This thesis has been submitted in fulfilment of the requirements for a postgraduate degree (e.g. PhD, MPhil, DClinPsychol) at the University of Edinburgh. Please note the following terms and conditions of use:

- This work is protected by copyright and other intellectual property rights, which are retained by the thesis author, unless otherwise stated.
- A copy can be downloaded for personal non-commercial research or study, without prior permission or charge.
- This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author.
- The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author.
- When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given.
Photograph by Dr. J. D. Bonrie of the Portrait in the R.C.P.

Tracing from the Minutes of the R.C.P.
THE LIFE AND WORK OF

ROBERT WHYTT, M.D., F.R.C.P., F.R.S.

Professor of Medicine in the University of EDINBURGH.

A Preliminary Study.

by

R. MARY BARCLAY. M.A., M.B., DIPL. PSYCH.

VOL. I.
PREFACE.

It is with pleasure that I acknowledge my debt to Professor Lorrain Smith and Dr Comrie for having suggested this subject and for the interest which they have taken in the work.

I have also to express my thanks for help to the Misses Balfour-Melville of Pilrig House, to Professor Barger, Dr H.S. Allen, Dr H.K. Anderson, Dr Ballantyne, Dr Drever, Dr Dryerre, and Dr Ebstein; also to the Librarians at the following Libraries, Edinburgh University, St Andrews University, Royal College of Physicians, Advocates', Signet, Public, and West House.

R.M.B.
PROFESSORS OF MEDICINE.

( Sir Robert Sibbald.
1685 ( James Halket.
( Archibald Pitcairne.

PROFESSORS OF INSTITUTES OF MEDICINE OR PHYSIOLOGY.

1724 William Porterfield.
( Andrew St Clair.
1726 ( John Rutherford.
1747 Robert Whytt.
1766 William Cullen.
1773 Alex. Monro Drummond.
1776 James Gregory.
1789 Andrew Duncan.
1819 Andrew Duncan, secundus.
1821 William Pulteney Alison.
1842 Allen Thomson.
1848 John Hughes Bennett.
1874 William Rutherford.
1899 Sir Edward Sharpey Schafer.

PROFESSORS OF MEDICINE.

1724 William Porterfield.
1726 ( Andrew St Clair.
1747 ( John Rutherford.
1766 John Gregory
1773 William Cullen.
1790 James Gregory.
1821 James Home.
1842 William Pulteney Alison.
1855 Thomas Laycock.
1876 Sir Thomas Grainger Stewart.
1900 John Wylie.
1915 George Lovell Gulland.

From the "Edinburgh University Calendar"

1921 - 1922.

----------
PRINCIPAL DATES IN ROBERT WHYTT'S LIFE.

1714  Birth
1730  Graduated in Arts at St Andrews.
      went to Edinburgh to study Medicine.
1736  M.D. Rheims.
1737  M.D. St Andrews.
      "  L.R.C.P. Ed. Commenced Practice.
1738  F.R.C.P. Ed.
1747  Appointed Professor.
1751  "Essay on the Motions of Animals" published.
1752  F.R.S.
1761  Appointed first physician to the King in Scotland.
1763  President of the R.C.P. Ed.
1764  "Observations on Nervous Diseases" published.
1766  Death.
1768  Collected works including "Observations on the Dropsy in the Brain" published.
INSCRIPTION ON TOMBSTONE IN GREYPRIARS' CHURCHYARD.

ROBERT WHYT, ESQ OF BENNOCHY.

In memory of a beloved mother, Martha, daughter of Robert Whytt, Esq., of Bennochy, M.D., and widow of Major James Wilson, Royal Artillery, died 5th July 1835, aged 77 years.


Optimis parentibus, patri vere illustri tam humanitate quam ingenio præclaro, matri dilectissimæ virtutibus quæ sexum suum ornant locupleti, hocce marmor sacrum voluit Robertus Whytt de Bennochy, armiger.

Here lies Robert Whyte of Bennochy, Knight, Physician to the King, Professor of Medicine in the University of Edinburgh, President of the Royal College of Physicians, and Fellow of the Royal Society, who died on 15th April 1766, at the age of 51.

Also Louisa Balfour, his wife, the mother of fourteen children, who died 25th May 1764, at the age of 46.
To his much esteemed parents - his father, truly
distinguished alike for his kindly disposition and
his uncommon abilities; his beloved mother, rich in
all the virtues which adorn her sex - Sir Robert Whyte
of Bennochy has consecrated this marble.

Translation by the Rev. William Skae, A.M. Brown's
Epitaphs.
I.

LIFE OF ROBERT WHYTT.

Robert Whytt was born in Edinburgh on the 6th of September, 1714. His father was a member of the Scottish Bar, and his mother was Jean, daughter of Anthony Murray of Woodend in Perthshire.

The family is usually said to be derived from the noble French family of Les Blance, "their armorial bearings being nearly similar," but Seller in his Memoir of Whytt states that the Whytts probably "represent the Witts of Friesland, one of whom, Witta the son of Wicte the grandfather of Hengist and Horsa, according to the probable conclusion of Professor Simpson in his very ingenious memoir entitled 'The Catstane', lies buried beneath a gigantic monolith of greenstone on the banks of the Almond, but a few miles from Edinburgh".

However this may be, the Whytts had been a well-known family in Fifeshire for many centuries. At different times they acquired land by charter under the great seal. They were connected by marriage with leading families. John Whyte who lived in the 16th century married Eupham, a daughter of Michael Balfour of Burleigh. He had a charter dated 19th July, 1539, of the lands of Kincothil, Lumbenny, Ballingall,
Ballingall, Balgady, etc., all in the county of Fife.

His second son, John, a merchant of Kirkcaldy in the time of Queen Mary, acquired considerable wealth, and became possessed of a wadset on the estate of Bennochy in 1580.

His son, Robert, was one of the most eminent merchants of Kirkcaldy and he was the first provost of the royal burgh. He purchased part of the lands of Abbots Hall and the whole estate of Bennochy, whence his descendants have since been chiefly designated. By his first wife, Janet Tennent, heiress of Powran, he had one son, John, who married Jane, daughter of Thomas Melville of Murdocairny, younger brother of John, third Lord Melville of Raith. John's eldest son was Robert, the father of the physician.

The name has been variously spelled. In the old charters it was Quhite. The physician always wrote Whytt, but his descendants wrote Whyte.

Six children survived Whytt. Two of his sons died unmarried. The three daughters were all married, Jean to her cousin, John Balfour of Pilrig, whose descendants are still in possession of Pilrig House. John assumed the surname and arms of Melville, upon succeeding by deed of entail to the estates of Strathkinness at the decease of his cousin, General Robert/
Robert Melville in 1809. He married Elizabeth, daughter of Archibald McGilchrist of North Bar in the county of Renfrew. His son, John, married Lady Catherine Osborne, daughter of Francis Godolphin, fifth Duke of Leeds. His son, George Whyte-Melville was the novelist. He married the Honourable Charlotte Hanbury, daughter of William, first Lord Bateman. George had four daughters but no sons. There are no male descendants of Robert Whytt.

The house on the property of Bennochy was already pulled down in 1835.

In Brown's *Epitaphs in Greyfriars' Churchyard* armiger is translated "knight", which is an obvious mistake as armiger simply denotes a person entitled to bear heraldic arms, and with this meaning it is used in English. "Esquire" would have been the proper translation.

Whytt's father had "the reputation among all who knew him of being an intelligent lawyer, and an honest man." His mother "was a woman not less remarkable by her manners than by her rank." His father died six months before his birth, and he had the misfortune to lose his mother before he had attained his seventh year.

Two sisters were already married, one of them to Mr Ramsay of Balmain, the other to Mr Melville of Carnbec.
Carnbec. He was at first taken care of by his elder brother Dr George Whyte. "This brother just after he had obtained a degree in medicine and had given proofs of spirit and abilities which excited in his friends the highest expectations was cut off in the flower and vigour of life.

"But notwithstanding these disadvantages, the conduct of his youth, the progress of his education, and his zeal in the acquisition of knowledge, were such as gave just forebodings of the conspicuous character he afterwards exhibited to mankind and were in every respect correspondent to his after life.

"Soon after the birth of Dr Whyte his mother left Edinburgh, and fixed her residence in the town of Kirkcaldy in Fifeshire. There her son Robert had the first rudiments of school education and he soon exhibited conspicuous and decisive marks of uncommon superiority of talents. From the public school of Kirkcaldy he went to the University of St Andrews. After the usual course of instruction in classical, mathematical and philosophical learning, during which he merited and obtained the applause of all his teachers he came to Edinburgh, where he entered upon the study of medicine.

"From his predilection for this science it may readily be supposed that his progress in the acquisition of medical knowledge was rapid and the rather
that he had an opportunity of studying under the most able teachers of that period.

"Although the medical school of Edinburgh was then but in its infant state, yet from the industry and genius of Dr Monro, conjoined with the attention and abilities of his colleagues it had already begun to attract the notice of the medical world. Here then Dr Whyte entered upon his studies, at an university of which he was afterwards one of the greatest ornaments; and under teachers of eminence, several of whom he had in no long time the satisfaction of ranking among the number of his colleagues. Here he had an opportunity of attending the lectures of those eminent medical teachers, Monro, Rutherford, Sinclair, Plummer, Alston, and Innes. Here he had an opportunity of improving by enjoying the society of fellow students whose merit was then as conspicuous as their fame was afterwards extensive. Among the companions of his studies we might mention the names of Fothergill, Armstrong, Akenside, and several others afterwards highly distinguished in the medical and literary way. After learning what was to be acquired at Edinburgh in the prosecution of his studies he visited foreign countries."

He first went to London where he studied under Cheselden and visited the hospitals. Next he went to Paris/
Paris and attended Winslow's lectures; he also was present at the visits of the physicians and surgeons of La Charité and L'Hôtel Dieu. He then went to Leyden where he heard the lectures of Albinus and Boerhaave. He took the degree of M.D. at Rhiems in 1736.

On his return home the University of St Andrews spontaneously gave him the same degree in 1737. In the same year he was admitted a Licentiate of the Royal College of Physicians of Edinburgh, and in the following year he became a Fellow. About this time he began to practise.

Bower in his History of the University of Edinburgh says, "He was very early introduced into an extensive practice; for which he was no doubt considerably indebted to his own family connexions, and being known to be in very easy circumstances; but his own merit, and the acknowledged superiority of his talents and acquirements, were what principally conduced to bring him into notice."

On the other hand in the Harveian Oration it says, "Although his abilities were universally allowed to be great, yet for several years his practice was not extensive, a circumstance which can hardly be wondered at when it is considered that so many other eminent practitioners who had the advantages of longer experience/"
experience were then resident in Edinburgh. But the leisure hours thus afforded him were not unemployed.

"The reputation which he acquired for medical learning pointed him out, as a fit successor for the first vacant chair in the University. Accordingly, when Dr St Clair, whose eminent medical abilities, and persuasive powers of oratory had contributed not a little to the rapid advancement of the medical school at Edinburgh, found that those conspicuous talents which he possessed could no longer be exerted, in the manner which they had once been, when he enjoyed bodily vigour, unimpaired by age, and powers of mind unclouded by disease, he resigned his academical appointments in favour of Dr Whyte. Not only the unanimous consent of the patrons of the University, but the unanimous approbation of the medical practitioners in Edinburgh, and the unanimous voice of the publick, applauded the succession.

"Thus was Dr Whyte introduced without opposition into the University of Edinburgh in a manner equally honourable to himself and to his predecessor. His admission into the College took place on the 20th of June 1746, and he began his first course of the institutions of medicine, at the commencement of the next winter session! This date is given by several authorities/
authorities, but Bower in his History of the University of Edinburgh says "He (Whytt) was elected to be professor both of the theory and practice of medicine, upon the 26th August 1747." He gives as reference the Register of the Council. And 1747 is the date given in the Edinburgh University Calendar. It would seem that the rising of 1745 caused much distraction in Edinburgh with interruption of studies, and that some events, or their dates, or both, suffered from the general confusion.

"The abilities which he displayed from his academical chair in no particular disappointed the expectations which had been formed of his lectures. The Latin tongue was the language of the University of Edinburgh, and he both spoke and wrote in Latin with singular propriety, elegance, and perspicuity." This point is mentioned also in the Biographie Universelle, Ancienne et Moderne, which speaks of his "leçons prononcées dans un latin plein d'élegance et de clarté." His English style was likewise universally admired.

In his teaching he followed Boerhaave till 1762, when he adopted the Institutiones pathologiae of Gaubius as a text book. Gaubius was Boerhaave's successor and had himself used Boerhaave's text book for twenty years. In his own book he gave a larger place to Pathology. But whichever book Whytt used, he was/
was in the habit of giving his own opinions, when necessary, with the facts and arguments on which they were founded.

According to the Harveian Oration it was not till the year 1756 that he gave clinical lectures in the Royal Infirmary. These lectures had been begun by Dr Rutherford, who now "found it necessary to retire from the fatiguing duties of an office to which the progress of age rendered him unequal. On this crisis Dr Whyte, Dr Monro, Senr. and Dr Cullen each agreed to take a share in an appointment in which their united exertions promised the highest advantages to the University."

Meantime his practice grew steadily and the extent of it "corresponded to his reputation. But independently of his abilities in teaching medicine, his success in healing disease could not fail to establish his reputation both at home and abroad. Although his rise was at first but slow, yet after his merit became generally known, after experience had created confidence, and success had extended his fame, the rapid progress which he made to the head of his profession was correspondent to his deserts." "His opinion on medical subjects was daily requested by his most eminent contemporaries in every part of Britain."

Among his correspondents was Dr Stephen Hales.

"Foreigners/"
"Foreigners of the first distinction, and celebrated physicians in the most remote parts of the British empire, courted an intercourse with him by letter."

"But his most intimate friends and most regular correspondents were Sir John Pringle of London and Dr Cumming of Dorchester."

He received many public honours. In 1752 he became a Fellow of the Royal Society of London, and in 1761 he was appointed first physician to the King in Scotland, an office said to have been created for him. In most accounts of his life, as in the Harveian Oration from which I have taken almost all the quotations here, it is said that he was chosen President of the Royal College of Physicians in 1764, but Wood in his Historical Sketch of the Royal College of Physicians gives the date as Dec. 1, 1763. This office he held till his death, which occurred on the 15th of April, 1766, when he was in the fifty-second year of his age.

"Let us next take a view of his character as a man. With a mind formed for the joys of a virtuous and social life, he was neither an abstruse student who converted his chamber into a cloister nor did he seek for amusement in these scenes of dissipation which are qually destructive to health, and adverse to business. Amidst all his exertions he took a large share/
share of amusement, without transgressing the bounds of the strictest sobriety or most exemplary virtue."

"He was rather above the middle stature, of a stout and well formed make, of an open and comely countenance. His manners were easy and engaging, his temper cheerful, and his dispositions amiable. He exhibited a striking example that life is short only to the indolent, in as far at least as it can be computed, not by days or years, but by meritorious transactions. And during the course of an active life, not only in the duties of his profession, in relaxation from business and from study, and in private or domestic life, but in many important transactions both in the church and in the state he demonstrated a conduct regulated by the most determined steadiness of mind, the greatest probity, and the strictest honour. He was a fond father, an affectionate husband, and a firm friend. He shewed a steady attachment to his King and to his country; and an ardent zeal for the support both of civil and religious liberty. In the line of a physician he was a discerning practitioner, an able teacher and a judicious writer, in the line of a private citizen he was an accomplished, and active and an honest man."

His domestic life was full of sorrow. Soon after he settled in practice he married Miss Robertson*, the daughter of William Robertson of Newbigging, by whom he/

*In one account she is described as Mrs. Melville, a widow, with several children.
he had two sons who both died in infancy. She died in 1741. Her brother was General Robertson, governor of New York. In 1743 he married Louisa Balfour, the daughter of James Balfour of Pilrig. Her brother, James Balfour, became Professor of Moral Philosophy in the University of Edinburgh in 1754. She was known as the "white rose of Pilrig," and was said to be "vastly beautiful". Her husband "remained her lover till her death."

By her Whytt had fourteen children, of whom four died about the age of twelve months and four at the age of five years. The remaining six survived their parents, but two of the surviving sons died young and unmarried.

His oldest grandson died young and unmarried, and as his brother did the same, and his father does not seem to have been old when he died, it may be inferred that the Whyttts had not much physical stamina.

In the Register of Greyfriars Churchyard both Whytt and his second wife are entered as having died of "decay." In the Harveian Oration it says, "In the beginning of the year 1765 his health was so far impaired, that he became incapable of his former exertions. A tedious complication of chronical ailments which chiefly appeared under the form of diabetes, was not to be resisted by all the medical skill/
skill which Edinburgh could afford." Dr Seller in his *Memoir* gives some details of the illness and of the post-mortem examination, but they do not correspond with any known disease. He thought himself that he suffered from gout, which was also the opinion of his medical attendants, Dr Rutherford and Dr Clerk. It is quite evident from his writings that he had always suffered from "nerves" and from a weak digestion with disturbed sleep.
II.

THE WORK OF ROBERT WHYTT.

It is generally said of Whytt that posterity has not given him his due. I have tried to find out if that is true, and, if true, what the reason is.

It is certain that books on Scotland in general, or on Edinburgh in particular, even when some account of the early medical school is given, usually omit Whytt's name. And even books on the history of medicine or psychology either do not mention him or mention him only in a short paragraph or sentence.

The fact of his not being so well known to fame, as he appears to deserve, may be partly due to the circumstances of his life. He died in his fifty-second year at which age a scientist may be regarded as still young, and the many afflictions of his domestic life must have prevented him from taking that place in public and social life which he might otherwise have done, in spite of what is said in the Harveian Oration. His own health can never have been very good and his last illness was prolonged.

Cullen, whose name is better known, lived from 1712 to 1790, and was a man of massive personality. It is not true that he did not respect Whytt's teaching, - quite the contrary, - but he could not help bulking larger in the public eye. Before Whytt a noted
noted name is Pitcairne (1652-1713), of whom it was said that he was drunk twice a day. No picturesque tales have come down the generations about Whytt. He is described as a lovable man, of great intellectual acuity, with an ingenious mind.

It might be said of him that he undertook too much. Had he limited his energies to a narrower channel, he might have accomplished more. And indeed it seems probable that if his collected works had been published in three volumes instead of one, his reputation might have better withstood the wear and tear of time. In Germany they were published in two volumes.

When I began this work, I intended to make a summary of Whytt's outstanding writings, but they do not lend themselves to summary. Some of his critics seem to have misread him and to have ignored some of his statements, or to have accepted what others said about him without looking at his books themselves. He is often represented as a follower of Stahl, although he criticises Stahl's doctrines adversely.

The great men of that time, including Whytt himself, complain of being misquoted and misrepresented. So I began to suspect that Stahl (1660-1734) had also been misrepresented, and I looked up one of his books and found my suspicions confirmed, although I had not time/
time to read much.

That I might not add another name to those who misrepresent, I decided to make extracts from Whytt's writings. These extracts have grown to a somewhat unwieldy extent, and in making them I came to the conclusion that some of his Essays should be reprinted in full, or otherwise that some one with literary leisure should write a book *Robert Whytt and his Contemporaries* after the manner of Dr John Fothergill and his Friends.

I propose now to make a few remarks on each of the writings in the *Collected Works* in turn.*

AN ESSAY ON THE VITAL AND OTHER INVOLUNTARY MOTIONS OF ANIMALS.

In the dedication to the Earl of Morton and in the preface Whytt speaks of his work as philosophical. This almost points to his going further than known facts would allow. In his day, however, science and philosophy, were not clearly differentiated from each other, while psychology was hardly recognised as a separate science.

We notice that he wrote "for his own satisfaction." This is obvious throughout in his leisurely descriptions of his own observations and experiments and in his careful reasoning.

When/

* References are to the typed MS. unless otherwise stated.
When he speaks of the "power or influence of the nerves" (pp. 15-16), he states what he means by "animal or vital spirits." Here it can only be regretted that he should ever have used a term liable to misapprehension, merely "in compliance with custom".

Already (p. 27) he has begun to consider active movements in capillaries, on which he published a separate essay in 1755.

The argument (p. 28) about the mutual interaction of the blood and the vessels brings him nearer the unity after which he is seeking. He might perhaps have made more of this.

Of "sympathy between their nerves" (p. 41) he says "a phrase indeed oftener used than well understood. To this subject he devotes the first chapter of his Observations on Nervous Disorders published in 1764.

In Section XI the facts are taken from the experiments of Stephen Hales, with whom he corresponded.

His remark about Stahl (p. 58) has to be noticed in connection with the idea that he himself was a follower of Stahl. "The indeed extravagant notions of Stahl and his followers with regard to the manner in which the mind regulates all the actions of the body." (p. 61).

Objections to Stahl's views are again expressed (p. 64) in connection with the motions of "infants, ideots/
What is said (pp. 89 et seq.) about the soul not leaving the body immediately upon death, is apparently one of the passages which have blinded some readers to Whytt's real merits. And similarly the passage (pp. 94 et seq.) about the extension and indivisibility of the soul.

PHYSIOLOGICAL ESSAYS.

The first of these, the Inquiry etc., was read at several meetings of the Philosophical Society of Edinburgh in the years 1745 and 1746. It was published with some corrections and additions in the year, 1755.

The second shews Whytt as a controversialisist.

SOME EXPERIMENTS MADE WITH OPIUM.

This is again a controversial paper, and Whytt uses the action of the opium to reinforce his theory about motions being dependent on a sentient principle.

OF THE VIRTUES OF LIME-WATER AND SOAP.

As these remedies were much used in the treatment of stone, it seems as though some people must have derived benefit, possibly from the large quantity of fluid/
fluid ingested, and also from the modification which these remedies would entail on food and other beverages. Washing out the bladder with a mild astringent was probably beneficial. Some of the impurities or undetected foreign matter may occasionally have been effective.

It was owing to Whytt's experiments with different kinds of lime, that Joseph Black was led to make the investigations which resulted in the discovery of carbon dioxide.

OBSERVATIONS ON NERVOUS DISORDERS.

In a footnote in the first chapter Whytt says that the purpose of these observations is "to endeavour to trace the sympathy of the nerves to its true source, which I take to be the brain and spinal marrow." And in another footnote, "By the sentient principle, I understand the mind or soul in man, and that principle in brutes which resembles it."

Whytt again separates himself from the followers of Stahl. (p.187).

There is almost an anticipation of Sir James Mackenzie's work (p.194).

OBSERVATIONS ON THE DROPSY IN THE BRAIN.

The priority which he claims here has been disputed, but he shews his clinical acumen by the accuracy of his description.

Besides/
Besides the papers in the Collected Works there are several papers by Whytt scattered in the periodicals of the time. Watt gives the names of several of these. Some of them illustrate the breadth of his interests as "The Cure of a fractured Tendo Achilles." Ess. Phys. et Lit. 1754, "Description of the Matrix or Ovary of the Buccinum Ampullatum." Ib. 1756. "Of the use of Bark in a Dysentery and a Hoarseness after Measles." Ib. "Observations on the anomalous and true Gout." Ib. "Account of an Earthquake felt at Glasgow and Dumbarton; also, of a shower of Dust falling on a Ship between Shetland and Iceland." Phil. Trans. 1755.

The "Table of the several Treatises and Papers" in the Collected Works shows the variety of subjects which are brought together. The same readers would not wish all the parts, and would not be inclined to buy a heavy quarto of nearly 800 pages. I have not been able to find out the price at which it was published; it cannot have been small. Mr Thin, the bookseller, advertised for a copy for me and got no response. As the book was not a text-book for undergraduates, nor a book which professors would use in the ordinary course of their work - they would at most refer to it occasionally, as Cullen did, - nor was it a book for the general public, it is quite likely that few copies were bought, and that the remainder was sold as waste paper. This does not help a man's name to go down to posterity./*

* One guinea. See appendix I. p.48.
posterity.

There remains to be discussed whether Whytt exercised much influence on medical science, directly or indirectly, and what credit is generally conceded to him.

In his own day he was well known both at home and abroad. In 1743 he attracted attention by his Essay on the Virtues of Lime-Water in the Cure of the Stone. In 1739 £5000 was given by Parliament to Mrs Stephens for her cure for stone, which consisted mainly of soap and lime water. This attracted the attention of physicians all over Europe, and in this connection Whytt was brought into contact with many important people. There can be little doubt but that his careful observations and experiments encouraged others in the prosecution of similar work, and we have already seen how Joseph Black was led to the discovery of carbon dioxide.

The publication in 1751 of the "Essay on the vital and involuntary motions of animals" aroused the interest of all the outstanding physiologists of the time, and led him into controversy. It must be allowed that some of the expressions used by Whytt and the manner in which he sometimes stated his opinions, gave an opportunity to his opponents of which they did not fail to avail themselves. He also introduced metaphysics and theology into what should/
should have been kept within strictly scientific limits. Seller writing in 1862 says that unless Whytt had assigned a cause, "he would not have satisfied those to whom he addressed himself." This may be true, but in spite of his pleasant and leisurely style and insinuating interrogatory method of reasoning, perhaps partly because of this, the impression is given to the reader that he must at times have been a very irritating opponent.

An extract from a letter of Smellie to a friend may, or may not, throw a side-light on the manner in which controversies were conducted by professors in Edinburgh in the eighteenth century. Smellie is discussing dreams. "Another nocturnal entertainment, though not so alarming, was much more extravagant and ludicrous. I was for some time diverted with a furious dispute between Dr Monro and Dr Whytt concerning the uses of the Deltoid Muscle! The combatants at length became so hot, that they were just proceeding to give the dispute an effectual termination by the intervention of the cudgel, when I awoke." It will be noticed, however, that Smellie calls the dream "extravagant." He goes on to discuss the use of dreams for the analysis of character. Such theories were then known in Edinburgh.

Dezheimeris in his Dictionary (1828-1839) says, "Heller/
"Haller eut à ce sujet (l'irritabilité), avec Whytt et d'autres, une discussion dont l'amour de la vérité était le motif de part et d'autre, et où l'on trouve d'ailleurs ces égards et cette retenue que tous les hommes et surtout les savants se doivent réciproquement."

Haller begins his article on Whytt in the "Bibliotheca Anatomica" (1774-1777) with the following paragraph, "Professor & Medicus primarius Edinburgensis. Cum me passim sit adgressus, cavendum est, ne meum de Cl. viro judicium a dolore meo vitietur. Magni certe ingenii vir fuit & perspicacis, & cum pene ad Stahlii modum de anima omnis in animale motus causa sentiret, me & mechanicos sibi adversos inventit, quorum placita sibi putavit necessese esse infirmare."

It is tempting to give more quotations from Haller, but it would lead too far for the present purpose.

In Edinburgh Porterfield in his "Treatise on the Eye (1759) criticized Whytt somewhat severely and at considerable length. He speaks of "the learned Dr Haller" and of "the learned Dr Clerk" but of "the ingenious Dr Whytt". Bower in his "History of the University of Edinburgh" follows on much the same lines as Porterfield; he gives Whytt credit for general culture and metaphysical acuteness, and says, "He was naturally of a bold enterprising turn of mind, and was extremely interesting as a public lecturer. His character/
character as a medical philosopher stood much higher on the continent than it did in his native country." That might only be because there were relatively more philosophers in his native country, and also more students of the classics than on the continent. Philosophers, general or special, would not stand out as much. Grant in his "History of the University" follows Bower.

Cullen spoke with great respect of Whytt in various connections, and his biographer, John Thomson, gives nearly a hundred pages to a discussion of vitalism, etc., beginning with Hippocrates and going on to Whytt to whom nearly thirty pages are allotted. Abroad Unzer (1727-1799) and Prochaska (1749-1820), who were both familiar with Whytt's writings, worked on similar lines.

In his other works Whytt continues to prove and illustrate his main doctrine of a sentient principle. These writings contributed not a little to his fame, for whatever subject he takes up, he shews the same unwearying carefulness in observation and attention to detail.

The "Harveian Oration" gives a good account of his life and work, and though unpublished, it has been largely used for articles in Encyclopædias. The last edition of the "Encyclopædia Britannica" in which an article is devoted to Whytt, is the Seventh (1842).
The next full account of his Life and Work is so thorough that it might be considered final. It is the "Memoir", which was read by Dr William Seller on the 7th April, 1862, before the Royal Society of Edinburgh and which was printed in the Transactions of the Society in the same year. For this "Memoir" the MakDougall - Brisbane prize was awarded to Dr Seller. He says, "Whytt's great claim to a permanent fame, therefore, is that he was the first to strike into a right path of investigation, in respect to the relation, in organic nature, between external impressions and the movements determined from within the organism." He gives an analysis of Whytt's writings, which leaves little to be desired.

It would be difficult, if not impossible, to enumerate all the books and papers in which Whytt is mentioned. Let it suffice here to give some of the principal of these.

Alison in his "Observations on the Physiological Principle of Sympathy" (1826) speaks of Whytt as being successful as far as he went, and that he himself (Alison) considered his own observations "only as somewhat fuller illustrations of the principles which he has laid down."

Marshall Hall (1850), Brown-Séquard (1858), Laycock (1840 and 1869) do him justice. Richardson (1890) in a paper on Cullen speaks of "Dr Whytt, a man of/
of the finest qualities."

Sherrington in the "Text-Book of Physiology," edited by Schafer (1900) mentions Whytt as having shewn that the seat of reflexion was the cerebo-spinal organ (p.786), that the reflex function does not depend on the integrity of the cord as a whole (pp.811 & 813), that the destruction of an anterior corpus quadrigeminum abolishes reflex contraction of the pupil to light, "Whytt's reflex" (p.913), and as having drawn attention to the phenomenon of "shock", a century previous to Hall, although assigning to it no descriptive term (p.845). This last point Sherrington brings up again in "The Integrative Action of the Nervous System" (1920) in very much the same words (p. 240).

"Whytt's reflex" appears to refer to a case described in the collected "works" (p.70) in Section XII of the "Essay on the Motions of Animals." "From this case it seems probable, that the dilatation of the pupil soon after the coming on of the coma, was owing to the compression of the thalami nervorum opticorum, by the water collected in the brain, which rendered the retina insensible of the stimulus of light." "As these different states of the pupil were more remarkable in the left than in the right eye, it is probable, that one side of the medullary substance of the brain was somewhat more compressed than the/
the other." See also Collected Works p. 760 + pp. 742-3. I think there is another
footnote at p. 743.

That Whytt drew attention to the phenomenon of shock, obviously refers to his objections to the way
in which Haller carried out some of his experiments, and made inferences therefrom, e.g. in Section II of
the "Observations on Sensibility". (p. 124.).

Brett (1912-1921), Garrison (1917), Comrie (1921),
all mention Whytt appreciatively.

He is mentioned by many foreign writers, as
Luciani, Haeser, Puschmann, Baas, Bilguer, and others.
Some of these names are taken from a list of books, in
which notice is taken of Whytt, sent to me by Dr Erich
Ebstein of Leipzig. Max Neuburger is specially marked
as giving an excellent account of Whytt, and H.S.
Reimarus in his "Autobiography" speaks of having
attended Whytt's lectures. Franz Carl Müller is
quoted as saying, "Schon 1770 stellte Whytt die
Behauptung auf, dass die schlimme Krankheit haupt-
sächlich in Entbindungsanstalten vorkommt und auf
Zersetzung fahulger Stoffe zurückgeführt werden musse,
welche die Luft verpesten." "1770" is clearly a
mistake. I have not come across any statement of
that kind, but I have not seen all Whytt's scattered
articles which seem to have been numerous.

The work of Whytt which appears to have been most
neglected, is that on the circulation in capillaries.
Perhaps Brown-Séquard had it in mind when he said

(1858)/

"Die histor. Entwicklung der ex. Gehirn- und Rückenmarkspathologie
von Lewens, Stuttgart 1897, sel. 174 ff. über Stahl und Whytt ausgezeich-
net!"
"Before treating of the reflex changes in nutrition, which are by far more frequent, and more important to be well investigated, than the reflex secretions, I must remark that the reflex character of facts more or less similar to those I have to mention has been known for a long while, and that the modern theory is not far in advance of that given, in this respect, by Robert Whytt in the last century. In one of his important works he has shown that the normal and morbid sympathies either for movements, nutrition or secretion, are reflex phenomena. Still more, he has shown that the share of blood-vessels is very great in many of these phenomena." He refers to the "Observations on Nervous Disorders."

Whytt states that the very small vessels are themselves active in promoting the passage of the blood through them, and he says that the alternate contractions "may be seen in the legs of a bug; in the small vessels of which an extraordinary vibration is discovered by the microscope." (Works. p.234 Typed M.S. p.110).

Langley in "The Autonomic Nervous System" (1921) refers to Todd’s Cyclopaedia Anat. and Physiol. I, p.671. Todd (p.671) speaks of "a merely oscillatory movement" and says (p.672), "But, although the small vessels do not contribute by their active contraction to propel the/
the blood through them, or although they do not as a whole assist the force of the heart, it is yet very apparent that they have the power of modifying in a remarkable manner the flow of blood in particular parts." He quotes Haller, James Black, Alison, Marshall Hall, and others, but does not mention Whytt.

The omission of Whytt's name here and elsewhere may be due in part to his use of the expressions, "vibratory motion" and "oscillatory motion." He sometimes appears to mean an oscillation of the whole vessel; at least a casual reader would be inclined to think that. But he quite definitely speaks of contraction. A good deal of work, however, was done on the circulation in his time, and his name may simply have dropped out here as elsewhere.

At present much attention is being given to circulation in the capillaries. Bayliss in the Preface to the Third Edition of the "Principles of General Physiology" says that the chief addition is a section on the capillary circulation. Krogh in a communication to the Journal of Physiology (1921) says, "Capillaries are contractile and can react independently of the arterial pressure." It is "desirable to emphasize the quantitative and even qualitative difference in the behaviour of vessels supplying different organs." Is Whytt's voice not heard here saying, "Is not this the sentient principle reacting according/
according to the nature of the stimulus?" For the
initiation of the present movement in favour of active
contraction Langley gives the credit to Stricker (1865),
as also does Shafer in the "Essentials of Histology,
(1920) 11th edition (p.221). Langley further mentions Roy
and Graham Brown (1879), Krogh (1919 & 1920) and others.

Whytt's "Observations on Nervous Disorders" and
on "Dropsy in the Brain" are models of clinical
method, and they still repay perusal. There is no
time to speak of them here.

I had hoped to say something of Scotland in the
eighteenth century, of Whytt's contemporaries in
medicine at home and abroad, with a note on some of
the terms used, as vital spirits, sympathy and irrit-
ability, and of his methods of treatment, but these
I must leave alone.

Just one remark about his treatment. Sinclair in
the "Robert Campbell Memorial Oration" printed in the
"British Medical Journal" (March 11, 1922) says, "It is
more than possible that we abstain from this (blood-
letting) too often, and that we should reconsider its
value." It might likewise be said that we are too
afraid of opium and alcohol, and for some mysterious
reason are not afraid of tea.

According to Henry Grey Graham, one of the few
general writers who mention Whytt along with Cullen,
Black,/

※See appendix II p.49.
Black, the Monros, and the Gregorys, the eighteenth century in Scotland was one of rapid progress from "social stagnation" to "general energy" from "abject poverty" to "wide-spread wealth."

In conclusion it may be said that Whytt does not get the credit which he deserves. For this there may be some special reasons, as his domestic misfortunes, his early death, and, it must be admitted, his way of expressing himself at times, though this he might have rectified, had he lived other ten or fifteen years and had time to revise his work.

Among general reasons I think that we must allow our own negligence a fairly large place. Why do we not publish Fasti revised from time to time? Surely this might be done in connection with the "University Review", which was projected before the War, but which has not yet appeared. The Editor is the Lecturer on the History of Medicine, and with him the Lecturer on Psychology might well collaborate.

I have omitted much that is interesting in Whytt's writings, and have left unsaid much that might be said, but if I have proved even to a small extent that it is worth while remembering those who have gone before, my work will not have been done in vain, and it may perhaps lead to those who come after, remembering us.

*See appendix III. p. 51.*
<table>
<thead>
<tr>
<th>Author</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillimus</td>
<td>Borrichius</td>
</tr>
<tr>
<td>Astius</td>
<td>Boyle</td>
</tr>
<tr>
<td>Albinus</td>
<td>Bremond</td>
</tr>
<tr>
<td>Allan</td>
<td>Brunner</td>
</tr>
<tr>
<td>Alston</td>
<td>Brydone</td>
</tr>
<tr>
<td>Aretaeus</td>
<td></td>
</tr>
<tr>
<td>Aristotle</td>
<td>Celsus</td>
</tr>
<tr>
<td>Austin</td>
<td>Cheyne</td>
</tr>
<tr>
<td>Cicero</td>
<td></td>
</tr>
<tr>
<td>Bacon</td>
<td>Clark</td>
</tr>
<tr>
<td>Baglivi</td>
<td>Clarke</td>
</tr>
<tr>
<td>Baker</td>
<td>Cleghorn</td>
</tr>
<tr>
<td>Balderston</td>
<td>Clerk</td>
</tr>
<tr>
<td>Barbette</td>
<td>Cole</td>
</tr>
<tr>
<td>Barry</td>
<td>Cowper</td>
</tr>
<tr>
<td>Bartholine</td>
<td></td>
</tr>
<tr>
<td>&quot;Basil Valentine&quot;</td>
<td>Daran</td>
</tr>
<tr>
<td>Bauchimus</td>
<td>Dawson</td>
</tr>
<tr>
<td>Bayle</td>
<td>Descartes</td>
</tr>
<tr>
<td>Bernouilli</td>
<td>Diocles Cærystius</td>
</tr>
<tr>
<td>Black</td>
<td>Dioscorides</td>
</tr>
<tr>
<td>Boerhaave, Hermann</td>
<td>Dodwell</td>
</tr>
<tr>
<td>Boerhaave, Kaau</td>
<td>Douglas</td>
</tr>
<tr>
<td>Bond</td>
<td>Drake</td>
</tr>
<tr>
<td>Bonetus</td>
<td>Le Dran</td>
</tr>
<tr>
<td>Borelli</td>
<td>Duverney</td>
</tr>
<tr>
<td>Epicurus</td>
<td>Van Helmont</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Etmüller</td>
<td>Helvetius</td>
</tr>
<tr>
<td></td>
<td>Hierissant</td>
</tr>
<tr>
<td>Fabricius</td>
<td>Hieronymus Mercurialis</td>
</tr>
<tr>
<td>Du Fay</td>
<td>Highmore</td>
</tr>
<tr>
<td>Fernelius</td>
<td>Hildanus</td>
</tr>
<tr>
<td>Floyer</td>
<td>Hillary</td>
</tr>
<tr>
<td>Fordyce</td>
<td>Hippocrates</td>
</tr>
<tr>
<td></td>
<td>de la Hire</td>
</tr>
<tr>
<td>Galen</td>
<td>Hoadly</td>
</tr>
<tr>
<td>Gardiner</td>
<td>Hoffman</td>
</tr>
<tr>
<td>Gassendi</td>
<td>Homberg</td>
</tr>
<tr>
<td>Geoffrey</td>
<td>Home</td>
</tr>
<tr>
<td>Glisson</td>
<td>Hook</td>
</tr>
<tr>
<td>Gilchrist</td>
<td>Horace</td>
</tr>
<tr>
<td>De Gorter</td>
<td>Houston</td>
</tr>
<tr>
<td>Gross</td>
<td>Huneuld</td>
</tr>
<tr>
<td>Hales</td>
<td>Jacobaeus</td>
</tr>
<tr>
<td>Haller</td>
<td>Junckerus</td>
</tr>
<tr>
<td>Du Hamel</td>
<td>Jurin</td>
</tr>
<tr>
<td>Hamilton</td>
<td>Juvenal</td>
</tr>
<tr>
<td>Harder</td>
<td>Keill</td>
</tr>
<tr>
<td>Hartley</td>
<td>Kirkpatrick</td>
</tr>
<tr>
<td>Harvey</td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>Lancisi</td>
</tr>
<tr>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Langrish</td>
<td>Monro Junior</td>
</tr>
<tr>
<td>Laurentius</td>
<td>Monro, Donald</td>
</tr>
<tr>
<td>Leeuwenhoek</td>
<td>Montanus</td>
</tr>
<tr>
<td>Leibnitz</td>
<td>Morand</td>
</tr>
<tr>
<td>Lieutaud</td>
<td>More</td>
</tr>
<tr>
<td>Linden</td>
<td>Morgagni</td>
</tr>
<tr>
<td>Linning</td>
<td>Morton</td>
</tr>
<tr>
<td>Lobb</td>
<td>Muschenbroeck</td>
</tr>
<tr>
<td>Lommius</td>
<td>Musgrave</td>
</tr>
<tr>
<td>Lower</td>
<td>Muzzel</td>
</tr>
<tr>
<td>London Dispensatory</td>
<td></td>
</tr>
<tr>
<td>Lowthorp</td>
<td>Newcome</td>
</tr>
<tr>
<td>Lucretius</td>
<td>Newton</td>
</tr>
<tr>
<td>Lupsius</td>
<td>Nuck</td>
</tr>
<tr>
<td>Lymery</td>
<td>Nugent</td>
</tr>
<tr>
<td>Macquer</td>
<td>Ovid</td>
</tr>
<tr>
<td>Maître-Jan</td>
<td></td>
</tr>
<tr>
<td>Malpighi</td>
<td>Paul of Venice</td>
</tr>
<tr>
<td>Mandeville</td>
<td>Paulus Aegineta</td>
</tr>
<tr>
<td>Martine</td>
<td>Pechlinus</td>
</tr>
<tr>
<td>Mayow</td>
<td>Petit</td>
</tr>
<tr>
<td>Mazini</td>
<td>Peyer</td>
</tr>
<tr>
<td>Mead</td>
<td>Pharmacopoeia Edinburgensis</td>
</tr>
<tr>
<td>Mery</td>
<td>Piso</td>
</tr>
<tr>
<td>Michellotii</td>
<td>Pitcairn</td>
</tr>
<tr>
<td>Molinelli</td>
<td>Platerus</td>
</tr>
<tr>
<td>Monro Senior</td>
<td>Plempius</td>
</tr>
<tr>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Pliny</td>
<td>Springsfeld</td>
</tr>
<tr>
<td>Polignac</td>
<td>Stahl</td>
</tr>
<tr>
<td>Porterfield</td>
<td>Steno</td>
</tr>
<tr>
<td>Pringle</td>
<td>Stewart</td>
</tr>
<tr>
<td>Portarrield</td>
<td>Storck</td>
</tr>
<tr>
<td>Reaumur</td>
<td>Stuart</td>
</tr>
<tr>
<td>Redi</td>
<td>Swammerdam</td>
</tr>
<tr>
<td>Ridley</td>
<td>Van Swieten</td>
</tr>
<tr>
<td>Riolan</td>
<td>Sydenham</td>
</tr>
<tr>
<td>Robinson</td>
<td></td>
</tr>
<tr>
<td>Russel</td>
<td>Thruston</td>
</tr>
<tr>
<td>Rutty</td>
<td>Tuplius</td>
</tr>
<tr>
<td>Ruysch</td>
<td>Vesalius</td>
</tr>
<tr>
<td>Santorini</td>
<td>Vieussens</td>
</tr>
<tr>
<td>Sauvages</td>
<td></td>
</tr>
<tr>
<td>Schwencke</td>
<td>Walæus</td>
</tr>
<tr>
<td>Senac</td>
<td>Weitbrecht</td>
</tr>
<tr>
<td>Sennertus</td>
<td>Wepfer</td>
</tr>
<tr>
<td>Septalius</td>
<td>Van der Wiel</td>
</tr>
<tr>
<td>Sharp</td>
<td>Willie</td>
</tr>
<tr>
<td>Shawenberg</td>
<td>Winslow</td>
</tr>
<tr>
<td>Smith</td>
<td>Wisdom</td>
</tr>
<tr>
<td>Spotiswood</td>
<td>Wright</td>
</tr>
</tbody>
</table>
There is a little difficulty in enumerating the authorities quoted, because the same name is not always spelt in the same way, and sometimes it is difficult to know if the same man is meant.

The list of names, however, serves to show wide reading, constant intercourse with colleagues, careful consideration of the opinions of others, and willingness to give credit where credit is due.

This extensive reading must have helped to form Whytt's style which was good in both Latin and English, but indeed a good English style follows naturally from a good Latin style. Bower points out that Scotland had not neglected the classical writers of Greece and Rome, but it was only now in the eighteenth century that intercourse with England became general and that books of general interest were brought north. English writers of influence at the time were, Sir William Temple, (1628-1699), Dryden (1631-1700), Addison (1672-1719), and Pope (1688-1744). These, one would suppose, were read by Whytt while he was still at St Andrews taking his Degree in Arts during the formative years of his life.
BIBLIOGRAPHY.


Bower, Alex. The History of the University of Edinburgh. Edinburgh, 1817.


Buck, A.H. The Growth of Medicine, New Haven, Yale University Press, 1917.

Calendar, Edinburgh University, 1921-1922. Edinburgh, 1921.

Calendar, St Andrews University, 1921-1922. Edinburgh, 1921.


Comrie, J.D. Article "Medical School to 1870", Edinburgh's Place in Scientific Progress. Edinburgh, 1921.


Encyclopædia Britannica. 7th ed. 1844. 11th ed. 1911.


Fox, R. Hingston. Dr John Fothergill and his Friends. London, 1919.


Grant, Alex. Story of the University of Edinburgh, London, 1884.


New English Dictionary, Oxford. Referred to as O.E.D.


Rees,


Verworn,


Wordsworth, Christopher. Scholae academicae. Cambridge, 1878.

In order to do Whytt justice it would be necessary to go over the various editions of his works, and the translations into other languages. A recent writer remarked that there is no English equivalent to the French word esprit. And the meanings which have been given to pneuma at different times are many and various. Books on psychology and cognate subjects are always peculiarly difficult to translate, and it is difficult to give the exact meaning of an author, even in the same language, without using his exact words.

In the literature I might have mentioned J.H. Baas, "Grundriiss der Geschichte der Medicin". Translated by H.E. Henderson, New York, 1889. Baas calls Whytt a follower of Stahl but gives him a certain/
certain amount of credit.

J. Ruhrah is mentioned in Dr Ebstein's list as having published a paper on Whytt in the Med. Libr. & Hist. Journal, Brooklyn, 1904, Vol.II, with a portrait. And Mr Graham, the Librarian of the R.C.P. Library, told me of an article by Ruhrah in the "Journal of the Alumni Association of the College of Physicians and Surgeons, Baltimore, U.S.A. (1911-1912). Mr Thin ordered this for me two months ago, but it has not yet come.

There is a volume of Whytt's Clinical Lectures (c.1762) in M.S. in the Library of the R.C.P.
APPENDIX I.

Upon the suggestion of Mr W. J. Hay, Bookseller, John Knox's House, I looked up the "Edinburgh Evening Courant" and on the front page of the issue for Monday, January 4, 1768, I found an advertisement beginning "This day is published" of "The Works of Robert Whytt, M.D." The book is described as "elegantly printed in 4to, price neatly bound, one guinea," and a table of the principal contents is given.

The "Observations on the Dropsy in the Brain" is advertised separately at 2s. "And this compleats the octavo edition of his works."

There are also advertised the "Essay on the Vital and other Involuntary Motions of Animals, 2d edition, 5s." the "Physiological Essays, 3d edition, 3s." and the "Observations on the Nature, Causes, and Cure of those Disorders, which are commonly called nervous, hypochondriac, or hysteric, 3d edition, 6s."
APPENDIX II.

In the O.E.D. Sympathy is defined as "a (real or supposed) affinity between certain things, by virtue of which they are similarly or correspondingly affected by the same influence, affect or influence one another (esp. in some occult way), or attract or tend toward each other. Obs. exc. Hist. or as merged in other senses." One of the examples is 1658 R. White (title).

In a foot-note (Works p. 504) Whytt gives an historical note on sympathy beginning with Hippocrates. Curiously he omits Sibbald, who in "Scotia Illustrata", Edinburgh, 1684, discusses the subject and explains it in this way, "Compatitur autem pars alteri tribus modis. Vicinitate. Societate. Communione. This is the first mention of sympathy which I have found in Scottish literature, though it was known, according to the "Archæological Essays", in Scotland as early as in the reign of James IV (1488-1513), for the explanation of his well known fall by John the Leeche Abbot of Tungland (1508) is said to be by the "doctrine of sympathies". As given by John Lesley, Bishop of Ross, in his "History of Scotland", Edinburgh, 1830, (but a derivative of it, Rome, 1578), "He causeth mak ane pair of wings of fedderis, quhilkis beand fessinit apoun him, he flew of the castell/
castell wall of Strivelings, bot shortlie he fell to the ground and brak his thee bane; bot the wyt thair-of he asscryvit to that thair was sum hen fedderis in the wingis, quhilk yarneit and covet the mydding and not the skyis."

For "reflex consciousness", "Works" p.206 foot-note.
Typed MS. p.97.
For "muscular movement compared with pendular movement and elasticity", "Works" p.193 et seq.
Typed MS. p.90.
Some medical dictionaries still give "Whytt's disease", e.g. Gould, Dorland, Lippincott, and Stedman. The last three explain who Whytt was, and Lippincott gives "Whytt's Tincture", as a compound tincture of gentian, cinchona, and orange peel.

Osler in "The Principles and Practice of Medicine", speaking of Tuberculous Meningitis says, "Our first accurate knowledge of this affection dates from the publication of Robert Whytt's Observations on the Dropsy of the Brain, Edinburgh, 1768. He studied 20 cases and divided the disease into three stages, according to the condition of the pulse."

The tincture is given on page 635 of the "Works".

"R. Cort. Peruvian. Pulv. unc. IV.
Rad. Gentian.
Cort. Aurant. ana unc. i. ss. Misce.
Infunde in spir. vin. Gall. lib. IV. in balneo arense per dies VI. et cola.

"Of this tincture, I generally give one tablespoonful, with four or five spoonfuls of water, every morning, an hour and a half before breakfast, and between seven and eight in the evening. I sometimes add to each pound of this tincture, an ounce or more of the sp. lavend. comp. which improves its taste, and makes it sit better on some stomachs."

"When/
"When acids do not disagree, twenty or thirty drops of the elixir of vitriol may sometimes be taken with advantage in each dose of the tincture." (p.636)

"When the patients are liable to fits of the true gout, I increase the proportion of the *rad. gentian.* and *cort. aurant.* in the tincture, adding at the same time some nutmeg or ginger, especially if the stomach be cold and flatulent. In this case also, the tincture may be taken to the quantity of two tablespoonfuls twice a-day." (p. 653).
THE
LIFE AND WORK
OF
ROBERT WHYTT, M.D., F.R.C.P., F.R.S.
Professor of Medicine in the University of EDINBURGH.

A Preliminary Study.

by

R. MARY BARCLAY. M.A., M.B., DIPL. PSYCH.

VOL. II.
1.

THE

WORKS

OF

ROBERT WHYTTE, M.D.

Late Physician to His Majesty;
President of the Royal College of Physicians,
Professor of Medicine in the University of
Edinburgh, and Fellow of the Royal Society.

Published by his Son.

Edinburgh:
Printed for T. Becket, and P. A. Dehondt, London;
and J. Balfour, Edinburgh.
By Balfour, Auld, and Smellie.

M. DCC. LXVIII.
2.

TO

SIR JOHN PRINGLE, BARONET,

Physician to Her Majesty;

In Testimony of the sincere Friendship that subsisted between him and the Author;

AND

In Gratitude for the Care he has taken of this complete Edition of his works,

They are most respectfully dedicated

by his son,

ROBERT WHYTT.
<table>
<thead>
<tr>
<th></th>
<th>A Table of the several Treatises and Papers contained in this Collection.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An essay on the vital and involuntary motions of animals.</td>
</tr>
<tr>
<td>2</td>
<td>An inquiry into the causes which promote the circulation of the fluids in the small vessels of animals.</td>
</tr>
<tr>
<td>3</td>
<td>Observations on the sensibility and irritability of the parts of men and other animals.</td>
</tr>
<tr>
<td>4</td>
<td>An account of some experiments made with opium on living and dying animals.</td>
</tr>
<tr>
<td>5</td>
<td>An essay on the virtues of lime-water and soap in the cure of the stone.</td>
</tr>
<tr>
<td>6</td>
<td>Appendix to the above essay, containing the cases of the R.H. Horace Walpole, etc.</td>
</tr>
<tr>
<td>7</td>
<td>An essay on the various strength of different lime-waters.</td>
</tr>
<tr>
<td>8</td>
<td>Postscript on Lord Walpole's case.</td>
</tr>
<tr>
<td>9</td>
<td>Some observations on the lithontriptic virtue of the Carlsbad waters, lime-water, and soap.</td>
</tr>
<tr>
<td>10</td>
<td>An instance of the electrical virtue in the cure of a palsy.</td>
</tr>
<tr>
<td>11</td>
<td>Observations on the nature, causes, and cure of those disorders, which are commonly called nervous, hypochondriac, or hysteric.</td>
</tr>
</tbody>
</table>
12. Cases of the remarkable effects of blisters in lessening the quickness of the pulse in coughs attended with infections of the lungs and fever.


APPENDIX.

1. An account of an epidemic distemper at Edinburgh and several other parts in the south of Scotland, in the Autumn of 1758.

2. Extracts of several letter to Dr Pringle relating to the use of the sublimate in the cure of phagedaenic ulcers.
AN ESSAY
ON THE
Vital and other Involuntary Motions
of Animals.

Inanimum est omne quod pulsu agitetur externo; quod autem est animal, id motu cietur interiore et suo. Nam haec est propria natura animi atque vis. - Quae sit illa vis, et unde sit intelligendum puto. Non est certe nec cordis, nec sanguinis, nec cerebri, nec atomorum.

Cicero, Disput. Tuscul. lib.1.

The first Edition printed in the year 1751, and the 2nd in the year 1763.
TO THE RIGHT HONOURABLE.

JAMES EARL OF MORTON,

LORD ABERDOUR, etc., etc., etc.

It is not your Lordship's high station in the world, but your extensive knowledge of the works of nature, and taste for Philosophical inquiries, which have determined me to inscribe the following Essay to your Lordship, and makes me, with pleasure, embrace this opportunity of publicly declaring the great respect with which I am,

My Lord,

Your Lordship's

most obedient, and

most humble Servant,

ROBERT WHYTT.
PREFACE.

About twelve years ago, not long after the author of this essay had left the schools of medicine, he began to be dissatisfied with the common theories of respiration and the heart's motion; and as he had not met with any writer, who had given, as he thought, a just account of the vital and other involuntary motions of animals, or derived them rightly from their true source, he purposed some time or other to write on this subject, if not for the public, at least for his own satisfaction. In pursuance of this resolution, the following essay was begun in the year 1744, and might have been finished long ago, had not the author's time been greatly taken up with more necessary business. In composing it, he has been careful not to indulge his fancy, in wantonly framing hypotheses, but has rather endeavoured to proceed upon the surer foundations of experiment and observation. No doctrine in philosophy, which was not built on these, has ever been able to stand its ground for half a century; and the theories of Newton, and some few others of the more happy philosophers, have therefore triumphed over all objections, because they were founded on nothing else but plain facts; facts indeed, whose existence was/
was perhaps unknown before, and whose influence is so extensive, that while they are simple and uniform in themselves, they serve as causes for explaining innumerable effects. On the other hand, in the hypothetical method of philosophising, causes are usually assigned, which not only cannot be proved to exist, but which are frequently more intricate and complex than even the effects to be explained from them. And indeed, it cannot be expected that unguided imagination should hit upon the truth, since nature has so closely concealed many of her operations, that they often elude the united efforts of genius, industry, and experiment.

There is one favour which the author would ask of those who may take the trouble to peruse this performance, viz. that they would delay passing judgment upon any part of it, till they have attentively and fairly considered the whole; because it is apprehended, that the theory of every one of the motions here explained, supports and strengthens what is said of the rest, and that, when all are taken together, each receives an additional weight of argument, and appears in a stronger light.

Edinburgh,

Octob. 1. 1751.
CONTENTS.

Introduction. P. 11

SECT. I.
Principles and facts necessary to be premised. 15

SECT. II.
An examination of the opinions of some of the most considerable authors concerning the motion of the heart. 22

SECT. III.
Of the systole of the heart. 24

SECT. IV.
Of the relaxation and diastole of the heart. 24

SECT. V.
Of the motions of the alimentary canal and bladder of urine. 26

SECT. VI.
Of the motions of the blood-vessels, and of several others of the spontaneous kind. 27

SECT. VII.
Of the motions of the pupil, and muscles of the internal ear. 30

SECT. VIII.
Of the alternate motions of respiration. 36
10.

SECT. IX.
Of the beginning of respiration in animals. 47

SECT. X.
Of the reason why the muscles of animals are excited into contraction by the application of stimuli. 49

SECT. XI.
Of the share which the mind has in producing the vital and other involuntary motions of animals. 57

SECT. XII.
Of the reason why the vital motions continue in sleep. 79

SECT. XIII.
Of the difference between respiration and the motion of the heart, in sleeping and waking persons. 82

SECT. XIV.
Of the motions observed in the muscles of animals after death, or their separation from the body. 85

Conclusion. 100
Physiological writers have divided the motions of animals into voluntary, involuntary, and mix'd.

The voluntary motions are such as proceed from an immediate exertion of the active power of the will. The involuntary and mix'd motions (which last, though subject to the power of the will, yet are not ordinarily directed by it) may be aptly enough comprehended under the general denomination of spontaneous; since they are performed by the several organs as it were of their own accord, and without any attention of the mind, or consciousness of an exertion of its power: such are the motions of the heart, organs of respiration, stomach, intestines, etc.; which have been also distinguished by the term automatic; though perhaps there is an impropriety in the word, as it may seem to convey the idea of a mere inanimate machine, producing such motions purely by virtue of its mechanical construction: a notion of the animal frame, which ill agrees with the inertia and other known properties of matter.

Although we may be at a loss to explain the nature of that substance in the nerves, by whose intervention/
intervention the mind seems to act upon the muscles; and though we may be unacquainted with the subtile structure of those fibres upon which this substance operates, yet we have no reason to doubt that voluntary motion is produced by the immediate energy and agency of the mind; manifold experience convincing us, that though there be required certain conditions in the body in order to its performance, it is nevertheless owing to the will. Nor ought we to be surprised when we meet with these kind of difficulties; for they attend most of our inquiries and researches: Thus, though the laws of motion and gravitation be fully understood and demonstrated by philosophers; yet the first cause of motion, the manner in which it is communicated to bodies, and the nature of gravity itself, have never been explained.

But how it comes to pass that many of our muscles are brought into contraction, not only without the concurrence of the will, but in opposition to its strongest efforts, and why most of the organs of spontaneous motion are continually agitated with alternate contractions and relaxations, of which we are not conscious, while the muscles of voluntary motion remain at rest, and are not contracted but in/
in consequence of a determination of the will to that end; are questions which have occasioned no small debate among medical writers, and about which as yet they are far from being agreed. To clear up these points, is the principal design of this Essay; and I flatter myself, that the following account of the vital and other involuntary motions of animals, will not less recommend itself to equal judges by its simplicity, than by its agreeableness to the known laws of the animal economy, and the easy solution it affords of all the appearances of the human frame with respect to its involuntary motions.

Nature, as far as we can judge from the plan and scheme of things surrounding us, delights in simplicity and uniformity, and, by general laws applied to particular bodies, produces a vast variety of operations; nor is it improbable that an animal body is a system regulated after the same manner. Following the path, therefore, which nature has pointed out in her other and more grand operations, I have in this essay endeavoured to show, that all the spontaneous motions of animals are explicable upon the same principle, and owing to one general cause. How far some authors of great note have been unsuccessful in their inquiries into this matter, from their neglecting so obvious an analogy, and endeavouring/
endeavouring to explain the vital motions of almost every different organ, by a different theory, is left to the reader to judge.

As the heart is one of the principal organs of the body, and its action immediately necessary to life, I shall begin with inquiring into the cause of its alternate contraction and relaxation, and whence it happens that these motions are performed without the mind's seeming to have any concern in them, nay in opposition to the strongest efforts of the will. But it will be necessary, previously, to lay down a few postulata, as a ground-work upon which to build our theory of the involuntary motions of animals in general, and of that of the heart in particular.
Section I. begins with the statement that "a certain power or influence lodged in the brain, spinal marrow, and nerves, is either the immediate cause of the contraction of the muscles of animals, or at least necessary to it." This is proved by reference to "the convulsive motions and palsies" of the muscles, which occur on irritation or destruction of the medulla cerebri, medulla oblongata and spinalis.

"When the brain is wanting, nature may have other ways of supplying the nerves, and of keeping them in such order, as that they may be able in some sort to perform their functions. And since the spinal marrow not only depends, for its powers, on the brain from which it proceeds, but also on a particular secretion performed by its own blood-vessels, we may reasonably conclude, that the nerves proceeding from the brain and spinal marrow are partly nourished and kept in a proper state for action, by the fluids conveyed to them, by the small arteries which are distributed on their surrounding membranes."

"The immediate cause of muscular contraction, which, from what has been said, appears to be lodged in the brain and nerves, I chuse to distinguish by the/
the terms of the power or influence of the nerves; and if, in compliance with custom, I shall at any time give it the name of animal or vital spirits, I desire it may be understood to be without any view of ascertaining its particular nature or manner of acting; it being sufficient for my purpose, that the existence of such a power is granted in general, though its peculiar nature and properties be unknown."

Experiments in tying and cutting arteries are described and the conclusion is come to "that the arterial blood sent to the muscles is only necessary to their motion, in so far as it supplies the vessels and fibres of the muscles with fluids proper for their nourishment, gives them a suitable degree of warmth, and thus preserves them in such a state as may render them most fit to be acted upon by the nervous power. While therefore the nourishment and growth of the muscles are owing to the motion of the arterial blood through their vessels, their powers of motion and sensation proceed from the nerves alone."

"The muscles of living animals are constantly endeavouring to shorten or contract themselves."

"The natural contraction of the muscles is owing partly to all their vessels being distended with fluids, which separate and stretch their smallest fibres. -- But farther, the natural contraction of the/
the muscles is, in a great measure, to be ascribed to the influence of the nerves, which is perpetually operating upon them, though in a very gentle manner:—

"The natural contraction of the muscles arising from the constant and equable action of the nervous power on their fibres, and of the distending fluids on their vessels, is very gentle, and without any such remarkable hardness or swelling of their bellies, as happens in muscles which are contracted by an effort of the will. ——

"As often as the influence of the nerves operates more powerfully than usual on the muscles, they are excited into stronger contractions, which are not natural, and therefore may be called violent. This extraordinary action of the nervous influence may be owing either to the power of the will, or to a stimulus.

"Voluntary contraction is owing to the stronger action of the nervous influence upon any muscle, excited by the power of the will."

Stimuli of various kinds - mechanical and chemical - and the consequent contraction in muscle, are considered. "Unless the motions of irritated muscles depended upon the brain and nerves, it would be difficult to conceive why an irritation of the medulla oblongata or nerves should occasion more violent convulsions of the muscles in animals newly killed, /
killed, than an irritation of those muscles themselves."

In the following paragraphs various statements are made about the contraction of muscle, each being illustrated by examples.

"In proportion as the stimulus is more or less gentle, so is the contraction of the muscle to which it is applied. ---- The effects of different stimuli depend very much upon the peculiar constitution of the nerves and fibres of the muscles to which they are applied: ---- Further the same organs in different people are sometimes very differently affected by the same stimuli; ----"

"An irritated muscle does not remain in a contracted state, although the stimulating cause continues to act upon it; but is alternately contracted and relaxed. ---- In morbid cases, our muscles or muscular organs are frequently affected with a continued contraction or fixed spasm; which symptom, however, is owing either to an irritation of the brain or nerves, or of the muscles themselves: nay, even in a sound state there are a few -- muscles which -- remain uniformly contracted as long as the stimulating cause continues to act with the same degree of force, such as the orbicular muscle of the uvea, the bladder of urine, and some others."

"Irritated muscles are not only agitated with motions/
motions while the stimulating cause continues to act upon them, but also for some time after it is removed; although these motions become gradually weaker, and are repeated more slowly."

"The motions of muscles from a stimulus are altogether involuntary." This is illustrated by the behaviour of the acceleratores urinae while the semen is being poured into the beginning of the urethra, and the muscles of the eye when gently stimulated with the point of a file, and by the motions of the stomach and diaphragm when excited by emetics. Such motions "can neither be accelerated, retarded, augmented nor diminished by the power of the will."

"From which it follows, that the power of stimuli in exciting the muscles of living animals into contraction, is greater than any effort of the will." This is illustrated by the effect of electricity on a palsied arm. "If then, the voluntary muscles can, even in a palsied state, be excited into contraction by the action of a stimulus on their fibres, it follows, that when this is applied to them in a sound and more sensible state, any effort of the will to prevent their contraction must be vain and impotent. Hence the muscles of voluntary as well as of involuntary motion cease to be under the power of the will, while their nerves or sensible fibres are irritated by/
by stimulis."

"Although we cannot, by an effort of the will, prevent the motion of any muscle whose fibres or nerves themselves are irritated, yet we can, in many cases, restrain the action of certain muscles, whose motions are excited by an irritation of a distant part, with which they have a particular sympathy; thus, we can prevent the motions of the muscles employed in coughing, and in voiding the urine and fæces, when the trachea, bladder, and rectum, are only slightly stimulated; unless these parts have been rendered much more sensible than usual, by being inflamed, or deprived of their mucus."

The next paragraph is a recapitulation.

"There are three kinds of contraction observable in the muscles of animals, all of them different from each other, viz. natural, voluntary, and involuntary, from stimuli. The first is gentle, equable, and continued, and is owing to the causes mentioned. (p. 16) The second proceeds immediately from the power of the will, is always stronger than the former, and may be continued for a longer or shorter time, or performed with more or less force, as one pleases. The third is strong, but, suddenly followed by a relaxation, seems to be a necessary consequence of the action of the stimulus upon the muscle, and cannot be affected, either/
either as to its force or continuance, by the power of the will.

"That continued contraction or fixed spasm, with which our muscles are sometimes affected (p. 16) being almost always a morbid symptom, and not the natural or usual effect of an irritation of their fibres, its particular consideration is of less use in treating of the vital and other involuntary motions of animals in a sound state."

"The natural contraction above explained (p. 16) is what we observe in the sphincters, and in muscles whose antagonists are paralytic or destroyed."

"While the sphincters of the anus and bladder, and those muscles whose antagonists are destroyed, remain always in a state of contraction, and while such muscles as have antagonists are kept in æquilibrio, or without any motion, except when the will interposes; the heart, which has no proper antagonist, is alternately contracted and dilated, without our being able, by any effort of the will, directly to hinder or promote its motions."

"The contraction of the heart is, therefore, not only involuntary, but of a different kind from that of the sphincters and muscles deprived of antagonists; and seems, as to its appearances, to agree with the contraction of muscles from a stimulus."
"The mind may, by disuse, not only lose its power of moving even the voluntary muscles, except in a particular way, but also of exciting them into contraction at all. Of the former we have an example in the uniform motions of the eyes; and of the latter in the muscles of the external ear, and of such members as have remained long without motion."

In Section II various opinions are reviewed, as that of many of the ancient physicians, that the motion of the heart was owing to a vital principle particularly residing in it, that of Galen, that motion was as natural to the heart, as rest to the other muscles, that of Des Cartes who attributed the motions to the ebullition of the blood dropping into its ventricles. "After Harvey's doctrine of the circulation was fully established, the heart was allowed to be a muscle, and its systole to be analogous to the contraction of other muscles; the vital spirits of the nerves were supposed to flow alternately into its fibres, either on account of valves, which by turns admitted and denied them a passage; or because it was thought that the spirits could only be discharged by drops, and not in an equable stream, from the extremities of such subtile tubes as the nerves were conceived to be." Boerhaave thought that the cardiac nerves must be compressed/
compressed at the end of every systole, "whence the motion of the spirits being intercepted, the heart must be rendered paralytic; but that whenever, upon the subsequent contraction of the auricles and arteries, this compression ceases, and the nerves transmit their fluid as formerly, the heart must contract anew."

Whytt shews that this is not possible anatomically, and it does not agree with what we know of dying animals or frogs and fishes, nor does this theory help to explain the spontaneous action of other organs.

"The learned De Gorter, fully aware that the supposed alternate compression of the cardiac nerves afforded no satisfactory account of the motions of the heart, supposes that vital or involuntary motion is owing to one and the same cause, both in the heart and other organs of the body: this cause he imagines to be such a structure of the involuntary muscles, that, when their fibres are dilated by the spirits, the small nerves which pass between them are compressed; so that no sooner are the fibres inflated, than the spirits are intercepted, and consequently the muscle begins to be relaxed; but by this relaxation of the muscular fibres, freeing the nerves from compression, the spirits are transmitted as formerly, and the muscle is contracted anew."

Against/
Against this theory it is pointed out that this is mere hypothesis and in any case does not agree with what is known of other muscles. Elasticity of the fibres is set aside as an explanation, because the sides of the heart contract with a much greater power than that with which they were forced asunder: there must therefore be some additional **impetus**.

In sections III and IV the systole, relaxation, and **diastole** of the heart are discussed. The first and last are violent; the second is natural to the heart.

A hypothetical general structure in the brain, determining the vital spirits through the nerves of the heart alternately would not account for the motions; "since its alternate contractions continue for some time after all communication between it and the brain has been cut off." And as the contractions continue after the heart is separated from the body, the filling of the coronary vessels is not a cause.

"It remains to inquire, what influence the returning venous blood, with which the ventricles of the heart are distended during its **diastole** may have in producing its subsequent **systole**. And is it not reasonable to suppose, that this fluid returning by the **cavae** and pulmonary veins, and rushing into the cavities/
cavities of the heart, with a considerable force, must, by distending its fibres, as well as by its motion and attrition upon the scabrous surface and fleshy pillars of the ventricles, so stimulate and affect the nerves of the heart as to bring it immediately into contraction?" In support of this theory Whytt quotes Harvey and Glisson in a footnote. The rest of the sections is devoted to proving that the blood acts upon the heart both by its composition irritat­ ing the internal surface of the ventricles, and also by its weight and impulsive force stretching and extending the fibres which compose its ventricles. "In animals newly dead, warm water, air, and a variety of other stimuli excite into action this power which seems to reside in the fibres of the heart."

Relaxation is caused by the blood being expelled out of the cavities of the heart and the fibres of the muscle which were in a violent state, endeavouring to return to their natural state. The "full diastole is produced by the returning venous blood, which enters its cavities with a considerable force." "The blood, in its return, enters the ventricles with considerable force, and, by dilating them, acts in some respect as antagonist-muscles do in other parts of the body; and, at the same time, by its gentle irritation, it is the cause of their subsequent contraction."
In Section V the motions of the alimentary canal and the bladder are accounted for in a similar manner to those of the heart.

"The aliments which are generally composed of parts fit to act as a gentle stimulus on the sensible parts of animals, are no sooner received into the stomach, than by its heat and motion, as well as the action of humours flowing into it, they begin to swell, and continue, during the whole time of their dissolution, to emit bubbles of elastic air: At the same time the cool air swallowed, every now and then, with the saliva, is quickly rarified by the heat of the stomach." "The contraction of the stomach never happens but in consequence of its preceding intumescence."

"The vermicular motion of the intestines is similar to that of the stomach, and produced by the same causes." "There is no reason to believe, that, on account of any alternate compression of their nerves, the animal spirits are transmitted to the intestines in successive streams: nor would this, if supposed, answer the appearances; since the whole intestinal canal is not, like the heart, alternately contracted and relaxed, but, as to time, is irregular in the motions of its several parts."
The bladder has its contractile power overcome by the urine gradually oozing into its cavity from the ureters. The diaphragm, abdominal muscles, and levatores ani, assist the contractions of the muscular fibres to open the sphincter, after which "the contractility of the bladder alone is sufficient to expel the urine."

p. 52

In Section VI the first question to be discussed is the alternate systole and diastole of the arteries. "The diastole of the arteries, like the dilatation of the heart, is owing to the blood pushed into their cavity, with a considerable force, and their systole or succeeding contraction is effected chiefly by their elasticity, and partly by the proper contraction of their muscular coat, excited by the blood gently stimulating their internal surface, and at the same time stretching their fibres."

"Besides this, there is a vibrating or oscillatory motion in the inferior orders of vessels, to which the direct force of the heart does scarcely reach, and where elasticity is not concerned." "The motion of the fluids through the inferior orders of vessels and secretory tubes of the glands, to many of which the impulsive force of the heart seems not to extend, is chiefly carried on by the vibrating contractions of these/
these vessels, excited by the gentle stimulus of the circulating fluids."

"The fluids are in some sense the cause of their own motion; since, without their stretching power and stimulating quality, the heart and arteries, however well fitted for muscular contraction, would remain unactive and at rest: and that as the contractile power of the solids is necessary to carry on the vital functions, so likewise is the action of the fluids upon the solids, in order to excite their muscular power into action.

In Section III it was said, "Heat seems to be no more than a quick vibration or motion in the smaller parts of bodies; therefore the blood, as it is a warm fluid, will have its particles agitated by perpetual vibrations." And here it is said, "Heat not only renders the heart and vascular system more sensible, but, by raising an intestine motion and brisk vibrations in the particles of the fluids, must necessarily communicate some degree of irritation to the solids; and thus bring them into alternate contractions."

Similar arguments are brought forward to explain the erection of the penis. "There is no example to be found of any motion or action in the animal body being performed/
performed by the contraction of the nerves, whose office is to supply the muscular fibres everywhere through the body, with that influence or power which seems to be immediately necessary to their contraction: but, by the increased oscillatory motion of the small vessels, which we have assigned as the cause of the erection of the penis, we daily observe a variety of sudden and surprising changes produced in the circulation. To this is to be ascribed the profuse secretion of pale limpid urine, to which hysterical people are so liable; as also the tears from the lachrymal vessels, in people affected with great joy or grief. "Blushing," which attends a sense of shame", is caused by "an increased oscillatory motion of the small vessels of the face." "Why this affection of the mind should produce such a change in the circulation of the blood in those parts rather than any other, we do not pretend to say. Sufficient it is, that from experience we know that the several parts of the body are variously affected by the different passions of the mind."

As the semen acts as a stimulus to the urethra, the ovum excites the muscular coat of the Fallopian tubes to contraction.

Section/
Section VII begins with a discussion of the pupil and its variation according to the degree of light to which the eye is exposed and the distance of the objects to which the eye is directed.

"The natural state of the pupil is that of dilatation; for since the longitudinal fibres of the iris are much more conspicuous and stronger than the circular plane, they must, by their natural contraction, keep the pupil always dilated, unless the latter are excited into action by some cause." "The coarctation of this passage is owing to the action of light on the eye as a sensible organ, and its dilatation is owing to the superior contractile power of the longitudinal fibres of the uvea, when the eye is left to itself, and not affected by any external cause."

"The pupil is contracted more or less in proportion to the quantity of light admitted into the eye, not on account of any immediate action of this subtile fluid on the fibres of the iris, as some have imagined, but in consequence of its affecting the tender retina with an uneasy sensation."

The phenomena in cataract are then discussed. "When one eye is quite lost by a confirmed amaurosis, if the sound one be covered or kept shut, the pupil of/"
of the diseased eye remains in every degree of light immovable, and of the same size; but if the sound eye is exposed to the sun-beams, the pupil of the other, which showed no motion before, will be observed to contract. This contraction can only arise from the sympathy between the two pupils; and shews, that when the sound eye is covered, the defect of motion in the morbid eye is not owing to the nerves of the uvea being paralytic, but to the want of a cause increasing their action upon the orbicular muscle of the pupil."

"But if we allow the contraction of the pupil to be owing to a sentient active principle, which, in proportion as it is more or less affected by the uneasy sensation arising from the action of light on the retina, contracts the pupil in a greater or less degree; then, when one eye is shut, its retina being no more exposed to the light, and consequently the sentient principle being no longer excited to contract the orbicular muscle of the uvea, its pupil must be widened by the natural contraction of the stronger longitudinal fibres of that membrane: but as the mind has, from the time of birth, been always accustomed to contract the pupils of both eyes at the same time, the one pupil can no more be relaxed without/
without the other being partly relaxed, than one eye can be directed to the nose, while the other is turned from it: for how much soever the motions of certain muscles are owing to the immediate energy of the mind, yet it is undeniable, that by constant habit, we soon lose the power of moving them, except in a particular way: and as this is true of the eyes, whose motions are of the voluntary kind, --- it cannot well be denied to take place in such muscles whose action is from the beginning independent on the will.

"The necessity of the contraction of the pupil when we look at near objects, in order to render vision more distinct, is easily understood; for as in near objects the divergency of the rays is greater than in distant ones, and as those rays only serve for distinct vision which do not diverge much from the axis of each pencil, the pupil must be contracted, in order that the useless or disturbing ones may be excluded. The contraction therefore of the pupil in viewing near objects, is not solely owing to the spissitude of the rays reflected from them, --- but chiefly to an effort of the will in order to distinct vision: --- In looking at anything nearer the eye than that distance at which we see distinctly, and/
and with the greatest ease, the contraction of the pupil is principally owing to a voluntary exertion of the mind's power in order to render vision more distinct; and but in a very small degree, to the stronger and more vivid light, which the object, on account of its vicinity, reflects upon the eye."

"Since the image of any object is formed by the union of the pencils of rays that flow from each point of the object in correspondent points of the retina, it appears, that its magnitude depends on no other circumstances, but the real magnitude of the object, and its real distance from the eye. The different size of the pupil may, agreeably to what has been observed above, affect the lustre and accuracy of the several points of the image, but cannot alter their distance, because the axis of the several pencils, and their angles of inclination, continue the same, whatever is the bulk of the pupil."

"Neither the single effort of the mind to avoid indistinct vision, nor a vivid light alone, can contract the pupil to its least size, that is, not so much as when both these causes of its contraction are united."

The dilated pupil in infants and the smaller pupil in old people are next discussed. In the former case, the undeveloped state of the cornea prevents/
prevents rays of light from being freely transmitted to the retina or properly collected upon it. In the latter case, involutorial changes cause diminished elasticity of the longitudinal fibres of the uvea and diminution of the quantity of the humours of the eye, whereby the eye becomes less.

This part of the section closes with an account of hemeralopia, nyctalopia, and a case of double gutta serena. It is noteworthy that the words hemeralopia and nyctalopia are printed in Greek characters, but the modern meaning is given to them, hemeralopia being used for night-blindness and nyctalopia for day-blindness.

"The ear would have been unfit for hearing distinctly a diversity of sounds, were not some of its parts capable of various degrees of tension. A musical chord, of a determinate length and tension, can only vibrate harmonically with one particular sound; if therefore there was no mechanism, by means of which the membranes of the tympanum and fenestra ovalis could be more or less stretched or relaxed, they could only be harmonically affected by one sound; which, therefore, alone would be heard distinctly and all others more or less confusedly."

The mechanism consists of the three muscles connected/
connected with the malleus and the one muscle connected with the stapes, the membrane of the tympanum being rendered more or less tense by the former, and the membrane of the fenestra ovalis by the latter.

"That the motions of the muscles of the internal ear proceed from the mechanical action of sound or vibrating air on their fibres, the analogy of the motions of the pupil would seem to contradict. And, if this were the case, why should not all the muscles of the malleus be equally contracted by the same sound? And why should those which serve to stretch the membrane of the drum be excited into motion by acute sounds, while the muscle which relaxes it is only brought into action by grave ones? As brute animals, upon the first perception of any noises turn their external ears towards the place from whence it comes; so, at the same time, they adapt their internal ear to it; the first of these motions cannot be denied to flow from their sentient principle actuated by the sound; why then should we doubt that the latter proceeds from the same cause?

"The motions of the muscles of the internal ear, in consequence of various sounds, are not only unattended with any consciousness of volition, but are altogether involuntary; for we cannot move them except when sound strikes the ear, nor hinder them to act when it does."

Section/
Section VIII begins with a definition of respiration and an explanation of its mechanism. "Respiration is that action whereby a certain quantity of air is alternately received into the lungs and expelled out of them: it consists of inspiration and expiration. Inspiration, or the reception of air into the lungs, is owing to the contraction of the intercostal muscles and diaphragm, whereby the cavity of the thorax is both lengthened and widened; for as the lungs, together with the heart, etc. perfectly fill the cavity of the breast, and as their exterior surface is everywhere contiguous to the pleura and diaphragm, it necessarily follows, that when the diaphragm, by its contraction, descends, and the ribs, by the action of the intercostal muscles, are raised, the lungs must follow them, and consequently the external air must rush in by the glottis, to fill the vacuity that would otherwise happen in the cavity of the chest.

"Inspiration being thus performed, the inspiratory muscles are relaxed, upon which the ribs by the renitency of their elastic cartilages return to their former situation, and the diaphragm, by the reaction of the stretched peritoneum, pericardium, and abdominal muscles, is pushed up into the thorax; whose/
whose cavity being therefore diminished, the air contained in it must be expelled by the glottis.

"In order to account then for the alternate motions of respiration, it is only necessary to shew, why the intercostal muscles and diaphragm are alternately contracted and relaxed; since their contraction occasions inspiration, and their relaxation allows the elastic force of the cartilages of the ribs, etc. to produce expiration."

Here follows a refutation of the theory that the lungs are active in respiration. "It is easy to shew, that the lungs cannot be endued with a power of expanding themselves, independent of the dilatation of the thorax, as Mr Bremond seems to think, after Platerus, Sennertus, and others, who in this followed the Arabian physicians. "Supposing the vesicles of the lungs empty and collapsed, by what mechanism can they expand themselves, or where are the antagonist muscles that can overcome the natural contraction of their fibres? All the hollow muscles of animals are continually endeavouring to contract, nor can they be dilated by any mechanism of their own: " The bladder, and the stomach and intestines, are taken as examples. "They are ever endeavouring to arrive at their least capacity." It follows, therefore, that the pulmonary vesicles/
vesicles and cells which are composed of elastic contractile fibres, cannot be dilated by any power or action of their own."

"We proceed next to inquire, by what power or mechanism inspiration and expiration alternately succeed each other, or why the intercostal muscles and diaphragm are contracted and relaxed by turns, as long as life remains.

"The learned Boerhaave ---- supposes, that, at the end of inspiration, the blood is transmitted in smaller quantity to the left ventricle of the heart, since the pulmonary vessels must be considerably compressed by the lungs, which, at that time are greatly distended with air: hence he conceives, that not only less blood will be distributed to the intercostal muscles and diaphragm, but, also, that the influence of their nerves must be weakened; as the secretion of the spirits in the cerebellum must be diminished, when a smaller quantity of blood is pushed into its vessels by the heart: the causes, therefore, which are supposed to contract the inspiratory muscles, being weakened at the end of inspiration, these muscles will be overcome by the natural resiliency of the elastic cartilages of the ribs, together with the re-action of the abdominal muscles, &c., i.e. expiration must necessarily follow; but no sooner does the/
the blood, by the motion of the lungs in expiration, flow in a more plentiful stream to the left ventricle of the heart, than the causes actuating the inspiratory muscles begin to increase; whence these muscles are contracted a-new; i.e. inspiration is produced, to which for the reasons above mentioned, expiration must necessarily succeed; and in this way the alternate motions of the chest in respiration are carried on through life. This theory, it must be owned is ingenious, and has an air of simplicity which further recommends it; but if strictly examined, I doubt it will be found insufficient to account for the alternate motions of the thorax, and the other appearances of respiration."

1. If this were true, the heart, "which also receives its nerves from the cerebellum," would be affected in the same way. But the pulse is equally strong at the end of inspiration as at the end of expiration, "as far as our sense of feeling can determine".

"2. After both the carotid arteries have been tied in a dog, the motions of the heart and respiration went on in the ordinary way, while in the meantime the cerebrum and cerebellum were deprived of more than one half of the blood usually bestowed on them."
"3. After the lungs have been kept for some considerable time in a collapsed state by an effort of the will, the inspiratory muscles — immediately — contract, and produce a new inspiration; which, however, could not happen if Boerhaave's theory was true;"

"4. — After both sides of the thorax were laid open, the diaphragm and intercostal muscles continued their alternate contractions for a long time, although the lungs were collapsed and motionless."

"5. Lastly, The various appearances of respiration, in the air-pump, diseases of the head, asthma, and the symptoms in melancholy people, are not to be accounted for from Boerhaave's theory, and are alone sufficient to overturn it:"

Dr Martine's theory of the alternate compression of the phrenic nerves at the end of inspiration is then disposed of as inadequate to explain all the phenomena and there is also the fact that "the soft and spungy lungs" would not be capable of compressing the nerves sufficiently.

"The various opinions of other writers, I shall not stay to enumerate, much less undertake to examine, but proceed to give an account of the motions of the thorax, which it is hoped will tend equally to explain the experiences observed in respiration, whether the lungs/
lungs and other instruments concerned in it be in a
natural or diseased state."

"1. -- After expiration the blood, on account of
its difficult passage thro' the pulmonary vessels,
is partly accumulated in them, and, by stretching their
sensible fibres and membranes, acts as a stimulus
upon the pulmonic nerves, occasioning an uneasy sense
of fulness, stoppage, or suffocation in the breast. --
The blood -- will, not only by its quantity stretching
their vessels, but also by its heat, occasion an un-
easy sensation, that is, act upon these parts as a
stimulus;"

"2. If it be asked, how a stimulus or uneasy
sensation in the lungs can affect the inspiratory
muscles, with which they seem to have no immediate
connection? I should answer, It were easy to ascribe
this effect to a sympathy between their nerves; a
phrase indeed oftener used than well understood! --
As the nerves of the inspiratory muscles and lungs
most certainly do not terminate precisely in the same
part of the brain, but probably in places somewhat
distant from each other, any sympathy that obtains
between them, as proceeding from one common origin,
must be owing to something equally present in these
several places, i.e. to the mind or sentient principle:
for without supposing some percipient BEING in the
brain,/
brain, how can an irritation of the extremities of
the nerves, taking their rise from one part of that
organ, occasion a more than ordinary derivation of
spirits into such nerves as have their origin from a
different part? If external objects act on the
nerves only, by putting a stop to the equable pro-
gression of their fluids, or by exciting some vibratory
motions in them, how can any of these occasion, not
only a more copious derivation of spirits through the
nerves thus affected, but also through a variety of
other nerves with which they have no connection, and
whose rise is from a different part of the brain?
The sympathy, therefore, or consent observed between
the nerves of various parts of the body, is not to
be explained mechanically, but ought to be ascribed
to the energy of that sentient BEING, which in a
peculiar manner displays its powers in the brain,
and, by means of the nerves, moves, actuates, and
enlivens the whole machine."

"When -- the inspiratory muscles are contracted;
we are not to ascribe this to any unknown sympathy
acting mechanically upon these muscles or their
nerves; but to the MIND or sentient principle, which
being affected by the uneasy perception in the lungs,
is thereby excited to increase the action of the
nervous influence upon the intercostal muscles and
diaphragm;"

"3. /
"3. It does not appear, that any effort of the mind or sentient principle is necessary to expiration; for this naturally takes place as soon as the muscles of inspiration cease to act."

"4. If it be demanded, why, after the lungs, by an effort of the will, have been kept for some time in a state of full inspiration, the inspiratory muscles are immediately relaxed, when this effort ceases, and not rather continued in a state of contraction, seeing there is an uneasy sensation in the lungs, equal to what happens after expiration? the answer is, That the disagreeable sensation is of a different kind, and which the keeping the lungs in a state of inspiration would tend rather to increase than remove; for such is the constitution of our frame, and the law of that wonderful union between the soul and the body, that the former, upon any uneasy perception, produces such motions and changes in the latter, as naturally and most effectually tend to lessen it, or expel the irritating cause."

"5. -- As the convulsive motions of coughing, sneezing, and the hiccup, are undoubtedly owing to an uneasy sensation affecting the mind, may we not conclude, that the gentler stimulus of the blood, in the vessels of the lungs, becomes, through the intervention/
intervention of the mind or sentient principle, the cause of the less violent motions of the inspiratory muscles?

6. The phenomena in morbid cases and in animals placed in a receiver partly exhausted of air are easily explained upon the principles laid down but they are inconsistent with mechanical accounts of respiration. "In these cases, the brain, and common sensorium, being greatly affected, the mind or sentient principle must have been much less sensible, than it usually is, of any impression, irritation, or stimulus affecting the nerves. Hence, after expiration, which, from the resilation of the cartilages of the ribs, &c. naturally, and without the intervention of the mind, succeeds inspiration, a long pause intervenes, before a new inspiration comes on; because the mind is not roused to exert her influence, till the uneasiness and sense of suffocation in the breast becomes so considerable, as to awake her, as it were, out of a profound sleep."

"Thoughtful melancholy people, whose minds are fixed upon some particular object, being thereby less affected by the stimulus or slight uneasiness which begins to be felt in the lungs, after expiration is ended, usually breathe more slowly, and after longer intervals, than those who are in perfect health; by which/
which means, the blood passing less freely through the pulmonary vessels, and being accumulated in them, a sense of weight and suffocation arises, which more powerfully affects the mind, obliging them, often, to draw in a more than ordinary quantity of air, and occasioning what is usually called a deep sigh.

"By what mechanism can it be, that in the half-exhausted receiver, animals breathe quicker and higher than in the open air? --- It is evident, upon the theory which we have offered, that in proportion as the air in the receiver is exhausted, and respiration becomes more difficult, the mind must increase its efforts, in order to dilate the lungs more fully, and to get rid, if possible, of that anxiety, or sense of suffocation, which always accompanies the stagnation of the blood in the pulmonary vessels, or its difficult passage through them.

"Lastly upon what hypothesis, founded wholly on the received properties of bodies and the laws of motion, can it be shewn, that the frequency and fulness, slowness and smallness of respiration should, in healthy people, be constantly in proportion to the heat and cold, rarity and density of the air?"

"7. Respiration differs from most of the other spontaneous motions, in being subject to the power of the/
the will: thus we can at pleasure accelerate, retard, or put a stop, for some time, to the motions of the intercostal muscles and diaphragm: — But though respiration thus differs from the proper involuntary motions, yet it does not perfectly agree with those that are voluntary, since it is regularly performed in time of sleep, and when we are awake, although we be not conscious of it."

"But whatever may be the efficient cause which thus subjects respiration to the government of the will, the final cause of this difference between it and the other vital motions is pretty evident: for were it not that the motions of the muscles employed in respiration may be varied at pleasure, we should not only be unable to evacuate the urine and faeces, but must have been deprived of speech.

"If it shall be objected, that the motion of respiration cannot be owing to the mind or sentient principle; because it obtains at all times, and is kept up when we are asleep and not conscious of it, equally as when we are awake and attentive; I would observe that a variety of actions are performed by the influence of the mind, without our adverting to them." Examples are given, as the movements of the eye-lids, and the swallowing of saliva, talking and moving during sleep.

"And/
"And this I should take to be no small proof of the mind, as a sentient principle, being often affected by what passes in the body, and in consequence thereof, excited into action, when, in the meantime, we do not advert to any such thing."

Section IX treats of the beginning of respiration. "However presumptuous it may appear to attempt the solution of a problem, in which some of the greatest physiologists have failed, I must beg leave, however, to say, that I think it as easy to account for the beginning of respiration, as for its continuance when once begun; and that both are owing to the same cause, namely, to an uneasy sensation in the lungs."

"The necessity of air and aliment commences with our birth; and as we are excited to take in meat and drink by the uneasy sensations of hunger and thirst, which, as faithful monitors, never fail to warn us when these are wanted, but immediately cease upon the appetite's being satisfied; so, to prevent our being in danger of perishing thro' the want of fresh air, there arises, unless the action of breathing be continually repeated, and new supplies of fresh air thus brought into the lungs, an uneasy sensation, which/"
which may not improperly be termed the APPETITE of breathing."

Breathing is then compared to the taking of food, which cannot be accounted for "without having recourse to the mind; why should we attempt to explain the action of respiration from principles purely mechanical, and deny the perception and operation of a sentient active principle to be the cause which at first begins, and ever after continues it? I should think that the analogy were too strong not to strike every unprejudiced mind!"

"As food has the highest relish to a hungry person, so, to one half-suffocated for want of air, nothing is more refreshing or more greedily taken in than that fluid."

It is then shewn how the circulation of the blood must be quickened and "more copiously determined into the pulmonary artery" just before and during birth, so that there will "ensue a greater degree of heat, and fulness, a more active stimulus and uneasiness in these vessels", i.e. the vessels of the lungs.

"Nor is breathing the only action performed by a new-born child, which it was a stranger to before, since sucking is equally new to it as breathing. The former has been generally referred to instinct, and/
and so perhaps may the latter: but as I would decline the use of words whose meaning may be obscure or indeterminate, I should say, that sucking and breathing are owing to particular sensations in the body, determining the mind or sentient principle to put certain muscles or organs in motion."

After several theories are discussed and set aside, the section ends with this paragraph, "Having thus shewn, that all the vital and other involuntary motions of animals are owing to stimuli of one kind or another, acting either immediately upon the organs moved, or on some neighbouring part with which they seem to have a peculiar sympathy; it remains that we next inquire, whence this power of stimuli over the muscles of animals must be derived?"

Section X accordingly begins with the following statements: "The muscular fibres of animals are so framed, as to contract whenever a cause proper to excite their action is applied to them, or, in defect of this, always to remain at rest. This cause is either an effort of the will, or a stimulus of some kind or another: to the former are owing the voluntary motions; and to the latter all such as we call vital and spontaneous.

"How,/

For meaning of instinct see "Instinct in Man." James Driver, Cambridge.
"How, or in what manner the will acts upon the voluntary muscles, so as to bring them into contraction, is a question beyond the reach of our faculties; and, indeed, were it otherwise, the answer would be here of no great importance, it being sufficient that experience convinces us that the will is really possessed of the power. But, in this our endeavour to trace the vital and other involuntary motions up to their first source, it seems to be a matter of no small moment, to investigate the cause or causes which enable stimuli of various kinds to excite the muscles of living animals into contraction."

1. Mere elasticity of muscular fibres is not a sufficient explanation, since "an elastic body --- is no more than a piece of dead inactive matter"; it recoils "only in consequence of its being acted upon", and "with a force proportional to that which bent or wound it up."

2. The theory of animal spirits, lodging in the cavities of the muscular fibres and consisting "of a number of little springs wound up, which, by the application of stimulating bodies, being put into vibratory motions, dilate these fibres, and so render the whole muscle shorter", is unsatisfactory; "for these spirits must either act entirely as a mechanical power, or not: if the affirmative be taken, it must be granted, at/
at the same time, that their reaction, like that of other elastic bodies, cannot exceed the power acting upon them and putting them in motion; but if their action instead of being properly mechanical, be ascribed to some unknown active properties, this will be found, as I shall afterwards shew, an hypothesis inconsistent with the appearances of muscular contraction from stimuli:"

"As we are entirely ignorant of the nature of the animal or vital spirits, as they are called, every account of muscular motion from a stimulus which depends on their peculiar energy or manner of action, must therefore be merely hypothetical and precarious":

"3. It may be thought, that muscular contraction is owing to some kind of explosion, ebullition, or effervescence, occasioned by the mixture of the nervous and arterial fluids, or perhaps to the agency of some subtile ethereal or electrical matter residing in the nerves;" But for these effects "certain kinds of stimuli" would be necessary; now "we know from experience, that --- every kind of irritation excites muscles of animals into contraction; and that there is no difference in the motions they produce, except what arises from their acting as stronger or weaker stimuli, i.e. from their irritating the part more or less."

Further,
Further, the stimulus may be applied to the fibres of the muscle, to the common membranes covering them or the stimulus may affect a remote part, with which the muscle has no immediate connection, not even "a communication by means of nerves, unless it be that general one subsisting between all the parts, as having their nerves derived from the same brain."

"Lastly, as the electrical effluvia, excited by the friction of certain bodies, are not emitted by fits and starts, but in a continued equable stream, so neither do the explosions or effervescences produced by the mixture of substances of disagreeing natures exert themselves, like irritated muscles, by alternate efforts. As little will the oscillations of an elastic aëther (supposing the animal spirits to be of that nature) serve to explain this appearance, since these must follow the laws of vibration observed in other elastic bodies, which yet are inconsistent, as we shall have an opportunity to prove below, with the alternate and vibratory-like contractions of muscular fibres occasioned by irritation."

4. Powers latent in muscle have been supposed but not proved. "It seems to be improper to attribute active powers to that, which, however modified or arranged, is yet no more than a system of mere matter? powers, I say, which are not only confessedly beyond those/
those of mechanism, but seemingly contrary to all the
known properties of matter."

"5. Some may be of opinion, that the all-wise
AUTHOR of nature hath endued the muscular fibres of
animals with certain active powers, far superior to
those of common matter, and that to these the motions
of irritated muscles are owing. And indeed we cannot
but acknowledge, that he has animated all the muscles
and fibres of animals, with an active sentient
PRINCIPLE united to their bodies, and that, to the
agency of this PRINCIPLE are owing the contractions
of stimulated muscles. But if it be imagined that
he has given to animal fibres a power of sensation,
and of generating motion, without superadding or
uniting to them an active PRINCIPLE, as the SUBJECT
and CAUSE of these, we presume to say, that a sup­
position of this kind ought not to be admitted; since,
to suppose that matter may, of itself, by any modi­
fication of its parts, be rendered capable of sensa­
tion, or of generating motion, seems to be as un­
reasonable as to ascribe to it a power of thinking.
Matter, as far as we can judge by its known properties,
appears to be incapable either of sensation or thought;
and the whole appearances of the mere material world
shew, that it acts invariably according to laws
prescribed to it, and without any feeling, inclination,
or/
or choice of its own; nor is there anything resembling will, self-determination, or real active power in the most refined and subtile parts of matter, more than in the most gross and sluggish.

If then the effects of stimuli upon the muscular fibres of animals, cannot be deduced from any property or powers belonging to them, as mere material organs, it remains, that they are owing to an active sentient PRINCIPLE animating those fibres. But this will more evidently appear from the following considerations.

(1) Alternate contractions of muscles "are easily accounted for, if we suppose them to proceed from a sentient PRINCIPLE, which, in order to the getting rid of the pain or uneasy sensation that arises from the irritation of the muscle, determines the influence of the nerves into its fibres more strongly than usual." The contractions will be "in proportion as the stimulus and painful sensation hence ensuing are stronger or weaker."

"If the contraction of an irritated muscle were owing to the action of the stimulus upon it as a mere mechanical organ, then, so long as the stimulus continued to act equably, the muscle ought to remain equally contracted, and, upon its ceasing, the muscle ought to be relaxed; or rather the muscle, upon the first application of the stimulus, ought to be suddenly/
suddenly contracted; which contraction should become weaker by slow degrees, till at length the muscle has returned to its natural state of relaxation."

"Since the alternate contractions of irritated muscles do not follow the law of the vibration of elastic bodies, but become remarkably slower when they decrease in strength, and before they cease altogether; it follows that they cannot be owing to any elastic vibrations excited in the muscular fibres, or in the nervous fluid contained in them."

(2) "As we find the muscles of animals brought into action without any irritation of their fibres, whenever a stimulus is applied to the coats or membranes covering them, to the nerves which are sent to them, or to some neighbouring or even distant part, it seems unreasonable to ascribe such motion to the mechanical action of the stimulus upon the fibres of the muscle, and not to the impression it makes on the sentient principle." Various examples are given, as light on the retina, sound on the auditory nerve, boiling water on the foot.

"Is it not reasonable to think, that even when the muscles themselves, or a few of their fibres, are irritated, the subsequent motions are owing to the mind's being excited, by a disagreeable sensation, to determine the influence of the nerves more strongly into them?"

(3)"
(3) --- "The remembrance or idea of substances, formerly applied to different parts of the body, produces almost the same effect as if those substances themselves were really present." The secretion of saliva, the sight of an emetic, the fear of having one's sides tickled, are brought forward as examples.

"That many remarkable changes and involuntary motions are suddenly produced in the body by the various affections of the mind, is well known. -- All the nerves do not at last terminate in a point, but in a large space of the brain; therefore the consent between them cannot be deduced from their contiguity, but from a sentient principle, which is present, at least, wherever the nerves have their origin, and which, accordingly as it is variously affected, produces motions and changes in different parts of the body."

"The various appearances above mentioned would evince the presence, agency, and extensive influence of something in the bodies of animals, of a nature different from mere matter, and of powers superior to it, however modified, compounded, or arranged."

The effects of stimuli on different muscles and organs of the body are different according to what tends to remove the irritation or renders the mind less sensible of it. This is illustrated by sneezing, hiccup,
hiccup, coughing, defaecation, erection of the penis, the contraction of the orbicular muscle of the uvea, the muscles of the malleus and stapes, the heart-muscle, the muscles of the intestines and the bladder.

"We are so framed by nature, as spontaneously, and without any previous reflection, to perform those motions and actions which tend most effectually to the preservation of our bodies."

"Upon the whole, as nature never multiplies causes in vain, it seems unnecessary, in accounting for the motions of the muscles of animals from stimuli, to have recourse to any hidden property of their fibres, peculiar activity of the nervous fluid, or other unknown cause, when they are so easily and naturally explained, from the power and agency of a known sentient PRINCIPLE."

Section XI discusses the share of the mind in the movements which are under consideration.

"That all the motions of animals were by some of the ancient philosophers ascribed to the energy of a living principle wholly distinct from the body, the passage of Cicero prefixed to this Essay clearly shews. And it was the difficulty of accounting for the motion of the heart from mechanical principles alone, which made Borelli doubt, whether it were not rather/
rather owing to the mind, than to any natural necessity arising from the structure of that organ or its nerves. The celebrated Leibnitz, in a letter to Michelloti, goes still further, and supposes that the natural motions may be owing to some impressions made on the mind, altho' we are no ways conscious of them. It is true that Stahl, by extending the influence of the soul, as a rational agent, over the body a great deal too far, has been the occasion why, for many years, it has been considered rather as a subject of ridicule, than deserving a serious answer."

"In every circulation, the blood loses \( \frac{9}{10} \) of the momentum communicated to it by the left ventricle of the heart; therefore there must be in every animal some cause which repairs this loss of motion arising from friction, &c. i.e. a cause generating motion: But, as has been observed above, matter, in its own nature inert, is incapable of this." The case of hibernating animals is then discussed; "there is in these animals some living principle, which, by the stimulus of warmth, being roused, as we may say, out of a state of indolence, brings into gentle contractions -- those parts of the body most sensible of the irritation of the fluids when rarified and agitated by heat."

"The contraction of the heart, so far as it is owing/
owing to a material cause, seems to proceed from the action of the nervous power upon its fibres: but as, perhaps, \( \frac{1}{100000} \) part of the blood thrown out by the left ventricle of the heart, does not return to it again in the form of vital spirits, as they are called; and as the motion of this fluid must be much diminished by its passage through the very subtile vessels of the cerebellum &c. there can be no force in these spirits derived from the last systole of the heart sufficient to produce a new contraction of that muscle, since no cause can generate an effect greater than itself:"

The contraction of the heart and the secretion of the spirits "act in a circle, and may be considered mutually as cause and effect". "As a perpetual motion is --- above the powers of mechanism, -- the contraction of the heart, and the propulsion of the blood through the body, and consequently the continuance of life, are not owing to any mechanical or even material causes alone, but to the agency of a living principle capable of generating motion."

"We shall endeavour briefly to obviate some of the strongest objections, which at first sight, seem to lie against this doctrine."

"Objection I. While we ascribe the vital and other involuntary motions of animals to the mind, we, in fact, attribute them to a power whose nature and manner/"
manner of acting we are ignorant of."

"Answer. That there is united to the bodies of men and animals an active, living, sentient principle, which is the cause of voluntary motion, it may be hoped there are few philosophers at present who will deny: and if it be thought no absurdity to ascribe voluntary motion to the energy of the mind, though we do not understand its nature or manner of operation, why should it be reckoned such, to derive the vital and other involuntary motions from the same source; especially, when a variety of appearances and analogy concur in supporting this opinion:"

"There is no need of understanding the nature of the soul, or the way in which it acts upon the body, in order to know that the vital motions are owing to it: it is sufficient, if we know from experience, that it feels, is endued with sensation, and has a power of moving the body."

"Nor can I conceive why physicians should have so long laboured in accounting for the action of the heart and other vital motions of animals, from the powers and properties of body independent of the mind, if it be not, that with some, the Cartesian principles still continue; with others, too great a fondness for mechanical reasoning in physiological matters prevail; and/
and in both, a contempt of the indeed extravagant notions of Stahl and his followers, with regard to the manner in which the mind regulates all the actions of the body."

"Many philosophers have supposed two distinct principles in man; one of which has been called the anima or soul; the other, the animus, or mind; by the former, they understood the principle of life and sense influencing the vital motions; and by the latter, the seat of reason or intelligence. According to them, we have the anima, or vital and sentient soul, in common with the brutes; but the animus or mens, which is of a more exalted nature, is proper to rational creatures alone."

The next paragraphs are an argument against materialism.

"Upon the whole, as I cannot agree with those who, in ascribing all our powers to mere matter, seem willing to deprive us wholly of mind; so neither do I see any reason for multiplying principles of this kind in man: and, therefore, I am inclined to think that the anima and animus, as they have been termed, or the sentient and rational soul, are only one and the same principle acting in different capacities. Nay, Epicurus himself, according to Lucretius, did not look/
look upon these two as separate beings, but considered
the mind as a kind of mouvement produced by the anima
or soul."

"That the involuntary motions in man are not
owing to a principle distinct from the rational soul,
seems probable, from the muscles and organs, whose
action has generally been ascribed to the anima, being,
in many cases, subject to the power of the animus or
rational principle; as well as, on the other hand,
from the motions of the voluntary muscles often
becoming involuntary, or independent upon the will."
Examples are the diaphragm, rectum, bladder, eye-lids,
acceleratores urinæ, the pupil. "In short, there is
not a voluntary muscle in the body, whose motion does
not become involuntary, as often as it is either
directly, or from its consent with some neighbouring
part, affected by any considerable stimulus: if the
irritation be very gentle, we still retain a greater
or less power over the muscle; but when it becomes
stronger, we lose all this power.

"Further, in man the sentient and rational prin-
ciple must be acknowledged to be one; since we are
all conscious that what feels, reasons, and exerts
itself in moving the body, is one and the same, and
not distinct beings. It is the mind, therefore, that
feels, thinks, remembers, and reasons; which, though
one/
one principle, is nevertheless possessed of these
different powers, and acts in these different capacities:
nay, since memory is as different from the present
perception of ideas, or the exertion of the will in
order to action, as sense is from reason, it might
with equal propriety be maintained, that we are en-
dowed with four souls, namely, with a rational a
reminiscent, an active, and a sentient one, as that
we have two."

"In brutes of the lowest kind there is evidently
a sentient principle; but it seems to be devoid of
reason or intelligence: in those, however, of a higher
class, we can perceive faint traces of something like
what we call reason and reflection in man. Why,
therefore, may not the human mind, which enjoys all
the powers belonging to the souls of the lowest
creatures, and has also reason superadded to those
powers, be allowed sometimes to act as a sentient,
and at other times as a rational being, i.e. in dif-
ferent capacities?"

But for the present subject it does not matter
"whether the sentient and rational soul be supposed
distinct, or otherwise.

"However, although we conceive it to be the most
probable opinion, that the sentient and rational
principle in man are one and the same; yet we think
it/
it a clear point, that the mind does not, according to Dr Stahl and others, preside over, regulate, and continue the vital motions, or, upon extraordinary occasions, exert its power in redoubling them, from any rational views, or from a consciousness that the welfare of the body demands her care in those particulars: for infants, idiots, and brutes of the lowest kind, (which last are destitute of reason), perform those motions in as perfect a manner as the wisest man; and the mind, when life is endangered by the too violent circulation of the blood, neither does, nor can moderate the motion of the heart. If the contraction of the heart were owing to any reasoning or consciousness of its being necessary to the continuance of health or life, the mind ought to have a power of restraining the uniform motions of its auricles and ventricles, or of repeating them at shorter or longer intervals, notwithstanding their having become, like those of the eyes, in a manner necessary, through long habit: for though we cannot, indeed, move our eyes in every different direction, yet we can restrain or vary their uniform motions as we please.

"Further, if there were any exercise of reason necessary to the continuance of the vital motions, the mind ought certainly to be conscious of it; since, in every ratiocination respecting action, there must first/
first be a comparison of things, and then, in consequence of that comparison, a preference or election: but, I believe, few will maintain, that the mind can compare two or more ideas, and thence form certain conclusions and determinations, without being conscious, in any degree, of what it has been all the while employed about: for though, when we are solicitously engaged in any action, involved in any thought, or hurried away by any passion, we may be unconscious of the impressions made by material causes on the organs of sense; yet we cannot but be sensible of the ideas formed within us by the internal operation of our minds, because their very existence depends upon our being conscious of them, and is at an end, as soon as either we attend not to, or forget them: to say therefore that such ideas may be formed and exist in the mind without consciousness, is, in effect, to say that they may and may not exist at the same time."

Foot-note. "To avoid all metaphysical disputes about different degrees of consciousness; I desire it may be understood, that here and in other parts of this essay, when I say we are not conscious of certain impressions made on the mind by the action of material causes on the organs of the body, I mean no more, than that we have no such consciousness or perception of them, as either convinces us of their existence when present/
present, or enables us, by the help of memory, to recall them when past."

"Add to this, that the motions excited by any pain or irritation, are so instantaneous, that there can be no time for the exercise of reason, or a comparison of ideas in order to their performance; but they seem to follow as a necessary and immediate consequence of the disagreeable perception. And as the Deity seems to have implanted in our minds a kind of sense respecting morals, whereby we approve of some actions and disapprove of others, almost instantly, and without any previous reasoning about their fitness or unfitness; a faculty of singular use, if not absolutely necessary, for securing the interests of virtue among men; so I should think, the analogy will appear easy and natural, if we suppose our minds so formed and connected with our bodies, as that, in consequence of a stimulus affecting any organ, or of an uneasy perception in it, they shall immediately excite such motions in this or that organ or part of the body, as may be most proper to remove the irritating cause; and this without any previous conviction of such motions being necessary or conducive to this end. Hence, men do not eat, drink, or propagate their kind, from deliberate views of preserving themselves or their species, but merely in consequence/
consequence of the sensations of hunger, thirst, etc.

"The mind, therefore, in carrying on the vital and other involuntary motions, does not act as a rational, but as a sentient principle; which, without reasoning, is as certainly determined by an ungrateful sensation or stimulus affecting the organs, to exert its power, in bringing about these motions, as is a scale which by mechanical laws turns with the greatest weight.

"The general and wise intention of all the involuntary motions, is the removal of every thing that irritates, disturbs, or hurts the body; hence, those greater motions of the heart, in the beginning of fevers, small-pox, measles, &c. when the blood, by the mixture of some particular miasma, acts as a stronger stimulus than usual upon that organ. Nevertheless, as in many instances the best things may, by excess, become hurtful; so this endeavour to free the body, or any of its parts, from what is noxious, becomes unhappily, sometimes, so violent as to threaten the destruction of the animal fabric. But, in the main, this faculty must be accounted highly beneficial; since, without it, we should constantly have cherished within our bodies the lurking principles of diseases, slowly indeed, and by imperceptible degrees, but not less surely, ruining our health and constitutions.

"Upon/
"Upon the whole, there seems to be in man one sentient and intelligent PRINCIPLE, which is equally the source of life, sense, and motion, as of reason; and which exerts more or less of its power and influence, as the different circumstances of the several organs actuated by it may require. That this principle operates upon the body, by the intervention of something in the brain or nerves, is, I think, likewise probable; though, as with regard to its particular nature, I presume not to offer any uncertain conjectures. I shall only observe, that, perhaps, by means of this connecting medium, the various impressions made on the several parts of the body, either by external or internal causes, are transmitted, and perceived by the mind; in consequence of which it may determine the nervous influence variously into the different organs, and so become the cause of all the vital and involuntary motions, as well as of the animal and voluntary. It seems to act necessarily, and as a sentient principle only, when its power is exerted in causing the former; but, in producing the latter, it acts freely, and both as a sentient and rational agent.

"The bodies of brute animals are actuated by a principle of a like kind with that which is placed in man, but greatly inferior with regard to the degrees of/
of reason and intelligence which it possesses: in the more perfect brutes, this principle is plainly intelligent as well as sentient; and their actions so evidently shew them to be endued, not only with a good memory, but with reflection and some degrees of reason, that it is surprising to find Descartes and his followers seriously maintaining them to be mere machines formed entirely of matter, and, as it were, so many curious pieces of clock-work wound up and set a-going. Nor is it less surprising that some theological writers, after once admitting all the actions of the most perfect brutes to result from mere mechanism, should not have been aware that the ascribing every action in man to no higher a principle, would be a natural and easy consequence:"

"In the inferior orders of brutes the appearances of reason and reflection are more obscure; and, in the lowest species of animals, there are no marks of intelligence, nor do we observe them to differ otherwise from vegetables, than as they are endued with some degree of sensation and self-motion."

"Objection II. It may be allledged, That the vital motions cannot be owing to stimuli affecting the mind in the manner above explained, since we are not conscious of any such thing.

"Answer."
"Answer. This may be owing either to the gentleness of the irritation, or to our having been long accustomed to it, perhaps from the beginning of our lives."

"Objection III. It may be said, That although we are insensible of the stimuli affecting the organs of vital motion, either from their slightness or from custom; yet we ought to be conscious of the exertion of the power of the mind in producing those motions."

"Answer. That a man may, in general, be called conscious of any action, it is not only necessary that he should perceive it, during the time in which it is performed, but also that he should be able to recollect it after it is past: for though one be sensible, while a visible object is before him, that he sees it; yet if he retains not the least memory of it after it is removed out of his sight, he can neither satisfy himself nor others that ever he saw it. In like manner, we cannot be called conscious of an action or volition that is not adverted to when performed, or, as soon as it is over, is entirely forgotten: for as there are some sensations, either so slight in themselves, or so much weakened by the diversion of our attention, that they leave no traces in the memory; so there may be actions and volitions that are either so faint, so habitual, or so much lessened amid stronger and more important/
important exertions of the mind, that they may not only be entirely forgotten, but not so much as taken notice of or reflected upon."

Various examples are given of actions performed by the mind without consciousness, as the secretion of saliva on the remembrance of grateful food, nausea and vomiting caused by certain ideas being excited in the mind.

"But the objection against the mind's being concerned in the vital and other involuntary motions, drawn from our not being conscious of its interposing for that purpose, is removed, by considering that many even of the voluntary motions are performed, when we are insensible of the power of the will exerted in their production. Thus, while in walking, we either meditate by ourselves, or converse with others, we move the muscles of our legs and thighs, without attending to it, or knowing what we are doing. We are not sensible of the eye-lids being kept open by the continued operation of the will; but yet, when drowsiness and sleep steal upon us, we find it requires a considerable effort to prevent the falling down of the superior palpebrae. The same thing is true of the action of the muscles which support the head. The most probable account of our ignorance of these things seems to be this, viz. that we not only acquire,
through habit, a faculty of performing certain motions with greater ease than at first, but also, in proportion as this facility is increased, we become less sensible of any share or concern the mind has in them. Thus a young player upon the harpsichord, or a dancer, is, at first, solicitous about every motion of his fingers, or every step he makes, while the proficients or masters in these arts perform the same motions, not only more dexterously, but almost without any reflection or attention to what they are about.

"Some indeed have gone so far, as to deny that even the voluntary motions are owing to the mind as their proper cause, and have thought the direction of the voluntary muscles, in order to perform the various motions of the body, to be an office which its faculties are not equal to. But if these motions be not owing to the mind, from what cause, external or internal, do they proceed? They cannot be owing to the powers of the body alone; and it is in vain to attribute them to any law which it may be pretended the Deity has established; since a law can produce no effect of itself, and, without some agent to execute, it is only a mere name or empty sound: they must, therefore, be ascribed either to the immediate agency of the SUPREME BEING, or to that of some general inferior NATURE which HE has constituted for this purpose,"
purpose, or to the energy of a particular active principle united with the body. The first two suppositions are indeed possible, but not probable, as is the last; whence it may be inferred, that not only the voluntary motions of which we are immediately conscious, but those also which we do not advert to, proceed from that sentient and intelligent principle with which the Creator has animated our bodies; whose powers and operations, it must be owned, are, in many instances, as much above our knowledge as is the nature of its union with the body, or the manner of their reciprocal action upon each other.

"Objection IV. If the vital motions were owing to the mind, they should be under its dominion or control; and we ought at any time to be able to suspend or vary these motions at pleasure."

"Answer. In all actions which are the result of reasoning and deliberation, man evidently appears to be a free agent: for he has it in his power, after weighing all motives and circumstances, to prefer this or the other action, or to abstain from acting altogether. But there are actions, towards the performing of which we are not determined by reason, and where the mind is not a free but a necessary agent. Of this kind are the involuntary motions of those muscles whose fibres are affected by any considerable/
considerable stimuli; for the application of external objects to their proper organs, does not more certainly or immediately excite corresponding ideas in the mind, than certain uneasy sensations produce motions of the body. As we cannot, therefore, hinder ourselves from seeing every object which is painted on the bottom of the eye, nor from hearing every sound which affects the ear; so neither can the mind refrain from exerting its power of moving a muscle whose sensible fibres are strongly affected by a stimulus. And as nobody denies that it is the mind which sees colours and hears sounds, (because, whenever the external causes exciting these are applied to their proper organs, we can, by no effort of the will, prevent ourselves from seeing or hearing, nor can see and hear objects or sounds different from what these impressions naturally represent); so it must be unreasonable to say that the vital and other involuntary motions cannot arise from the energy of the mind, because the will has no immediate power over them.

"An action is denominated free, from the agent's having willed or chosen it, when he had a physical power of doing otherwise; thus the action of swallowing poison is said to be free, when a person chooses it, and might have refrained from it; but the convulsive motions of the stomach and diaphragm which soon/
soon ensue upon taking it, are strictly involuntary; since the mind cannot, by any effort or exertion of its power, prevent them; being as certainly determined to move these parts violently, from the disagreeable sensation which the poison excites, as a stone is in falling to the ground, or a scale in inclining to the side where there is the greatest weight, from the principle of gravity. The only difference in these cases is, that in the first, the cause operates by means of a living sentient principle; and in the last, acts upon inert and lifeless matter.

"As the actions which follow an irritation of our muscles, or any uneasy sensation in the body, are not performed by the mind, in consequence of any reasoning, or from any view of their being immediately necessary, or conducive to the welfare of the body; so neither do they flow from custom or habit; since new-born children perform them as well as the oldest and most experienced man. Infants, as soon as they come into the world, perform the action of breathing, though quite unaccustomed to it before; they shut their eye-lids upon the approach of light, vomit when their stomach is oppressed, suck when hungry, sneeze, or cough, upon any irritation of the membrane of the nose or wind-pipe, and void their excrements and urine, when these excite an uneasy sensation in their intestines or bladder."
"And I imagine, that the mind's want of power over the motion of the heart, is not only owing to its being continually acted upon by a stimulus, but in part to an original constitution; and that though we should suppose that organ for a little while free from every degree of irritation, yet the mind, by an effort of the will, could not move it."

Foot-note. "By an original constitution, I here mean no more, than that we are so formed, that the mind, which can at pleasure move most of the muscles of the body, has, from the beginning of life, no power to move the heart and other involuntary muscles, unless when it is excited by stimuli acting upon them, or upon some neighbouring part with which they have a peculiar sympathy."

"Thus, notwithstanding the mind remains present with the body, and ready to actuate it in a syncope; yet it can neither directly renew the motion of the heart after it has ceased, nor communicate a stronger contraction to it when it is going to fail: and there is no reason to think, that those animals which lie in a death-like state during the winter-season, have when they begin to revive in the spring, any more power over the motion of their heart, than those in whom its motions continue without any such interruption/"
interruption from the beginning to the end of their lives.

"We need not, therefore, with an ingenious author, have recourse to any crossings or entrelacements of the nerves of the vital organs, or to their proceeding from different parts of the brain, in order to account for their not being subject to the power of the will; especially since we see that the motions of the uvea and muscles of the internal ear, notwithstanding their nerves are without the above conditions, are equally involuntary with those of the heart; that the muscles of the arm, whose nerves have these crossings, are, nevertheless, moved by us at pleasure; and that, in short, even the voluntary muscles, when affected by any remarkable stimulus, cease to be under the control of the will.

"Objection V. The mind can only perceive distinctly one idea at once; and therefore must be incapable to attend to and govern all the vital and involuntary motions, which are so numerous."

"Answer. This objection is chiefly levelled against the opinion which supposes the vital motions to be regulated and carried on by the mind as a rational agent, and therefore does not much affect our theory: for whether the mind can distinctly apprehend/
apprehend more ideas than one at a time, or no, yet surely it can and does feel various sensations in different parts of the body at one and the same time; and we know that it can move many of the voluntary muscles in the same instant. Why, therefore, may it not, in consequence of the perception of various stimuli affecting the different vital organs, move them alternately?

"But further, when Mahomet Caratta, the famous equilibrist, stood with one foot on the slack wire, tossing, with his hands, six or seven balls up into the air, and catching them again, was he not attentive to more than one thing at once? In this case, the equilibrium of the body was to be preserved, the balls were to be taken out of his girdle, they were severally to be thrown up into the air, to be caught as they came down, and tossed up again; and these motions, which followed each other with surprising quickness, were continued for some considerable time. Any man can hear a sound and perceive a particular colour at the same time; and though ever so attentive to these, he will not fail, if a fly happens to run along his face, to drive it off with his hand, that he may avoid the tickling sensation which it excites. In like manner, how much soever the mind may be busied with its own thoughts, or the ideas of external objects;/
objects; yet it is ever ready to perceive and feel the various stimuli which alternately affect the vital organs, and, in consequence of this, to continue their motions. Nor is there any need of an infinite wisdom in the mind, as some have objected, to enable it to carry on the several vital and other involuntary motions, with different and always varying degrees of force and quickness, according to the different circumstances of the body; since, in so doing, the mind has no particular wise ends in view; nor is it influenced by any rational motives, but merely by the stimuli affecting the several organs, i.e. it acts as a sentient, and not as a rational principle. In the Author of nature, however, who has framed both the soul and body, and thus adapted them to each other, we ought, as upon many other accounts, so also upon this, to acknowledge a wisdom infinite and unsearchable!"
Various experiments are then described, as pressing on the brain, wounding it, and wounding the cerebellum.

"Since various experiments concur in shewing the cerebellum to be more concerned in the vital motions than the cerebrum, while none at all can be produced in proof of the cerebrum being more immediately necessary to these than the cerebellum, it follows, that the vital organs have their nerves, either wholly or principally, from the latter.

"But though the cerebellum be the chief source of the vital nerves, yet its destruction does not put an immediate stop to the vital motions, for the same reason that cutting off the head, or tying the intercostal and eight pair of nerves, does not produce this effect; because the branches from the spinal marrow which join the intercostals, together with the spirits (if I may be allowed to call the influence of the brain by that name) remaining in the trunks of the nerves and fibres of the heart, are sufficient to keep up these motions for some time: in man, perhaps, only for a few pulsations, in young dogs or cats for several hours, and in a tortoise for several months; which last animal, not to mention other differences, has its spinal marrow remarkably large: nay, the motion of the hearts of many animals, after they are taken out of their bodies, affords us ocular demonstration,
demonstration, that the nervous influence, lodged in
the fibres of the heart and in the smaller filaments
of the nerves, is sufficient to continue the motions
of this muscle for some time, or to enable it to
perform a great number of contractions."

"In time of sleep, the sensorium commune remains,
in a great measure, at rest, and consequently the
usual exercise of the internal senses, and the volun-
tary motions, are suspended; but the nerves distribut-
ed to the several parts of the body do not lose either
their sentient or moving power. It must be acknow-
ledged, however, that in time of sleep our feelings
are less acute than when we are awake; and hence the
same irritation in the trachea makes us cough less in
the former than in the latter state; but, notwith-
standing this, the nerves continue to be so sensible,
that not only pricking any part of the body with a
pin, but touching it gently with one's hand, or
whispering softly into the ear, will break off sleep
in many people. And as the feeling of the parts of
the body, although it be impaired, is not suspended
in time of sleep, so neither is their motion."

"As the heart and intestines retain their power
of motion, after they are separated from the body,
longer than the other muscles, so their nerves may be
framed in such manner as to be better able than those
of/
of the voluntary muscles to continue their motion 
uninterrupted, and without wanting any intervals of 
rest."

" 'Sequimur probabiliora; nec ultra quam id quod 
verisimile occurrit progredi possumus, et refellere 
sine pertinacia, et refelli sine iracundia, parati 
sumus.' " Cicero. Disput. Tusculan. lib.2.

Section XIII treats of the difference between 
respiration and the motion of the heart in sleeping 
and waking persons.

"Although the vital motions continue without any 
interruption in time of sleep, yet as they suffer some 
change at that time, i.e. become then somewhat fuller, 
slower, and more equable than when we are awake, it 
may be proper to inquire into the reason of this 
appearance.

"It has been shewn, that as the dilatation of the 
ventricles of the heart is owing to the force of the 
refluent venous blood; so their contraction is pro-
duced by the same blood acting upon them as a stimulus; 
and that the heart can only be affected by stimuli, 
in so far as it is a sentient organ, i.e. endued with 
feeling. Whence it must follow, that the slowness 
of the pulse in sleep, and indeed in every other case, 
can only arise from one or more of the following 
general/
general causes, viz. 1. A diminution of the stimulating quality of the blood; 2. Its slower return to the heart; or, 3. A less degree of sensibility or aptitude for motion in the heart itself."

"When the blood is neither loaded with new chyle, nor become acrid through the want of it; neither too much heated by cloaths or the external air, nor too cool, through want of proper covering; its stimulating quality will neither be augmented nor diminished by sleep; but will continue the same as in a person who is awake in the same circumstances. It remains, therefore, that the slowness of the heart's motion in time of sleep, must be owing, either to the slower return of the venous blood to it, or to some diminution of its sensibility."

"In sleep where the horizontal posture of the body, the quiescence of the voluntary muscles, and composure of the mind, all concur to render the return of the venous blood to the heart more equable and slow, the contraction of that organ must be renewed at greater intervals, and with more regularity, than when we are awake."

"Though the difference may be small, and there may be many causes which may render it difficult, by observation, to determine that difference with any/
any degree of certainty; yet the remarkable slowness and fulness of the pulse in the deep sleep accompanying an appoplexy, or occasioned by opium, makes it probable, that, even in the much gentler sleep of people in health, the pulse is somewhat slower and fuller than it would be, merely from the composure of mind, horizontal position of the body, and quiescence of the muscles of voluntary motion."

"In time of sleep, as the exercise of the several senses is either suspended or much impaired; so the sensibility or feeling, with which the organs of the body are more or less endued, seems to be rendered less acute. Thus we feel ourselves affected with a kind of stupor, when we are just falling asleep, and are then insensible of lesser stimuli." -- "If the heart, therefore, like the other organs of the body, becomes less sensible or irritable in time of sleep, it will not be so quickly excited into contraction as usual by the venous blood rushing into its cavities; and hence its contractions will not only be more slowly-repeated, but the pulse will be full, because the ventricles do not contract, till they are much distended with blood."

"It is, however, to be observed, that the fulness of the pulse in sleep may be owing partly to the fluids passing with greater difficulty through the very small lateral/"
lateral arteries, and the secretory tubes of the glands. For we know that the fulness or softness of the pulse does not depend, solely, upon the quantity of blood thrown out by the left ventricle of the heart, but also upon the more or less difficult passage of this fluid through the extreme arteries; since in proportion as these are obstructed or open, a greater or less resistance will be opposed to the blood projected by the heart.

"After what has been said of the slowness of the motion of the heart in sleep, it will be easy to shew why respiration should be performed then at greater intervals.

"The cause exciting the alternate contraction of the inspiratory muscles, is an uneasy sensation in the lungs, occasioned by the blood pushed into their vessels by the right ventricle of the heart. If then less blood is sent, in a given time, into the lungs in sleep, than when we are awake, the necessity of new supplies of fresh air will be lessened, and consequently inspiration will be performed at greater intervals.

"Further, as in time of sleep the sensibility of the lungs, like that of the heart and intestines, must be somewhat impaired, respiration must also, on this account, be performed more slowly; for the inspiratory muscles/
muscles will not be excited into action till a greater degree of irritation than usual be occasioned by the blood accumulated in the pulmonary vessels. And to this it is owing, that respiration is not only slower but somewhat deeper in time of sleep, than in a waking person at rest in a horizontal position."

"The whole amounts to this: In ordinary sleep the sensibility of the heart and lungs suffer so small a diminution, that their motions will be very little more affected by it, than they would be from the horizontal position and rest of the body, and composure of mind attending it. In the deeper sleep which succeeds great fatigue, the motions of the heart and lungs will be more observably altered. And, in the most profound sleep, occasioned by opium or a morbid state of the brain, where a general insensibility prevails over the whole body, the pulse will become more remarkably slow and full, and respiration slower and deeper.

p.183

Section XIV discusses the motions of muscles of animals after death or their separation from the body.

"Since the heart in many animals continue their alternate contractions for some time after they are taken out of the body; and as this is a circumstance which/
which may be offered as a strong objection to the account which we have given of the vital motions, we shall here inquire into the nature and cause of those motions which are so frequently seen in the muscles of animals after death, or their separation from the body; and I flatter myself much, or it will appear, that instead of these being inconsistent with our theory, they will serve rather to illustrate and confirm it.

"Several authors (some of them indeed of great character) have ascribed the motions of the heart after death, or its separation from the body, to some peculiar property, not found in the other muscles, wherewith they suppose it to be endued; but with what reason, will appear from the following experiments and observations."

Various examples are given here of the movement of separated muscles.

"Hence it appears, that all the muscles of living animals, whether they be of the voluntary or involuntary kind, are agitated with alternate contractions, after being separated from their bodies; and, consequently, that the vibrations performed by the hearts of animals, after they are cut out of the thorax, bespeak not any latent power peculiar to the fibres of that organ, or which they do not share in common/
common with those of every other muscle.

"If the voluntary muscles, which in a healthful state remain at rest when the will interposes not to the contrary, are alternately contracted and relaxed, as well as the heart, when they are separated from the body; it cannot be concluded, that, because the heart beats after such separation, it must therefore move also while in the body: on the contrary, it follows, that the alternate motions of the heart in living animals must be owing to its being acted upon by some particular cause which does not affect the voluntary muscles."

Various examples are given of the heart vibrating in different circumstances.

"From the above experiments it appears,

"That the separated hearts of some animals vibrate more strongly, and for a much longer time, than those of others.

"That animals of the amphibious kind, which have either no lungs or imperfect ones, which bear the air-pump long, and whose blood is cold, as well as languid in its motion, shew signs of life, not only in their hearts, but also in their other members, longer after they are separated from their bodies, than animals which have more perfect lungs, hotter blood, and a quicker pulse.

"Those/
"Those animals whose parts preserve motion and appearances of life longest after being separated from their bodies, seem to have both their fluids and solids somewhat different from those of other animals: their blood is not only colder, but perhaps more viscid and less volatile; and their fibres are so constituted, that constant supplies of this fluid from the heart are not necessary to keep them in due order for motion; while their nerves, after their communication with the brain has been cut off, preserve their powers much longer than in man and the more perfect animals: thus frogs, eels, vipers, and tortoises live and move several hours without their heart; and the various parts of their body continue to move long after all communication between them and the brain is cut off."

Several other inferences are given and the necessity of a stimulus is emphasized.

"Whence it follows, that the vibrating contractions of the muscles of animals after death, or their separation from the body, cannot be owing to any innate power, whereby, independent of all external causes, they move themselves alternately, but must be ascribed to the action of a stimulus of one kind or other upon their fibres."

"The motions of the heart, therefore, in animals newly dead, or after it is separated from the body, are/
are owing to the stimulus of the blood remaining in its cavities, to the contact of the external air, or to the irritation which is communicated to it by stretching or cutting its own fibres, or those of such parts as happen to be immediately connected with it.

"The same causes excite the motion of the heart in living animals and in those newly dead, in the body and out of it.

"The conclusion to be drawn from what has been said is, that there remains in the muscles of animals and their nerves, for some time after death, or their separation from the body, the immediate cause of motion, which may be excited into action, as in living animals, by any stimulus or irritation."

Various theories are set aside as untenable, as spirits remaining in the nerves and continuing for some time to go into the muscular fibres, or elasticity.

"It appears, from the experiments already recited, compared with" what has been said in previous sections, "that the motions of the heart and other muscles after death, and when separated from the body, are owing to a stimulus; that where no stimulus is applied, they either happen not at all, or soon cease; that, when failing, they are excited a-new by any irritation; and that, in the laws which they observe, and the appearances which they exhibit, they agree exactly with/
with the motions which stimuli excite in the muscles of living animals. But we have fully shewn, in Sect. X that the contractions of the muscles of living animals, arising from anything that tears, stretches, or otherwise irritates their fibres, are not owing merely to the peculiar structure and arrangement of their parts as mechanical organs, or even to the sole efficacy of any material powers, but to their being endued with feeling, and animated by a sentient principle. Whence it follows, that the motions of the heart and other muscles, after death, or their separation from the body, must proceed from their sensibility. As long as this sentient power remains, or is but little impaired, they are impatient of any irritation, and are, therefore, alternately contracted and relaxed; but when it becomes considerably weaker, stronger stimuli are required to rouse them into action, and even then their motion is more languid.

"Harvey, who formed his judgment of things, not as imagination might suggest, but from repeated experiments and observation, ascribes the various and irregular motions of the heart of the chick, when irritated by different stimuli, to its being endued with sense; and therefore compares it to an animal which lives, moves, and feels."

Some experiments with opium on frogs are described.

"Is/
"Is it not probable, that opium stops or retards the motions of the heart, only as it renders it wholly, or in a great degree, insensible of the stimulus of the returning venous blood; and that the contractions of the heart, both in the body and after it is separated from it, are owing to the sentient power of its nerves and fibres, by which it is made capable of being properly affected by various stimuli?"

"Since the sensibility of our fibres is owing to their being animated by a living principle different from matter, and of powers superior to it, it may be objected, that if we ascribe the motions of the muscles after death, or their separation from the body, to their being endued with sense, we must not only suppose the soul to continue present with the body after death, but also to be extended and divisible.

"But though these objections, as they are founded in our ignorance of the nature of the soul, and its union with the body, and of the manner of their mutual action upon each other, ought perhaps to have little regard paid them in a physical inquiry; yet, to clear our subject as much as I am able of all difficulties, we shall consider them particularly.

"I think it is not only probable, but even demonstrable, that the soul does not immediately leave the body upon a total stoppage of the motion of the heart,"
heart, and, consequently, of the circulation of the blood, i.e. upon what we usually call DEATH, but continues for some time present with it, and ready to actuate it."

[Foot-note. "By death is here meant the general death of the body as a system, and not the particular death of the several parts, which does not happen for some time after."]

"Thus, a variety of insects, bats, hedge-hogs, and other animals, which continue in a death-like state in the cold winter-season, are restored to life by the kindly warmth of the returning spring, which, as it stimulates the solids into contraction, as well as rarifies and agitates the fluids, gives the latent soul an opportunity of shewing itself by its effects: yet, in these animals, during the cold weather, there is no circulation of the blood; they are without feeling, may be torn and cut in pieces, without shewing any sense of pain, and cannot be distinguished from such animals as are really dead, except in this circumstance, that, by the assistance of warmth, they may at any time be brought to life."

"Several of the human kind have been recovered by shaking their bodies, blowing into their lungs, or exposing them to heat, after having been for hours, nay, sometimes days, to all appearance, dead, without pulse/
pulse, breathing, or any degree of natural heat. Had not the soul been present with such bodies, and ready to actuate them, is it to be imagined, that blowing air into the amus or lungs, that heat, friction, or any other stimuli, could, as it were, by some magic charm, have called it back from distant regions? Upon the whole, it appears certain, that after death, or an entire stop of all motion in the bodies of animals, the soul still remains present with them, and can be again brought to exert its influence, by various kinds of stimuli applied to their different parts. May not then the same principle continue present with the several muscles after they are separated from the body, and be the cause of their motions when irritated?"

"But here it will be said, that, not only contrary to the opinion of many philosophers, we suppose the soul to be extended, but also, in opposition to them all, seem to make it divisible."  

"As the schoolmen supposed the Deity to exist in every ubi, but not in any place; so they imagined the soul of man not to occupy space, but to exist in an indivisible point. Yet, whoever considers the structure and appearances of the animal frame, will soon be convinced that the soul is not confined to an indivisible point, but must be present at one and the/
the same time, if not in all the parts of the body where the nerves are found, yet, at least, at their origin; i.e. it must be, at least, diffused along a great part of the brain and spinal marrow. Nay, while, in man, the brain is the principal seat of the soul, where it most eminently displays its powers, it seems to exist or act so equally through the whole bodies of insects, and other animals of the lowest class, that its power or influence scarce appears more discernible in one part than another: and hence it is, that, in such creatures, the several parts of the body live longer after being separated from each other, than they do in man and the other animals more nearly resembling him, where the soul seems chiefly to act on the different parts by means of their connection with the brain and spinal marrow; or, at least, where the cutting off such connection, soon renders the parts unfit to be any more acted upon by it."

"But if the soul, without extension, be present at one and the same time in different places of the brain; and if, in many animals, it can act along the spinal marrow for a great while after the head is cut off, why may not it also actuate parts separated from the body, without being extended? On the other hand, if we allow the soul to occupy space, I do not see why it may not continue to be present with the parts/
parts of its body after they are separated, as well as when they were united. And with respect to the divisibility of the soul, which is generally thought to follow from the supposition of its being extended; why may it not be a substance so perfectly and essentially one, as that a division or separation of its parts would necessarily infer a destruction of its essence? Further, if the soul can be present in all or in any considerable part of the body at one and the same time without being discernible, its sphere of existence being so much increased, as to act upon the parts when separated, will not infer its divisibility. As the Deity is everywhere present, and, in the infinitely distant parts of space, actuates at the same time a vast variety of different systems, without any inconsistency with his unity or indivisibility; so, may not the souls of animals be present everywhere in their bodies, actuating and enlivening, at the same time, all their different members? Nay, further, when the fibres and threads connecting some of these parts are divided, may not the soul still act in the separated parts, and yet be only one mind?"

"But because we cannot explain fully, are we therefore in noways to attempt explaining the operations of nature?"

"At/
"At this rate, we ought to give up all inquiry into the works of nature, and, with our arms across, sit down contented in ignorance."

Here more experiments are recorded.

"...We are naturally led to observe, that while those animals who have a small brain and large spinal marrow, live long after decollation; man, and most quadrupedes, which have a large brain, survive the loss of it only for a few moments."

[From footnote. "We have reason to believe that the motions excited by stimuli in the muscles of animals, after they are separated from their bodies, are owing to some kind of feeling or simple sensation (such as oysters and other animals of the lowest class, who have no brain, are endowed with) in those muscles or their nerves, which, though not attended with any reflex consciousness, a power the soul only exercises in the brain; is nevertheless the immediate occasion of all those motions which arise from the irritation of the fibres of the muscles, whether they be connected with the other parts of the body, or newly separated from them."

"And here it is proper to remark, that, while those motions which are occasioned by stimulating the fibres of any muscle, continue for some little time after its communication with the brain, by means of the nerves, has been cut off; such motions as proceed from sympathy, and are owing to the irritation of some distant part, cease as soon as the brain is rendered unfit."

* See p. 138 foot-note.
unfit for action, or the communication with it is interrupted, because they depend on a perception in that organ from which the nerves proceed, and where alone the cause of their sympathy is to be found. If the motions of the muscles in the limbs of a cock, after decollation, are, without dispute, owing to its soul; may we not also ascribe to the same principle the like, but less remarkable motions in men and quadrupedes, after their heads are struck off; and, consequently, the tremulous motions and palpitations of their hearts too, after death or separation from their bodies?

To sum up all in a few words; from what has been said, it appears evident, that the involuntary motions of living animals, and the alternate contractions of their muscles, after the general death of the body, or their being separated from it, are owing to one and the same cause, viz. an irritation of their fibres or nerves, or of such parts as are nearly connected with them. If then, as we have shewn (Sect.X), that the motions of animal fibres, from a stimulus, most certainly bespeak a feeling, and cannot be explained unless we admit it; and if feeling be not a property of matter, but owing to a superior principle, it must follow, that the motions of the heart, and other muscles of animals, after being separated from/
from their bodies, are to be ascribed to this principle; and that any difficulties which may appear in this matter are owing to our ignorance of the nature of the soul, of the manner of its existence, and of its wonderful union with, and action upon the body."
"As philosophical inquiries, however agreeable and entertaining they may be to the mind, become still more interesting when they can be applied to practice; I intended to have shewn, how far the theory of the vital and other involuntary motions, which we have endeavoured to establish, may be useful towards explaining the nature of several diseases, and consequently towards pointing out the most proper method of curing them. But, as this Essay has swelled to a much greater bulk than I at first expected, I shall now, omitting that part of my design, conclude with a reflection of a different nature.

* * * * * * *

"The true physiology, therefore of the human body, not only serves to confute those philosophers who, rejecting the existence of immaterial beings, ascribe all the phenomena and operations in nature to the powers of matter and motion; but, at last, like all other sound philosophy, leads us up to the first cause and Supreme Author of all, who is ever to be adored with the most profound reverence by the rational part of his creation."
PHYSIOLOGICAL ESSAYS.

containing,

I. An Inquiry into the Causes which promote the Circulation of the Fluids in the very Small Vessels of Animals.

II. Observations on the Sensibility and Irritability of the Parts of Men and other Animals; occasioned by M. De Haller's late Treatise on these Subjects.

The first Edition published in the year 1755, the 2nd in 1759, and the 3rd in 1766.
CONTENTS.

I.
An inquiry into the causes which promote the circulation of the fluids in the very small vessels of animals.

SECT. I.
Of the force of the heart, contraction of the arteries, gravity, and attraction of capillary tubes, considered as causes of the circulation of the fluids in the small vessels of animals.

SECT. II.
That the vibratory motion of the small vessels is the principal cause promoting the circulation of their fluids.

SECT. III.
Of the motion of the fluids in those vessels of animals commonly called absorbent.

II.
Observations on the sensibility and irritability of the parts of men and other animals.

PART I.
Of sensibility.

PART II.
Of irritability.
INTRODUCTION.

Several things relating to the doctrine of the circulation of the blood have not yet been satisfactorily accounted for, one of these being the motion of the fluids in the smaller vessels.

"But, how easy soever it may have appeared to some authors to account for the motion of the fluids in the small vessels of animals, yet whoever considers the resistance that a fluid, moving through the aorta and all its branches, must meet with from friction, which increases as the diameters of the vessels decrease, and adds to this the mutual attraction and cohesion between the particles of the fluids and the sides of the vessels in which they move, will not only see that there is some difficulty in this matter, but suspect that neither the force of the heart, nor the alternate contraction of the larger arteries, is sufficient to drive the fluids thro' the smallest vessels of the brain, testes, and many other parts of the body."

SECTION I.

An inquiry is here made how far the contraction of the heart "may be supposed sufficient to account for the motion of the fluids in the very small vessels of animals."
Mathematical calculations are made from which it appears, that the velocity of the blood will not be the same in all the arteries of the same diameter, (as some have imagined), but will be greater or less, according to their distance from the heart, the excess of the areas of the branches above their trunks, the angles at which they go off, and the number and degree of their flexures."

From various calculations made "it is evident, that the force of the heart is insufficient to push the fluids thro' all the inferior orders of vessels; or, which is the same thing, that the left ventricle of the heart does not, by its direct projectile force at every contraction, move forwards the whole circulation of fluids in all the vessels of the body."

Investigations into "the force of the heart at the origin of the nerves" leads to this, that "the momentum of a small sphere of animal spirits in a nerve is 38 times less in proportion to its weight, than the moving force of a globule of red blood in its capillary artery. And the difference of their forces will be still greater, in proportion to the resistance which each has to overcome; since the resistance to the motion of a fluid from friction must be, \textit{ca\ae\textit{teris paribus}}, as much greater in the nerves than in the red capillary arteries, as the diameter/
diameter of the latter exceeds the diameter of the former."

"It is easy to see that in the nerves, whose cavities are so inconceivably small, but whose length is generally considerable, the force of the heart, which we have shown to be very little, must be unable to overcome the friction, nay even the mutual attraction of cohesion betwixt them and their fluids, and consequently be, of itself, insufficient to propell the animal spirits to the different parts of the body. And this, even upon the supposition that the nerves were continued directly from the minute capillary arteries: but, if we consider how much the force of the blood must be broken in passing through the infinitely convoluted and amazingly fine vessels of the cortical part of the brain, together with the follicles in which these vessels are imagined, by some, to terminate, what we have been contending for will appear more evident."

An experiment of Baron Van Swieten, in which "he tied both the carotid arteries of a dog without any observable harm to him", shews "that the secretion of the nervous fluid, and its derivation to the several parts of the body do not so much depend upon the force of the heart as has been generally imagined, but must, in a great measure, be owing to some other cause."
"We come now to compare the force of the left ventricle of the heart with the obstacles it has to overcome, upon the supposition that at each systole it pushes forward the whole fluids in all the arteries and veins of the body."

Calculations shew that "a resistance in the aorta equal to two pounds, will require a force of above 60 pounds exerted by the whole internal surface of the left ventricle of the heart to overcome it: from which it follows, either that the resistance to the motion of the blood in the aorta, and all its branches and ramifications, must be less than two pounds, which I believe no body will affirm; or else that the protrusive force of the left ventricle of the heart alone, is unable to drive the blood through all these vessels, and consequently insufficient, without the assistance of some other power, to carry on the circulation."

"We shall next briefly consider the alternate contraction of the aorta and its branches, which has been justly reckoned among the chief causes of the motion of the blood."

"This contraction, however of the arteries may, perhaps, be considered rather as a continuation of the force of the heart than as any new power impressed on or communicated to the blood; since it does not appear that the arteries contract with a greater force than that/"
that by which they were dilated. But, whatever may be the force with which the aorta and its branches restore themselves, we know that it is less than the systolic power of the left ventricle of the heart; because the blood is projected to a greater distance from a cut artery during its diastole, than in the time of its systole. Hence it follows, that, if the force of the heart is insufficient to account for the motion of the fluids through the inferior orders of vessels, the alternate contraction of the muscular coat of the aorta and its branches must be so likewise."

"With respect to gravity, it is sufficient to observe, that in a horizontal position of the body, it can have no effect; and, in an erect one, it must retard the return of the blood by the vena cava inferior, as much as it promotes its motion downwards in the aorta and its branches."

Capillary attraction can be of no use in promoting the circulation of the blood in the capillary arteries and veins; since these vessels are always full; or, if they were not, the fluids would be determined, by this attraction, equally backwards towards the larger arteries as onwards to the veins."
"We shall now proceed to explain what we imagine to be the principal cause of this circulation", i.e. of the fluids in the very small vessels of animals.

"Although, as has been observed above, the regular alternate pulsation of the arteries does not extend beyond the capillaries of the first order, except, perhaps, in parts very near the heart; yet we are not to consider the serous, lymphatic, and other still smaller vessels, as unactive canals not contributing to promote the circulation of their different fluids: on the contrary, it is probable, that these vessels are continually agitated with small alternate contractions, to which the circulation in them is in a great measure owing.

"Several physiological writers have supposed an oscillatory motion in the small vessels of animals; but few have said any thing satisfactory concerning its cause."

"Many experiments and observations shew that the muscular fibres of animals are so framed, as to be readily excited into contraction by a stimulus."

The blood "is well fitted to act as a gentle stimulus upon the sensible fibres of animals, whether we/
we consider its composition, heat, or intestine motion: for, while the saline and other acrid particles in the blood render it proper for irritating the tender vessels, its heat and intestine motion keep all its parts in a perpetually vibrating state, which must increase their stimulating power."

Alternate contractions in the several portions of the intestinal tube are caused by aliment, air, and bile; the alternate contractions of the venae cavae are owing to the blood acting upon them as a stimulus; the contraction of the tendineo-carnous coat of the larger arteries is excited by the blood thrown into them gently irritating their internal surface; "it seems reasonable to allow, that the smaller vessels, endowed at least with equal sensibility, must be excited into feeble but continually repeated contractions, by the gentle stimulus of their circulating fluids."

Some imperfect animals have no heart; likewise some monsters want a heart; in these the circulation must be carried on by the power of the vessels.

The facts of inflammation are due to irritating substances acting on the vessels.

Blushing "can only be satisfactorily accounted for from an increased motion of the small vessels of the face."

Similarly/
Similarly an extraordinary flow of saliva and a profuse secretion of urine "cannot be well explained without having recourse to an increased motion suddenly excited in the small vessels of the salivary glands and kidneys."

"The secretion of tears is immediately increased in a very great degree by acrid applications to the eyes, or by certain passions of the mind."

"The withering of a member that is palsied, or deprived of the nervous power, is to be accounted for in the same manner, and is a proof that the circulation of the fluids through the inferior orders of vessels, is not more owing to the force of the heart, than to the action of these vessels themselves. This withering has made some imagine, that nutrition is performed by the nerves: but the appearance, we see, is easily accounted for without this supposition; and there are good reasons to think that the nerves are solely subservient to motion and sensation.

"Altho' the alternate contractions of the smaller vessels cannot be discerned in most animals; yet they may be seen in the legs of a bug: in the small vessels of which an extraordinary vibration is discovered by the microscope."

"The objection against the reality of a vibratory motion in the small vessels of animals, because the microscope/"
microscope shews it not in most animals, is of no great weight; since it can scarce be doubted, that the particles of all bodies, especially fluids, are affected by heat with a perpetual oscillatory motion; and yet, unless the heat be great, the eye, even assisted by the best microscopes, cannot discern this motion."

After a numerical calculation the conclusion is come to that "the space described by each side of such an artery, when it performs one of its small vibratory contractions, will be only equal \( \frac{1}{600000} \) part of an inch, which is greatly too small to be discerned by the best microscope."

"It must appear evident to every one, that the inferior orders of vessels will not only not retard the motion of the fluids, but greatly promote it; since every small portion of them will, like a little heart, by its alternate contractions, push on its contained fluid. Nor ought these contractions, however weak and imperceptible, to be judged unable to produce this effect; since the motion of the fluids in the very small vessels is far from being rapid, and just such as might be expected to arise from this cause."

"Upon the whole, as we conceive the motion of the blood in the larger vessels, and even capillaries of/
of the first order, to be owing to the alternate systole of the heart and arteries; so in the serous, lymphatic, and still smaller vessels, where this force either reaches not at all, or is greatly diminished, the circulation seems to be carried on chiefly by the vibratory motions of those vessels themselves: and, the finer fluids being in this manner conveyed into the larger veins, the pulsation of the neighbouring arteries, the action of the voluntary muscles, and the alternate compression made upon all the contents of the abdomen and thorax by the motion of respiration, will promote their return to the heart along with the red blood in the venæ cavae.

"What we have said of the circulation of the fluids in general, we would have understood also of their motion in the secretory ducts of the several glands. In those glands whose vessels are most patulous, the secretion may be partly, and indeed principally, carried on by the force of the heart and larger arteries; a proof of which seems to be the bloody urine voided by such as have weak kidneys, after violent exercise: but in other glands, whose structure is finer, and particularly in the brain and testes, the motion of the fluids in the secretory and excretory vessels seems to be much less owing to the force of the arterial blood a tergo, than to the/
the gentle vibratory contractions of the vessels themselves.

"With regard to the nerves, which are generally considered as the excretory ducts of the brain; it is probable, that the conveyance of their fluid to the various parts of the body is not only owing to a gentle oscillation in them and their surrounding membranes, but also, in some degree, to their attraction as capillary tubes; for no sooner can there be a waste of this fluid at the extremity of any nerve (whether this happens from exhalation, alternate compression of the neighbouring parts, or any other cause) than, by its attractive power, it will be filled again. In the other glands, however, whose excretory ducts, by their union, soon form pretty large canals, no such attraction will have place."

Inflammation and its cure are discussed in the remainder of the section.

SECTION III.

p. 243

"Besides the small veins, which are continued vessels with the arteries, and terminate at last in the two venæ cavae, there are others which take their rise from the internal surfaces of the several cavities in the body, and from the skin: and, as the fluids which/
which these vessels convey cannot be impelled into them by the force of the heart or arteries, they have been thought to receive them by suction, and therefore have been called absorbent or imbibing veins."

Capillary attraction is discussed and the movements of the sap in plants.

"When any proportion of the intestines is relaxed, the lacteal vessels, which open everywhere on the surface of the villous coat, receive the chyle by their attractive power, so as to fill those branches which are dispersed in the membranes of the gut. The chyle being thus admitted into the capillary lacteals, is by the succeeding contraction of the muscular coat of the intestine, which compresses them, pushed on towards the mesentery. As soon as this contraction ceases, the emptied lacteals, being free from compression, fill themselves with chyle as before, which the next contraction of the gut presses forward to the larger lacteals in the mesentery. And thus the chyle is by turns attracted and propelled by the capillary form of the lacteals and the peristaltic motion of the intestines.

"Further, it is probable, that the lacteal veins, like the other small vessels of animals, have a vibratory motion excited by the gentle irritation of the chyle, which assists the alternate contractions of the intestines in the propulsion of that fluid."

Similar/
Similar arguments are brought forward in connection with the absorbent veins of the intestines, and the bibulous veins of the internal surfaces of the cavities of the body.

"These absorbent veins, which, like those of the guts, have no valves, receive, by their attraction as capillary tubes, the dewy vapour of the arteries, which they convey either to the lymphatics, or to the sanguiferous veins, by their vibrating motion, the pulsation of the contiguous arteries, and the alternate compression of the muscles. The absorption in the cavities of the abdomen and thorax is promoted by the alternate pressure of the muscles concerned in respiration; while the muscles of voluntary motion employed in all kinds of exercise and labour, by accelerating the motion of the fluids in the absorbent vessels of the trunk and extremities of the body, enable them to imbibe more copiously. And hence we may see, why animals which move little, are generally loaded with fat; while those which are kept at hard labour are very lean."

"If the exhalent vessels of any cavity throw out too much, or if the absorbent power of the veins be weakened, or if both these happen together, a watery fluid will be collected in it; and in this way are produced an ascites, hydrocele, hydrops pectoris, &c."

"The/
"The surface of the skin and vesicles of the lungs, like the other surfaces in the body are furnished with exhaling arteries and absorbent veins: by the former a fine lymph is perpetually discharged from the blood; and by the latter, the aqueous particles floating in the air are constantly conveyed into it."

"Altho' the exhalations from animal, vegetable, and mineral bodies, may, along with the aqueous particles in the air, be taken into the blood by the absorbent veins of the skin and lungs, (and thereby account for pestilential and epidemic diseases raging at particular seasons), yet it is not probable, that elastic air can be imbibed by these vessels, and so conveyed into the blood: for it has been observed, that air moves with great difficulty through capillary glass tubes, tho' some hundred times larger than the pores of the skin: and it is well known, that water and other fluids can penetrate many substances thro' which air cannot pass."

"As the effluvia of different substances floating in the air, are, by means of the cutaneous absorbents, conveyed into the blood, so likewise are the finer parts of plasters, cataplasms, fomentations, and other applications: which ought therefore to be considered, not only as having a local influence, but also a general one upon the whole body by their subtile parts, which/"
which are mixed with the blood and other fluids."

"To conclude our observations on the absorbent vessels; it may not be amiss to take notice, that upon the internal surfaces of the follicles and secretory and excretory ducts of the glands, there are bibulous veins, whose office is to carry off those fluids which would be improper to enter into the several secretions. And, if we suppose these absorbent vessels, like other capillary tubes, to attract, according to their different natures, different fluids more or less strongly, we shall see one great cause of the various secretions performed in the bodies of animals."
II.

OBSERVATIONS

ON THE

SENSIBILITY AND IRRITABILITY

OF THE

PARTS OF MEN AND OTHER ANIMALS

Occasioned by

The Celebrated M. de Haller's late Treatise

on those Subjects.

Spiritus intus alit; totamque infusa per artus
Mens agitat molem— Virg.

------------------------
"The truly learned and justly celebrated 
M. de Haller, in his late treatise De partibus 
corporis humani sensibilibus et irritabilibus, has 
favoured the world with an account of many new and 
curious experiments; from which he has sometimes 
drawn such conclusions as, if just, must necessarily 
produce some considerable changes both in the theory 
and practice of medicine. Being sensible how con-
trary his doctrine is, in many things, to the received 
opinion of almost every physician, antient as well 
as modern, he has taken uncommon pains in making many 
and repeated experiments; as much to overpower the 
incr edulous by their number, as to secure himself 
from any chance of being deceived.

"If the conclusions, I say, in that learned 
treatise shall be thought just, physicians and 
surgeons must treat some of their patients in a manner 
very different from what they have hitherto done; 
it seems therefore to be of some consequence to con-
sider this matter with attention, and to examine 
particularly, How far M. de Haller's system of 
sensibility is, or is not, well founded."
SECTION I.

"The illustrious author, in treating of the sensibility of the several parts of the human body, reckons among the insensible parts, the tendons, aponeuroses, ligaments, *capsulae* of the articulations, periosteum, bones, marrow, *dura* and *pia mater*, *pleura*, *peritonæum*, *pericardium*, *mediastinum*, and *cornea*.

Experiments on living animals are enumerated, in which these different parts were cut, burnt, pricked, torn, scraped, touched with oil of vitriol or *butyrum antimonii* or spirit of nitre, and the animals showed no sense of pain. Wounds of ligaments, articulations, tendons, "were followed with no bad symptoms, and were cured without any other remedy than the *saliva* of the animal, and sometimes without it."

"He allows feeling to the teeth, but not to the other bones, because they are not furnished with nerves, and because he has seen the skull trepanned, without giving pain, in persons who were possessed of all their senses."

"When the *pia mater* was burnt by touching it with *butyrum antimonii*, the animals neither cried, nor were convulsed; but, as soon as the brain itself was wounded, the body of the animal was twisted and distorted with violent/
violent convulsions."

"Besides the insensible parts above mentioned, there are others which, according to M. de Haller, have either no sense of feeling, or a very obscure one; these are the arteries, veins, glands, and viscera, viz. the lungs, liver, spleen and kidneys, which, when pricked, cut, or otherwise irritated, shewed nothing like feeling."

From these various facts "he thinks it follows, That those parts which, from his experiments, he concludes to be insensible, have been unjustly accused by physicians as the seat of some painful diseases."

"In the few observations which I propose to make on this doctrine, I shall, first, Consider the parts reckoned insensible by M. de Haller, in a sound natural state, such as they were in his experiments; and, 2ndly, when they are affected with diseases, whether in consequence of such experiments, or from other causes."

SECTION II.

p.260

"In making or relating experiments, with a view to discover the sensibility or insensibility of the several parts of animals, particular regard should be had to an observation made by Hippocrates, viz. That a greater pain destroys, in a considerable degree,
the feeling of a lesser one; an observation which is confirmed by daily experience. Thus, pricking any part of the body so as to give considerable pain, will so obliterate the irritation in the left orifice of the stomach, which is the cause of the hiccup, as instantly to stop that convulsive motion. If a candle be brought near a person whose eyes are a little inflamed, it will give him uneasiness: but, if he be placed first in the sunshine, the candle will not add sensibly to his pain.

"When the hinder-feet of a frog are pricked, or otherwise wounded immediately after cutting off its head, it makes scarce any motions with its legs, and shews almost no signs of feeling; but if the toes be pricked or cut ten or fifteen minutes after decollation, the legs and thighs are not only violently moved, but sometimes also the trunk of the body. Now, if in this case, as we see, the great pain occasioned by cutting off the head rendered the animal for some time insensible when its toes were wounded; is it to be wondered at, that, after the more sensible parts were cut, those animals which M. de Haller opened, shewed no signs of pain, when the less sensible parts were wounded?"

"Does it not appear, from what has been said, that a want of attention to the above mentioned maxim of Hippocrates/
Hippocrates may have given occasion to some mistakes with regard to the degree of sensibility in many of the parts of animals? Thus, it will not follow, that the tendons, ligaments, capsule of the joints, periosteum, and dura mater, are altogether without feeling, because no convulsive motions or other signs of acute pain appeared in the animals when they were cut, pricked, or torn; for this might be owing either to their not being endowed with any painful feeling, or to the greater pain occasioned by cutting the skin, subcutaneous nerves, &c. in order to get at those parts the sensibility of which our learned author proposed to try. I presume therefore to think, that the conclusion which should be made from his experiments, is, not that the parts above mentioned are wholly without feeling, but that they are much less sensible than many others, or than has been commonly believed by physicians."

Examples are given proving the sensibility of the marrow, the tunica cornea, the kidneys, and the glands.

"As the learned author not only forms his opinion of the insensibility of many parts of the body upon experiments made on living animals, but also on their want of nerves; we shall briefly consider, whether, from the real or seeming insensibility of any part,
or from anatomists being unable to demonstrate its nerves, we are allowed to conclude that it has none.

"Altho' the tendons are quite insensible, according to M. de Haller, and their nerves can scarcely be shewn by anatomists; yet we are convinced that the tendons have nerves, from the following observation. In foetuses and new-born children, many parts which afterwards, in an adult state, become tendinous, are then muscular, or partly so; and as animals advance in age, the proportion of the tendinous to the muscular part gradually increases: we must either, therefore, deny nerves to the muscles, or allow them to the tendons also.

"Altho' we cannot trace nervous filaments to the small arteries, we have reason to believe that they are furnished with them; else, how could the distension of their coats in inflammations occasion such acute pain? I think we may conclude every part that is liable to be inflamed by irritation to be, in some degree, sensible and possessed of nerves; for, since the inflammation cannot in this case be owing to any increased force of the heart, the distension of the small arteries, and the greater impetus of the blood in them, must be owing to an increased oscillatory motion in the vessels themselves, excited by the unusual irritation: but these motions of the small vessels/
vessels being of a like kind with those alternate contractions which are observed in muscles whose fibres have been irritated, it will follow that those vessels partake of a muscular nature, and consequently have nerves like the other muscles.

"With regard to the membranes; since the dura mater and pleura are furnished with nervous filaments, which anatomists have been able to demonstrate, we may reasonably conclude that the other membranes are not destitute of them; although they may be too small to come under the eye of the best dissector: this is certainly true of the cornea and the membranes containing the marrow, which we have shown to be sensible, and consequently not without nerves. It appears, therefore, that we cannot conclude any part to be insensible, merely because its nerves cannot be discovered.

"On the other hand, it is allowed, that we cannot certainly conclude, from a part's being furnished with nerves, that it is therefore sensible, and to what degree: for the nerves must be in a certain state to perform their functions rightly; and, in proportion as they recede from this, their sensibility will be more or less blunted."

Examples of this are given in bones, the membranes of the tela cellularis, and the dura mater.

"Without attention to this change in the firmness of parts, and its effect upon their nerves, we could never/
never account for what has been observed above, viz. that the parts of muscles, which in foetuses and children are lax contracting fibres and very sensible, become in a great measure insensible, in a sound state, when, by the age of the animal, they are compacted into tendons, as happens to many of them.

"If sensibility, then, be a sure mark of the existence of nerves in any part of the body, there is none without them, altho' anatomists will never be able to demonstrate them in every part."

SECTION III.

"If the parts reckoned insensible by the learned M. de Haller were really without nerves, it would follow, that they could in no case become the seat of painful sensation; and even supposing them furnished with nerves, but possessed only of a small degree of feeling, it may be thought, at least, improbable that they can be the seat of those painful diseases commonly ascribed to them. In order to set this matter in a just light, it will be proper to distinguish between parts in a sound and in a diseased state. In a sound state, the feeling of many parts of the body is but dull, and this is necessary to prevent the uneasiness we should otherwise suffer, when our organs are stretched, pressed upon, &c. in the common offices of life: such parts, therefore, when cut or wounded, in/
in a sound state, give little uneasiness; but, if afterwards an inflammation comes on, they become extremely sensible, and their over-stretched vessels and nervous filaments occasion acute pain, by which we are excited to endeavour to remove the complaint.

"It is certain, that those parts which are most sensible in a sound state, acquire a more acute feeling when inflamed. Thus the stomach, which, in health, can bear wine, brandy, and other pungent liquors, without being hurt, is, when inflamed, often brought into convulsions by the mildest. And light, which gives so much pleasure to the eye in a sound state, becomes intolerable when that organ is inflamed. Nor can we doubt that the more insensible parts may acquire, when inflamed or otherwise diseased, a great degree of sensibility. The instances above recited have shewn this to be true of the bones, tela cellularis, and dura mater; and the following facts will, I believe, evince the same thing, in other parts, which have been accounted either wholly, or almost wholly, insensible by the learned author."

Examples are given of inflammation in various parts, of rheumatic joints, contusions, and fulness of the vessels.

The pain, swelling, and inflammation of the arm, which have sometimes followed the opening of the median vein, is said to be due probably to a wound in the/
the tendon of the biceps muscle, not from a wound in the median or some other nerve, as M. de Haller imagines.

Gout is more deep-seated than he thinks, the pain not being in the skin or subcutaneous nerves, to which he refers it, but in the ligaments of the articulations, and tendons of those muscles which are inserted near them.

"M. de Haller is of opinion, that the insensible dura mater cannot be the seat of a headach or of a phrenitis. But how little sensible soever this membrane may be in a natural state, yet, if it may be affected with pain as often as it is inflamed or obstructed, it may still be the seat of those disorders." This is proved by the findings at post-mortems and by the headach in fevers beginning several days before delirium, and by the pain not being increased by pressure.

The pain of pleurisy has its seat in the pleura, not in the intercostal muscles, or large nerves running between the ribs, as M. de Haller thinks.

"Upon the whole, although these curious experiments shew, that several parts of animals are possessed of a much more obscure degree of feeling than has been commonly imagined; yet I should think, that the reader, after weighing what has been said, will not pronounce them altogether insensible."
PART II.

OF IRRITABILITY.

SECTION I.

"Although many of the parts composing the human body are endowed with a considerable degree of elasticity, whereby they restore themselves when overstretched; yet muscular fibres alone are possessed of a peculiar contractile power, which they exert in consequence either of an effort of the will, or of some stimulus applied to them or their nerves: by the former, voluntary motion is produced; by the latter involuntary. The illustrious M. de Haller, who calls the contractile power of irritated muscles by the name of Irritability, has, by a variety of curious experiments upon living animals, shewn, that it is a property of all muscular fibres; and that no part, which is not muscular, is irritable, although of the muscular parts, some are more and others less sensible of irritation. But when, in his enumeration of the parts of the body that are or are not irritable, he allows irritability to the lacteal veins, mucous glands, and sinuses, and yet denies it wholly to the kidneys/
kidneys and ureters, and almost wholly to the arteries, veins, and excretory ducts of the glands, we cannot help differing from him: since these last parts are, at least, as much muscular as the former; and since his own experiments on living and dying animals shew neither the one nor the other to be irritable."

Experiments and observations are brought forward to shew that M. de Haller is wrong, as inflammation produced in the skin by an acrid cataplasm or in the eye by the application of spirit of wine, which inflammation must be produced by the irritated vessels being agitated with alternate vibratory contractions.

"M. de Haller, because he cannot discover any orbicular muscle surrounding the edge of the pupil, concludes that there is none; and ascribes the contraction of that part to a stronger influx of fluids into the small vessels of the uvea, occasioned by the stimulus of light acting upon it. My reasons for not admitting this hypothesis I have shewn elsewhere; and therefore shall only add, that as we conclude from the various motions of many of the smaller insects, that they are, as well as larger animals, furnished with muscles, though we can neither demonstrate those instruments of motion by the knife, nor by the microscope, so we may infer the existence of the/ * Essay on vital motions.
the orbicular muscle of the uvea from the regular motions of the pupil, although its texture may be so delicate as scarcely to be distinguished by the anatomist from a denser kind of cellular membrane.

SECTION II.

p.279

"In my Essay on the vital and involuntary motions of animals, I have endeavoured to shew, that stimuli applied to the muscles of animals excite them into contraction, by producing an uneasy feeling in them or their nerves; but M. de Haller, who judges irritability to be an innate property of muscular fibres, is of opinion that it depends not upon the nerves, and has no connection with sensibility:

1. Because the most sensible parts, such as the nerves and skin, are not irritable.

2. Because the irritability of our organs is observed not to be in proportion to their sensibility.

3. Because some parts which have no feeling are irritable.

"With regard to the first of these, since muscles are the only organs of the body which, by their peculiar structure, are fitted for motion, it is no wonder that the nerves should have no irritability, since the want of it is only a necessary consequence of/
of their make; for a power of contraction does not
depend on sensibility alone, but upon that in con-
junction with a particular form.

"In answer therefore to the first argument, I
should say, that, although irritability always infers
some degree of sensibility, yet sensibility does not
infer irritability, unless the part be, by its struc-
ture, fitted for motion, i.e. in other words, unless
it be what we call muscular."

The skin and the dartos are shewn to be "affected
by stimuli, and consequently are irritable, though
not in the same manner with the muscles. The irrita-
bility therefore of the parts of the body may perhaps
be not improperly distinguished into three kinds: viz.
that power of alternate contraction which is peculiar
to the muscles; that uniform constriction which happens
to the dartos and pores of the skin; and that redness
and inflammation which is excited in every part of
the body that is sensible, as often as acrid things
are applied; although indeed this last is only an
effect of the first kind of irritability in the small
vessels of the parts.

"I must likewise dissent from M. de Haller in
regard to his second argument, viz. That irritability
is not observed to be in proportion to sensibility;
since an inflammation of any irritable organ, which
increases/
increases its sensibility, is always observed to make it more irritable, as will be shewn afterwards by a variety of instances."

The stomach, intestines and heart are discussed.

"As for the third argument, viz. That some parts which have no feeling are irritable; there is no experiment offered, and I doubt no instance can be given, of any part being irritable that is naturally insensible and without nerves: but what he thinks equivalent to this, is, that muscles continue to be irritable, not only for some time after their nerves have been tied or cut, and so all communication between them and the brain intercepted, but also after they have been separated from the body. And, indeed, it must be owned, that there is some weight in this argument: but that it nevertheless seems to me inconclusive, has been already suggested in the last section of my Essay on the vital and other involuntary motions of animals; and will, I believe, appear still more so from the following considerations.

"1. Although the irritability of muscles continues, in a small degree, for some time after their nerves are tied or otherwise destroyed; it will not follow, as M. de Haller thinks, that this power does not depend upon, or proceed from the nerves: for, if this were so, one would expect that, in a living animal, where the muscles are all supplied with blood by/
by the arteries, they should continue to preserve
their power of irritability, not only for a few minutes,
but for many hours and days after their nerves have
been tied or cut. Further, if the irritability of
the muscles were not owing, some how, to the nerves
or their influence, why should an irritation of the
nerves or medulla oblongata, produce such strong
convulsions?

"These convulsions cannot be owing to the pro-
pulsion of any subtile fluid in the nerves towards
the muscles; since, as M. de Haller and others have
observed, these motions follow equally whether a
nerve going to any muscle is squeezed upwards or down-
wards. If they were owing to the connection or
vicinity of the nerves to the muscles, one would ex-
pect, that stronger convulsions should follow from
the irritation of the tendons than that of the nerves:
the contrary of which, however, is true; for, while
the irritation of a nerve produces stronger con-
vulsive motions in the muscles, than arise even from
the laceration of their own fibres, the tendon, how-
ever pricked or irritated, produces no change in them.
The reason is plain; the tendon has little or no
feeling, while the nerves have a very acute one.

"Further, it ought to be observed, that when,
after decollation, the spinal marrow of a frog is
destroyed/
destroyed with a red hot wire, no visible motion is produced in its limbs or body, by pricking, cutting, or otherwise hurting them: only, when the skin of the thighs was dissected off, and the muscles were irritated, the fibres of those muscles were agitated with a weak alternate tremulous motion. Now, as the strong convulsive motions excited by irritation in the legs and trunk of the body of a frog after decollation, are to be ascribed to the sound state of the spinal marrow, since they cease as soon as it is destroyed; is it not highly probable, that the weak tremulous motion in the irritated muscles of the thighs of a frog, after the destruction of the spinal marrow, were owing to the influence or power of their nerves, which still remained intire? It seems also to deserve notice, that, after the destruction of the spinal marrow, altho' the fibres of such muscles as were irritated exhibited a weak tremulous motion; yet there was no sympathy between the different muscles, or other parts of the body, as was observed while the spinal marrow was entire: from whence it seems to follow, that the nerves distributed to the several parts of the body have no communication but at their termination in the brain or spinal; and that to this, perhaps alone, is owing the consent or sympathy observed between them.

"Upon/
"Upon the whole; the weak alternate motions produced by irritating the muscles, whose nerves have been tied or cut, do not prove, that their irritable power is independent of the nervous influence: they only shew, that these motions are not owing to any new derivation of spirits from the brain into the muscles at that time; that the presence of the nervous influence in their fibres is only requisite; and that the spirits remaining in the nerves, below the ligature and in the muscular fibres, may be sufficient to preserve a certain degree of irritability, or power of motion in them, for some little time.

"M. de Haller also concludes irritability to be independent of the brain and nerves; because the smallest insects, which have no head, are irritable. But by the same argument we might prove sensibility and voluntary motion to be also independent of the brain and nerves; for the smallest insects seem to be endowed with feeling, and undoubtedly perform voluntary motions. May not these insects which want a head have something to supply the place of a brain, from which the nerves may take their rise? Or may not their nerves be so formed, as to be sufficient of themselves, without a brain, for the purposes of motion and sensation?"
137.

"2. M. de Haller, while he denies feeling to the dura and pia mater, allows it to the medullary substance of the brain; because, when it is wounded, the muscles of the body are convulsed in an extraordinary manner. Now, if the sensibility of the medullary part of the brain in living animals may be deduced from the convulsive motions which ensue upon hurting it, are we not (the learned author himself being judge) to ascribe feeling to the brain, even in animals newly killed; since in these the motion of the heart is renewed by irritating the medulla oblongata, and the whole muscles of the body are convulsed by dissecting the spinal marrow? And altho', in animals newly dead, the convulsive motions produced by irritating the medulla oblongata or spinalis be weaker and less remarkable than in living animals; yet it will not follow, that they are not indications of sensibility, and owing to the same cause as in living animals: for, as the death of the body in general soon puts an end to every kind of feeling and activity in the parts of most animals, so it is not to be doubted, that, immediately after death, these powers begin to be weakened; therefore the motions owing to them must be less considerable.

"Again, if the convulsions occasioned by irritating a nerve in its natural state are allowed to be a proof of its feeling the like, though weaker, convulsions/
convulsions excited in the muscles by irritating a
cut or tied nerve must be an equal proof of its re-
taining, in some measure, its sensibility. When all
communication, therefore, with the brain, by means of
the nerves, is cut off, convulsive motions, which
arise from a stimulus applied to any part, are as
much a proof of the sensibility of that part as if
the communication were preserved. And, if in the
latter case, these motions may be justly ascribed to
the nerves being hurt by the irritation, they must be
equally so in the former.

"3. Here it will be objected; How can there be
any sensibility or feeling in a nerve whose commu-
nication with the brain is cut off?

"In answer to which, it may be said, that, since
we have good reason for believing that the parts of
many insects continue to be sensible for a considerable
time after they have been divided from each other; and
that the bodies of some larger animals continue to
live and feel after they are deprived of their heads:
Why may we not suppose that the muscles of men pre-
serve some degree of sensibility for a few moments
after their nerves are tied or cut, altho' we may not
be able to account for this from any thing we know
of the nature of the body, or of the manner in which
the soul is present with, or acts upon it?"

Some/

"+- this reflex act, by which a person knows his thoughts or sen-
sations to be his own, is a faculty of the soul exercised in the brain
only," G. "reflex consciousness" p. 97.
Some observations of the movements of separated parts of animals are given.

"Further, we must either allow that both the head and body of a frog continue to be animated for some time after they are separated from each other; or else affirm, that the life, feeling, and active powers of animals, are merely properties of that kind of matter of which they are made. The former opinion is attended with some difficulties, which arise chiefly from our ignorance of the nature of immaterial beings: the latter seems to be inconsistent with all the known properties of matter. If the latter therefore be admitted, we not only ascribe qualities to matter which it does not possess, but presume to limit, by our narrow and inadequate capacities, the powers of incorporeal natures, their manner of acting upon bodies, and co-existing with them.

"If the soul were confined to the brain, as many have believed, whence is it that a pigeon not only lives for several hours after being deprived of its brain, but also flies from one place to another? And to what cause are we to ascribe the continuance of life and motion in a viper for three days after its head is cut off, and in a tortoise for three weeks after decollation, and six months after the loss of its brain? The motions performed by these animals cannot surely be attributed to their material part alone; unless we shall deny them a soul altogether, and,
and, with Des Cartes, refer all their actions to their corporeal machinery."

"If then the soul in pigeons, frogs, vipers, and tortoises, is not confined to the brain, but can continue for a long time to actuate their bodies independent of that organ; and if, in many insects which have no brain, every part of the body is both sensible and irritable; why should we deny, that, in man and such animals as resemble him most, the parts may continue to be actuated by the soul or sentient principle for some few minutes after their communication with the brain has been cut off?"

["Foot-note. The difference between men and those animals which live long after decollation or the excision of their heart, seems to be, that the latter are so framed that fresh supplies of blood and spirits from the heart and brain are not immediately necessary to keep the several parts in due order to be acted upon by the soul: as seems to be, in a great measure, the case in man and many other animals."]

"I have elsewhere endeavoured to shew, that the supposition of the soul or sentient principle's continuing for some time to actuate the separated parts of animals, does not infer its real divisibility; nor is it necessary to repeat the same things again: but I cannot help observing, that, when M. de Haller represents/"
represents me as holding the soul to be divisible, so as that it may be cut into as many pieces as the anatomist pleases, he inadvertently charges me with an opinion which I not only do not maintain, but which I have brought arguments to disprove. I shall only add, that the indivisibility of the soul does not depend on the unity of the body, but on its own particular nature."

"As we can, from the little we know of matter, see that inactivity is one of its essential properties, we are hence convinced of the necessity of ascribing the life and motions of animals to the power of an incorporeal agent."

SECTION III.

p292

"The learned M. de Haller, after endeavouring to prove that irritability is independent on sensibility, gives it as his opinion, that this remarkable property of the muscles has its seat in the glutinous matter connecting the earthy elements of which their fibres are composed; and that irritability ought to be considered as a peculiar property of this glutinous substance, in like manner as gravity is allowed to be a property of matter in general, altho' its cause cannot be assigned.

"But surely the glutinous matter of the muscles of animals seems as unlikely to be endowed with an/
an active power, such as irritability, as any other constituent part of the animal body; nor can any argument be deduced from its endeavouring to shrink or shorten itself when drawn out; for the glue of the skin, ligament, and tendons, as well as of the muscles, has this property, which is, indeed, a kind of elasticity, and not similar to that power of alternate contraction which muscular fibres are endowed with.

"In proof of his notion of the irritable nature of the muscular glue, he adds, that young animals which abound most with it are most irritable. The observation is true, but seems to prove nothing in the present case; for the skin, ligaments, and tendons (which last are a continuation of the muscles, only harder and more compacted) abound more in glue than the muscles, and yet are in no degree irritable. The greater irritability of the fibres of young animals is to be deduced from their greater sensibility, and this is owing to their greater softness and tenderness: thus, what in new-born animals is a sensible and irritable muscle, becomes afterwards a tendon, which, in a sound state, is free from irritability, and is endowed with little or no feeling.

"Further, since the gelatinous matter in our aliments, and even in our blood, is quite without any irritability, it must owe this power to the particular/
particular disposition or arrangement of its parts, or to some other change which it undergoes when it becomes a part of a muscle. If this may be so, why may not the finer and more subtile parts of the blood be so changed in the brain, as there to acquire a power of feeling and thinking? i.e. if irritability be a property of the muscular glue, why may not sensibility and intelligence be properties of the medullary substance of the brain? for the known properties of matter give us reason to think, that real activity is not more consistent with its nature, than feeling or thought.

"But it has been said, that irritability may be a property of the muscular glue, as well as gravity is a property of matter in general: let us therefore consider this notion a little, and see whither it will lead us. Gravity, which is a property of matter, continues to be so, let matter be ever so much altered or changed by fire, menstruums, or other causes; but, when the gluten of the muscles is extracted from them, it appears as inert and void of active powers as any other matter; nay, though allowed to remain in them, yet, in most animals, it wholly loses its irritable power soon after the muscles are separated from the body.

"But, supposing irritability to be a property of the/
the muscular glue, in the same sense that gravity is a property of all matter; yet, as the most attentive consideration of matter has convinced philosophers that gravity is not essential to it, but owing to some general cause acting upon it; so the irritability of the muscular glue must be allowed not to be a property essential to it, but arising from the action of some other cause upon it. Gravity has been ascribed either to the immediate and continued operation of an immaterial being, or to the action of some subtile elastic medium on matter: but since the elasticity of the parts composing such a medium must be, at last, referred to the active power of some incorporeal cause, it follows, that gravity must be so likewise.

"It appears, therefore, after all that has been said to shew that the motions of irritated muscles are owing to a property of irritability in them or their glue, that we are at last obliged to refer them to the active power of an immaterial cause; unless we shall, contrary to sound philosophy, ascribe feeling and spontaneous activity to matter. And, as gravity must finally be resolved into the power of that BEING who upholds universal nature; so it is probable, that the irritability of the muscles of animals is owing to that living sentient principle which animates and enlivens their whole frame."
"The word irritability seems to imply a kind of life or feeling in the part endowed with it, which renders it capable of being fretted, provoked, or irritated; and therefore seems to be improperly applied to express the contractile power of stimulated muscles, if this power has no connection with, or dependence on their sensibility. We never talk of irritating a stone, a piece of wood, a tree, or indeed any thing that is without feeling."

There now follow a few observations on the connection between the motions of stimulated muscles and their sensibility.

"I. We almost always observe the irritability of the muscles or muscular organs of the human body to bear a proportion to their sensibility."

This is illustrated by the difference between young people and old people, more delicate people and stronger people, and by the great sensibility of the nerves.

"II. Whatever increases the sensibility of the muscles or moving organs of our body, also increases their irritability."

This is illustrated by inflammation of various parts and disagreeable sensations, as wind in the stomach.

"If/
"If therefore it appears, that the irritability of the moving organs of our body is increased as often as their own sensibility, or that of other parts with which they have an observable sympathy, is increased; it will be thought probable, that the irritability of any part depends upon its sensibility."

"III. Whatever lessens or destroys the sensibility of the muscles of animals, also lessens or destroys their irritability or power of motion."

This is illustrated by the effect of cold and opium, and several experiments are related to shew the power of opium over the heart, as M. de Haller had denied this.

"How M. de Haller was deceived in this matter, I cannot conjecture; since he has not told us in what manner his experiments were made: but, it is not to be doubted, that from his candor and love of truth he will readily acknowledge his mistake, as soon as he shall discover it."

"IV. When a viper is pricked with the point of a knife three days after being deprived of its head, heart, and other viscera, it moves, not only those muscles whose fibres are touched, but also the other muscles of its body which have no connection with those that are stimulated. This indicates either a sympathy between those muscles, which supposes feeling/
feeling, or some general active principle animating them, which, being affected with a disagreeable sensation by the stimulus applied to any one muscle, brings many others into action, in order to avoid what is hurtful to it. In like manner, when a few drops of hot water fall upon one's leg, the muscles which move it are instantly and involuntarily brought into contraction, in order to remove it from the offending cause."

A frog is described drawing its feet up to its body, when its toes are in any way stimulated. "Now, if these motions were owing to some property of the insensible matter of which the muscles consist, why should not an irritation of the toes be sometimes followed by a contraction of the extensor as well as the flexor muscles of the legs and thighs? But, if we allow them to be owing to the painful sensation in the toes, we shall see that the frog does, in this case, with its limbs, just what a snail does with its horns, when they are roughly touched."

The loss of sensation in a frog immediately after having its head cut off, and the return of sensation later are described.

"Is not the irritation of the toes, immediately after decollation, rendered ineffectual for producing any motion in the muscles of the legs and thighs, by the greater pain occasioned by cutting off the head? And/
And are not the muscles of the posterior extremities, as well as those of the trunk of the body, brought into action by wounding the toes fifteen or twenty minutes after decollation, because the pain occasioned by cutting off the head is now so much lessened (perhaps wholly obliterated) as not to prevent the animal from feeling very sensibly when its toes are hurt?

"V. That the motions of irritated muscles are owing to the sensation excited by the stimulus applied to them, will appear probable, if we consider, that we are in fact conscious of many involuntary motions in our bodies proceeding from a particular sensation, either in the organs moved, or in some neighbouring part."

Examples are given such as vomiting and hiccup, sneezing and coughing.

"We find, that, while most of our muscles are brought by the action of stimuli into alternate contractions, there are some few which contract uniformly and equably during the time the stimulus operates, without any intermissions or alternate relaxations. Of this kind is the contraction of the diaphragm and abdominal muscles when the intestinum rectum is irritated, of the sphincter pupillae, while the same degree of light continues to act on the retina, and of the muscles of the internal ear as long as the same/
same sound is applied to that organ. Nay, the diaphragm, which is brought into one continued contraction by a stimulus affecting the intestinum rectum, is agitated with alternate convulsions from an irritation of the left orifice of the stomach, or of the olfactory nerves. What account can be given of this, upon supposition that these motions proceed from the gluten of the muscular fibres? or what difference can it make to this insensible glue whether the stimulus be applied to the nose or anus? But, allowing these motions to arise in consequence of an uneasy sensation in the part stimulated, it will appear, that they are performed in such a manner as is most effectual to lessen or remove the irritating cause.

"Again, if the motions of muscles from stimuli were not owing to a feeling, how could the convulsive motions of the diaphragm in the hiccups be often immediately stopped by sudden fear, joy, or grief? Why should an irritation of the olfactory nerves become ineffectual to produce sneezing, when some of the muscles of the back or thorax are affected with a rheumatism? And why should the convulsive motions of the stomach and diaphragm in vomiting, be frequently interrupted by extraordinary fear, or any great and sudden surprise? It will be hard to give any satisfactory solution of these appearances, if the motions of irritated muscles are supposed to proceed from/
from some unknown property of their insensible glue: whilst they may be naturally accounted for upon the principle that they are owing to an uneasy sensation; for as often as this feeling is overpowered by a stronger one in some other part of the body, or when the mind is so suddenly and strongly affected by external objects, as, for a short time, to become almost insensible of the irritation, the motions owing to it must be lessened or cease.

"Gravity, magnetism, and electricity, are all regular and uniform in their operations; they bespeak nothing of feeling or life in the bodies which are endowed with them, and may therefore be supposed to proceed immediately from material causes; although the activity of these causes must be, at last, referred to the great ORIGIN of all power and life in the universe. But the motions of animal bodies from a stimulus are, in many cases, so plainly perceived to flow from an uneasy feeling, their various appearances can be so easily explained upon this supposition, and are so unaccountable on any other, that I am surprised to find so many learned and ingenious physiologists endeavouring to refute this opinion, and to derive those motions from inanimate matter.

"Life, sense, and self-activity, seem to be inconsistent with the known properties of matter; and therefore,
therefore, when we see a system of matter endowed with these, we may, without presumption, conclude, that they are owing, not to the material system alone, but to some active principle animating it. And although, even upon this supposition, it may be difficult to account for some of the motions observed in such a system, or in its parts when separated, we cannot therefore conclude, that they are not owing to any such power; but only that our ignorance of the nature of immaterial beings, and of their union with, and manner of acting upon bodies, throws a veil of obscurity over those things which the most enlightened philosopher will never be able to remove.
AN ACCOUNT OF SOME EXPERIMENTS MADE WITH OPIUM ON LIVING AND DYING ANIMALS.

First published

In the Edinburgh Physical and Literary Essays.
AN ACCOUNT OF SOME EXPERIMENTS MADE WITH OPIUM ON LIVING AND DYING ANIMALS.

p.309

"The ancient physicians imagined that opium extinguished the flame of life in animals by its excessive cold; and in later times, there have not been wanting those who deduced its effects from a quite opposite quality whereby it was thought to rarify the blood and to compress the brain or origin of the nerves. These false notions, however, of the nature and action of opium, have been refuted by several of the moderns, whose writings have thrown considerable light upon this subject.

"The following experiments were made with a view still further to illustrate the manner in which this wonderful drug produces its effects, and particularly to shew its influence upon the motion of the heart."

Twenty-four experiments are described. Two may be given as examples.

"14. I cut out the heart of a frog, and put it in fountain-water at ten minutes past ten; immediately after/
after immersion, it beat about 28 times in the minute. Eighteen minutes past ten, it made 6 pulsations in thirty seconds. Twenty minutes after ten, I took it out of the water and laid it on a table, and observed, that as often as it was gently touched with any thing, it made one full and strong contraction and no more: however, in four or five minutes, it began to beat of its own accord, and, at twenty-eight minutes after ten, performed 19 pulsations in a minute. Thirty-five minutes past ten, it beat 12 times in a minute."

"18. I cut out the heart of a fifth frog, and put it into a solution of opium in water five minutes before eight. After seven minutes immersion, I took it out, and laid it on a plate, where it remained at rest. When pricked with a knife, it did not perform a full pulsation like No.14 but seemed to feel a little, by a very faint kind of motion which was excited in some of its fibres."

"From the preceding experiments, we may, I think, fairly draw the following conclusions.

(a) Opium applied to the stomach, guts, cavity of the abdomen, and thorax, and abdominal muscles, soon lessens, and after some time entirely destroys all feeling and power of motion, not only in the parts to which it is applied, but thro' the whole body.

(b) Opium produces these effects much more quickly in animals which are soon killed by want of food/"
food and air, than in those which can live long without them, and the parts of whose bodies preserve a power of motion and appearances of life for a considerable time after they are separated from each other.

(c) Since a solution of opium injected into the stomach and guts destroys the sensibility and moving power of frogs, fully as soon when they are deprived of their heart, as when this organ remains untouched; it follows, that opium applied to these parts does not produce its effects by entering the blood, and being, by its means, conveyed to the brain, as some have imagined, but by its immediate action on the organs and parts which it touches.

"(d) Since, after decollation and the destruction of the spinal marrow, opium operates much more slowly in destroying the heart's motion in frogs, than it does when the animals are intire; it follows, that it must produce its effects chiefly, if not wholly, by its action on the brain, spinal marrow, and nervous system."

"(e) When opium injected into the veins, and thus mixed with the blood lessens or destroys the sensibility and moving power of animals, much in the same way as when it is applied to their stomach, guts, or cavity of the abdomen; is it not probable, that it produces these effects by its action on the extremities of/
of the nerves which terminate upon the internal surface of the heart and whole vascular system; and perhaps, also, by affecting immediately the medulla cerebri itself?"

"(f) Since opium, without entering the blood, or being carried to the several parts of the body, destroys the power of feeling in animals merely by acting on the nerves to which it is applied, it follows, that the nerves are the instruments of sensation, or, at least, necessary to it."

"(g) It appears from No. 4 and 5, compared with No. 3, 6, 8, 10 and 11, that decollation and the destruction of the spinal marrow does not weaken or destroy the heart's motion in frogs, near so soon as opium injected into their stomach and guts, or applied to the muscles and bowels of the lower belly and thorax.

"(h) Although a solution of opium applied to the open thorax and abdomen of a frog, after decollation and the destruction of its spinal marrow, soon weakens or destroys the motion of the heart; yet it does not produce these effects so speedily as when the brain and spinal marrow are intire. In the former case, the opium can only affect the heart by its topical influence; in the latter, it not only acts this way, but also exerts its powers upon the brain, spinal marrow, and whole nervous system; and therefore must produce more sudden effects.

"(i)/
(i) It appears, beyond doubt, from the preceding experiments, that the heart is not exempted from the power of opium, as the learned Dr Haller has affirmed, but has its motion destroyed by it, as well as the other muscles, only not so soon.

(k) Opium injected into the stomach and great guts of dogs, does not produce either such speedy or powerful effects, as when thrown into the cavity of the abdomen. A solution of opium applied to the abdominal muscles, does not kill frogs so soon as when all the viscera of the lower belly are exposed to its action.

(l) Although it seems probable, from No. 22, compared with No. 24, that a solution of opium injected into the veins of dogs does not kill them so soon as when thrown into the cavity of the abdomen; yet this cannot be certainly concluded, since the dog of No. 24 was much older and above ten times heavier than the other.

(m) It appears that a solution of opium injected into the great guts of a dog, affects the inferior part of the spinal marrow much more remarkably than its superior part, or the brain; since the dogs of No. 21 and 22 not only lost the power of motion sooner in their hinder legs than in their fore ones, but also were insensible of any pain in them, and yet howled strongly when their ears were pinched.

(n)/
"(n) A solution of opium injected into the cavity of the abdomen or great guts of dogs, does not destroy the feeling and power of motion of their hinder limbs, by sending any effluvia to their muscles; otherways it could not produce these effects so instantaneously. Besides, since opium thrown into the stomach and guts of a frog after being deprived of its heart, destroys the sensibility and moving power of its muscles equally soon as if the animal had been intire; it is plain, that these effects cannot be owing to the finer parts of the opium being received into the blood, and by its means carried to the several muscles and organs.

"(o) Nor does a solution of opium injected into the great guts or cavity of the abdomen in dogs produce its effects by transmitting through the nerves any subtile effluvia to the spinal marrow; otherways its operation could not have been so instantaneous; nor could the spinal marrow and its nerves have recovered their functions so soon after the opium was evacuated by a purgative clyster.

"(p) It remains, therefore, that opium, by affecting the extremities of the nerves of the parts to which it is applied, does, by means of their connection and sympathy with the brain and spinal marrow, destroy or prevent, through the whole nervous system, the operation of that power upon which depends sensation and motion in the bodies of animals.

"(q)"
"(q) Since opium applied to the abdominal muscles of a frog deprived of its brain and spinal marrow, does not destroy the motion of the heart so soon as when it is applied to the abdominal muscles of a frog whose brain and spinal marrow are intire, it follows, that the brain and spinal marrow, and consequently the nerves derived from them, have a greater influence than any other part of the animal system upon the motion of the heart.

"(r) Opium does not only destroy the moving power of the muscles of animals by intercepting the influence of the brain and spinal marrow, but also by unfitting the muscular fibres themselves, or the nervous power lodged in them, for performing its office: otherways a solution of opium, when applied to the abdominal muscles or viscera of a frog, would not put a stop to the heart's motion sooner, or indeed so soon, as decollation and the destruction of its spinal marrow. Opium therefore does not produce its effects solely by putting a stop to the function of the brain and spinal marrow, but its influence reaches to the fibres of the muscles themselves, or to the extremities of the nervous filaments which terminate in them."

(s) and (t) state that the experiments prove that what has been stated elsewhere by the author about the motions of muscles is true.

(u)/
The distention of the veins which occurs after a large dose of opium "seems to be no more than a consequence of the very slow motion of the blood through the heart, on account of the insensibility with which this organ is affected.

"(v) Since opium soon puts a stop to the vital motions of animals, which yet continue in time of sleep with little or no diminution of their vigour; since it often eases pain without bringing on sleep; and since, by its topical action on the heart, it destroys the motion of this organ after all communication between it and the origin of the nerves is cut off; it follows, that the effects of opium are not owing, as some have thought, to its producing sleep: on the contrary, the sleep which it occasions seems to be only a consequence of its impairing the sensibility of the whole nervous system.

"The other effects of opium may be also deduced from the same cause, particularly its restraining all evacuations that are owing to an unusual irritation of the parts of the body, and at the same time promoting those natural secretions which have been diminished or stopt by spasmodic strictures of the vessels, from some uncommon stimulus affecting them.

"(w) Lastly, does not opium kill animals by rendering their several organs wholly insensible of the/
the stimuli which are destined by nature to excite them into action; whence not only a stop is put to the peristaltic motion of the guts, and to the propulsion of the chyle, but the fluids also begin to stagnate first in the smaller and afterwards in the larger vessels; while the heart becoming gradually less sensible of the stimulus of the blood with which it is distended, contracts more feebly and at greater intervals, till at last it ceases from motion altogether?

-------------------
AN ESSAY ON THE VIRTUES OF LIME-WATER AND SOAP IN THE CURE OF THE STONE.

Non fingendum aut excogitandum, sed inveniendum.

Bacon.

-------------
This Essay is inscribed to the Duke of Argyll. It has three "advertisements", one for each of the editions, 1752, 1754, and 1761. It was published originally in the year 1743, in the Edinburgh Medical Essays, Vol.5 Part 2.

In each edition some changes have been made, as additions relating chiefly to the nature of quick-lime and water, its action and mode of administration, and corrections of errors, and omissions of things less material and of conjectures.

Cases are given, particularly the case of the Right Honourable Horace Walpole, Esq; written by himself. "I have chosen, however, to insert Mr Walpole's case preferably to any other, not only because the good effects of the medicines were here very remarkable, but as it is written by himself, and as the histories of those in conspicuous stations of life are wont to make the strongest impressions upon the generality of mankind."

The Table of Contents shows that the Essay treats of experiments with quick-lime, its action upon urine, the calculus, some of the animal humours, fermented liquors and spirits, animal food, also milk, honey, and sugar, several fruits, herbs, and roots, and several medicines. It treats, further, of the different strengths and specific gravities of different/
different lime-waters, with experiments shewing the change made on lime-water by boiling, and being exposed to the open air, and observations on its use in several diseases. There are also experiments with lime-water, soap-leys, soap, etc.

The last four sections are as follows, "Of the action of lime-water in dissolving the stone", "Of the cure of the stone", "The comparative value of the several medicines proposed for dissolving the stone", "The dissolving powers of the menstrua". Several cases are given.


Oyster-shell lime-water is said to be stronger than stone-lime-water. The oyster-shells made use of in the experiments were got from among the rubbish on the south side of the Castle of Edinburgh and were quite free of any sea-salt. See also p. 357.
OBSERVATIONS

ON THE

NATURE, CAUSES, AND CURE

OF THOSE DISORDERS WHICH ARE COMMONLY CALLED

NERVOUS, HYPOCHONDRIAC, OR HYSTERIC;

\[ \Sigma \nu\nu\nu\nu\nu\nu \varepsilon \delta \varepsilon \alpha \varepsilon \pi \delta \alpha \tau \eta \alpha \varepsilon \]. Hippocrat. de slement. § 4.

TO WHICH ARE PREFIXED SOME REMARKS

ON THE SYMPATHY OF THE NERVES.

The first Edition published in the 1764, the Second
in the 1765, and the Third in the 1767.
"The disorders which are the subject of the following observations have been treated of by authors, under the names of Flatulent, Spasmodic, Hypochondriac, or Hysteric. Of late, they have also got the name of NERVOUS; which appellation having been commonly given to many symptoms seemingly different, and very obscure in their nature, has often made it to be said, that physicians have bestowed the character of nervous, on all those disorders whose nature and causes they were ignorant of. To wipe off this reproach, and, at the same time, to throw some light on nervous, hypochondriac, and hysteric complaints, is the design of the following observations; which are also intended to shew, how far the principles laid down in my Essay on the vital and other involuntary motions of Animals, may be of use in explaining the nature of several diseases, and consequently, in leading to the most proper method of cure."

"It is only proposed to treat of those disorders which in a peculiar sense deserve the name of nervous."

"As many of these complaints depend upon that sympathy which obtains between the various parts of the body, it seemed necessary to begin with some observations/"
observations on the sympathy of the nerves; a subject of the greatest importance in pathology!

"In reasoning on the nature and causes of nervous disorders, I have endeavoured to avoid uncertain hypotheses; and therefore have had no recourse to any imaginary flight, repercussion, dispersion, confusion, or jarring contest of the animal spirits; for whose existence we have only probability, and of whose peculiar nature and properties we are altogether ignorant".

"In the practical part, I have confined myself chiefly to what experience had suggested; and have only advised such remedies as I have used with success myself, or had recommended to me by those whom I could trust."
THE

CONTENTS

CHAP. I.

Of the structure, use, and sympathy of the nerves. ........................................ 171

CHAP. II.

Of nervous, hypochondriac, and hysterical disorders in general.
The most common and remarkable nervous symptoms. ........................................ 191

CHAP. III.

Of the predisposing causes of nervous, hypochondriac, and hysterical disorders. .......... 194

CHAP. IV.

Of the general occasional causes of nervous, hypochondriac, and hysterical disorders. .... 195

CHAP. V.

Of the particular occasional causes of nervous, hypochondriac, and hysterical disorders. 197

CHAP. VI.

Observations on some of the most remarkable symptoms of the nervous, hypochondriac, and hysterical kind. 199
I. An uncommon sense of cold or heat in different parts of the body.

II. Pains in different parts of the body, suddenly moving from one place to another.

III. Hysteric faintings and convulsions.

IV. A catalepsis and tetanus.

V. Wind in the stomach and bowels.

VI. A great craving for food.

VII. A black vomiting.

VIII. A sudden and great flux of pale urine.

IX. A nervous atrophy.

X. A nervous or spasmodic asthma.

XI. A nervous cough.

XII. Palpitations of the heart.

XIII. The pulse often varying in quickness, strength, and fulness.

XIV. Periodical headaches.

XV. A giddiness.

XVI. A dimness of sight, without any visible fault in the eyes.

XVII. Low spirits, melancholy, and a mania.

XVIII. The incubus or night-mare.

CHAP. VII.

Of the cure of nervous, hypochondriac, and hysteric disorders.

CHAP. VIII.

Of the cure of some of the most remarkable nervous, hypochondriac, and hysteric symptoms.
I. Convulsive motions, or fixed spasms of the muscles.

II. Hysterical faintings with convulsions.

III. A violent pain with cramps in the stomach.

IV. An indigestion and vomiting, with pains in the stomach.

V. A colic of the hysterical or flatulent kind.

VI. Flatulence in the stomach and bowels.

VII. A nervous or spasmodic asthma.

VIII. A palpitation of the heart.

IX. An immoderate discharge of pale urine.

X. Periodical headaches.

XI. Low spirits.
"Before we enter upon the subject of the following observations, it may be proper to make a few remarks concerning the structure, use, and sympathy of the nerves.

1. The nerves are those small cords, which rising from the brain and spinal marrow, are distributed to every part of the body. They appear to be no more than continuations of the medullary substance of the parts from whence they proceed, and owe their strength and firmness to the membranes and cellular texture which surround them.

2. The larger nerves (1) are evidently composed of many smaller ones, which run parallel to each other, and seem to be quite distinct from their origin to their termination, without any such communications between their branches as are observed everywhere in the system of arteries and veins.

3. The smallest nervous filaments that can be traced by dissection are still composed of lesser threads; so that we can have no idea of the exility of a single nervous fibril.

4. Altho' it seems probable that the nerves (3), which are continuations of the medullary substance of the brain and spinal marrow, derive from thence a fluid, yet the extreme smallness of the nervous tubes, and/
and the subtility of that fluid which they contain, make us altogether ignorant of its peculiar nature and properties. Nor do we know, certainly, whether this fluid serves only for the nourishment and support of the nerves, or whether it be not the medium by which all their actions are performed.

"5. The nerves communicate sense and a power of motion to the body."

"6. Altho' every part of the body furnished with nerves, has either more or less of feeling; yet there are only some of those parts whose structure renders them capable of motion."

"7. There are only two kinds of motion observed in the bodies of living animals, viz. voluntary, and involuntary from stimuli. In order to the performance of the first, the nervous power is not only necessary, but also a free communication, by means of the nerves, between the brain and the parts to be moved. The second continues for some time, though in a much weaker degree, even in those muscles whose connection with the brain is wholly cut off; whence it has been concluded, that this kind of motion is independent of the nerves, and owing to some power or property in the muscular fibres themselves, or in the glutinous matter connecting the elements of which they are composed. That this conclusion is not, however, well founded, I have/
have formerly shewn by several arguments."

"From the continuance of the motion of the heart, and other muscles, after they are separated from the body, one may safely conclude, that the contraction of irritated muscles is owing to the distention of their hollow fibres, by a more copious influx of the nervous fluid \textit{max} at that time. Does this fluid act in some other way than by distending the muscular fibres? or is it only necessary to keep them in a proper state for being acted upon by that living principle from which all their motions are to be derived.

"8. As the nerves are continuations of the medullary substance of the brain and spinal marrow, it is probable that they are partly nourished, by those vessels, which are spread on that production of the \textit{pia mater} which surrounds them, in like manner as the brain derives its nourishment from the arteries of the \textit{pia mater}."

"9. Our bodies are, by means of the nerves, not only endowed with feeling, and a power of motion, but with a remarkable sympathy, which is either general, and extended through the whole system, or confined, in a great measure, to certain parts.

"10. That every sensible part of the body has a sympathy with the whole, will sufficiently appear from the following facts."

Various examples are given, as cold water thrown on a warm part of the body, the \textit{effluvia} of certain substances/
substances, musical sounds, doleful stories, shocking sights, any hurt to the brain, disorder of the stomach, grateful food, strong wine, or other spirituous liquors, various poisons, worms in the stomach or intestines, and others.

"11. Besides this general consent (10) which prevails throughout the whole body, there is a particular and very remarkable sympathy between several of its organs, by means of which many operations are carried on in a sound state; and pain, convulsive motions, and other morbid symptoms, are often produced in such parts as have no near connection with those that are immediately affected.

"To illustrate this, I shall give several instances, beginning with the head, and taking the parts in their order downwards."

A great many examples are given, as "Light and noise are offensive both to the eyes and ears in severe headaches." "The great consent between the brain and heart appears from the sudden and remarkable effects of the passions on the latter." "Hyppocrates has observed, that the unexpected sight of a serpent will make the countenance pale." "Yawning and vomiting are often catching." "After hard drinking, or a large dose of opium, the eyes lose their lustre. The headach, after a debauch, proceeds chiefly from the stomach, as appears by the removal of the pain, upon/
upon drinking a few glasses of strong wine." "A tremor of the hands is often lessened or removed, for a while, by a dram, or some strong wine; and this effect is owing solely to the action of these liquors on the stomach, and not to their having entered the blood, which does not happen so soon." "When one of the kidneys is inflamed, little urine is separated by the other, probably on account of a spasmodic stricture of its secretory vessels." "A strangury and tenesmus mutually occasion each other."

"12. All sympathy or consent supposes feeling; and therefore must be owing to the nerves, which are the sole instruments of sensation (5)."

"That all sympathy is owing to feeling, and consequently proceeds from the nerves, appears evident, because the changes in the body, occasioned by the sympathy of the parts, are stopt by whatever affects the nervous system so strongly as to overcome the sensations that produced those changes. Thus the hiccup is stopt by terror, fear, surprise, or other strong passions."

"Could we suppose the circulation of the blood were to remain, after a total abolition of the sentient powers of the brain and nerves, there would be no more sympathy between the parts of such an animal body than between those of any hydraulic machine. As in this case the motion of the fluids would/
would be merely mechanical, so every change made in any of its parts must be the result of mechanism alone, and consequently, wholly different from consent, which, as it depends upon feeling, cannot be explained upon mechanical principles.

"13. Those sympathies which have been ascribed by some authors to the tela cellulosa, blood-vessels, membranes, and the similarity of parts, if duly considered, will appear either to proceed from the nerves, or not to deserve the name of consent or sympathy."

What happens in the cellular membrane "cannot be properly referred to sympathy, and is no more than what happens to a sponge, a piece of sugar, or other porous substances.

"The system of blood-vessels affords us no more instances of true sympathy than the tela cellulosa, except what may be owing to the nerves which belong to these vessels."

"The various instances of consent from the continuity of membranes, are, strictly speaking, owing to the nerves themselves, with which those membranes are supplied; for, were they destitute of nerves and feeling, no such consent could happen."

"The sympathy between the breasts and the uterus, has been derived from the similarity of their structure, or of the liquors secreted by them. But altho' those parts were much more similar in these respects than they really are, yet if there were no connection between/
between them by means of blood-vessels, or consent by means of nerves, it would be difficult to conceive, how the condition of the one could be so much affected by that of the other; and much more how a titillation of the one should communicate a particular sensation to the other."

"14. Although it may appear, from what has been said, that all real consent between the different parts of the body is owing to the nerves; yet it will be found very hard to account, particularly, for the various instances of sympathy, either in a sound or morbid state.

"The prevailing opinion has been, that these sympathies are owing to the communications between the nerves, and particularly to the connection which the intercostals have with the fifth, sixth, and eighth pairs, and with almost all those which proceed from the spinal marrow.

Upon this principle it has been thought easy to trace the various sympathies, not only between the several parts of the abdomen, but also between them and the head, neck, thorax, and extremities. But however plausible this theory may appear at first view, and how readily soever it may seem to explain many remarkable instances of consent, yet a more strict examination will shew it to be liable to insuperable difficulties.

"(a) Since every individual nerve appears to be quite/
quite distinct from every other, not only in its rise from the medullary substance of the brain or spinal marrow, but also in its progress to that part where it terminates (2), it follows, that the various instances of sympathy, observed between the different parts of the body, cannot be owing to any communication or anastomosis of their nerves; and consequently that it can be here of no use minutely to inquire into the numerous connections which the intercostal nerves have with the fifth, sixth, and eighth pairs, and with those of the spinal marrow.

"But, lest it should be alleged, that the course of the nervous filaments in the ganglia is so intricate, that it is not altogether clear, whether they may not intermix or communicate with one another in their passage through those bodies, it will be necessary to offer some less doubtful arguments, for proving that the sympathy of the several parts does not depend on any union or anastomosis between their nerves.

"(b) If there were any anastomosis, or real communication between the nerves of the same or different trunks, either in the ganglia or elsewhere, it is natural to think, that a confusion would necessarily happen in our sensations, as well as in the motions of our several muscles; for the impressions of external objects would be communicated, at the places of union, to other nerves than those affected; and the/
the change produced by the will in any nerve, at its origin in the brain or spinal marrow, in order for moving a particular muscle, would affect all those nerves with which it has any communication by means of the ganglia or otherwise.

"(c) It does not appear, that there is any sympathy between the nerves that are derived from the same trunk, by means of the membranes that surround them."

"(d) We observe a remarkable sympathy between many parts, whose nerves have certainly not the smallest communication with one another. Thus the dimness of sight occasioned by a disorder of the stomach, the nausea upon seeing others vomit, and the flux of the saliva into the mouth of a hungry person, at the sight of savoury food, are proofs, that the stomach and salivary glands sympathize with the retina, though there is no communication between the optic nerves and any other. A shuddering is excited by particular sounds, and yet the portio mollis of the auditory nerve, after it leaves the brain, does not appear to communicate with the portio dura, nor any other nerve. Although the optic nerves unite at the cella turcica, yet it has been shown, that their fibres do not cross, intermix, or truly communicate with each other; nevertheless there is a considerable sympathy between the two eyes."

Further examples are given, the two kidneys, the retina/
retina and uvea, and the uvea of the two eyes, and convulsive motions caused by tickling the soles of the feet, or the sides, or by the dread of this.

"(e) If the consent between the viscera of the abdomen, and the other parts of the body, be owing to a communication of nerves, by means of the intercostals; why do not all those parts sympathize, whose nerves are either derived from, or communicate with the intercostals? Why, in the nephritis, does the stomach suffer more than the intestines? and why are not the lungs and other parts at all affected in this disease? -- Since the diaphragm sympathizes with the nose, lungs, uterus, rectum, and bladder, why do not these parts suffer equally when that muscle is inflamed or otherwise violently affected?"

"15. If, therefore, the various instances of sympathy cannot be accounted for from any union or anastomosis of the nerves, in their way from the brain to the several organs; and if there are many remarkable instances of consent between parts whose nerves have no connection at all; it follows, that all sympathy must be referred to the brain itself and spinal marrow, the source of all the nerves.

"But for a more direct proof of this, we may observe, that the consent of the several parts instantly ceases, when their communication with the origin/
origin of the nerves is interrupted. Thus, though the muscular coat of the stomach, in an animal newly dead, is excited into contraction by irritation, yet the diaphragm is no ways affected by this stimulus. In like manner, when any of the muscles of the leg of a frog are pricked, most of the muscles of the legs and thighs contract, even after cutting off its head, if the spinal marrow be left entire; but when that is destroyed, although the fibres of the stimulated muscle are affected with a weak tremulous motion, yet the neighbouring muscles remains wholly at rest.

"Further, the effects of pain, and of fear and other passions, in preventing several sympathetic motions, seem to shew, that the cause of that consent which obtains between the parts of animals is to be referred to the origin of the nerves: and, since certain affections of the mind, excited by the action of external objects on the organs of sense, produce extraordinary motions and other effects in the body, merely by affecting the brain; why may not impressions made on the nerves in other parts produce likewise, through the intervention of the brain, various motions and other effects in distant parts of the body? The analogy is obvious.

"Lastly, notwithstanding the many sympathetic motions, which are daily observed by physicians to arise from an irritation of the nerves in different parts of the body; yet, when the nerve going to any muscle/
muscle is irritated, there is no motion excited in any part, except in the muscle to which it is distributed. Does it not hence appear highly probable, that the various sympathetic motions of animals produced by irritation, whether in a sound or morbid state, are owing, not to any union or connection of their nerves, but to particular sensations excited in certain organs, and thence communicated to the brain or spinal marrow? For, if this were not the case, why should not the diaphragm, for example, be convulsed, by irritating the nerves that go to the bladder and intestinum rectum, as well as when these parts themselves are affected by an unusual stimulus?

"If the sympathies observed between the different parts of the body be owing to particular sensations excited in them, and thence communicated to the brain; we may easily see why an irritation of the intestinum jejunum does not affect the diaphragm so much as an irritation of the rectum; for though the jejunum is not less sensible than the rectum, and the nerves of both have the same remote connection, with the nerves of the diaphragm; yet the sensations excited by the same stimuli, acting on the jejunum and rectum, are very different, and therefore must affect the brain or common sensorium differently. - - - And the diaphragm, which is brought into a continued contraction, when the extremity of the rectum or neck of the/
the bladder is painfully affected, is agitated with alternate convulsions, when the left orifice of the stomach is irritated, because very different sensations are excited by an irritation of those parts.

"16. But altho', from what has been said, it may appear probable, that all nervous consent proceeds from the brain; yet we cannot pretend, from this principle, to account, in a satisfactory manner, for all the various instances of sympathy observable in the bodies of animals, since many of them may depend on such a state of the brain and other parts as cannot be the object of our senses.

"The sympathy between every individual nerve and the whole system, will be readily allowed to be owing to the mediation of the brain, and not to any connection or communication among the nerves proceeding from it: I shall, however, mention one experiment as the most decisive of this question.

"A solution of opium, applied to the abdominal muscles of a frog, whose brain and spinal marrow had been destroyed, did not stop the motion of the heart near so soon as it would have done, if the brain and spinal marrow had been entire. A clear proof, that the power of opium, to destroy the motions of those parts which it does not touch, is owing solely to the mediation of the brain and spinal marrow, and not to any other communication among the nerves.

"'Tis/
"'Tis true, when a frog is deprived of the brain and spinal marrow, upon applying a solution of opium to the abdominal muscles, its heart will cease from motion somewhat sooner than it would otherwise do; but this effect is not to be ascribed to the action of the opium on the nerves which it touches, but to some of its finer parts being taken up by the absorbent veins, and carried with the blood to the heart."

"17. Nothing makes more sudden or more surprising changes in the body, than the several passions of the mind. These, however, act solely, by the mediation of the brain, and, in a strong light, shew its sympathy with every part of the system.

"Such is the constitution of the animal frame, that certain ideas or affections excited in the mind are always accompanied with corresponding motions or feelings in the body; and these are owing to some change made in the brain and nerves by the mind or sentient principle: but what that change is, or how it produces those effects, we know not: as little can we tell, why shame should raise a heat and redness in the face, while fear is attended with a paleness. These, and many other effects of the different passions, must be referred to the original constitution of our frame, or the laws of union between the soul and body.

"But although, in these matters, we must confess our/
our ignorance, yet, from what we certainly know of the action of the nerves, we can easily see, that a change in them may occasion many of those effects which are produced by the passions."

"It. Because the nerves are observed, in many parts of the body to surround the arteries and veins like small cords, it has been thought, that the sudden changes in the motions of the fluids made by the passions, are owing to these vessels being contracted by such ligatures. But this opinion, though supported by authors of great character, will, upon a further inquiry appear inconsistent with what we know for certain of the nature and use of the nerves.

"Every part endowed with a power of contraction, owes that action either to its muscular structure, or to its elasticity; but as the nerves are in no sense muscular, so they have been proved to be among the least elastic parts of the body. Further, in a natural state, the nerves lie pretty loose in that cellular substance which surrounds the arteries, and are never on the stretch: and, upon making the experiment, we shall find, that the trunks of those nervous branches that encompass the large arteries and veins must be considerably pulled before these vessels can be sensibly contracted. There is no example of any motion being performed by a contraction of the nerves, whose action does not consist in pulling, or in/
in growing more tense at one time than another, but in supplying the muscular fibres with that influence or power which seems to be immediately necessary for their contraction.

"Lastly, it appears from experiments, that the nerves are utterly incapable of any such contraction as is here supposed."

"19. There are many of the most remarkable sympathetic motions, both in a sound and diseased state, in which we can plainly perceive a wise intention. Thus, the contraction of the pupil when light offends the eyes, and of the eye-lids when grosser bodies threaten to hurt them; --- and the uncommon flux of humours to every part that is irritated: All these, and many more, are the efforts of nature to free the body of something hurtful; and are so many instances of that principle of self-preservation so conspicuous in all animals. These motions, therefore, cannot, in my opinion, be referred to any connection or communication among the nerves, but to the brain itself, and to that sentient being which animates our whole frame, and which endeavours, at all times, to free the body from whatever occasions pain or uneasiness.

"Indeed, when these efforts are unable to expel the offending cause, as in great inflammations of the stomach, or when a large stone is lodged in the kidneys or bladder, they often become hurtful, and increase/"
increase the pain they were intended to remove. Nay, as in many other instances, the best things may, by excess, become the worst; so this endeavour to free the body, or any of its parts, from what is noxious, is sometimes so strong and impetuous as to have fatal consequences. But, in general, this principle of preservation is highly useful, since without it we should often cherish within our bodies such causes as would, sooner or later, end in our ruin.

"Nor can we consider the mind as acting either ignorantly or perversely, when it sometimes excites such motions in the body as increase its own pain, and, in the end, prove more hurtful than beneficial; for these motions do not proceed, as the followers of Stahl have imagined, from any rational views in the mind, or a consciousness that the welfare of the body demands them, but are an immediate consequence of the disagreeable perception which excites it into action.

"20. There are various instances of sympathy, which seem to be chiefly occasioned by the vicinity of the parts. Of this kind is, perhaps, the consent between the neck of the bladder and extremity of the rectum; whence a violent tenesmus and strangury mutually excite each other!"

"To this head also may be referred those sympathies which are sometimes occasioned by hard tumours/"
tumours pressing upon, or irritating the nerves that are contiguous to them. Thus, a hard swelling on one side of the neck has occasioned an uneasy sensation near the end of the radius, a little above the wrist: and the swelling and drawing up of the testicle, from a stone descending thro' the ureter, is probably owing to an irritation of the nerves of the testicle, where they run along the psoas muscle, over which the ureter passes."

"21. May not the complaints of the stomach and bowels, from a suppression of the menses, and soon after conception, be owing not only to a particular sympathy between their nerves, but partly also to the change made in the quantity of the blood thrown upon these parts, by the obstruction of the uterine vessels? And does not the sudden relief, obtained by a small evacuation of blood from the haemorrhoidal veins, shew, that many disorders may be either occasioned or cured by a small change made in the distribution of the blood to the different parts of the body."

"22. Lastly, in morbid cases, we meet with a variety of anomalous sympathies, which we can neither explain from the vicinity of the parts, the connection or communication between their nerves, nor from that general tendency to the welfare and preservation of the/
the body, which is so observable in many sympathetic motions that take place in a sound as well as a morbid state.

"Of this kind are the purging from smelling to a cathartic medicine; that pungent sensation felt on the top of the left shoulder-blade, when a pimple, a little below the out-side of the right knee was scratched; that burning pain which, upon making water, has been felt in the soles of the feet by a person affected with an ulcer in the bladder; the spasmus cynicus from a wound in the foot, and the locking of the jaws after an amputation. Thus, what reason can be given why sometimes, after cutting off an arm or leg, those muscles which raise the lower jaw should be affected with a spasm rather than any other muscles? I shall allow, that some symptom of this kind might be expected from the irritation of the nerves of the stump, or from some acrid humour absorbed by the vessels of the sore, and carried to the brain; but in either case, why do the temporal and masseter muscles only suffer?

"I think it most probable, that the anomalous sympathies above mentioned, and many others whose cause appears equally obscure, proceed from that general sympathy, which prevails thro' the whole nervous system, and which, in certain cases, in consequence/
consequence of the uncommon weakness or delicacy of a particular organ, makes it suffer, altho' the other parts of the body are not sensibly affected."

"Since we observe that only those whose nervous system is remarkably delicate are affected with general and violent convulsive motions or spasms from the passions of the mind, disorders in the prime viæ, and other causes; have we not reason to conclude, when, in consequence of an irritation of any one part, an uncommon sympathetic motion is produced in a distant organ, with which it has less connection, either by the nerves or blood-vessels, than with many other parts which are noways disturbed, that such sympathetic motion is owing to a peculiar delicacy or mobility of that organ; and that, were the other moving organs of the body equally delicate and sensible, universal or at least more general convulsions or spasms would have been the consequence?

"But, supposing we could neither explain satisfactorily, nor even conjecture with probability, concerning the cause of many uncommon and anomalous sympathies, it would be no more than what happens to us every day in our inquiries into the more abtruse operations of nature. In every part, even of the inanimate world, we find inexplicable difficulties: what wonder then, if, in the human body, a system so curious,
curious, so subtile and compounded, we should meet with many appearances which we cannot at all account for? The farther we push our inquiries into nature, the more shall we be convinced of our ignorance, and how small a portion is known of the works of the Great CREATOR!

"'Scarcely do we guess aright at the things that are upon earth, and with labour do we find the things that are before us.' Wisdom, chap.XI. ver.16."

**CHAP.II**

Of Nervous, Hypochondriac, and Hysteric Disorders in general.

The introductory paragraph discusses the various diseases to which nerves are subject, as obstruction, inflammation, compression or irritation of any of their parts or of the brain or spinal marrow.

"With respect to that fluid which the nerves are supposed to contain, as we are wholly ignorant of its nature, both in a sound and morbid state, we can never know when the diseases of the nerves arise from a fault in this fluid, altho' their action must be considerably affected/
affected whenever it is vitiated."

"But how much soever we may be in the dark about the immediate causes of the diseases of the nerves, yet their effect may all be reduced to some change in that sensibility or moving power which the nerves communicate to the different parts of the body.

"The sentient power of the nerves may be either too acute, obtuse, depraved, or wholly wanting; and that power in them which is necessary for muscular motion may be either weakened or quite destroyed."

These various points are more fully discussed in turn, and then "the difficulty, perhaps the impossibility, of fixing a certain criterion by which nervous disorders may be distinguished from all others--- because, in almost every disease, the nerves are more or less hurt. --- However, those disorders may peculiarly deserve the name of NERVOUS, which, on account of an unusual delicacy, or unnatural state of the nerves, are produced by causes which, in people of a sound constitution, would either have no such effects, or at least in a much less degree."

"In treating, therefore, of nervous disorders, I shall confine myself chiefly to those complaints which proceed, in a great measure, from a weak or unnatural constitution of the nerves; and of this kind, I presume, are most of those symptoms which physicians have commonly distinguished by the names of flatulent, spasmodic,"
spasmodic, hypochondriac, or hysteric."

Many symptoms are enumerated, and the patients who are reliable to them are distinguished into three classes.

1. Those who are usually in good health, but are apt to be affected with some of these symptoms.

2. Those who, being liable to such disorders, are almost always, more or less, troubled with indigestion and allied complaints.

3. Those who, without being subject to the more general symptoms, are seldom free from indigestion, low spirits, and such complaints.

"The complaints of the first of the above classes may be called simply nervous; those of the second, in compliance with custom, may be said to be hysterical, and those of the third, hypochondriac.

"The hypochondriac disease is not more unlike the hysterical, than this last is often unlike to itself."

"But whether these two distempers be considered as the same or distinct, since the symptoms of both are so much akin, we shall consider them under the general character of NERVOUS; and begin with inquiry into the causes from which they most commonly proceed."
CHAP. III.

Of the Predisposing Causes of Nervous, Hypochondriac, and Hysteric Disorders.

"These may be reduced to two, viz.

"1. A too great delicacy and sensibility of the whole nervous system.

"2. An uncommon weakness, or a depraved or unnatural feeling, in some of the organs of the body."

The first of these may be either natural or produced by disease or irregular living. As regards the second, the alimentary canal, especially the stomach, is most often at fault.

"When my stomach and bowels have been out of order and affected with an uneasy sensation from wind, I have not only been sensible of a general debility and flatness of spirits, but the unexpected opening of a door, or any such trifling unforeseen accident, has instantly occasioned an odd sensation about my heart, extending itself from thence to my head and arms, and, in a lesser degree, to the inferior parts of my body. At other times, when my stomach is in a firmer state, I have no such feelings, or, at least, in a very small degree, from causes which might be thought more apt to produce them."

*Note phrase on page 542 "a particular sympathy between the nerves distributed to the segments of the abdomen and those of the intestines"
Of the general occasional Causes of Nervous, Hypochondriac, and Hysteric Disorders.

These are either to be found in the blood, or they have their seat in some particular organ of the body. The former I shall call general, the latter particular occasional causes.

The general occasional causes may be reduced to three, viz.

I. Some morbid matter bred in the blood.

II. The diminution or retention of some accustomed evacuation.

III. The want of a sufficient quantity of blood, or of blood of a proper density.

I. Examples are given of the action of the first cause and gout is discussed. With regard to that morbid matter in the blood, the cause of so many nervous complaints, and even of the gout, all we know is, that it is apt to stick in the smaller vessels; that it disagreeably affects the nerves as often as it falls upon them, and thereby occasions various symptoms, more or less violent, according to the greater or lesser sensibility of the parts affected, and the constitution of the patient. But in what manner, or by means of what/
what particular kind of acrimony, it produces these effects, we are yet entirely ignorant, and indeed likely to continue so.

"II. A second occasional cause exciting nervous disorders, may be the retention of some accustomed evacuation, such as the menses or hæmorrhoids."

"And it may not be amiss, when treating of the suppression of the menses and hæmorrhoids, to add the discharges of issues, setons, or other old sores suddenly dried up, as producing similar effects. Further, since cold feet or cold and moisture in general, by stopping the perspiration, is observed to increase nervous disorders, is it not probable, that some acrid matter may be then retained, which, by falling on the stomach and other internal parts, sometimes gives rise to nervous, as well as to other morbid symptoms? Hence we find, that, during the dry warm weather in our climate, and the dry and temperate weather of hotter countries, the nervous hysterical, and hypochondriac complaints are less frequent than at other times."

III. In connection with the third cause it may happen "that an immoderate flux of the menses, lochia, and hæmorrhoids, or any other great hæmorrhage, will often occasion violent symptoms of this kind."

"Under this head of general occasional causes, may also be comprehended watching, great fatigue, and excessive/"
excessive venery; all of which not only tend to break the constitution, and dispose the body to nervous diseases, but also to create them, especially in such as are already predisposed to them."

CHAP. V.

Of the particular occasional Causes of Nervous, Hypochondriac, and Hysteric Disorders.

"These may be reduced to the six following, viz.

I. Wind
II. A tough phlegm in the stomach and bowels.
III. Worms
IV. Aliments improper in their quantity or quality.
V. Scirrhous or other obstructions in the viscera of the lower belly.
VI. Violent affections of the mind.

"I. The manner in which wind produces so many and such various complaints, may be understood from its distending the stomach and intestines, and thereby occasioning spasms in those parts, or otherwise disagreeably/
disagreeably affecting their nerves, which have so
great a sympathy with the other parts of the body.

"II. A tough phlegm in the stomach and intestines."

"Patients generally imagine, that this is produced
by their food, which they believe is all turned into
phlegm: But they are mistaken; for while the stomach
remains disordered, be the aliments ever so little of
a glutinous nature, this substance will be continually
generated."

"III. Worms in the first passages, especially in
children, are frequently the cause of nervous symptoms.

"Worms produce most of these symptoms, by prevent­
ing the proper digestion of the food, or by irritat­ing,
with their frequent motions or biting, the sensible
nerves of the stomach or bowels, whence every other
part may be affected by sympathy."

"IV. Aliments improper in their quantity or quality."

Too much food, even though wholesome, "becomes
either acid or putrid, and generates much wind." Too
little food weakens the stomach and bowels.

The quality of the food "may dispose it to produce
nervous disorders. Thus high-seasoned and heavy
meats, strong sauces, and wines, will not only, by
degrees, enervate the tone of the stomach, and prevent
or destroy the natural feeling of its nerves, but will
corrupt the blood - - - . On the contrary, a watery
flatulent diet, - - not affording proper nourishment,
will be the cause of many ailments."

"V."
V. Scirrhous, or other obstructions in the viscera, "seem to occasion many of the above effects, by hindering the free circulation of the fluids through these parts, by affecting their nerves with an uneasy sensation, and by preventing digestion, and disturbing the functions of these parts.

"Melancholy, or long continued grief, frequently gives rise to hypochondriac and hysteric complaints, and sometimes to obstructions in those viscera."

"VI. Violent affections of the mind.

"Nothing produces more sudden or surprising changes in the body, than violent affections of the mind, whether these be excited by external objects, or by the exercise of the internal senses. Excessive fear, grief, joy, and shame have been sometimes followed by sudden death."

"And it has frequently happened in the Royal Infirmary here, that women have been seized with hysteric fits, from seeing others attacked with them."

CHAP. VI.

Observations on some of the most remarkable symptoms of the Nervous, Hypochondriac, and Hysteric kind.

"I./
"I. An uncommon sense of cold or heat in different parts of the body, sometimes suddenly succeeding each other."

"As often as there is a more rapid motion of the fluids through the whole body, or only in the smaller vessels of some part, we feel a greater heat than the natural. In like manner, a sensation of cold proceeds from a diminished circulation, or a stagnation of the fluids in the smaller vessels.

"In hypochondriac and hysterical cases, a quicker or slower motion of the fluids, and consequently an unusual sensation of heat or cold in the vessels of the head, back, arms, legs, and other parts, may arise either from the vessels themselves, or their fluids. From the vessels, when these, from some fault or irritation of the nervous system, or from sympathy between their nerves and those of the stomach, or some other very sensible part, are either thrown into an unusual alternate motion, or affected with a continued spasmodic stricture: From the fluids, when, by their acrimony or viscid quality, the very small vessels are either excited into uncommon vibratory contractions, or become in a great measure obstructed."

"II. Pains in different parts of the body, suddenly moving from one place to another."

"Their true cause seems to be, either some viscid or acrid matter sticking, for a short time, in the small/
small vessels of certain parts, and irritating them, or spasmodic contractions of these vessels from a sympathy between their nerves and those of the stomach and intestines, or some other very sensible part.

"III. Hysteric faintings and convulsions."

The fits are described along with the various attendant symptoms.

"Fits of this kind may be owing to various causes: such as;

"1. An irritation of the nerves of the stomach or intestines, from wind, acrid humours, or other causes, whence the whole system is often brought into consent."

"2. A sudden suppression of the menses often gives rise to hysteric fits: And in some a fatal apoplexy, attended with a violent spasm of the muscles of the glottis, has been the consequence of the menstrual evacuation being suddenly stopt."

"3. A very acute pain in any of the more sensible parts of the body, or violent affections of the mind, as terror, grief, anger, or disappointments, will sometimes so strongly affect the whole nervous system, as to bring on hysteric faintings, with convulsions, altho' the body be in every respect healthful and sound, bating the too great delicacy or sensibility of the brain and nerves.

"IV. A Catalepsis and Tetanus."

"This/
"This disease may be owing to some violent affection of the mind disordered the brain and nerves, or to some scid matter affecting them, either by its immediate contact, or by sympathy with the stomach, intestines, uterus, or some very sensible parts. To the same general causes are likewise to be ascribed the emprosthotonous and opisthotonous, and tetanus. And here we must rest; for to endeavour to explain more particularly, either how the passions, or an irritation of the brain or other sensible parts, bring on alternate convulsions or fixed spasms of the muscles, would be to no purpose, till we are better acquainted with the structure of these organs, and with that cause which immediately produces their contraction; points which will probably forever elude our researches."

"V. Wind in the stomach and bowels.

"All our aliments, especially those of the vegetable kind, abound with air. In the time of digestion, part of this air is separated, and produces that flatulence or wind in the stomach and bowels with which many people are greatly troubled."

"The cause which makes air separate from them [aliments] in such quantity as to occasion uneasy complaints in the prime vitro, is, almost always, a fault there; for, when, on the account of a weakness of the stomach and bowels, or an unnatural state of their nerves/"
nerves, the digestion does not go on properly, not only more flatulence is produced, but less of it returns again to a fixed state."

"VI. A great craving for food.

"This may be owing to some humour in the cavity of the stomach stimulating its nerves, or to those nerves being so changed, that they are almost always affected with that sensation we call hunger, unless when food is newly taken into the stomach."

"In other cases, however, the morbid matter affecting the nerves of the stomach in hypochondriac and hysterical patients sometimes occasions a want of appetite and a nausea."

"VII. A black vomiting."

"Patients who have been long afflicted with violent pains and cramps, or other disorders in their stomach, often throw up some dark coloured stuff, which is commonly nothing but blood that has lost its colour; This kind of black vomiting is generally owing to one or more of the following causes, viz.

"1. Violent pain or cramps in the stomach."

"2. Scirrhous tumours in the stomach beginning to ulcerate, or a rupture of some of the small vessels leading to them."

"3. A suppression of the menses or haemorrhoids."

"VIII. A sudden and great flux of pale urine."

"The real proximate cause of this symptom is always the same, viz. an increased motion, together with some/
some degree of constriction of the secretory vessels of the kidneys; the first augments the quantity, and the second occasions the pale colour of the water. Altho' it must be owned, that this colour is principally owing to the quickness of the secretion of the urine, and of its passage thro' the bladder, before the finer parts are absorbed, and it has had time to acquire the common smell and taste, as well as colour, of that fluid.

"The causes of such an increased motion of the secretory vessels of the kidneys may be reduced to the following:

"1. Sudden or violent affections of the mind. -- as the perspiration is generally checked by disorders of the mind, the watery parts of the blood will be turned more upon the kidneys.

"2. An increased motion of the renal vessels is often owing to sympathy."

"3. Since Sydenham has observed, that the hysterical disease does often seize the kidneys, and occasion a pain, like that of a nephritic paroxysm, may not that noxious matter in the blood, which is often the cause of nervous disorders, be thrown sometimes in such a manner on those parts as, tho' not to produce pain, yet so to stimulate their secretory vessels as greatly to increase the quantity of the urine?"

"Further/
"Further, since a stoppage of urine, with a pain at the neck of the bladder, does in such patients sometimes proceed from the morbid matter producing a spasm there; may not a diminished secretion of urine, without any pain in the bladder or urethra, be owing in some cases to a spasmodic contraction of the ureters or secretory vessels of the kidneys?"

"An increased secretion of the saliva, is, like the copious limpid urine, owing to an unusual motion of the vessels of the salivary glands: And it may be observed, that, in patients whose salivary vessels are weakest and most irritable, a salivation will oftener happen, while, in those whose kidneys are most apt to be affected by any disorder in the body, a flux of pale urine will be more frequent.

"IX. A nervous atrophy."

"But this kind of atrophy, tho' not, perhaps, owing to any fault in the spirits, or even in the brain or nervous system in general, may yet deserve the name of nervous, as it seems frequently to proceed from an unnatural or morbid state of the nerves of the stomach and intestines."

"We know, that an unnatural state of the nerves of the stomach may either produce a craving or an aversion to food, that low spirits and melancholy often proceed from that cause;"

"The morbid affection of the nerves of the stomach/
stomach, by sympathy, impairs the vigour and energy of the whole system; The patient decays daily, tho' exhausted by no excessive evacuations, because his food is not converted into good chyle;"

"X. A nervous or spasmodic asthma."

"I should chuse to define a spasmodic asthma to be that species of difficult breathing, which is not owing to any obstruction in the lungs, or load of humours compressing their vessels, but to an uncommon contraction of their bronchial tubes and vesicles, whereby they do not yield, as usual, to the pressure of the air in inspiration."

The predisposing cause and the occasional causes are discussed as under other heads.

"XI. A nervous cough.

"A cough may be called nervous, when it does not proceed from any phlegm, obstruction, or other irritating cause in the lungs themselves, but from sympathy with some other part whose nerves are disagreeably affected."

"XII. Palpitations of the heart.

"1. In those whose nervous system is easily moved, any sudden and strong passion, but especially fear, will produce palpitations, and an irregular motion of the heart, by rendering it more irritable, and, at the same time, by forcing upon it the venous blood in greater/
greater quantity than usual.

"2. The regular motion of the heart may be also
disturbed by its sympathy with the stomach, when this
organ is disordered."

"XIII. The pulse often varying in quickness,
strength, and fulness, not only in different patients,
but in the same at different times."

The general causes of a strong and weak, hard and
soft, quick and slow pulse are discussed.

"A soft pulse is more common than a hard one, in
those patients who are subject to nervous or hysterical
complaints; because too thin blood and a laxity of
the vascular system are more common in such, than
dense blood and a too great tension or spasmodic
contraction of the arteries, which occasion a hard
pulse."

"XIV. Periodical headaches."

"The most common causes of periodic headaches in
those who are subject to nervous disorders, are,

"1. Sympathy with the stomach, by which the nerves
chiefly of the fore part of the head suffer; and the
small vessels to which they are distributed are either
affected with a continued spasm, or agitated with
uncommon alternate contractions and relaxations; in
consequence of which the patient feels a pain, strit-
ness, fulness, and pulsation about the forehead and
temples.

"2./
2. A viscid or acrid humour obstructing or irritating the small vessels of the pericranium, muscles of the head, or dura mater, and consequently affecting the nerves of those parts with a painful sensation. This may be often no other than a rheumatic, gouty, or scorbutic humour falling chiefly on the head.

3. A particular weakness, delicacy, and sensibility of the nerves of those parts of the head; whence, from sudden changes of weather, errors in diet, fatigue of body, strong passions, intense application of mind, suppression of ordinary evacuations, or even from slighter causes, these nerves being easily susceptible of pain, the small vessels to which they are distributed become affected either with violent alternate contractions and relaxations, or with a fixed spasm.

XV. A giddiness.

This may proceed from some of the causes which have been mentioned above, as producing periodic headaches, especially when they affect the anterior part of the brain or dura mater.

XVI. A dimness of sight without any visible fault in the eyes.

This sometimes proceeds from the stomach; in which case, the patients are only affected with it at particular times, when that organ is out of order, and by/
by sympathy affects the retina, optic nerves, or that part of the brain from which they take their rise."

"XVII. Low spirits, melancholy, and a mania."

Irregular gout, morbid matter in the blood, flatulent and improper aliments, obstructions in the hypochondriac viscera, sudden terror, excessive grief, or other violent passions of the mind, are discussed as causes.

"XVIII. The incubus, or night-mare."

Various forms are described, and various supposed causes are dismissed as unsatisfactory.

"The sympathy of the stomach with the head, heart, lungs, and diaphragm, is so remarkable, that there can be no difficulty in supposing the several symptoms of the incubus to arise from a disagreeable affection of the nerves of that organ."

"Symptoms like those of the night-mare may sometimes arise without any fault in the stomach."

The chapter ends by shewing how violent or long continued complaints of the nervous, hypochondriac, or hysterical kind may lead to other diseases, as apoplexy, palsy, jaundice, dropsy, tympany, or phthisis.

CHAP. VII.

Of the Cure of Nervous, Hypochondriac, and Hysteric Disorders.
As these disorders vary in cause, so they also vary in danger, and also in hope of cure and means of cure. A long perseverance in a course of medicines, diet, and exercise is necessary, or else no great or lasting benefit can be expected.

"The general intentions in the cure of nervous disorders, may be reduced to the two following, viz. "I. To lessen or remove those predisposing causes in the body which render it peculiarly liable to nervous ailments.

"II. To remove or correct the occasional causes which, especially in such as are predisposed, produce the numerous train of nervous, hypochondriac, and hysterical symptoms mentioned in the preceding part of this work."

"I. The best remedies to answer the first intention of cure, are either such as not only strengthen the stomach and bowels, but the whole body, or those which, by their peculiar action on the extremities of those nerves to which they are applied, lessen, for a time, the too great sensibility of the whole system."

"To prevent mistakes, it may be proper to mention here, that while I recommend bitters, the bark, elixir of vitriol, chalybeates, and cold bathing, as the best strengtheners of a delicate nervous/
nervous system, I do not mean that all these are
to be used, especially at once, by the same patient. They must each be used according to the condition of the patient.

Cool dry air, a thin flannel waistcoat next the skin, nourishing easily digested food, are recommended, also wine, preferably upon an empty stomach, a little rum or brandy for those patients who are troubled with acidity, and avoidance of tea. Exercise is necessary, and riding on horse-back is the best form of it. Sailing suits some patients. Friction is beneficial. "Lying too long in bed will weaken and relax; while early rising, like gentle exercise or cool air, will brace and invigorate the body."

"The mind ought to be diverted and kept as easy and cheerful as possible; since nothing hurts more the nervous system, and particularly the concoctive powers, than fear, grief, or anxiety."

"2. But as the remedies above mentioned, however proper for mending a delicate state of the nerves in general, or of those of the alimentary canal in particular, must often be used a considerable time before they can produce any great effects, it becomes frequently necessary to have recourse to medicines of another nature, in order to palliate those uneasy symptoms/"
symptoms with which nervous and hysterical people are often affected.

"The principal remedies of this kind are the following, viz.

"(a) Such as weaken, during the time of their operation, the sentient power of the nerves, and consequently lessen those pains, irregular motions, or spasms which arise from any usual irritation. (? unusual). The chief of these is opium, which, when applied in sufficient quantity, to the nerves of any sensible part, not only lessens their power of feeling, but by sympathy also that of the whole system: By this quality it often gives sudden relief in many violent disorders of the nervous and hysteric kind." Where opium is unsuitable, extractum hyoscyami may be used.

"(b) Such as, by affecting the nerves in an agreeable manner, and perhaps relaxing them, lessen the sense of pain, and often put a stop to tremors, convulsions, spasms, and an uncommon agitation of the nervous system. Of this kind are the warm semi-cupium, pediluvium, and hot fomentations, which are frequently serviceable in cases where opium would be improper; but as they all tend to relax, they are only to be used by delicate people, as palliatives in urgent cases.

"(c) Such as, by their peculiar stimulus, powerfully affect the nerves, so as not only to render/
render them less sensible of the irritation arising from various morbid causes, but also to communicate to them some degree of vigour, at least for a short time.

"Of this kind are camphire, castor, musk, and the fetid gums. The first and most remarkable effects of these medicines are owing to their action on the nerves of the stomach; but in what particular manner they operate on these nerves, we know not."

"II. With regard to the second intention of cure, which was to correct or remove the occasional causes, as these causes are various, the medicines must be often different: Nay, what is proper in one case, may be hurtful in another."

The general causes are first taken in order.

"1. Some morbid matter in the blood."

(a) When it is of the kind that produces arthritis vaga, diet and exercise, bark and bitters do good service. A milk diet may be tried, warm lime-water, and soap, and perhaps tansy.

(b) For the kind which is commonly, but improperly called scorbatic, we must endeavour to drive the morbid humour outwards to the skin, by vomits, warm stomachics, and sudorifics; after which the radical cure must be attempted by mild mercurials, and the purging mineral-waters.

(c) When some morbid matter remains in the blood from a disease imperfectly cured, we must consider the disease/
disease and circumstances of the patient.

If the humour which produces the rash or miliary eruption falls on the internal parts, "I have found most advantage from the warm pediluvium, or warm fomentations applied to the feet and legs, from blisters, wine, whey, and boluses of camphire, saffron, and salt of hartshorn." For oppression at the stomach, and difficulty of breathing, a gentle vomit of ipecacuanha, or of an infusion of camomile, often gives relief. Bleeding will help in plethoric patients.

2. If there is a diminution of some habitual evacuation, "that evacuation is to be promoted by the proper remedies."

(a) If the menses are obstructed, the cause must be discovered. For the want of good blood, the best remedies are the bark, bitters, and steel, together with a nourishing diet, and exercise. When the blood is improved, it ought to be determined to the uterus by frequent doses of tincture sacra, and by making the patient sit every evening over the steam of warm water.

"If a plethora prevents the flux of the menses, bleeding especially in the foot or at the ankle, and gentle purges, will prove most effectual.

"When the thickness or viscosity of the blood hinders it/"
it from making its way through the uterine vessels, frequent vomits, and the pilulae mercuriales laxantes, or gentle purges with calomel, will answer best."

For "a spasmodic contraction of the uterine vessels, in consequence of cold, some violent passion, or other causes, the chief remedies are the warm semicupium and pediluvium, oily draughts; and pills of aloes, asa foetida, extract of black hellebore, and saffron. A clyster of warm water, with thirty or forty drops of laudanum, may be given, in the evening, about the time the menses should return.

"Obstinate obstructions of the monthly evacuation in women have sometimes been cured by electrifying them, and drawing the sparks chiefly from their thighs."

"When, in the decline of life, the menses cease, various nervous or hysteric symptoms appear, which are generally lessened, and sometimes removed, by frequent small bleedings, gentle stomachic purges, and issues."

Suitable remedies are given for cases when a haemorrhoidal flux has stopped, old ulcers and sores have been dried up too quickly, when pimplles or other eruptions on the face have been suddenly repelled by improper applications.

3. When there is "an immoderate flux of the haemorrhoids, menses, or lochia, the cure consists in restraining/
restraining these evacuations, and filling the vessels by means of such aliments as are light and nourishing, but not heating. In the mean time, the violence of the symptoms must be abated by anodynes and *wine,* or other cordial medicines. A horizontal posture is here of considerable use. The *tinctura roserum,* *terra Japonica,* *alum,* *opium,* and *elixir of vitriol,* are sometimes successful. "If the *elum-whey occasions* a sourness in the stomach with a *cardialgia,* a scruple of crabs eyes or prepared oyster shells, twice or thrice a-day, will be useful."

"I come next to mention the method for lessening or removing their (the disorders treated of) particular causes."

"1. Wind in the stomach and bowels." This is the same as under the first intention of cure above, and below under No. 4.

"2. Tough phlegm bred in the stomach and intestines." Besides frequent *vomits,* we must have recourse to the bark, *bitters,* *chalybeats,* animal food, and exercise, especially riding or sailing. Lime-water will dissolve the phlegm, and brace the relaxed pores and vessels of the stomach. Salt of *tartar* may be given twice a-day, when there is acidity, and afterwards *elixir of vitriol* to strengthen the vessels.

"3. Worms in the stomach and intestines." In some cases, I have seen good effects from an infusion/
infusion of the root of the Indian pink." "I have ordered, with good success, to some grown persons, six drams or an ounce of Spanish soap daily."

"4. Aliments noxious from their quality or quantity."

(a) The quantity of food must be, by slow degrees increased or decreased according to the error.

(b) With regard to the quality of the food, the patients ought to abstain from all heavy and fat meats, from whatever they find hard of digestion, and from all flatulent aliments."

Vegetables and milk, wine and flesh-meats, should be given according to circumstances. Vegetables and milk sometimes agree best, when, at the same time pepper is taken or other spicery.

"5. Indolent obstructions, chiefly of the scirrhous kind, in some of the abdominal viscera."

It is difficult to discover when these are present, but when they are, "we must endeavour to resolve them by degrees, and, in the meantime, palliate the most troublesome symptoms occasioned by them."

Various methods of treatment are discussed, as gentle friction, sometimes with oleum camphoratum or saliva, warm fomentations, gentle vomits and purges frequently repeated, internal deobstruent medicines. Among these last are tartarus solubilis, sal polychrestus, mercury, and soap, also bark in strumous cases."
cases. Diet and exercise must be attended to; bleeding may be necessary; and symptoms must be palliated.

"6. Violent affections of the mind.

"When nervous or hysterical disorders arise from this cause, the cure consists,

"(a) In avoiding all disagreeable and shocking sights, and every occasion that may be apt to excite violent passions, or commotions of the nervous system.

"(b) In strengthening the nerves, so that the mind may be less apt to be strongly affected, either by impressions from external objects, or by such ideas as arise purely from reflection; the best medicines for this purpose are the bark, bitters, steel, the cold bath, and exercise, with proper aliment.

"(c) Nervous disorders occasioned by strong impressions of the mind, are often prevented, lessened, or cured by exciting other sensations or passions of a superior force. -- Epileptic fits have been cured by whipping.

"(d) Nervous or hysterical affections from a concealed or disappointed passion, are better cured by the fruition of the object; or, if this cannot be obtained, by proper diet, amusements and by opiates, especially at bed-time, for composing the mind and procuring sleep, then by the whole class of nervous medicines."
CHAP. VIII.

Of the cure of some of the most remarkable Nervous, Hypochondriac, and Hysteric Symptoms.

p. 679
"I. Convulsive motions, or fixed spasms of the muscles."

Narcotics, especially opium, are recommended, and such medicines, as are found by experience to be useful, and seem to produce their good effects, by that stimulus which they communicate to the nerves, especially of the stomach and intestines. Of this kind are camphire, castor, musk, asa foetida, the spiritus aethericus, spirit of hartshorn, etc.

"A dram of brandy, by stimulating the nerves of the stomach, will almost instantly lessen a tremor of the hands, and in some cases make the pulse slower; And do not other stimulating medicines, in some such way, remove a palpitation of the heart, and other convulsive motions, as well as fixed spasms of the muscles? — — A glass of warm wine with cinnamon and nutmeg, and a mixture with aqua pulegi or ruteae, tincture of castor and asa foetida, will often have similar effects in flatulent and spasmodic affections of the alimentary canal."

The warm bath, semicupium and pediluvium, emollient clysters and warm fomentations applied to the feet and legs.
legs, or other parts of the body are useful by relaxing the muscular fibres and nerves, affecting them agreeably, and so rendering them less liable to suffer from irritation. Venaesection may be referred to this class.

"The warm bath affects the nerves with an agreeable sensation, removes spasms in the small vessels, promotes an equable circulation, gently expands the fluids, and consequently fills the whole vessels of the body. But in whatever manner the warm bath and fomentations may act, their power in giving often immediate relief from violent pain, and preventing or allaying spasms and convulsive motions, has been sufficiently ascertained by experience."

Several cases are described.

"Instead of adding more cases, I shall only observe, that I have saved more patients who appeared to be in great danger in the delirious state of a fever, by the fomentations, and especially by the warm pediluvium, than by any other remedy: and even in those cases, where these applications were insufficient to compleat the cure, they, almost always, gave some present relief, by making the patients somewhat quieter and disposing them to sleep."

"In convulsive motions or spasms, such remedies are often useful, as by painfully affecting the nerves of some part of the body that is sound, in a great measure/
measure lessen or destroy the sense of that irritation which was the cause of those symptoms. Of this kind are blisters, acrid cataplasms, dry cupping, friction, and the cold bath."

"In cases, where epileptic convulsions took their rise from an uneasy sensation in some part of the arm or leg, I have found blisters applied to these parts the best remedy."

"Fear, surprise, attention, or other strong affections of the mind, will frequently put a stop to convulsive motions and spasms, and sometimes succeed after other remedies have failed."

"Celsus, in the spasmus cynicus, recommends pouring on the patient's head warm sea-water and sulphur: And a roll of brimstone held in the hand is frequently used now-a-days as a cure for cramps or fixed spasms of the muscles; and I have known it succeed in several cases. -- -- I am of opinion, that brimstone cures spasms not by any medical virtue; but that its effects are to be ascribed to the patient's attention and faith, or rather to the surprie occasioned by the roll snapping in his hand. And as a confirmation of this, I have known some affected with the cramp, who, having been informed that the breaking of the brimstone was owing to the heat of the hand, missed of a cure.

"Convulsive motions or spasms are often prevented or cured by compression, which braces and renders
firmer such parts of the body as are most subject to
them."

"To the remedies already mentioned may be added
the bark, which has sometimes cured periodic
convulsions after other medicines had failed."

"II. Hysteric faintings with convulsions."

"There is no remedy which I have found so
effectual in removing hysteric faintings with con-
vulsions, as the warm pediluvium; for, after many
other things had been tried to no purpose, I have seen
the patients restored to their senses, almost instant-
ly, by putting their feet and legs in water a little
more than blood-warm:"

"III. A violent pain with cramps in the stomach."

Draughts of warm water and a clyster with
laudanum in it, are recommended. The clyster may be
repeated with a larger quantity of laudanum. A
julep, anodyne balsam, the warm semicupium, the
emplastrum antihystericum, bleeding, may be used
according to circumstances.

"IV. An indigestion and vomiting, with pains in
the stomach."

Various remedies may be used according to the
cause, as vomits and gentle stomachic purges together
with elixir of vitriol, or the testaceecus powders,
Spa or Pyrmont water, bark, bitters, chalybeates, and
exercise./
exercise. In cases of a too great delicacy of the nerves of the stomach "I have found nothing produce such immediate good effects as laudanum given an hour or more before dinner or supper."

"In some cases I have known a pain in the stomach with vomiting after eating, cured by soap taken daily to the quantity of two drachms; in other cases half a pint of tepid lime-water, drunk thrice a-day, has answered better than the soap."

"V. A colic of the hysterical or flatulent kind."

The bowels must be well opened and laudanum given. "To prevent the frequent return of hysterical colics, an antihysteric plaister applied to the abdomen, a dose of the sacred tincture or elixir once a-week, and exercise, especially riding, will be found useful."

"VI. Flatulence in the stomach and bowels.

The medicines most proper in complaints of this kind, are either such as procure speedy relief by expelling the wind, or those which, by strengthening the alimentary canal, lessen its generation. Among the former I have found none more efficacious than the spiritus aethereus and laudanum. Among the latter the most proper are the bark, bitters, chalybeates, and exercise.

"With regard to diet, I shall only observe, that tea/
tea and all flatulent aliments are to be avoided; and that for drink, water with a little brandy or rum, is only not preferable to malt-liquor, but in most cases also to wine.

"VII. A nervous or spasmodic asthma."

"The fits are best relieved by bleeding and opium."

If necessary, the lungs must be cleared first. The lungs and the whole nervous system must be strengthened.

"VIII. A palpitation of the heart."

"For present relief, spirit of hartshorn, the tinctura castorei composita, spiritus aetheraeus, and opiates generally answer best." General health must have attention.

"IX. An immoderate discharge of pale urine."

"There is no medicine that will generally lessen it so soon, or so remarkably as opium, but ——— other remedies are required to prevent its frequent returns.

"Those which have succeeded best with me are, the bark, either in substance or decoction, with some cinnamon added to it; small doses of the tinctura rhabarbari amara cum vino, once in three or four nights; moderate exercise on horseback or in a chaise, and a diet consisting chiefly of rice, sago, salep, and the lighter flesh-meats roasted, together with a few glasses of claret or red port after meals.

"In/
"In cases where the flux of pale urine is attended with hectic heats, I add to the above remedies the tinctura rosarum, or elixir of vitriol.

"When the increased secretion is, in a great measure, owing to a particular debility of the kidneys, a flannel shirt will sometimes lessen the quantity of the urine, by increasing the perspiration.

"A tight belt about the loins, or a strengthening plaister applied to them, has been attended with remarkable effects."

"X. Periodical headaches."

"The stomach must be treated, or gout, or rheumatism. Sternutatories may be used, or tonics. Suppressed evacuations must be restored, if possible.

"Cold water will give ease in some headaches, while hot applications do most service in others. In like manner, shaving the head relieves some patients, but is hurtful to others."

"In all violent headaches, we ought to begin the cure with bleeding, either by applying leeches to the temples, or opening the artery there. If the patient be plethoric, a larger quantity of blood may be taken from the jugular vein."

"XI. Low spirits.

"Hypochondriac and hysterical patients are commonly affected with this complaint, in a greater or less degree. In general, exercise and the cold bath are among/
among the best remedies. But to be more particular:

"(1) When low spirits are owing to a weak state of
the nerves of the stomach and bowels, the tincture of
the bark and bitters, chalybeates, aromatics, a proper
diet and riding, will do most service.

"(2) When they arise from obstructions in the hypo-
chondriac visera, or a foulness of the stomach and
intestines, the most proper medicines are, aloetic
purges, Harrowgate waters, and soluble tarter."

"(3) When low spirits proceed from a suppression of
the menses or haemorrhoids; if these evacuations
cannot be restored, some others must be substituted
in their place: But nothing has such sudden good
effects as bleeding.

"(4) Lastly, when low spirits or melancholy have
been owing to long-continued grief, anxious thoughts
or other distress of mind, nothing has done more
service than agreeable company, daily exercise,
especially travelling, and a variety of amusements."
OBSERVATIONS

on the

DROPSY

In the Brain.

Never before published.
OBSERVATIONS

on the

Most frequent Species of the Hydrocephalus Internus.

viz.

The Dropsy of the Ventricles of the Brain.

"The hydrocephalus, or dropsy of the head, is either external or internal. The former has its seat in the cellular substance, between the skin and the periocranium, or between this membrane and the skull. In the internal hydrocephalus, the water is sometimes collected between the cranium and dura mater, or between this last and the pia mater; but most commonly it is found in the ventricles of the brain, immediately below the corpus callosum: And this is not only the most frequent and fatal species of the hydrocephalus, but also that with which medical writers seem to have been least acquainted.

"Hippocrates,"
"Hippocrates, in his second book de morbis, has enumerated the signs of water in the brain, as his words have been rendered by all the translators. But ἐπὶ τῶ εὔκεφαλω more properly signifies upon than in or within the brain; and that Hippocrates only speaks here of water lodged between the dura mater and brain, can scarcely be doubted, since he proposes to evacuate it, by making a perforation in the upper part of the cranium, πρὸς τὸν εὔκεφαλον; which operation could have been of no use, had the water been contained within the brain itself.

*Calenus has only mentioned briefly the hydrocephalus externus, or dropy of the teguments of the head. Aetius and Paulus Aegineta go a little farther; for when they treat of this disease, they observe that water is sometimes found between the skull and the membranes of the brain.

"Hieronymus Mercurialis, who flourished in the beginning of the sixteenth century, mentions the collection of water in the ventricles of the brain as a thing that may possibly happen, but adds, that in such a case an apoplexy must be the consequence.

"Wepfer has collected several cases from different authors, in which water was found in the cavities of the brain; and the celebrated Boerhaave mentions such a disorder as one species of the hydrocephalus. But none/
None of these authors, nor indeed any other that I have met with, who wrote before them, have favoured us with the signs by which we may distinguish a dropsy of the ventricles of the brain from other diseases affecting that organ.

"M. Petit, in a short paper on the hydrocephalus, published in the Memoirs of the academy of sciences for the year 1718, observes, that in all the bodies which he had opened, he never found water anywhere within the cranium, but in the ventricles of the brain; and therefore supposes the other species of internal hydrocephalus to be very rare.

"The symptoms of a dropsy in the cavities of the brain, according to that justly esteemed author, are, in the beginning, slight convulsions of the mouth and eye-lids, biting of the lips, grinding of the teeth, and picking of the nose, as in the case of worms. The patients are either costive or have a purging, and sometimes a vomiting. They are more or less drowsy, according to the quantity of water within the brain. They grow languid, feeble, sad, and pale; the eyes look dull, the pupil dilates, the sutures of the skull open, and its bones become soft. The forehead rises, the eyes seem to be protruded out of their orbits, the head swells so as sometimes to burst, and the patient dies soon after.

"Although/
"Altho' this account of the symptoms of the hydrocephalus internus be much more just than what is to be met with in any author before M. Petit; yet still it is so far incompleat, that I may venture to say, that it will not be found sufficient to distinguish a dropsy within the brain, unless when it is attended with a swelling in the head.

"M. Petit mentions slight convulsions of the mouth and eye-lids in the beginning; whereas I have never seen any convulsions till towards the end. He says, the patients are always more or less drowsy; but I, on the contrary, have often observed them more watchful at first, altho' in the advanced state they not only become drowsy but comatose. He informs us, that he never saw the water collected any where, but in the ventricles of the brain. Now, were this the case, it is certain that the opening of the sutures and swelling of the head could not happen but to the youngest infants, who, by the bye, are not so subject to this kind of hydrocephalus as children of two years old and upwards; for, of about twenty patients whom I have seen die of this distemper, one only was under half a year old, the rest between two and sixteen; who all went off without any swelling of the head, opening of the sutures, or protrusion of the eyes.

"Lastly, M. Petit has taken no notice of the aversion/
aversion to light, squinting, the variations of the pulse, and the degree of feverish heat, which, as we shall afterwards see, are the surest diagnostics of the disease.

"M. le Dran, who wrote after M. Petit, has described the **hydrocephalus internus** in such a manner as would make one believe he had never seen the distemper, except when it happened to be joined to a collection of water between the cranium and brain.

"Dr Donald Monro, in his treatise of the dropsy, has well enumerated the several kinds of the **hydrocephalus**: But by the symptoms he mentions, of the internal kind, we shall be hardly able to distinguish it from several other disorders of the brain, as he himself has very justly remarked.

"It may seem strange, that a dropsy of the ventricles of the brain, which in our days so frequently occurs, should have been altogether unknown to the ancients, and so little attended to by most of the moderns. The reason may be, that those patients who were carried off by this disease have been generally supposed to die of a fever ending in a coma; and in such cases the head is seldom opened.

"Altho' a dropsy of the ventricles of the brain does very rarely occasion any opening of the sutures, or swelling of the head; yet in most cases it may be easily/
easily distinguished from every other disorder, by
the following symptoms, which with the greatest care
I have collected, in attending about twenty patients
in this disease."

An Account of the Symptoms in the Dropsy of the
ventricles of the Brain.

First Stage.

p. 729

"Children who have water in the ventricles of
the brain begin to have many of the following symptoms,
four, five, or six weeks, and in some cases much
longer, before their death.

"At first they lose their appetite and spirits;
they look pale, and fall away in flesh; they have
always a quick pulse, and some degree of fever."

"They are thirsty, and frequently vomit once or
twice in a day, or once in two days. They complain
of a pain in the crown of their head, or in the fore-
head above their eyes. They are commonly costive,
' tho' sometimes they have returns of a looseness. When
bound, they are not easily moved by a purge; some-
times they are troubled with gripes. Their spirits
being/
being low, they incline mostly to be in bed, altho' they are often more disposed to watching than to sleep. They cannot easily bear the light, and complain when a candle is brought before their eyes. They are observed to pick their nose, and in their sleep to grind with their teeth, as in the case of worms.

The Symptoms of the Second Stage.

"I date the beginning of the second stage from the time the pulse, from being quick but regular, becomes slow and irregular. This sometimes happens about three weeks, often a fortnight or less, before the death of the patient.

"In this stage the pulse is commonly not only much slower than it was before, but often more so than in health."

"In this distemper it is observable, that when the pulse is nearly as slow, or slower than natural, it is always irregular or unequal, both as to the strength and the interval of the strokes. When it grows quicker, the irregularity lessens; and when it becomes very quick, it is then most equal and regular. Farther, it deserves notice, that, altho' in the second stage the pulse becomes much slower than it was before, the heat of the skin continues much the same, and sometimes seems rather to increase."
"I have insisted the longer on the state of the pulse in this period, as from thence we can learn the surest diagnostic.

"During the second stage, most of the symptoms mentioned in the first continue. The sick are then unable to sit up, tho' generally they sleep little, till towards the end of this period, when they begin to grow drowsy. They moan heavily, yet cannot tell what ails them. Their eyes are often turned towards their nose, or they squint outwards, and sometimes they complain of seeing objects double. Some, towards the end of this stage, grow delirious, and cry out in a wild manner, as if they were much frightened:"

"The breath has now, but especially in the last stage, such a sickish and offensive smeel, as I do not remember to have observed in any other distemper."

The Symptoms of the Third Stage.

"When the pulse (which for some time was nearly as slow or slower than in a healthful state) rises again to a feverish quickness, and becomes regular, the third and last stage may be said to begin.

"This change in the pulse is observed five, six, or seven days before death. -- -- As the time of this change in the pulse is different in different patients, so is the degree of its quickness. -- -- In the last stage,"
stage, after the pulse grows quicker, it does not keep constantly to the same measure, but will be often a good deal slower for part of a day, and quicker all the rest. The pulse beats generally faster on the day they die than at any time before."

"In the third stage, the patient, who before was little disposed to sleep, becomes then drowsy and comatose. When roused, he utters only a few incoherent words, and appeared to be insensible. The beginning of the coma is uncertain; it is often about the end of the second stage before the pulse grows quicker for the second time; but in a few cases I have known this quickness of the pulse come on before the patients become comatose.

"Frequently one eye-lid loses its motion, and afterwards the other becomes also paralytic. About this time, or rather sooner, the pupil of one or both eyes ceases to contract, and remains dilated in the greatest light. But the time of this symptom varies much."

"Before they are seized with the coma, they sometimes complain of seeing strange and frightful objects. A day or two before death, the túnica conjunctiva of one or both eyes frequently becomes inflamed; but they generally continue to hear for some days after they are blind.

"In this stage, the patients are sometimes observed/
observed to be constantly raising one of their hands to their head; and are generally troubled with convulsions of the muscles of the arms, legs, or face, as well as with a subsultus tendinum."

"Those who have been costive before, often become loose in the third stage, and complain of gripes. A day or two before death, the patient either swallows with difficulty, or not at all. Lastly, the respiration grows more frequent and laborious; and in some there is a considerable pause after every expiration. This kind of breathing I have also observed in those who have died of an apoplexy, arising from a suppression of urine."

The Diagnostic Signs of a Dropsy within the Brain.

The various characteristic symptoms are emphasized and the diagnosis from scirrhous glands of the mesentery, from worms in the stomach and intestines, cramps of the stomach, spasmodic colics, and violent nervous headaches.

Of the Causes of a Dropsy in the Ventricles of the Brain.

"The immediate cause of this disease, and indeed of every kind of dropsy, is always the same, viz. such a state of the parts as makes the exhalant arteries throw out a greater quantity of fluids than the/
the absorbent veins can take up.

"This may be owing to several causes:

1. There may be an original laxity or weakness in the brain, whereby the small exhalant arteries of the ventricles will throw out the lymph faster than the absorbent veins can imbibe it."

2. Birth injury.

3. A scirrhoues tumour of the glandula pituitaria, or in any part contiguous to the ventricles of the brain, by compressing the neighbouring trunks of the absorbent veins, will prevent the due absorption of that fluid which the small arteries constantly exhale."

4. Altho' there may be no obstruction in any part of the brain, a dropsy may be formed in it, merely from a too thin or watery state of the blood."

5. A suppression, or a diminished secretion of urine."

6. Lastly, in tedious chronic diseases, water is often collected in the ventricles of the brain, but not in such quantity as to occasion the symptoms of a dropsy within the brain."

An Attempt to account for some of the most remarkable Symptoms attending a dropsy in the Brain.

p. 740

"In general, the whole symptoms of this disease proceed from different degrees of the same cause, viz./
viz. the pressure or distention of the parts of the brain, occasioned by the water contained in its ventricles."

The symptoms discussed are the loss of appetite and inclination to vomit, the aversion to light in the first and second stage, the slow irregular pulse in the second stage, the quick pulse in the third stage, the dilatation of the pupil, the slow respiration towards the end of the disease.

The causes given are sympathy between various parts, as between the brain and the stomach, increased sensibility, as of the retina, decreased sensibility, as of the heart, increased irritation of the medullary part of the brain. Slow respiration occurs "because the mind is not excited to put in motion the muscles concerned in inspiration, till the sense of suffocation in the breast becomes so great as to rouse, as it were, the sentient principle from its lethargic state."

Of the Cure of a Dropsey in the Brain.

The disease cannot be recognised early enough for treatment.

"I freely own, that I have never been so lucky as to cure one patient who had those symptoms which with certainty denote this disease; and I suspect that those who imagine they have been more successful have mistaken another distemper for this."