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ANATOMY AND PHYSIOLOGY IN THE WORK OF NEMESIUS OF EMESA "ON THE NATURE OF MAN"

ANATOMIJA I FIZIOLOGIJA U DJELU NEMEZIJA EMEŠKOG "O LJUDSKOJ NARAVI"

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Summary

This study summarises the original medical information contained in the treatise On the Nature of Man *by the Byzantine scholar Nemesius, Bishop of Emesa (4th century), written in ancient Greek. Nemesius' work had a strong impact on later Byzantine scholarship, as witnessed by a number of treatises on human body that followed under a similar or identical title. This review introduces and summarises some of the basic views of Nemesius and compares them with those of Galen, one of the major contributors to medical knowledge of antiquity, in order to see how Galen's theories on anatomy and physiology influenced Nemesius. We conclude that the medical information in the work of Nemesius reflects the high level of Byzantine medicine of the time, as well as deep influences from ancient Greek intelligentsia and Galen in particular.*

Key words: *Byzantine medicine; Nemesius of Emesa; Galen; anatomy; physiology*

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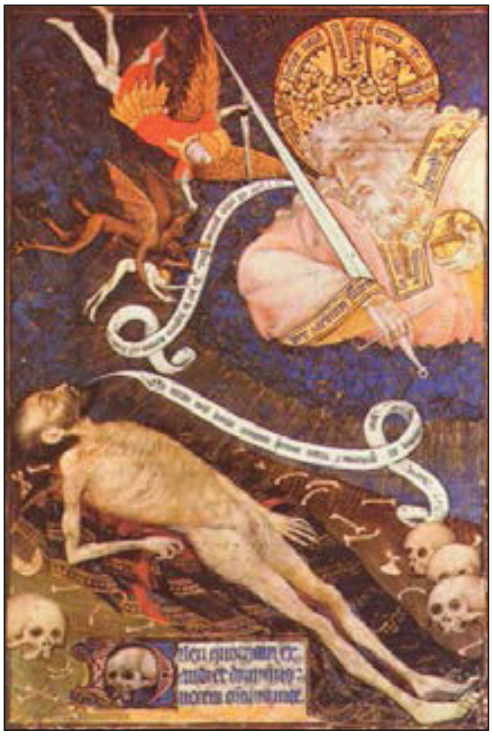
Introduction

The Byzantine scholar Nemesius, Bishop of Emesa in Syria (today Homs), who lived around the end of the 4th century AD (c. 390 AD), is the author of a major medical treatise on human nature *On the Nature of Man* (*De Natura Hominis*), which is included in the series of Greek Patrology of J. P. Migne (Migne, 1958). Even though he did not practice medicine, we see that he had a good knowledge of human anatomy and physiology.



Byzantine scholar Nemesius, Bishop of Emesa (today Homs in Syria), around the end of the 4th century AD.

Bizantski učenjak Nemezije, biskup od Emeze (danas Homs u Siriji), krajem IV. st.

On the Nature of Man was originally written in ancient Greek (*Περί Φύσεως Ανθρώπου*) and by the Middle Ages was translated into languages such as Latin, Arabic, Armenian, Georgian, and Syrian (Nemesio and Morani, 1987; Sharples and Eijk, 2008). Along with many other Byzantine scholars (such as Oribasius of Pergamum, Aetius of Amida, Alexander of Tralles, and Paul of Aegina), Nemesius witnesses to the high level of Byzantine medicine (Eftychiadis, 1995), which managed to preserve ancient Greek medical texts, review the Hippocratic and Galenic heritage, and ensure its transmission to Renaissance Italy and the Islamic world alike (Bennett, 2000). Byzantine medicine saw the development of a number of specialisations, such as surgery (Pentogalos and Lascaratos, 1984; Lascaratos and Kostakopoulos, 1997), geriatrics and gynaecology (Ellis, 2001), or pharmacology, as evident from the work of Nicholaos Myrepsos *Dynameron*, that contains over 2500 medical recipes based on pharmaceutical properties (Kazhdan, 1991; Lascaratos, 2004; Malkinson, 1982). In addition, physicians of the time were allowed to perform anatomical dissections not only on living or dead animals only, but also on human corpses. Finally, Byzantium introduced the institution of hospitals (*Xenones*) and social welfare and had organised care for the sick,

the elderly, and mothers and infants/children (Miller, 1997; Kourkouta, 2012; Jeffreys 2008).

The aim of this article was to give a brief review of Nemesius' views (since little literature is available on Nemesius himself) on anatomy and physiology put forward in his work *On the Nature of Man*, that was profoundly influenced by one of the most distinguished ancient Greek physicians - Galen. Nemesius, in turn, had a great influence on Byzantine scholars who followed in the 7th to 10th century AD, as evident from an array of treatises under a similar or identical title, such as Leon the Iatrosophista, Meletius Monachus, Theophilus Protospatharius.

On the Nature of Man discusses the structure of the human body, the position and function of its parts, and the relationship between body and soul (van der Eijk, 2008). We may also trace a strong influence of Plato, Aristotle, and the Stoic tradition (Young and Teal, 1983), even though Nemesius criticised Plato's and Aristotle's views about soul. He claimed that Plato regarded immortal soul independent of the body (Quin, 1994), while Aristotle regarded it too dependent on the body (according to Nemesius) *(Αριστοτέλης, Περί γενέσεως 731b, Περί ψυχής, 412a. par. 27-28)*. Nemesius believed that Christian theology held these two extremes in balance (Rist, 1988). The soul, according to Galen, was related to the humoral composition of the brain (Brock, 1929). Nemesius, in turn, believed that man possessed an incorporeal soul that permeated the whole of the body, but that mental faculties resided in brain ventricles, as opposed to cerebral substance as Galen had maintained (Quin, 1994). Nemesius thus creatively synthesises classical (pagan) and Christian beliefs, to which he makes reference in the last part of his work discussing soul and divine providence.

Modern scholars hold the view that Nemesius of Emesa drew heavily on the tradition of Galen of Pergamum (*Cl. Galenus*) in composing his treatise *De Natura Hominis* (Scarborough, 1984). On the other hand, it is obvious that Nemesius uses medical ideas which go beyond Galen's (Quin, 1994; van der Eijk, 2008). In addition, in his work we encounter scattered elements that reflect the views of distinguished Hellenistic philosophers, Posidonius the Stoic in particular, who adopted many Platonic ideas of the 1st century BC (Young and Teal, 1983). However, while it is clear that Nemesius drew a great deal from Galen, whose views he explicitly discussed, the attribution of many of his ideas to Posidonius is more speculative (Jaeger, 1914; Young and Teal, 1983).

Nemesius' *On the Nature of Man* was translated into Latin and gradually disseminated to finally dominate European thought during the Middle Ages. It considerably influenced physicians in formulating theories regarding the function of the nervous system and the structure of the human brain (Finger, 1994).

Brain function

Byzantine knowledge of brain structure was limited and influenced in a dogmatic way by the teachings of Galen (Schiller, 1997). Nemesius of Emesa was the first to map the brain by attributing specific mental faculties to different parts of the brain (Quin, 1994; van der Eijk, 2008). For instance, Nemesius places *perception (των αισθήσεων)* in the two anterior ventricles of the brain, *cognition (διανοητικόν)* in the middle ventricle, and *memory (μνημονευτικόν)* in the posterior ventricle (Paluzzi, 2007; Manzoni, 1998).

To support his mapping, Nemesius provides examples arising from damage to various parts of the brain. It this sense he is probably the first to have proposed the *localisation theory* that offers clinical evidence and empirical observations of impaired cognitive function in specific cases of brain injury. Nemesius argues that if only the front brain ventricles are damaged, this will affect the senses but not cognition or memory. Similarly, if the middle ventricle is damaged, this will only affect the cognitive function, and if the cerebellum is destroyed, this will result in memory loss without affecting perception or memory (Migne, 1858).

On the other hand, Galen's knowledge of different parts of the brain derives mainly from his anatomical studies and experiments on animals, as dissection of the human body was forbidden in his era (Gross, 1998; Finger, 2000). Galen described people with head injuries and regarded the brain as the definitive organ of mind. According to his theory, there are three kinds of spirits: i) the *natural pneuma (πνεύμα φυσικόν, spiritus naturalis)* associated with the liver and its veins, regulated nutrition, and vegetative functions, ii) *vital pneuma (πνεύμα ζωτικόν, spiritus vitalis)*, which are natural spirits that have been converted in the heart to generate body's internal heat and are partly responsible for our base emotions, and iii) *psychic pneuma (πνεύμα ψυχικόν, spiritus animalis)*, which have gone beyond the heart and reached the brain to convert to the spirits of mind. According to Galen, the spirits of the ventricles act as the physical instrument of soul, and the 'true seat of the rational soul' must therefore be the brain. Galen considered *perception*, *cognition*, and

memory the most important functions of the rational soul. Brain damage can affect the rational mind. Nevertheless, he stopped short of localising these three distinctive functions into different parts of the brain, and there is no evidence that he associated these functions with the 'anterior', 'middle', or 'posterior' ventricles (van der Eijk, 2008).

It is obvious that Nemesius draws on medical ideas that go beyond Galen, as he assigns to each of these three cardinal mental functions a specific region of the brain. He elaborates on Galen's claim that the physical structure of the brain serves as a suitable instrument for the activities of soul, *i.e.*, the three most important cognitive functions: sensation/imagination, thought, and memory.

Blood circulation and heart function

Nemesius calls the pulse *vital force (ζωτική δύναμις)*, placing its origin into the heart's left ventricle, which he calls *spiritual (πνευματικήν).* The left ventricle distributes vital heat to every molecule of the body through the arteries in the same way the liver distributes food nutrients through the veins. Moreover, Nemesius argues that veins, arteries, and nerves branching throughout the body, spread the vital force. The nerve starts from the brain as the origin of motion and sensation. The liver, which is the origin of blood and nutrients, branches through the veins, which is a blood vessel. The heart is the origin of the vital artery, which Nemesius describes as a vessel of the spirit. All these benefit from one another because the vein grants sustenance to the nerve and the artery, whereas the artery transmits heat and vital spirit to the vein. Thus, no one can find artery without thin blood or vein without vaporous spirit. Arteries dilate and contract firmly and their movement derives from the heart. During the diastolic phase, the heart violently pulls unclean blood from the nearby veins to enrich it with oxygen and turn into 'food' for the vital spirit. However, during the systolic phase, blood is full of soot, and the heart empties it from the body and invisible sources (Migne, 1858). The heart pushes upward smoke through the mouth and nose. Finally, Nemesius repeats Galen's statement that blood is cleared by the kidneys and describes the kidney as a sieve that filters urine (Scarborough, 1976; Marketos, 1993).

According to Galen, the liver is the organ of blood formation. It digests food, transforming it into blood by the addition of *natural spirits*. Blood formed in the liver is carried by the veins to all parts of the body, providing

nutrients to the tissues. A very small fraction of blood leaving the liver finds its way to the heart. The heart is considered the 'hottest' part of the body, the source of body heat, which is actively dilated, drawing blood from the liver into its right-side chamber, just as "the flames of a lamp suck up oil". This active diastole coincides with the active dilation of the arteries (the arterial pulse) (Mowry, 1985). The thick venous blood from the liver is drawn into the right heart chamber and is partly transformed due to the cardiac fire into a sublime type of blood *(arterial blood).* From there, most of the blood flows through minute pores in the heart's dividing septum into the left chamber, where it is endowed with *vital spirits* borne by air coming from the lungs via the pulmonary veins. A small part of this blood is further refined in a network of nerves at the base of the skull and the brain to produce *psychic pneuma (πνεύμα ψυχικόν)* (Mowry, 1985; Boylan, 2007; Aird, 2011). According to Galen's physiology *De usu partium*, blood is filled with a thin watery substance (the carrier of nutrients according to Hippocrates). When this thin substance has accomplished its task, it should no longer remain in the body. The kidneys attract this residue through one vessel and excrete it through another. In this way the blood is cleansed and only purified blood with minimum watery fluid is returned to the body. Galen believes that the kidney is the organ where urine is produced, passes through the ureters to the bladder, and is finally excreted (Diamandopoulos, 2009).

In other words, Nemesius has adopted Galen's view of the kidney role in blood clearance. He furthers it by adopting Hippocrates' theory of humours, adding elements related to physiology and purification of the blood, which according to Nemesius, occurs in the spleen, gall bladder, and kidneys (Eftychiadis, 1995). We can also trace Galen's influence in Nemesius' theory about the central role of the liver in blood production.

Respiration

Nemesius claims the thorax to be the main organ of respiration, and its expansion is done by muscles. He regards respiration as a continuous, uninterrupted function, claiming that any interruption may lead to death. Therefore, breathing continues even in sleep. As regards the physiology of respiration, Nemesius argues that it is *mental strength (ψυχική δύναμις)* which moves the breathing organs, muscles, chest, lung, and its hard arteries. Then he points out that the lung is a kind of nexus consisting of four parts: hard and soft arteries, a vein, and foamy flesh that fills the space between the

nexus, both arteries, and the veins of the lung. Air is treated in a way similar to how food is processed by the liver. The bronchus consists of three parts: three large cartilages, the pharynx, the mouth and the nose, which facilitate inhalation (Migne, 1858).

According to Galen's theory, ambient air is inhaled in the lungs, where it becomes a *spiritual substance*. It is then directed to the left heart chamber, where it is transformed into a *vital spirit*, thanks to the combined action of the internal heat and returning venous blood from the right chamber. The vital spirit is transferred through blood into the choroid plexus of the brain's ventricular system, where it becomes *psychic spirit* or *pneuma* (Debru, 1996; Vlastos and Stratakos, 2001). Galen regards the lung as the organ for cooling the heart with air, which contains the *vital spirit* (Sternbach, 2001). The lungs are therefore inseparable from the heart in facilitating the circulation of spirit (Vlastos and Stratakos, 2001). Galen defines trachea as a rough artery, as it consists of cartilaginous rings. He also considers it a vessel for breathing and phonation (Sternbach, 2001).

Conclusion

Nemesius' treatise *De Natura Hominis* contains important elements of anatomy and physiology, which had a considerable influence in formulating theories about the function of the nervous system and the mapping of the human brain. Nemesius' doctrine on ventricle localisation of mental functions reconciles Platonic with Christian doctrines on soul and also emphasizes Greek scientific interpretation and knowledge of the human body (Rist, 1988; Possekel, 1999). This doctrine was falsely attributed to Gregory of Nyssa (Migne, 1863) and was not recognised as the work of Nemesius until the 7th century AD.

Ultimately, Nemesius' work had a strong impact on later Byzantine scholars, as is apparent from a number of treatises written using a similar or identical title such as *Περί της του ανθρώπου κατασκευής* (*De corporis humani fabrica*) by Theophilus Protospatharios (7th century AD) (Greenhill, 1842), the namesake treatise by Meletius Monachus Iatrosophista (ca 8th century) (Migne, 1862), and *Σύνοψις εις την φύσιν των ανθρώπων* (*De natura hominum synopsis*) *by* Leon Iatrosophista (9th c.) (Renehan, 1969). All of these scholars underlined the importance of performing anatomical dissection as a way of understanding the structure of the human body and the functions and relationships of its components.

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Sažetak

Ovaj članak daje sažeti pregled medicinskih saznanja opisanih u djelu bizantskog učenjaka Nemezija, biskupa od Emeze (IV. st.), "O ljudskoj naravi", napisanog na grčkom. Nemezijevo je djelo snažno utjecalo na kasniji razvoj znanosti u Bizantu, što se vidi iz brojnih traktata napisanih pod istim ili sličnim nazivom, koji govore o strukturi ljudskoga tijela. U pregledu se uvode i kratko objašnjavaju osnovni Nemezijevi stavovi te se uspoređuju s Galenovim koji je velikim dijelom unaprijedio medicinsku znanost staroga vijeka. Svrha je usporedbe bila utvrditi koliko su Galenove teorije o anatomiji i fiziologiji utjecale na Nemezija. Kako bilo, Nemezijevo djelo svjedoči o visokoj razini bizantske medicine te o snažnim utjecajima grčkih intelektualaca, ponajprije Galena.

***Ključne riječi**: bizantska medicina, Nemezije Efeški, Galen, anatomija, fiziologija*