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IV. *Experiments in Support of the Uſes aſcribed to Ganglions of the Nerves, in* Philoſophical Tranſactions, *Vol.* LIV. *and Vol.* LVII. *by* James Johnſtone, *M. D.*

Read at R. S. Feb. 1, 1770.

HAVING before had the honour of having my thoughts on the uſes of ganglions, which hitherto had remained an unſolved problem, read to the Royal Society; it was obſerved that a principal, and indeed almoſt the only objection of any weight, to which the doctrine was liable, aroſe from the indiſputable fact, That each of the nerves ariſing from the ſpinal marrow had a ganglion.

The concurrence of argument in favour of the general doctrine perſuaded me, that theſe ganglions of the ſpinal nerves reſpected excluſively the filaments which are detached from the ſpinal nerves to the great ſympathetic nerves, a new contexture taking place in thoſe ganglions capable of intercepting the uſual powers of volition: and that thoſe filaments diſtributed to the voluntary muſcles, underwent no ſuch change from their uſual rectilineal and parallel direction

direction and arangement. I was not, till lately, capable of proving this by experiments, with which I beg leave once more to trouble the Royal Society, as they much ſupport the new uſes aſſigned to ganglions, in the Eſſay publiſhed in the LIVth volume of Philoſophical Tranſactions, and defended in another paper publiſhed in the Philoſophical Tranſactions, volume LVIIth, for 1767, and open a new field of anatomical reſearch and philoſophical ſpeculation, not without ſome proſpect of advancing the practice of medicine in nervous diſeaſes, with the knowledge of the nervous ſyſtem.

But before I proceed to relate the experiments which follow, I beg leave to premiſe what is allowed by all phyſeologiſts, that when any nerve is irritated, the muſcle it goes to, or, if it has a large nerve, or bundle of nerves, all the muſcles ſupplied from thence, are by that irritation violently convulſed.

If then it ſhall appear, that irritation and injuries of the ſpinal marrow, from which the intercoſtal nerves, which ſupply the heart and inteſtines, truly ariſe, no leſs than the nerves diſtributed to the limbs, occaſion violent convulſions of the limbs, and yet do not in the leaſt affect the motions of the heart, and inteſtines, parts the moſt irritable of any in the body, as will indeed appear to any one who repeats the following experiments:

The difference will probably be accounted for by the intervention of ganglion after ganglion, conſtantly found betwixt the ſpinal marrow, and the heart and inteſtines. And the unprejudiced inquirer into nature will probably be led to aſcribe thoſe uſes to ganglions, which I have done.

Experiment

Experiment 1ſt. On the 4th of March, 1767, a kitten a week old, had its head cut off betwixt the firſt and ſecond vertibre of the neck; the thorax was opened with all expedition, and the heart laid bare to view and obſerved for ſome time, that any difference might be eaſier and more certainly noticed. After the animal ceaſed to move its limbs, I touched the ſpinal marrow with a probe, immediately the extremities of the animal were all ſtrongly convulſed; but the heart alone ſeemed unaffected, and continued to move without acceleration, or any degree of alteration whatever.

Betwixt this time, and the 10th of April, I repeated the ſame experiment upon half a dozen kittens ſtill younger than the firſt; upon opening the thorax, the heart beat near 70 ſtrokes in a minute.

When the heart beat only 40 in a minute, or thereabouts, I began gently to touch the ſpinal marrow with the point of a probe, and the limbs were immediately convulſed, but the heart not in the leaſt affected.

I ſlit open both the ventricles of the heart, ſo as to let out all the blood they contained; and inſtantly the heart ceaſed to beat (though its pulſation continues otherwiſe very long in animals ſo young): but the auricles which were not opened, and therefore were ſtill ſtimulated with the blood, beat on.

In this ſituation, in ſeveral of theſe animals, I thruſt the probe into the ſpinal marrow; but the heart nevertheleſs continued in perfect reſt, and inaction; though, when its ſubſtance was pricked with the point of a knife, it might ſtill be made to contract.

But

But though the heart and inteſtines remained equally unaffected in all the tryals I made by thruſting the probe into the ſpinal marrow, the following contractions occaſioned by it deſerve particular enumeration.

All the limbs were violently convulſed.

The muſcles of the neck were convulſed, and the ſpine bent as in the opiſthotonos.

The intercoſtal muſcles were all contracted; and their natural action (that of drawing all the ribs nearer each other and the ſummit of the thorax) rendered matter of ocular demonſtration.

The diaphragm was contracted ſtrongly, notwithſtanding the phrenic nerve of one ſide was divided in making ſimilar experiments, by pricking and ſtretching it; which, by the way, conſtantly occaſioned a convulſive contraction of the diaphragm.

Even by plunging the probe into the brain, after the head had been cut off for ſome minutes, the tongue, and ſome other muſcles were made to contract.

But theſe experiments muſt be made in leſs than a quarter of an hour after decapitation; half an hour afterwards no ſuch effects follow the deſtruction of the ſpinal marrow. And they ſucceed beſt by previouſly opening the ventricles of the heart.

Experiments ſimilar to theſe have been made upon frogs, by Stuart, Baron Haller, and Dr. Whytt, and others. "When I opened" (ſays the laſt of theſe ingenious gentlemen) "the thorax of a frog, immediately after decollation and deſtroying its ſpinal marrow, I obſerved its heart beating at the rate of 60 in a minute, which is four or five pulſations

"leſs than I have generally ſeen the hearts of frogs "make, in that time, when their thorax was opened "without decollation." — (See Whytt's Exp. on living and dying animals. Eſſ. Ph. and Litt. vol. II. p. 282. — alſo Whytt's Phyſ. Eſſays.)

II. "Some young gentlemen having hanged a "cat, till ſhe was quite dead, opened the thorax, "and obſerved only a tumultuous motion in the "heart; which ſoon ceaſed, but was renewed by "pricking it with a ſharp inſtrument; after this, "by ſqueezing the cardine nerves downwards, or "otherwiſe irritating them, the heart was made to "perform two or three pulſations, which it con-"tinued to do for a conſiderable time whenever the "cardine nerves were thus ſtimulated." (Whytt's Vital Motions, p. 355.) I relate theſe experiments in the words of their excellent author, as they were made with no view to the doctrine I ſhall endeavour to ſhew they enforce and ſupport.

III. Animals are killed ſome ſooner, others, eſpecially of the cold kind, (as frogs and tortoiſes, probably on account of the largeneſs of their ſpinal marrow) much later, by cutting through the ſpinal marrow near its origin, by which the chief communication of the cardine nerves with the brain is cut off.

The cutting through the intercoſtal or great ſympathetic nerves, or the tying ligatures upon them, is alſo ſooner or later ever fatal to the animal the experiment has been tried upon; by finally deſtroying the motion of the heart, and inſtantly wonderfully weakening and diſturbing its motions. See Vieuſſens.

Theſe

Theſe experiments ſeem to prove, that the Ganglions on the ſpinal nerves do not hinder the irritation of the ſpinal marrow from cauſing convulſions in the voluntary muſcles; and that the ſame Ganglions, (Exp. I.) do in all probability hinder that cauſe from acting (as without their intervention it muſt have done) upon the heart by means of its nerves chiefly ariſing from the ſpinal marrow originally; and therefore it ſeems evident, and beyond a plauſible conjecture, that the Ganglions on the ſpinal nerves relate excluſively and ſolely to the intercoſtal, or as they are otherwiſe called, the great ſympathetic nerves, for the purpoſes I have formerly endeavoured to prove: and this derives farther confirmation from experiment II. as we thereby ſee that the heart may be made to move, as all other muſcles may, by irritating or ſqueezing its proper nerves below their ganglions; and that the motions of the heart cannot long continue, in warm animals eſpecially, III. after the diviſion of its principal nerves, which ſhews the dependance of the motions of the heart, ultimately, as that of all other muſcles, upon its proper nerves, and their connexion with the brain.