

# Symmetry, Asymmetry, Brain, and Sense Organs in Ancient Greek Medicine

Stefania Fortuna<sup>1\*</sup>, Christina Savino<sup>2</sup>

<sup>1</sup> Dipartimento di Scienze Cliniche e Molecolari, Facoltà di Medicina e Chirurgia, Università Politecnica delle Marche, via Tronto 10/A, I - 60020 Torrette di Ancona; <sup>2</sup> Dipartimento di Studi Umanistici e del Patrimonio Culturale, Università di Udine, Vicolo Florio 2/B, I - 33100 Udine

\*Corresponding author: s.fortuna@univpm.it

**Abstract.** Current neurophysiology accepts that sense organs are arranged in bilateral symmetry, whereas asymmetry is dominant in the brain. Symmetry and asymmetry are words of Greek origin (= *symmetria* and *asymmetria*), which are frequent in ancient medical texts, especially in those of Galen (129-216 AD), the most important anatomist and physiologist from the ancient world who lived in Rome, at the imperial court of Marcus Aurelius (161-180 AD) and his successors. In Greek, *symmetria* means “symmetry, due proportion, harmony among the parts, suitability”, and may be connected with the concept of health, whereas *asymmetria* is the opposite. As regards sense organs, Galen mentioned duality rather than symmetry, and considered it useful, because it ensures the preservation of health and body functions, when one of the pair is injured or lost. Galen established a close relationship between brain and sense organs, and believed that the brain has the same duality as the sense organs. Therefore, Galen contributed to the “obsession with brain symmetry”, which was abandoned only in the 20<sup>th</sup> century.

**Key words:** Hippocrates; Galen; symmetry; asymmetry; brain; sense organs; theory of humors; anatomy

## SIMMETRIA, ASIMMETRIA, CERVELLO E ORGANI DI SENSO NELLA MEDICINA GRECA ANTICA

**Riassunto.** L'attuale neurofisiologia accetta che gli organi di senso siano disposti in simmetria bilaterale, mentre l'asimmetria è dominante nel cervello. Simmetria e asimmetria sono parole di origine greca (= *symmetria* e *asymmetria*), frequenti nei testi medici antichi, soprattutto in quelli di Galeno (129-216 d.C.), il più importante anatomista e fisiologo del mondo antico vissuto a Roma, alla corte imperiale di Marco Aurelio (161-180 d.C.) e dei suoi successori. In greco, *symmetria* significa “simmetria, debita proporzione, armonia tra le parti, adeguatezza”, e può essere collegata al concetto di salute, mentre l'*asymmetria* è l'opposto. Per quanto riguarda gli organi di senso, Galeno menzionò la dualità piuttosto che la simmetria e la considerò utile, perché garantisce la conservazione della salute e delle funzioni del corpo, quando uno dei due viene ferito o perso. Galeno stabilì una stretta relazione tra cervello e organi di senso e credeva che il cervello avesse la stessa dualità degli organi di senso. Galeno ha quindi contribuito all' “ossessione per la simmetria cerebrale”, abbandonata solo nel XX secolo.

**Parole chiave:** Ippocrate; Galeno; simmetria; asimmetria; cervello; organi di senso; teoria degli umori; anatomia

## SIMETRÍA, ASIMETRÍA, CEREBRO Y ÓRGANOS DE LOS SENTIDOS EN LA MEDICINA GRIEGA ANTIGUA

**Resumen.** La neurofisiología actual acepta que los órganos de los sentidos están dispuestos en simetría bilateral, mientras que la asimetría es dominante en el cerebro. Simetría y asimetría son palabras de origen griego

(= *symmetria* y *asymmetria*), frecuentes en textos médicos antiguos, especialmente los de Galeno (129-216 d.C.), el anatomista y fisiólogo más importante del mundo antiguo que vivió en Roma, en la corte imperial de Marco Aurelio (161-180 d.C.) y sus sucesores. En griego, *symmetria* significa “simetría, debida proporción, armonía entre las partes, aptitud”, y puede vincularse al concepto de salud, mientras que la *asymmetria* es lo contrario. En cuanto a los órganos de los sentidos, Galeno mencionó la dualidad más que la simetría y lo consideró útil, porque garantiza la preservación de la salud y las funciones del cuerpo, cuando uno de los dos se lesiona o se pierde. Galeno estableció una relación cercana entre el cerebro y los órganos de los sentidos y creía que el cerebro tiene la misma dualidad que los órganos de los sentidos. Galeno, por tanto, contribuyó a la “obsesión por la simetría cerebral”, que fue abandonada sólo en el siglo XX.

**Palabras clave:** Hipócrates; Galeno; simetría; asimetría; cerebro; órganos sensoriales; teoría del humor; anatomía

## 1. Introduction

Current neurophysiology accepts that sense organs are arranged in bilateral symmetry, whereas asymmetry is dominant in the brain. It was always clear that the human body is symmetrical with respect to left and right, including sense organs; nevertheless the “obsession with brain duality” was abandoned only in the 20<sup>th</sup> century, when brain asymmetries were finally recognized [1].

The words symmetry and asymmetry have Greek origin, and they are frequent in ancient medical texts, but what was their meaning, and, moreover, how far was ancient Greek neurophysiology from now? This paper tries to give an answer to both these questions.

## 2. Symmetry and asymmetry in Greek medical texts

Symmetry and asymmetry are frequent words in Greek medical texts, especially those by the great Galen (129-216 AD), the most important anatomist and physiologist from the ancient world who lived in Rome, at the imperial court of Marcus Aurelius (161-180 AD) and his successors [2]. Galen wrote an amazing number of works, much more than the ones still in existence today, which were transmitted in different languages, mostly in Greek, but also Arabic, Latin, and Hebrew. Only the Greek works of Galen account for an eighth of the entire Greek literature that has survived over time [3-6]. They provide an original synthesis of ancient medicine and philosophy under the patronage

of Hippocrates (460-370 BC), the unquestioned father of medicine [7-10]. Galen presented himself as the best pupil and the unique heir of Hippocrates, so much so that he commented a large number of Hippocratic treatises and interpreted them according to his own theories. Galen's works had an enormous influence on different medical traditions, in Western medicine until the 19<sup>th</sup> century [11-12]. Some of Galen's theories are still dominant in common sense, including the belief that the heart is responsible for falling in love, which explains why love is represented with a red heart, sometimes beating, all over the world nowadays.

The term symmetry comes from the Greek *symmetria*, which is composed of the prefix *syn-* (= “with, together with”) plus *metron* (= “measure”), and means “symmetry, due proportion, harmony among the parts, suitability”, both in a physical and moral sense, whereas *asymmetry* means the opposite [13]. *Symmetria* with its derived adjective and adverb was employed as a technical term in several fields; in medicine, particularly in Galen, it is connected with the concept of health. In the introductory work *The Constitution of The Art of Medicine*, where Galen explains how medicine is structured in different parts, from biology, anatomy, and physiology to therapy, there is the following definition of health and disease (chap. 11: p. 69) [14]:

“Since a healthy body, whether it be *homioimerous* or organic, is entirely in balance (*symmetron*), while a diseased body is imbalanced (*ametron*), we must observe what the actual imbalance (*ametria*) is.”

Health is general symmetry and disease is the opposite. In the Hippocratic treatises (430-350 BC) the

term *symmetria* is not common (there are only 10 occurrences of this term and its derivatives, against 1.504 occurrences in Galen), and the concept of health and disease is instead expressed with good and bad temperament (*eukrasia* and *dyskrasia*) according to the theory of humors, as shown by *The Nature of Man*, which was written by Polybos, Hippocrates' son-in-law around 400 BC (chap. 4: p. 11) [15]:

“The body of man has in itself blood, phlegm, yellow bile and black bile; these make up the nature of his body, and through these he feels pain or enjoys health. Now he enjoys the most perfect health when these elements are duly proportioned to one another in respect of compounding, power and bulk, and when they are perfectly mingled. Pain is felt when one of these elements is in defect or excess, or is isolated in the body without being compounded with all the others.”

According to this theory, health and disease depend on liquids or humors in the body. There are four humors according to *The Nature of Man*, blood, phlegm, yellow bile, and black bile. Galen adopted the theory of four humors, which was able to interpret all diseases, to organize therapies, and to explain the relationship between man and nature. But he also founded his medicine on anatomy, which provides scientific knowledge. Hippocrates and Hippocratic physicians never dealt with anatomy nor practiced dissections. These developed later, from Aristotle (383-322 BC), who practiced animal dissections, then with the Alexandrian physicians Herophilos (335-280 BC) and Erasistratos (304-250 BC), who practiced also human dissections and vivisections, and Galen himself provided important contributions on nerves and muscles on the basis of animals. In his medical system, Galen actually aimed to combine the theory of humors and anatomy, that is, *eukrasia* (good temperament) and *symmetria*, as shown in the following definition of health in *The Art of Medicine* (chap. 2: p. 165) [14]:

“A body is healthy in the absolute sense when it is *eukratic* (*eukrator*) in the simple and primary parts from birth, and balanced (*symmetron*) in the organs compounded from these parts”.

The concept of *eukrasia* (good temperament) is only linked to the theory of humors, whereas that of *symmetria* may involve humors, as often happens, but also fits well with anatomy, as shown in the above-

mentioned text by Galen and in others. It should be pointed out that the concept of *symmetria* was developed by Plato [16], whom Galen considered as his master in philosophy, like Hippocrates in medicine.

### 3. Brain and sense organs in Galen

Galen wrote two major anatomical works: *Anatomical Procedures* (= *AP*), in fifteen books, are reports of Galen's dissections on several animals in order to describe all the parts of the human body, starting from the hand to the nervous system [17]; and *The Usefulness of the Parts of the Body* (= *UP*), in seventeen books, deal with the parts of the human body, their shapes, structures, functions, and especially usefulness, according to a providential and teleological theory of nature [18]. Galen speaks about the brain and sense organs in *AP* IX-X and XIV (books I-VIII and partly IX are preserved in Greek, the others only in Arabic), and in *UP* VIII-X; moreover, in a minor anatomical work entitled *The Dissection of Nerves*, and in *The Doctrines of Hippocrates and Plato*, a treatise devoted to the soul and its three parts, brain, heart, and liver, which is not considered in this article [19-22].

The term *symmetria* with its derivatives is never used in *The Dissection of Nerves*, while it occurs seven times in *AP* (never in book IX), and fifty times in *UP*. In *AP* it is related to anatomical parts, more precisely to the mouth of the bladder, only once (VIII 10: p. 224) [17]:

“Prepare in advance a bladder with a mouth of suitable size (*symmetron*).”

Otherwise, it regards the dissector and the surgical cuts made by Galen himself or by a dissector, as the following example shows (III 3: p. 63) [17]:

“The first step in the procedure is to remove the skin from the underlying tissues ... It is natural at the first attempt either to leave part of the skin uncut, or to sever the underlying membrane with it. By trying a second or third time, increasing or tailing off the depth of the cut, you will soon learn the right measure (*symmetria*).”

There is also a passage, where the adjective *symmetros* also qualifies the anatomical table (VII 12: p. 190) [17]:

“It [the animal] must be on its back, on a board of the kind that you see I have quantities at hand, both large and small, so that one may always be found to fit the animal (*symmetron*).”

The term *symmetria* with its derivatives is more common in *UP*, including books VIII-X on brain and sense organs. In a passage where Galen speaks about cranial sutures, there is a reference to the sagittal suture and both the right and left parts of the head, which are moderately wide (IX 17: p. 459) [18]:

“For, being most just, she [the nature] made a single, straight suture extending lengthwise of the head, since thus the parts of both sides of it, on the right and left, would be moderately wide.”

In another passage, the adjective *symmetros* qualifies the softness of the lens in the eyes, which should be precise (X 6: p. 479) [18]:

“Thus nature has ordered well the instrument of vision [the lens] in every way, in the proper degree of (*symmetros*) softness, in its suitable position, in brilliancy of colour, and in the excellence of its coverings.”

The other occurrences of *symmetria* and its derivatives in *UP* VIII-X, eight in all, have the same meaning, already mentioned above, and the bilateral symmetry is not taken into consideration.

Galen established a close connection between the brain and sense organs, as shown by the following metaphor in *UP* VIII 2: p. 387 [18]:

“The head seems to have been formed on account of the encephalon and for this reason to contain all the senses, like the servants and guards of a great king.”

The sense organs are servants and guards of the brain, which is a great king. The brain is dominant and helped by the sense organs in its functions. Not only the sense organs are double and in pairs, but also there is “the need for all the sense instruments to be double and paired”, as Galen affirms at the beginning of *UP* X (p. 463) [18]: this entire book is devoted to the eyes, which are considered by Galen as the most important sense organs, located in the best place, in an elevated position, in the anterior part of the body, and protected on all sides.

It was not difficult to observe that the head is divided into two sides by the already mentioned sagittal suture, as well as the brain, which is formed by two hemispheres separated by the longitudinal fissure.

Therefore, Galen found the connection between the brain and the sense organs in the duality, as he affirms in *UP* VIII 10: p. 413 [18]:

“It was better that there should be two [lateral] (*dyo*) ventricles rather than one, because there are two channels (*dittos*) leading downward, the sense instruments are all paired (*didymoi*), and the encephalon itself is double (*diphyes*).”

Galen tried to highlight every duality in all the structures of the brain, especially in *UP*, but also in *AP*. The terms applied by him are the number two and its derivatives (*dittos*, *didymoi*, and *diphyes*). Actually, Galen’s duality corresponds to what has been later called bilateral symmetry, probably because duality became so positive that could be symmetrical in the Greek sense, that is, “balanced, due proportioned, suitable.” Galen mainly described the brain in *AP*, while he provided an explanation of everything in *UP*, including the brain and its characteristics. Therefore, the duality of the brain and the sense organs is defined in the following way (VIII 10: p. 413) [18]:

“This duality (*didymotes*) also has another usefulness of which I shall speak when I turn to consider the sense instruments, but the principal and most general usefulness of pairing all instruments is to make it possible, in case one of them is injured, for the remaining one still to be of service ... It is safer whenever possible to make a part paired rather than single.”

Duality ensures the preservation of health and body functions, when one of the pair is injured or lost. Immediately after, Galen tried to provide evidence from his own experience, by telling the story of a youth in Smyrna, who suffered a wound on one side of the brain and survived thanks to the other. This story is probably true, but of course Galen’s anatomy, physiology, and pathology of the brain and nervous system have many limitations, which are comprehensible in the context. It should be mentioned that Galen had to discuss with his rivals, who followed Aristotle’s theory that mental faculties depend on the heart. The greatness of Galen is unquestionable: he was an extraordinary physician and scientist that provided important contributions to the brain and nervous system, as well as to the “obsession with brain duality.”

### 3. Conclusions

Current neurophysiology applies the terms symmetry and asymmetry to the sense organs (symmetrical) and the brain (asymmetrical), which have a Greek origin (*symmetria* and *asymmetria*). In Greek, *symmetria* means “symmetry, due proportion, harmony among the parts, suitability”, whereas *asymmetria* is the opposite. They are frequent in ancient medical texts, especially in those of Galen, where *symmetria* is connected with the concept of health and *asymmetria* with that of disease. In the Hippocratic treatises the concept of health and disease is instead expressed with good and bad temperament (*eukrasia* and *dyskrasia*) according to the theory of humors. Galen adopted the Hippocratic theory of four humors, but he also founded his medicine on anatomy, which started from Aristotle. As regards sense organs, Galen mentioned duality rather than symmetry, and considered it useful, because it ensures the preservation of health and body functions, when one of the pair is injured or lost. Galen established a close relationship between brain and sense organs, and believed that the brain has the same duality as the sense organs. Therefore, Galen contributed to the “obsession with brain symmetry”, which was abandoned only in the 20<sup>th</sup> century.

**Author Contributions:** Both the authors contributed equally to the conception of the idea, implementing and analyzing the experimental results, and writing the manuscript.

### References

1. Corballis, M.C. (2020). Bilaterally Symmetrical: To Be or Not to Be? *Symmetry*, 12, 3, 326. <https://doi.org/10.3390/sym12030326>
2. Nutton, V. (2020). *Galen: A Thinking Doctor in Imperial Rome*. London, New York: Routledge.
3. Kühn, K.G. (1821-1833). *Claudii Galeni Opera omnia*. 20 vols. Leipzig: Knobloch. <http://www.biusante.parisdescartes.fr/histmed/medica/>
4. Galen. (1914-). *Corpus Medicorum Graecorum V*. Berlin: De Gruyter. <http://cmg.bbaw.de/epubl/online/editionen.html>
5. Galen. (2011-). *Loeb Classical Library*. 7 vols. Cambridge, MA: Harvard University Press.
6. Galen. (2019-). *Cambridge Galen Translations*. 1 vol. Cambridge: Cambridge University Press.
7. Jouanna, J. (1999). *Hippocrates*. Transl. by M.B. De Bevoise. Baltimore, London: John Hopkins University Press.
8. Littré, É. (1839-1861). *Ouvres complètes d'Hippocrate*. Traduction nouvelle avec le texte grec en regard, collationné sur les manuscrits et toutes les éditions, accompagnée d'une introduction de commentaires médicaux, de variantes et de notes philologiques, suivie d'une table générale des matières. 10 vols. Paris: Baillière. <https://gallica.bnf.fr/>
9. Hippocrates. (1927-). *Corpus Medicorum Graecorum I*. Berlin: De Gruyter. <http://cmg.bbaw.de/epubl/online/editionen.html>
10. Hippocrates. (1923-). *Loeb Classical Library*. 11 vols. Cambridge, MA: Harvard University Press.
11. Temkin, O. (1973). *Galenism: Rise and Decline of a Medical Philosophy*. Ithaca, NY: Cornell University Press.
12. Bouras-Vallianatos, P., Zipser, B., eds. (2019). *Brill's Companion to the Reception of Galen*, Leiden/Boston: Brill.
13. LSJ, *The Online Liddell-Scott-Jones Greek-English Lexicon*. In *Thesaurus Linguae Graecae*. A Digital Library of Greek Literature. <http://stephanus.tlg.uci.edu/>
14. Johnston, I. (2016). *Galen, On the Constitution of the Art of Medicine, The Art of Medicine, A Method of Medicine to Glaucón*. *Loeb Classical Library*, 523. Cambridge, MA, London: Harvard University Press.
15. Jones, W.H.S. (1931). *Hippocrates, IV*. *Loeb Classical Library*, 150. Cambridge, MA, London: Harvard University Press.
16. Mugler, Ch. (1956). *Platonica*. *Antiquité Classique*, 25, 21-28.
17. Singer, Ch. (1956). *Galen, On Anatomical Procedures*. Translation of the Surviving Books with Introduction and Notes. London, New York, Toronto: Oxford University Press.
18. May, M.T. (1968). *Galen, On the Usefulness of the Parts of the Body*. Translated from the Greek with an Introduction and Commentary. Ithaca, New York: Cornell University Press.
19. De Lacy, Ph. (1978-1984). *Galen, On the Doctrines of Hippocrates and Plato*. 3 vols. *Corpus Medicorum Graecorum V* 4, 1, 2. Berlin: Akademie Verlag.
20. Rocca, J. (2003). *Galen on the Brain*. *Anatomical Knowledge and Physiological Speculation in the Second Century AD*. *Studies in Ancient Medicine*, 26. Leiden: Brill.
21. Manzoni, T. (2001). *Il cervello secondo Galeno*. Ancona: il lavoro editoriale.
22. Siegel, R.E. (1970). *Galen on Sense Perception*. His Doctrines, Observations and Experiments on Vision, Hearing, Smell, Touch and Pain, and Their Historical Sources. Basel: Karger.