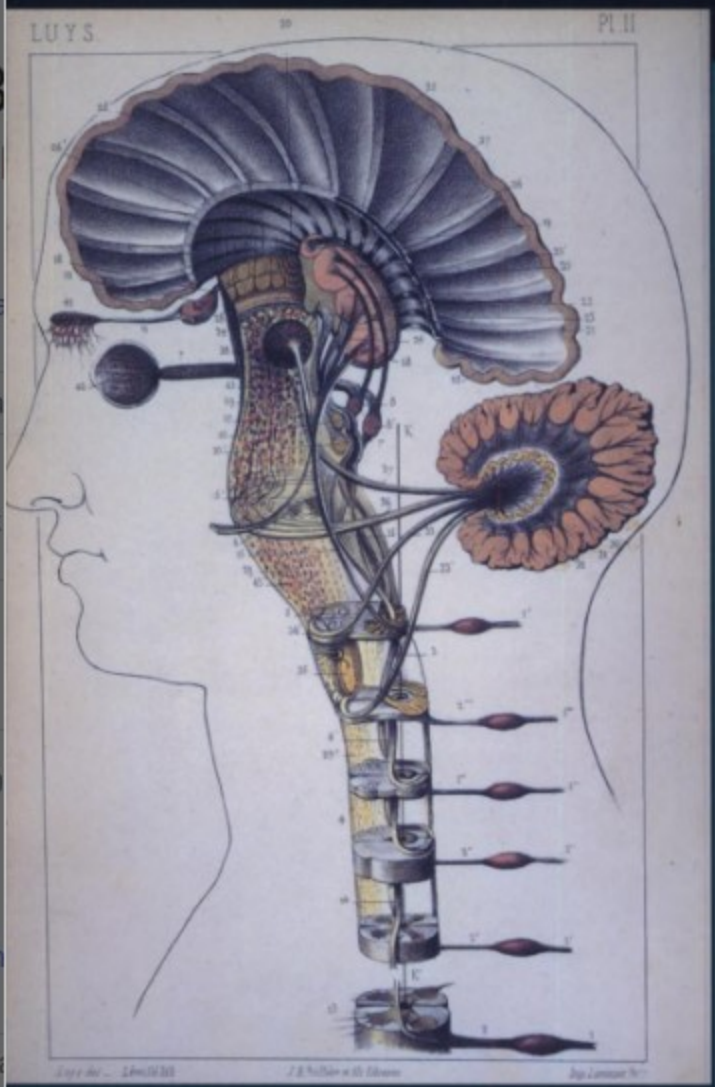
THE HUMAN BRAIN AND SPINAL CORD

A Historical Study Illustrated by Writings from Antiquity to the Twentieth Century



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A HISTORICAL STUDY ILLUSTRATED
BY WRITINGS FROM ANTIQUITY
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CHAPTER I

ANTIQUITY AND THE MEDIEVAL PERIOD

Introduction

Because of the rapid advances made in science during the last hundred years and because of its present-day complexity and sophistication, there is a tendency to neglect the most distant past. The ancient Greeks seem to be so far away in thought, as well as in time, that we tend to forget that their ideas, some of which now appear to be archaic and curious, were in many instances the origins of concepts that today are held to be of the greatest importance. This is certainly true in respect to the history of neuroanatomy and neurophysiology, and, in this work, in order to emphasize the direct links of modern beliefs with those of antiquity, the latter have been included with each theme or chapter, whenever appropriate, rather than collected in a single chapter. Nevertheless, there are several reasons that favor the inclusion of an additional, introductory chapter dealing primarily with certain aspects of the neurological knowledge of antiquity.

The first reason is the most important and has for the most part determined the choice of the material presented below. Although the overall objective of this book is to discuss only ideas that have survived into the present era, there is one exception to this rule. Throughout antiquity, and to some extent up to the end of the eighteenth century, there was controversy on the question of which organ was the seat of the soul, the intellect, the passions, and the guiding force in the control of the motor and sensory phenomena of the body. The problem is one that no doubt engaged man's attention from a very early period, but it does not become apparent to us in any detail until the time of the pre-Socratic philosophers of ancient Greece (6th and 5th centuries B.C.). Thereafter it became a major issue, and the field was divided between those who selected the brain and those who preferred the heart. As with any controversy, this one stimulated men to ponder and to seek evidence in support of one side or the other, and thus indirectly it centered interest upon the brain and also, of course, upon the heart. This then is the main theme of the first chapter: the cephalocentric versus the cardiocentric soul.

Although earlier Western civilizations such as those of the ancient Egyptians, the Mesopotamians, and the Hebrews had selected the heart as the central organ, the Greeks were divided on this matter. Thus Empedocles, Democritus, Aristotle, Diocles, Praxagoras, the Stoics, and the Epicureans favored the heart, whereas Alcmaeon, Pythagoras, one of the Hippocratic Writers, Plato, Herophilus, Erasistratus, Rufus and Galen chose the brain. In view of the fact that we today belong to the second

group, selections will be taken mainly from its representatives. There are, however, remnants of the contrary opinion still with us, preserved in the many expressions that refer to the heart and are probably chiefly Hebrew in origin.

The second reason for the inclusion of this first chapter arises from a fundamentally important concept that matured in antiquity. This was the notion of the nervous system as an anatomical and functional unit. Although the contributions to it were few, they could only be included in a chapter dealing with antiquity in general.

A further reason lies in the fact that a few authors, such as Rufus of Ephesus, gave brief yet outstanding accounts of the nervous system that could not conveniently be split up into their component sentences and distributed among the various chapters; hence almost all of Rufus's account has been reproduced here and will be referred to from the appropriate, later chapters.

In this first chapter, the writings of philosophers such as Plato and Aristotle must come under consideration. We are well aware of the hazards involved in removing portions of them from the general context of their authors' philosophy and considering them in isolation; and since it is difficult within restricted limits to set the selected passages in their correct perspective, authorities have been cited to whom the reader may refer for further assistance in this matter.

Finally, two writers from the medieval period have been included, not because of any original contribution but because of their wide influence in the maintenance and furtherance of classical ideas. These are Avicenna, one of the most outstanding representatives of Moslem medicine, and Mondino, the most important anatomist of the late medieval and early Renaissance period. In the instance of the former, his opinions regarding the heart-brain controversy have been illustrated, and in that of the latter, his description of the brain.

Alcmaeon

(fl. c. 500 B.C.)

Although there are occasional references to parts of the nervous system in the fragmentary remains of Ancient Egyptian (see pp. 383–384) and Mesopotamian writings available to us today, we can discern in them no clear opinions concerning its function. Such opinions did not appear until the pre-Socratic philosophers of the sixth and fifth centuries B.C., the earliest ancient Greeks to be interested in natural phenomena, began their studies. One of them, Alcmaeon of Croton, is of special importance in the history of knowledge of the brain.

Very little is known about Alcmaeon and even his *floruit* is still debated. He seems to have belonged to the earliest Greek school of physicians at Croton in southern Italy, but he was not closely associated with Pythagoras (*c.* 572–*c.* 490 B.C.) as is sometimes claimed. Unfortunately only a few fragments of his writings have survived, and later writers must be relied upon for his opinions, so that exposure to possible errors and misrepresentations is unavoidable. Nevertheless he has been ac-

claimed by some as the founder of empirical psychology (Beare, 1906), and his theory of opposites formed an important part of Hippocratic medicine. Alcmaeon appears to have dissected animals and to have discussed nerves. One of his most striking contributions was the recognition of the brain as the central organ of sensation and thought, and this, as well as other perceptive observations, was included in a book on nature that may have been written between 480 and 440 B.C. but, which apart from a few sentences, has been lost (see Kayserling, 1901; Guthrie, 1962, pp. 341–359; Freeman, 1959, pp. 135–139; Schumacher, 1963, pp. 66–81; Diels, 1964, I, 210–216).

The following passage has been taken from the works of Theophrastus (c. 371–c. 287 B.C.), the peripatetic philosopher who was a pupil of Aristotle and succeeded to the direction of his master's school in Athens. His treatise, *On sense perceptions* (*Theophrasti Eresii opera, quae supersunt, omnia*, edita Fridericus Wimmer [Paris, 1866]) presents Alcmaeon's opinions of the mechanism of the special sense organs connected to the brain, and these ideas are known to have influenced later writers such as Plato (pp. 5–7) .

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IV. (25) Among those who have decided that perception is not accomplished through similarity, Alcmaeon was the first to define the difference between man and animals, saying that man differs from the latter in the fact that he alone has the power of understanding. The others perceive but do not understand since to understand is different from perceiving and not, as Empedocles believed, the same thing. Then [Alcmaeon] discussed the separate senses. He tells us that we hear by means of the ears and that sound is heard because of the empty space in them; he says that the [internal] air resounds by means of that hollow space. [He asserts that] we smell by means of the nostrils when in respiration the air has been carried to the brain; that we distinguish flavors by the tongue, for since it is warm and soft it melts [substances] by its heat, and because of its yielding fineness it receives and passes on [the flavors]. (26) The eyes see through the surrounding water that obviously contains fire because it flashes out in those that have been struck a blow. Vision occurs when that shining, translucent quality [in the eye] reflects, and the more so the greater its purity. All the senses are related in some way to the brain so that if it is moved or if it changes its position, they are blunted because the passages by which sensation occurs are blocked. He did not define touch, nor how or by what organs it occurs. Such then are Alcmaeon's opinions about these matters.

Throughout the medieval period there was to be continued controversy over the relative merits of the heart or the brain as the central organ of the body. Although all Aristotle's original arguments, which had been dealt with so brilliantly by Galen, were not invoked, nevertheless, many individuals felt that there was sufficient evidence to support the argument in favor of the cardiocentric theory. The experimental data provided by Galen were not considered necessary by the medieval philosopher, who was content to solve the problem by disputation alone. In his eyes this was a more worthy and reliable method of tackling a controversial issue.

Such polemics were a feature of the Middle Ages; nor were they immediately dispelled by the new learning of the scientific revolution of the sixteenth and seventeenth centuries. The University of Padua was one of the strongholds of Aristotelian teaching, and its influence can be seen in the work of Harvey and his contemporaries. Andrea Cesalpino (1519–1603), a rigid Aristotelian, still believed in 1588 that nerves originated from the heart and stated that "the heart is not only the origin of all the veins but also of

the nerves" (*Tractationum philosophicarum tomus unus . . . . Quaestionum peripateticarum libri V [Geneva,* 1588], col. 516). Descartes, writing in 1649 (pp. 470–471), noted that some would place the seat of the soul in the heart, and such opinion can be traced well into the eighteenth century.

It is clear from the foregoing that a large body of ideas about the anatomy and function of the nervous system was assembled in Greco-Roman antiquity, some of which resulted from the heart versus brain controversy. Further details about this knowledge will be included in most of the subsequent chapters, and when brought together they reveal the remarkable legacy of achievement bequeathed to the neurological sciences by antiquity.

Conclusion

In this chapter excerpts have been presented which have dealt almost exclusively with the morphological characteristics of the neuron. Throughout the period covered, however, concurrent investigations that attempted to correlate this structural data with function were taking place, and the two groups of information must be considered together. The function of the nerve is the subject of Chapter III.

During the last few decades, new techniques have accelerated this process of correlation, and in the last twenty-five years in particular, the electron microscope, together with increasingly sophisticated chemical and physical intracellular techniques,

have helped to relate the basic histological findings of the nineteenth century to the cellular physiology of the twentieth (see Eccles, 1957). No attempt has been made to enter this current era of research, thought of perhaps as a fifth period of development, since an adequate evaluation of its themes will not be possible for several decades. At that time, it will be necessary to review the work that has been chosen here to illustrate the history of the neuron.