* These filaments appear as if passing towards the superior laryngeal nerve, which arise from this part of the vagus; but I have never been able to trace them fairly into it.

pend on other casual circumstances, such as the exhausted state of the muscular contractility and irritability, owing to the time required to perform the preliminary steps of the experiment; and of such sources of fallacy Dr Reid, at least, seems well aware; for when speaking of the absence of contractions of the laryngeal muscles on irritating the origins of the accessory, in reference to these very experiments, he says, "We certainly do not consider that these experiments entitle us to assert that they are not motor filaments." I cannot conclude these remarks without acknowledging the obligations I am under to Dr Allen Thomson, for the great interest he has taken in the dissections of which I have been detailing the results.

EXPLANATION OF PLATE VI.

- Fig. 1. Optic nerve.
 Fig. 2. Third nerve.
 Fig. 3. Fourth nerve.
 Fig. 4. Fifth nerve.
 Fig. 5. Sixth nerve.
 Fig. 6. *Portio dura* of seventh nerve.
 Fig. 7. *Portio mollis*.
 Fig. 8. Glosso-pharyngeal of eighth pair.
 Fig. 9. *Par vagum*.
 Fig. 10. The filament of the vagus which passes over its superior ganglion.
 Fig. 11. The filaments described by Bendz as the superior origins of the spinal accessory, and which form its internal root.
 Fig. 12. Spinal portion of the accessory.
 Fig. 13. Motor column of the vagus formed by the junction of its non-ganglionic filaments (10), with the internal root of the spinal accessory. This nervous cord, after giving off the pharyngeal branch (14), is seen descending over the second ganglion of the vagus, and along its trunk into the recurrent laryngeal, (15.)
 Fig. 16. Continuation of the *par vagum*.

part on other neural elements, such as the expanded white
of the medulla, and vitally, owing to the time
required to perform the preliminary steps of the experiment; and
of such nature of things the brain, at least, seems well aware; for
when speaking of the absence of sensations of the hysterical
class on entering the brain of the necessary, in reference to these
very experiments, he says: "We certainly do not consider that
these experiments entitle us to assert that they are not under the
control of the brain, but we cannot conclude these remarks without acknowledging
the obligations I am under to Dr. Allen Thomson, for the
great interest he has taken in the discussions of which I have been
detailing the results."

EXPLANATION OF PLATE VI.

- Fig. 1. Otic nerve.
- Fig. 2. Third nerve.
- Fig. 3. Fourth nerve.
- Fig. 4. Fifth nerve.
- Fig. 5. Sixth nerve.
- Fig. 6. Seventh nerve.
- Fig. 7. Tenth nerve.
- Fig. 8. Glossopharyngeal of eighth pair.
- Fig. 9. Vagus nerve.
- Fig. 10. The filament of the vagus which passes over its superior ganglion.
- Fig. 11. The filament described by B. as the superior origin of the spinal accessory, and which forms its internal root.
- Fig. 12. Spinal portion of the accessory.
- Fig. 13. Lower extremity of the vagus, formed by the junction of its non-ganglionic filament (10), with the internal root of the spinal accessory. This nervous cord, after giving off the pharyngeal branch (14), is seen descending over the second ganglion of the vagus, and along its trunk into the recurrent laryngeal (15).
- Fig. 14. Continuation of the vagus.

M^r. SPENCE'S PAPER







