A memoir on some recent discoveries relative to the functions of the nervous system : read before the Academie des sciences at Paris, at the public sitting of the 22d of June, 1823 / by F. Magendie.

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NERVOUS SYSTEM.

LONDON:

J. MOYES, TOOK'S COURT, CHANCERY LANE.

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Translated from the French.

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THE

TRANSLATOR'S PREFACE.

PART of the matter contained in this Memoir has already been noticed in this country; but as this small and interesting production embraces observations on subjects of the utmost importance, which have not been made public, and which may lead to further discoveries, I have been induced to publish it in a form calculated to facilitate its circulation. These motives, in common with the idea that

every thing which flows from Majendie's valuable pen must be welcomed by the Profession and the Public at large, will be, I trust, a sufficient apology. As a faithful translator, I have thought it becoming to follow closely my author, and hope this may entitle me to what indulgence will be deemed necessary, as a translation must unavoidably, in point of language, differ from an original work.

A MEMOIR,

ETC.

No remarkable length of time has elapsed since physiology consisted of little better than a fantastical assemblage of fictious, at times ingenious, and subtle arguments, invariably obscure: an assemblage in which chimerical beings, phantoms, humours, and principles, were actually supposed to exist; and what was termed the Science, was nothing more than a kind of fable or drama, in which these imaginary beings acted the principal parts; these actions or parts varied according to the fancy of authors, the taste of the times, or the ruling spirit of the school whence they had originated. In a word, physiologists were either

poets or romance writers; but none had thought of becoming an observer, and animated nature remained inscrutable and unscrutinised.

The seventeenth century, which forms so remarkable an era in the human understanding, gave birth to a new physiology, in which nothing is invented—nothing is created; it solely consists in observing and studying nature, and only admits of precise experiments and correct facts, from which strict inferences are deduced; and if, in point of perfection, this science does not as yet cope with that of physics, the fault does not rest with the method, but entirely with the nature of the phenomena in contemplation.

The Academy of Science has invariably held out every encouragement, and afforded every assistance in its power, to a science

grounded upon truth; and, undoubtedly, it was to secure to it a more sure and rapid progress, that, a short time since, this institution accepted the bequest of that inestimable man, who, from his death-bed, made such a noble and liberal use of his wealth.

We may now be allowed to anticipate, that the mysteries of life, of which man has for so considerable a length of time been an eye-witness, without having been able to understand them, shall, in succession, be revealed to him; and that his discoveries, with respect to the animated kingdom, will keep pace with those which relate to the inanimate world.

This hope is already nearly realised. From every civilised point of the globe a generation of physiologists is seen to rise, which, throwing systems aside, diffuse over the animated part of the creation that light which shines

over the science of physics, by submitting it to the test of experiments, and thus succeed in revealing some of the phenomena which had hitherto remained involved in the deepest obscurity.

It is not my object to enumerate, *in globo*, all the discoveries which have already resulted from this happy concurrence; the field of positive and strict physiology is too extensive to admit of being embraced in a single glance; let it suffice to state in what manner new and important discoveries have been obtained, with regard to one of the most important parts of human organisation, and to prove, by a single fact, what a considerable share of influence the method of experimental investigation must possess over the science at large.

However, the subject upon which I now dwell is pregnant with interest,—I allude to

the brain and nerves — to that whitish and grayish pulp, which, at times forming a mass more or less voluminous, fills the cavity of the head and that of the spine; at others, under the form of filaments, remarkably minute, keeps up a direct communication between the internal and external points of our body and those central pulpous masses.

Such is the nervous system connected with the whole of our moral existence, and with the greatest part of our physical life: — this system has been for philosophers, moralists, and physicians, a subject of unremitting meditation; and, remarkable to observe, the end which, in this twofold study, seemed the most difficult to attain, namely, the determination of our moral faculties, is precisely that which was the first and most correctly obtained: in this respect, it will suffice to name the im-

mortal works of Locke, Condillac, and the more recent labours of Dugald Stewart and of Tracy.

As to the physical faculties of the nervous system, we are very far indeed from being possessed of information so generally extended and equally precise as that which has our moral faculties in view. Notwithstanding the labours of Haller, and of his school — those of Bichat and Legallois,—we possess but few precise and important facts on this highly interesting question.

We had already been made acquainted that our organs receive sensibility, and our muscles motion, from the nerves; — that the brain appears to be more specially intended for intellectual phenomena, and the cerebellum for motion; —but what had not been so readily ascertained, and which is now, by the inge-

nious and beautiful experiments of Lorry and Legallois, placed beyond the possibility of a doubt, is, that the spinal marrow actually is the most useful part of the nervous system.

The spinal cord contains the principal seat of sensibility, and the source from which all our motions are derived. In this organ also resides that irresistible instinct which compels us to breathe; so that, strictly speaking, life might be continued without the brain and cerebellum; but life cannot possibly be protracted for a single moment without the spinal marrow.

The following statement contains new facts, which, by recent discoveries, are superadded to the too few important ones we are already possessed of.

For one of the most interesting of these discoveries, the Profession is indebted to a

British physiologist. It relates to that admirable faculty by which the face becomes the faithful reflector of our internal sensations.

That the muscles are the agents of the expression of our physiognomy, and that their divers contractions are directed by the nerves, has long ceased to be a question. But two distinct nerves are distributed to the face, particularly two on each side; the one of which is known under the denomination of *facial nerve*, the other having received the name of *maxillary*. Mr. Charles Bell, who has devoted much time to the nervous system, and who has published a work on the expression of the face, both in man and in animals, questioned whether the facial or the maxillary nerve was the agent for communication between the muscles of the face and internal sensations.

In order to ascertain this fact, an experiment, consisting in dividing one of these nerves and leaving the other uninjured, became indispensable.

The experiment was tried upon an ass.

To judge of physiognomy, a more suitable subject than a donkey might undoubtedly have been selected; however, this animal being possessed of rather quick passions, is not altogether void of expression.

The facial nerve of an ass was in consequence divided: it instantly became evident that all motions had ceased on that side where the section had been made, particularly those of the eye-lids and lips. Food was next brought within its sight, and the animal strongly expressed its wants on the sound side, whilst the other remained dull and unexpressive.

As soon as the donkey was allowed to eat, the same parts which had remained motionless with respect to expression, were roused to action the moment their agency became indispensable for mastication.

The reverse was next resorted to: another animal was selected, on which the maxillary nerve was divided and the facial left untouched; in this instance, the motions of expression were continued, whilst those connected with mastication had completely and for ever ceased.

It became important to repeat this experiment on some animal whose features were somewhat better calculated for expression than those of the donkey.

The most frolicsome monkey of Exeter Change was selected for that purpose, and a section of the facial nerve was effected on one

side: the animal instantly lost all power of contracting its features in that very part, and the whole of its physiognomy assumed, by the evident contrast between the two, so very singular an expression, that on beholding the creature it was impossible to abstain from laughing.

Every by-stander was struck with the analogy existing between the features of the monkey and those of a celebrated actor, who had long been a favourite of the British public. It appeared highly probable, that this man availed himself of some natural deformity to entertain the audience; and, upon further investigation, the fact was found correct.

I have myself repeated these experiments: in every instance they were attended with similar results.

They throw considerable light on the func-

tions of the nerves of the face, and prove, in a most indisputable manner, that the motions of the eye-lids, of the nostrils, lips, &c. in which the expression of physiognomy chiefly resides, are under the dependence of a particular nerve; whilst the sensibility of these parts, and the motions connected with mastication, are, on the other hand, influenced by a special nerve.

Such results are not only interesting, as far as they are connected with the science,—they, moreover, admit of direct application for the cure of diseases. Our features frequently become the seat of affections which specially bear upon the organs of expression; the mouth is often seen to twist and contract, the eye-lids to become paralysed, &c. Will not curative means be more easily attained and be more effectual, when we are better acquainted

with the mechanism of diseased organs? It is thus that physiological discoveries occasionally afford the means of improving the practice of medicine.

To feel and to move, are two phenomena with which every act of exterior life is immediately connected. This connection in the perfect healthy state is so very intimate, that these two phenomena seem to form but one; in pathology, on the contrary, the distinction becomes sometimes so very striking, that a part of the body, and even the whole, is completely robbed of sensibility, without the motions it admits of being anywise impaired. In other circumstances, all kind of motions will be at an end, whilst sensibility is seen to survive the loss.

These facts, known ever since man was afflicted with diseases, have been the object of

researches in every century: from this it has been most judiciously concluded, that the nervous system contained nerves specially intended for sensations, and others commissioned to effect motions.

But neither the nicest anatomical dissections, nor the injuries ascertained in *post mortem* investigations, nor even experiments tried on living animals, had led to a distinction of the nerves intended for sensations from those peculiar to motions.

I have recently been led, myself, to ascertain this distinction; and what at first had appeared to be hitherto attended with insuperable difficulty, actually is one of the most simple phenomena of the functions of the nervous system.

In order that this result may be perfectly understood, we ought, first, to bear in mind,

that all the nerves of the body and of the extremities originate from the spinal marrow; but the mode in which they are sent off ought to be minutely investigated. Two distinct orders of roots are observable: some take their attachment at the anterior part of the cord; the others, on the contrary, emerge from the posterior portion.

These two orders of roots are at first separated by a space somewhat considerable; however, they soon reunite and blend together so as to form but one single nerve.

I have ascertained, by direct experiments, that these distinct roots are also commissioned to perform quite distinct functions, — those anteriorly situated are intended for motions, the posterior for sensations. Subsequently to the section of the former, the animal becomes deprived of motion, but sensibility remains

untouched; and, *vice versâ*, on the latter being divided, sensibility is lost, though the subject retains the power of moving.

All difficulties respecting these two orders of nerves, some being calculated to give motion, the others being specially intended for sensation, are now completely removed. We even perfectly understand why anatomists in former times had not made the distinction; it was, because, operating upon nerves subsequent to the re-union of their roots into a single fasciculus, it became totally impossible for them to separate the threads intended for sensibility from those peculiar to contraction.

I recently had an opportunity of confirming these distinct functions of the roots of nerves on the human subject.

An individual had several years since lost the use of both his arms, but had retained the

nicest sensibility in those parts: he died, and on dissection, the posterior roots were found in a healthy state, whilst the anterior, evidently diseased, had been robbed of their medullary substance, and consisted of nothing more than their outward coat.

Nerves impart sensibility and motion to our organs only because they proceed from the spinal marrow; if they happen to be separated from it by a wound, or by any other cause, immobility and insensibility in the parts are the unavoidable consequences.

It then became interesting to ascertain whether the spinal marrow itself was not divided into two halves,—the one intended for motion, the other for sensibility.

In physiological researches, experience often contradicts speculations, when they are merely

grounded on analogy: here, on the contrary, experience fully confirms the conjecture.

I have demonstrated that the spinal marrow is, as it were, formed of two distinct cords, in juxta-position,—the one of which is endowed with exquisite sensibility,—whilst the other, almost completely unconnected with this property, seems to be reserved for motion.

I have ascertained that a separation between these two properties actually exists throughout the whole extent of the spinal cord; and as it has been demonstrated, by the beautiful experiments of Le Gallois, that all our organs receive from the spinal marrow both their respective sensibility and motion, we are naturally led to this remarkable conclusion, that to look for a single point in the human body wherein sensibility and motion were

confounded together, would be to look in vain.

Hence it became highly probable, that with ndividuals who had been deprived of the faculty of moving and who retained the sensibility of the parts, and reciprocally with such as had lost sensibility and preserved the moving power, there must unavoidably have existed some disease or other, either in the sensible cord or in the other agent of the spinal marrow.

Chance would have it, for chance also claims some share of influence over the progress of sciences, that an alienated patient, in the hospital of Charenton, had, for upwards of seven years, lost every motion in the body, although he had retained sensibility. Mr. Royer Collard, physician to that establishment, caused the spinal marrow to be mi-

nutely examined; a diseased state was evidently traced throughout the moving part of the cord, whilst that containing the focus of sensibility presented a most healthy aspect.

Thus, the slightest doubt can no longer be entertained respecting these two important phenomena of physical life: they are individually possessed of their respective and distinct organs; and if sensibility and motion most generally appear to be included in the same act, this is probably owing to these organs being continuous.

Whilst I was devoting some time to these researches on the spinal marrow, I was led to a remark which does not appear to me to be altogether void of interest. It might be supposed that the respective properties of these parts were the more striking as we penetrated deeper into their substance, and

that their centres would be, as it were, the *sanctum sanctorum* of sensibility and motion. Well then, precisely the reverse is observable: the central part of the marrow is insensible, and by stimulating it, no motion whatever can be produced.

It is at the surface of the organ that its properties, as far as regards motion and sensibility, are the better unfolded. Authors who pretend that the electric fluid habitually circulates through our nervous system, may draw from this fact an additional argument in support of their opinion; for electricity, it is well known, travels along the surface of such bodies as act as conductors.

It need not be remarked what considerable influence the facts I have just stated must have over the treatment of the divers palsies. How could it be possible, now, to treat by the

same means a palsy affecting sensation and a palsy affecting motion? The organs being distinct, the curative means can no longer be the same. I feel happy to observe, that already several eminent physicians, who wish to free the practice from the labyrinth of hypothesis, have drawn evident advantage from this physiological distinction in the treatment of these diseases.

Undoubtedly, it would be of the utmost importance to ascertain how sensation and motion,—which, as it has just been stated, have their seat in the spinal marrow,—are propagated to the head, and extended to the brain and cerebellum; or, to be more explicit, how the impressions perceived by the senses and the determinations of the will are transmitted to the spinal marrow. Here experimental difficulties become almost in-

superable; and I must confess that up to this day I have reaped nothing satisfactory on so delicate a question, and one which appears intimately connected with the most important secret of life.

The innumerable experiments I have unsuccessfully tried hitherto, have, however, enabled me to ascertain one fact, which appears to me worthy of being noticed by physiologists, and respecting which, as far as my information goes, nothing yet has been advanced.

If in a living animal you deprive the cerebral hemispheres of the power of acting, the animal will run straight forward with astonishing rapidity, as if propelled by some invisible and irresistible hand. If, on the contrary, the cerebellum be deprived of the power of acting locomotion assumes quite an opposite course—the animal recedes. It is a most remarkable

phenomenon, for instance, to witness a bird, slightly wounded in the cerebellum, effect, for several successive days together, no other motions, either for walking, swimming, or flying, except in a retrograde direction.

There should appear to result from these experiments, that any animal, otherwise enjoying its natural state of health, is placed, as it were, between two powers,which counteract and balance each other—the one impelling forward, the other backward; and that these two powers are completely under the influence of the will.

A disease of the horse, and which is not generally known, seems perfectly calculated to elucidate these last results. Farriers term it *immobility;* and, in fact, if you attempt to drive the animal backward, let the means and strength you resort to be what they may, it

remains rivetted to the spot,—the motions forward, on the contrary, are remarkably easy, and at times seem to be effected independent of the will.

If the consequences I have just drawn be correct, the disease must consist of some physical alteration in the brain, or in some obstruction or other in the action of that organ.

A few days ago I had two horses afflicted with immobility examined, and my conjecture was perfectly correct. In both, the brain was evidently diseased and the cerebellum perfectly sound.

It then appears demonstrated, that these two opposite powers of the brain and of the cerebellum exist in animals; and that in some peculiar cases these powers may resist the influence of the will.

Is this the case with man? Can our mo-

tions, which execute with so much precision the dictates of the will, cease to obey their commands, and be, as it were, in a state of rebellion? Finally, is the faculty of volition distinct from that by which our motions are regulated? Such are delicate questions we hardly dare to venture upon — they seem to lead to arduous abstractions, the insuperable limits of human understanding; but, however, I have witnessed myself, and I have had an opportunity of studying for several successive weeks, in a well-informed man, perfectly qualified for self-observation, a complete distinction between the will and that power by which our movements are regulated.

Subsequent to violent grief, the person I allude to, to his utmost surprise, was suddenly deprived of the influence of his will

over his motions; in spite of himself, he was compelled to assume the most ridiculous attitudes, and to make the most extravagant contortions. The eccentricity of his actions and postures baffle all description; in certain cases his motions would be natural: thus, without the slightest intervention of his will, he was seen to rise and walk precipitately forward, until he came in contact with some solid body that impeded his course; — at other times he would recede backward with equal promptitude, until he was checked by some similar cause. In other instances he was observed to recover the use of certain motions, and to remain incapable of directing others. It was thus that his hands and arms frequently obeyed the dictates of his will, and more frequently again could he regulate the

muscles of his features, and those connected with the organs of speech. At times he was allowed to walk backward, whilst his progress forward became totally impossible; he then would resort to this mode of progression to reach the objects he had in view. This state lasted four calendar months, and terminated most successfully. A few grains of a substance which chemistry has lately discovered (the sulphate of quinine), sufficed to confine his motions to the immediate dictates of his will.

It may then be correct to admit, that the faculty of volition is perfectly distinct from that faculty by which our motions are directed and classified into regular acts. Such is the only consequence I wished to infer from the fact I have just stated. Several

others rush to the mind, — to follow them up would make a metaphysician of me, and I mean to remain a physiologist.

Besides, the object of this Memoir, as I have already stated, is less to exhaust what might be said respecting the *nervous system*, than to explain in what manner we have succeeded in investigating what has been discovered on a subject of such importance, and so very difficult to study. I shall consider my task completed, if, by proving how effectual the results of experimental researches have been with respect to one of the parts of the science, I have succeeded in convincing what the influence of this method would be, if extended to every one of its branches.

May, then, this faithful method, the only one applicable to natural sciences, draw on its side every sincere well-wisher to the further

improvement of our sciences! May we, in the knowledge of ourselves, to use the noble expression of Bacon, proceed uninterruptedly, with giant steps, into the new career laid open before us,—and thus multiply discoveries which tend to reflect so much honour on the intellectual faculties of man, and to protect his existence!

THE END.

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