THE IMPORTANCE OF STUDYING GREEK PHILOSOPHERS AND PHYSICIANS (5TH – 3RD CENTURY B.C.): CONTRIBUTION TO THE DEVELOPMENT OF NEUROSCIENCE IN MEDICAL SCHOOLS

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Abstract:
The nature of psychic life, the anatomical seat of cognitive, motor and sensory functions, and the origin of neurological diseases were broadly debated by ancient Greek scientists since the earliest times. Within a few centuries, speculation of philosophers and physicians laid the foundations of modern experimental and clinical neuroscience. In this review we shall present the most important Greek philosophers and physicians living between the 5th and the 3rd century before Christ (B.C.) and examine some of their leading theories concerning the mechanisms of cognitive activity, the nature of perception and voluntary movement, and the causes of neurological and psychiatric disorders.

Key words: History of neuroscience; Presocratic philosophers; Alexandrian medicine; Hippocratic medicine.

Introduction
Since the earliest times ancient Greek scientists debated the nature of psychic life, the anatomical seat of motor, sensory and cognitive functions, and the basis of some neurological and psychiatric diseases.

The aim of this study was to present the theories of the most important ancient Greek philosophers and physicians (5th-3rd century B.C.).

Content
The origin of thinking activity was explained by Greek philosophers and physicians based on two theories. The encephalocentrism considered the brain as the seat of human consciousness, sensation and knowledge, all these faculties being attributed by the cardiocentrism to the heart. Both theories generated controversy within the scientific community [4].

a. Philosophers

Hippon of Samos (4th century BC) localized the main part of the soul to the head, particularly to the brain. Anaxagoras of Clazomenae (500–428 BC) and Diogenes of Apollonia (ca. 460 BC) believed that all sensations had connection to the brain [4].

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Empedocles of Acragas (490–430 BC) thought that “the blood around the heart is men’s thought” [5]. Thus, humans think with the blood and the level of intelligence depends on blood’s composition. That is why he considered the heart also as the seat of mental disorder [19].

In the opinion of Empedocles, sensation is a purely physical process, depending on pores and affluences. Affluences enter continually in another body through pores and sensation is a matter of symmetry of pores [5].

Aristotle (384 BC – 322 BC) was probably the first anatomist in the modern sense of this term [11]. According to Aristotle, the soul is defined as the the form of a living body [18].

Aristotle had interesting contributions to brain anatomy. He observed that the brain was placed in the front part of the head and was surrounded by the meninges, two membranes containing blood vessels. The external membrane was the thickest and located next to the bone of the skull; the more delicate internal membrane was localized around the brain itself.

For the first time an important anatomical distinction between cerebrum (enkephalos, brain) and cerebellum (parenkephalis, para-brain) was made by Aristotle. The para-brain was positioned beyond the brain, and its shape and tissues were different from those of the brain. Aristotle also identified three possible nerves - “poroi” (ducts) – two of them leading to the cerebellum and one to the brain [1]. These ducts might refer to the optic nerve and tract, and to trigeminal and oculomotor nerves [3]. He also described a cavity in the brain, probably the ventricular system, and made the observation that man has the largest brain in proportion of his size. He also referred to “liquidity about the brain”, probably the cerebrospinal fluid. Aristotle described the spinal cord as an extension of the brain and the similar constitution for both structures [1]. But Aristotle’s theories about brain function were rather disappointing. In his view, brain had no sensory properties and was insensible when touched. He concluded that the brain was a cooling organ, after he noticed a lot of blood vessels on the surface of the brain, therefore having no intellectual meaning. Aristotle also considered the brain as the sleep generator [3].

b. Physicians

The sensory and cognitive significance of the brain was probably first recognized by Alcmaeon of Croton (500 BC) [15]. He asserted that “all the senses are connected with the brain” through channel-like structures called “poroi”, two of them, no
doubt the optic nerves, joining the eyes to the brain. Alcmaeon claimed that the brain was the seat of consciousness and sensation because he recognized that all senses “are compromised if the brain is moved and changes its place” [5].

He distinguished sensation from understanding: “man differs from the other animals in that he alone has understanding, whereas, they have sensation but do not understand” [4].

Based on anatomical evidence, he proposed that the brain was essential for perception [6, 7] and “the seat, in which the highest, principal power of the soul is located” [5].

Alcmaeon was wrong saying that sleep occurs when blood vessels in the brain are filled and that waking is caused by the emptying of these vessels [16].

Fig.3. Alcmeon – source philosophers.endless-greece.com/alcmaeon.php

In the fourth century BC, Hippocrates (ca. 460 BC – ca. 370 BC), the “Father of Medicine”, started a new way of looking at illness. The main theory stated that disease is the result of an imbalance of body constituents or humors and that disease has nothing to do with demons [10].

For Hippocrates the human brain is cleft into two symmetrical halves by a vertical membrane and is also the seat of human intellect and the cause of neurological disorders. In De morbo sacro, epilepsy, called in antiquity “the sacred disease”, is not “any more divine or more sacred than other disease, but has a natural cause, and its supposed divine origin is due to men’s inexperience and to their wonder at its peculiar character”. In the same treatise, the brain was considered the seat of judgement, emotions and aesthetic activity [12]. Thus thinking activity, moral consciousness, perceptive elaboration and control of body’s movement, were functions all localized to the brain.

Hippocrates explained mental insanity as a process of brain corruption induced by bile, one of the four humours.

In a case report about sudden loss of speech and paralysis of the right hand, the term “spasm” is used [13].

It was stated that “an incised wound in one temple produces a spasm in the opposite side of the body” and that loss of speech occurred with “paralysis of the tongue or of the arm and the right side of the body” [2].

Hippocrates was also one of the most prominent ancient greek physician who practiced trepanation [17]

Diocles of Carystus (ca. 375–300 BC) stated that the right half of the brain provided sensation and the left intelligence, and that the heart is the centre for hearing and understanding. In his opinion, madness was “boiling of the
blood in the heart”, lethargy was “a chilling of the psychic pneuma about the heart and the brain and a freezing of the blood dwelling in the heart”, and melancholy was considered as a disorder arising “from thickening of black bile around the heart” [8].

Erasistratus of Chios (ca. 304 – ca. 250 BC) founded, together with Herophilus, a school of anatomy in Alexandria, where the two performed human dissections on criminals [21].

Erasistratus described a system of humors consisting of nervous spirit - carried by nerves -, animal spirit - carried by arteries -, and blood - carried by veins. Erasistratus considered that atoms are the essential body element. Atoms were activated by pneuma (external air) that circulated through the nerves. He thought that the inspired air is transformed into “vital spirit” and transported to the brain’s ventricles, where it becomes “animal spirit”. The animal spirit filled the empty nerves and let them control the muscle movement [21].

According to Erasistratus, the dura mater had the greatest significance, being considered the center of sensitive, motor, and cognitive functions. Therefore, psychiatric and neurological disorders were thought to depend on pathological changes of this membrane. He considered that lethargy “arises from an affection of the psychic faculty in the meninx, which is precisely where lethargy occurs”. Delirium was “a disorder of the activity of the meninx” [9].

Erasistratus is one of the first who described the cerebrum and cerebellum. Initially, he asserted that nerves also originate from the meninges. Later, he recognizes that nerves originate from brain. He also established a relationship between the the number and complexity of the human brain convolutions and intelligence [8].

Herophilus of Chalcedon (335-280 BC), the “Father of Anatomy”, is also considered the founder of human anatomy as a distinct branch of medicine [14].

He made a series of accurate descriptions of neuroanatomical structures. He also made a clear distinction of the brain ventricles, identifying that they are in reciprocal communication and therefore allow passage of the psychic pneuma.

He described precisely the cerebellar ventricle, the fourth ventricle or the posterior ventricle. He also described and nominated some structures visible on the floor of this cavity, such as the calamus
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scripторius, the posterior median sulcus and the colliculus facialis. He accepted Aristotle’s distinction between enkephalos and paraenkephalos, recognizing that they are separated by a thick membrane — tentorium cerebelli.

He described a membrane covering the ventricles of the brain as the “choroid meninx”. Along with Erasistratus, he was considered the first anatomist who identified motor and sensory nerves and who located their origin correctly in the brain or in the spine. He described the optic, oculomotor, trigeminal, motor root of the trigeminal, facial, acoustic and hypoglossal nerves [4, 20].

Erasistratus and Herophilus first identified that cutting nerves causes paralysis.

Conclusions
All these theories represent great achievements transmitted by Greek philosophers and physicians to later generations of neuroscientist.

References


