

Book Reviews

THOMAS WILLIS ON THE BRAIN* AN ESSAY REVIEW BY K. D. KEELE

Few events would have pleased Thomas Willis more than to see the publication of this beautiful edition of his *Cerebri Anatome* in 1964, 300 years after its first production. This delightful memorial to Willis and his work is evidence of the sincere feeling of appreciation, widespread in doctors of the present generation in the New World, for the efforts of our medical forefathers. Here it has been concentrated into the personal dedication of its editor, Dr. Feindel, the distinguished Canadian neurosurgeon. Merely by picking up these remarkable volumes one obtains, quickly and vividly, the feel and flavour of the work of Willis and the times in which he lived. These emanate from the two vellum-covered volumes, from the texture of the specially hand-made Spanish paper, and from the watermark of the Willis crest in its pages. All provide a realistic back-drop for the facsimile production of Pordage's English translation of the work.

The first volume is devoted to orientating the reader's appreciation of Willis and his works; the second consists of Pordage's translation of the work itself.

A notable contribution in the first volume is the foreword by Wilder Penfield in which he sees in the work of Willis on the anatomy of the brain an anticipation of the development of English neurology and neurophysiology, personified in our own days by Sir Charles Symonds and Sir Charles Sherrington to whom this tercentenary edition is dedicated. Dr. Feindel, too, in his preface, emphasizes the nodal position of Willis in the history of neurology, and stresses how appreciation of this point has arisen from the appraisals of his work made by Sherrington and Symonds. In an introductory essay on 'The Origin and Significance of *Cerebri Anatome*', Dr. Feindel draws attention to the use Willis made of the experimental method in applying Harvey's discovery of the circulation to the special problem of cerebral blood supply.

Short, informative sketches of the lives of Willis and his circle of friends, accompanied by fine portraits, place the achievements of each in perspective. In these Dr. Feindel takes the opportunity of assessing the debt Willis owed to each, particularly to Lower and Wren. Nor does he omit an account of Samuel Pordage who translated the work into English. This translation receives illuminating comment from Dr. Lloyd Stevenson who points out the difficulties experienced by translators from the Latin in finding suitable English equivalents for new scientific terms. This difficulty was sometimes beyond Pordage's capacity, as exemplified by his translation of the word 'sinus' by the English word 'bosom'. This, and other similar translations for the most part merely add a certain quaint amusement to the reading of the text, but on occasions they lead to serious difficulties of interpretation. Pordage himself seems to have been aware of his medical ignorance and linguistic difficulties, for he added at the end, 'A Table of all the hard words not vulgarly received, compiled for the benefit of the meer English readers.' This glossary however merely highlights his difficulties and limitations, for even 'the meer English' reader is not going to be greatly assisted

* *The Anatomy of the Brain and Nerves*, by THOMAS WILLIS, tercentenary edition (1664-1964) edited by William Feindel. Montreal, McGill University Press, 1965, 2 vols., illus., \$37.50.

by being told that the Conarium, 'is a kernel sticking to the outside of the Brain in the form of a Pine-apple'; or that Systole is, 'the motion of the heart and arteries . . . by this they are dilated'. On the other hand the colour and vigour of many of the words in Pordage's vocabulary would make a potent transfusion for the pallor of our modern medical jargon. One cannot help regretting the loss of such words as 'torrified', 'farciments' or 'pungitive', and 'aculeation'.

It will be appreciated from these examples of his vocabulary that Pordage's translation does not make easy going to a present-day reader of English. This verbal difficulty, combined with the particular anatomical and physiological ideas of Willis himself, demand the same kind of concentration in the reading as does a work in a not too familiar foreign language.

The first volume concludes with a 'Bibliographic Survey of *Cerebri Anatome*' by H. R. Denham, chief cataloguer of the Wellcome Historical Medical Library. This is the first original and definitive bibliographical survey of the works of Willis. It has the rare merit of combining skilful detection with fascinating clarification of its problems. It is particularly revealing on the methods of such notable seventeenth-century publishers as Martyn and Allestry in London, and Schagen and Commelin in Amsterdam.

The numerous collected editions of the works of Willis which appeared within fifty years of his death—nine in Latin and two in English—testify to his widespread influence. Mr. Denham ably sorts out the confusion produced by the publication of 'The Remaining Medical Works' of Willis in 1681, before the collected edition of 'Doctor Willis's Practice of Physic' in 1684. This was explained in the second issue of 'The Remaining Works' where it was stated that 'the first part though last published had now been added.'

The second volume of this work comprises a facsimile of 'The Anatomy of the Brain and the Description and Use of the Nerves in the Remaining Medical Works of that Famous and Renowned Physician Dr. Thomas Willis. Englished in 1681 by Samuel Pordage, Esquire.' The frontispiece consists of a fine engraving of Loggan's portrait of Willis. This is followed by Pordage's conventional dedication of his translation, and Willis's 'Epistle Dedicatory to His Grace Gilbert Archbishop of Canterbury etc.' This dedication, too, can be read as a merely conventional expression of orthodoxy, but there are good reasons for seeing in it something more. I would suggest that it truly reflects the position taken up by Willis in the then very sensitive area between religion and science. In 1664, when he wrote it, Willis was already greatly indebted to the Archbishop of Canterbury, Gilbert Sheldon, for his personally successful career. As Willis himself wrote: 'It was by your means (most noble Prelate) that I obtained the Votes in the Famous University for the place of Sidley Professor . . .' In 1657 Willis had married Mary Fell, sister of John Fell, Dean of Christ Church, Vice-chancellor, and promoter of Sheldon's magnificent gift of the Sheldonian Theatre to Oxford University. It was to this same Gilbert Sheldon that Willis dedicated his two later works, *Pathologiae Cerebri . . . Specimen* in 1667, and *De Anima Brutorum* in 1672.

That Willis throughout his life showed great devotion to the Anglican Church is

Book Reviews

well known. During the Cromwellian period he allocated a room in his house in Merton Street for religious assemblies. His whole life seems clearly to have been dominated by what might be called the Sheldonian outlook of devout Anglican orthodoxy. It is therefore of particular relevance to know how enlightened members of this circle of Anglican churchmen looked upon scientific research of the type carried out by the Royal Society; and this is just what is to be found in the dedication written by Willis to Gilbert Sheldon. Here Willis points out that it is not gratitude only that decided him to dedicate his work on the brain to the Archbishop of Canterbury, 'but another Reason, which may at least excuse and defend it. For when I had resolved to unlock the secret places of Man's Mind, and to look into the living and breathing Chapel of the Deity . . . I thought it not lawful to make use of the Favours and Patronage of a less Person. For you are He who most happily presides (both by Merit and Authority) over all our Temples and Sacred Things. Therefore after I had slain so many victims, whole Hecatombs almost of all Animals, in the Anatomical Court, I could not have thought them rightly offered, unless they had been brought to the most holy Altar of Your Grace.'

So sincere a statement can leave no reasonable doubt that Willis carried through all his great work on the anatomy of the brain in a deeply religious spirit. Like William Harvey before him Willis saw nothing incongruous between religious sincerity and anatomical investigation. Indeed for both Harvey and Willis anatomical discovery took the form of a further revelation of the mystery of God.

Willis expressed his position thus; 'It hath been a long while accounted as a certain Mystery and School-house of Atheism to search into Nature, as if whatever Reasons we grant to Philosophy should derogate from Religion. But truly he doth too much abuse the Name of Philosophy who considers . . . all the make and provision of a Clock, by which invented Machine the course of the Time may be exactly known and measured, if that at length, when by his search and consideration he hath profited himself so much, he should not acknowledge the Artist to whose Labour and Wit he owes all those things.' In subsequent passages of his dedication Willis repeatedly reasserts his conviction of the close relationship between research and revelation of the 'Divine Word', and as often he emphatically rejects any taint of atheism in such work.

However there were many Anglican Churchmen who were not in harmony with this view, who did look upon those who practised the New Philosophy, particularly the Fellows of the Royal Society, as a school-house of atheism. Willis was closely surrounded by such people. This is strongly emphasized by the antagonism to science loudly declared on an occasion which must have been of particular significance to Thomas Willis—the opening of the Sheldonian Theatre at Oxford.

On 17 July 1669 John Wallis wrote to his friend Robert Boyle describing this occasion: 'I thought it not unfit to give you some account of our late proceedings here. Friday 9 July was the dedication of our new theatre. In the morning was held a convocation in it for entering upon the possession of it. Wherein was read the archbishop's instrument of donation (sealed with the archiepiscopal seal) of the theatre . . .' Wallis then describes how, 'Dr. South, as university orator, made a long oration. The first part of which consisted of satirical invectives against Cromwell,

Book Reviews

fanaticks, the Royal Society, and new philosophy; the next of encomiasticks in praise of the archbishop, the theatre, the vice-chancellor, the architect, and the painter; the last of execrations against fanaticks, conventicles, comprehension, and new philosophy; damning them ad inferos, ad gehennam.' Such proceedings, painful enough to that Fellow of the Royal Society who was describing them, John Wallis, must have been even more so to another Fellow, Thomas Willis, who was so closely linked, by marriage, friendship, patronage, and religious conviction to those persons most concerned with the ceremonial opening of the Sheldonian theatre. Even though not in sympathy with these condemnations the intimacy of his contact with the Anglican group expressing such opinions cannot but have inhibited Willis from mixing freely with those damned souls who practised the new philosophy. Such being the case it is not surprising that Willis attended very few meetings of the Royal Society, and persistently failed to pay his subscriptions.

Like so many practising scientists of the seventeenth century, including Harvey, Willis wrote little about his scientific methods. For the most part one has to infer them from his practice. He was clearly influenced by Bacon's antipathy to scholasticism. In his preface to this work, *Cerebri Anatome*, he apologises for drawing out of himself, 'a certain Poetical Philosophy and Physick, neatly wrought with Novity and Conjectures which had made a Fucus as it were with deceits and incantations.' This 'fucus', or, as it were, deceptive paint, Willis claims to have now laid aside in favour of 'direct ocular demonstration',—a phrase that betrays the influence of Harvey. Accurate anatomical observation, Willis felt, could not deceive; and this must form, 'a stable basis on which not only a more certain Physiologie than I had gained in the Schools, but what I had long thought upon, the Pathologie of the Brain and nervous stock, might be built.'

In order to achieve this ambition Willis records his plan for selecting a research team composed of himself, Richard Lower, Thomas Millington and Christopher Wren—to all of whom he gracefully acknowledges his indebtedness, describing the particular nature of the contribution made by each. He continues; 'But although, instructed by these helps, and, as it were hem'd in by the plentiful assistance of these Illustrious Men, I come forth on the Stage, I presume I shall not be, however, safe from calumny and free from blame . . . but that, as it may be published and shewn for the Judgements of the more Learned, so it may be carpt at and torn by the opprobies of detractors.'

In cerebral anatomy the Willis Team was superb. Undoubtedly the technique of vascular injections introduced by Wren contributed much new knowledge of the cerebral vascular pattern. Lower's experimental genius elucidated many a physiological problem. But Willis himself directed the main strategy as well as contributing detailed methods of dissection. Such combined operations resulted in the new enumeration of the cranial nerves, the founding of the study of comparative cerebral anatomy, and, best known of all, the description of the eponymous Circle of Willis. Conflict amongst medical historians as to the justification of this eponymous term still continues; and there are plenty of grounds for it, should medical historians wish to regale themselves with such dead-sea fruit. It is of greater interest to see, as has been

Book Reviews

so clearly demonstrated by Meyer and Hierons, the gradual growth of knowledge of this region of the vascular system; and to appreciate the progress from Galen's rete mirabile, through the efforts of Vesalius, Fallopius, Casserius, Vesling and Wepfer to the experimental delineation of the vascular pattern achieved by Lower and Willis by injections of ink. Undoubtedly this new method gave them a richer knowledge of the physiological significance of the union of the carotid and vertebral systems occurring in the arterial 'heptagon' of Willis.

It was the new knowledge so acquired that Willis extended from normal anatomy to morbid anatomy, to 'Pathologie of the Brain'. The pathological significance of what Willis picturesquely called 'the fourfold Chariot of the Arteries' of the brain has only come into its true place since the advent of cerebral angiography.

Perhaps the most sensational example of Willis's ability to combine clinical and pathological investigation in this field is that of the man in whom

the right Carotides, rising within the skull, was plainly bony, or rather stony, its cavity being almost wholly shut up; so that the influx of the blood being denied to this passage, it seemed wonderful, wherefore this sick person had not dyed before of an Apoplexy; which indeed he was so far from that he enjoyed to the last moment of his life the free exercise of his mind and animal function. For indeed, Nature had substituted a sufficient Remedy against that danger of an Apoplexy; to wit the Vertebral Artery of the same side in which the Carotid was wanting; the bulk of the Pipes being enlarged, became thrice as big as both its pipes on the other side; because the blood being excluded the Carotid, adding itself to the wonted provision of the Vertebral Artery, and flowing with a double flood into the same belly, had so dilated the channel of that Artery above measure. This Gentleman about the beginning of sickness, was tormented with a cruel pain of the Head towards the left side. The cause thereof cannot be more probably assigned, than that the blood excluded from the right Carotid Artery, when at first it rushed more impetuously in the left had distended the Membrane; and therefore the same distemper did afterwards vanish of its own accord, to wit, the superfluous blood being derived through the Vertebral Artery.

This example (to be found on page 83 of volume II) is but one of many which illustrate Willis's remarkable ability in applying mechanistic principles to cerebral circulation and function. Such examples are so 'modern' that from them one can easily construct an image of Willis as a paragon of modern scientific virtue, and his critics through the subsequent centuries would thus appear as harsh, unreasonable men. But he had another side.

In reading large sections of the *Cerebri Anatome* one can easily forget that Willis had already, in 1659, published the *Diatribae Duae Medico-Philosophicae*, a collection of three essays on fermentation, fevers and urines. In these he had already begun to establish his reputation as a chemist. By the end of his life his eminence in this sphere was such that Robert Boyle, writing his paper on 'A Chymical Paradox' about 1680, lays special emphasis on his agreement with Willis on the important matter of the nature of the elements. Boyle writes:

I do not take chymical principles in the strictest sense of that term wherein it is confined to salt, sulphur and mercury; but in the larger acception wherein the learned doctor Willis, and divers other chemists (that are not all his juniors) employ it when they comprize under it two elementary bodies; as they do when they constitute five principles . . . in which number they comprize phlegm and earth.

Now Willis in his speculations on cerebral physiology draws as much on his chemical principles, which we find so incomprehensibly medieval, as he does on his mechanistic

principles, which we find so comprehensibly modern. To put it briefly the iatromechanical views of the seventeenth century, with all their failings were more soundly based than the iatro-chemical, so that whereas some of these mechanical principles of physiology make sense, all the chemical physiology of the time makes nonsense to us today.

When we read Chapter IX which is devoted to the Pia Mater we find Willis informing us that the cerebral and cerebellar parts of this membrane constitute the sites of distillation of the Animal Spirits from the blood. The blood vessels of the pia mater supply, 'a very pure and spirituous liquor instilled into the cortical substance of the cerebel which is presently exalted by the Ferment there placed into animal spirits.'

And when he approaches the subject of headache, this time from the iatro-chemical point of view Willis writes: 'Sometimes vaporous Effluvias do proceed from the blood boiling or estuating within the confines of the Brain, which being shut up together under the Pia Mater, and as it were gathered into a cloud do greatly blow up and distend it, and so distemper it with pain . . .'

Such speculations compounded of Galenic vapours, iatro-chemical distillations and ferments, have not appealed to later generations. It is on this side that Willis's speculations are most vulnerable; it is here he laid himself most open to criticism. Whilst some of his mechanical speculations still command our admiration and respect, this verdict can apply to few, if any of his iatro-chemical hypotheses.

Willis loved speculation for its own sake. He believed that, given certain data as a basis, truth could be evolved therefrom by the process of reasoning. And what is wrong with that? It was Steno who, of all his contemporaries criticized Willis most severely on the grounds that he was speculating far too rashly on insufficient facts. And Steno was right; so right indeed that he himself made no other contribution to cerebral physiology. He abandoned the physiology of the brain as a mystery known only to God. Scientifically justifiable as was this attitude, it may well be criticized as negative and less helpful to the advance of knowledge than the speculations of Willis.

Willis on the other hand, when he described and defined such structures as the corpus striatum, corpus callosum, cerebral and cerebellar cortex, and the corpora quadrigemina, felt that he had found enough facts to form a 'stable basis for a more certain Physiologie', and produced the first systematic conception of the cerebral localization of sensory and motor function. His knowledge of chemistry, of the works of Galen, Sylvius, Descartes and, as Meyer and Hierons have recently emphasized, of Gassendi, gave Willis the creative hypothesis from which he built up a consistent 'doctrine of Neurologie'.

To us today this appears as a vastly premature attempt, riddled as it is with speculative fantasy. But it was only the first of such attempts. For at least another 150 years, right up to the end of the eighteenth century, speculative systems of physiology and pathology abounded. Willis in this was a precursor of those systems of which those of Boerhaave and Cullen are perhaps the best known. Not until the voracious human appetite for 'explanations' began to be controlled and defined was the growth of knowledge to become slower, surer, and more specialized; and this process did not begin until the nineteenth century.

Book Reviews

Nor are we by any means free of the Willisian type of speculation in the present twentieth century. For it is still human (and will long remain so) to desire and accept explanations based on relatively simple systematized concepts, such as the 'sub-conscious' or 'stress' which elude all attempts to catch them in the net of experimental confirmation or refutation.

The production of facsimile editions of classical medical works is now becoming a welcome feature of the History of Medicine. Such classics, as has been emphasized in this review, often make difficult reading. They require time and leisure for their appreciation, facilities which have in the past been largely necessarily denied to the ordinary reader.

This particular facsimile production of Willis's *Cerebri Anatome* must be unique in the fineness of its materials and its workmanship. The editor, Dr. Feindel, and the printer, the Meriden Gravure Company of Connecticut, are to be heartily congratulated on the success of their handiwork. Such a fine production of this great work, well used, should do much to arouse the interest of students of science and medicine in the history of their subjects. Its greatest danger lies in its seductive beauty, which may result in its abduction into the secret closets of collectors' pieces.

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A Source Book in the History of Psychology, ed. by R. J. HERRNSTEIN and E. G. BORING, Cambridge, Massachusetts, Harvard University Press, 1965, pp. xvii, 636. Psychologists—unlike psychiatrists—have always delighted in their heritage and been proud to trace their descent from the great philosophers, scientists and physiologists of the past. As early as 1912 Rand of Harvard published his readings from the classical psychologists starting with Anaxagoras and ending with Wundt. This was followed in 1948 by Dennis's selections from Aristotle to Hull; and in 1961 by Shipley, who started with Herbart and ended with McDougall.

In their series of source books in the history of the sciences devoted to classical papers that have shaped their structure, Harvard have now issued this further series of extracts from psychological texts under the editorship of the associate professor of psychology and the distinguished emeritus professor at Harvard. They have limited their 116 excerpts to the history of experimental or quantitative psychology—specifically omitting clinical and social psychology—and have arranged them into fifteen chronologies according to topic, such as sensory specification, psychophysics, vision, reflexes, association and learning. Each topic has its general introduction and brief notes at the head of extracts. Sixty-two extracts appeared originally in English; of the rest twenty-seven are here translated for the first time. Those familiar with the subjects and authors will be glad to have their essence in this condensed form; those who are not will find this book a pleasant way of becoming acquainted with them.

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