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# On the Heart of the Hippocratic Corpus: its meaning, context and purpose

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## Abstract

Though the Hippocratic text *On the Heart* has garnered significant attention in the twentieth and twenty-first centuries from classicists, physicians and historians of medicine alike, no commentary on this important work currently exists. There remain, however, central questions of interpretation concerning a number of important points: in particular, how the author understands the structure and functioning of the heart.

The significance of this text for the history of cardiovascular medicine can be found first in its position as being radically advanced in its portrayal of the inner structure of the heart when compared with any other Hippocratic text. At the same time, the text falls dramatically short of the discoveries of the Alexandrian researchers who studied during the Hellenistic period—that is, around the same period as this text’s likely composition. In addition, this work contains the first extant description of the valves of the heart, and its detailed descriptions of a cuspid valve and the *chordae tendineae* have led several scholars to imagine that this text even contains evidence of either a systematic dissection of an animal heart or—what seems impossible outside of Alexandria, Egypt at that time—evidence of the dissection of a human heart.

This article intends to provide a full commentary on the text by consolidating, and in some cases correcting, previous interpretive attempts to understand an often referenced, and at times misinterpreted, ancient medical treatise.

**Keywords:** Alexandrian physicians; Ancient Greek medicine; cardiovascular; heart; Hippocrates; Hippocratic Corpus

## Introduction

The text *On the Heart* (Latin: *de corde*; Greek: *περὶ καρδίας*) is part of the 60 or so Greek texts that comprise the so-called *Hippocratic Corpus*. The work, however, is almost assuredly not by the historical Hippocrates (circa 460–377 BCE). Given how much interest there has been in this text over the last few decades, it is surprising that there is no full commentary that places the text in its cultural and historical context, explains some of the remaining misunderstood mechanical details of the heart, and compares and coordinates the various scholarly readings that have been published that focus on particular sections of the work. Since modern discussions of *On the Heart* acknowledge its ‘great difficulties in interpretation’,<sup>1</sup> the purpose of the current article is to answer these difficulties as much as possible for a reader interested in the history of cardiovascular architecture and mechanics.

The Hippocratic text *On the Heart* is, generally speaking, relatively strange: it is called ‘paradoxical’ (Lonie), and ‘entirely divergent’ from any other anatomical texts before the second century CE (Hurlbutt);<sup>2</sup> indeed, this short work is unlike any other text included in the *Hippocratic Corpus*. Scholars vary on its dating by whole centuries; attributions to ancient schools of medicine or intellectual traditions

<sup>1</sup>Lonie, 1973, 1; Cf. Iain M. Lonie, ‘The Paradoxical Text “On the Heart”, Part 1’, *Medical History*, 17.1 (1973), 1–15.

<sup>2</sup>Frank Hurlbutt, ‘*Peri Kardies*: A Treatise on the Heart from the Hippocratic Corpus: Introduction and Translation’, *Bulletin of the History of Medicine*, 7, 9 (1939), 1104–13.

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vary widely; the geographical and cultural context of the text is unknown. As a result, this work's authorship—as is often the case for Hippocratic texts—is even more speculative.<sup>3</sup> What we can say, however, is that it is the only systematic anatomical text identified within the *Corpus*. The anatomical approach of *Heart* cannot easily be located either within a typical Hippocratic context (itself a diverse ideological landscape), except in very general terms or within the rich mechanistic world of the third-century BCE Alexandrian anatomist-physicians, at least with any precision. In the end, *On the Heart* is a text that occupies a space all its own.

In some ways, quite a bit of what *Heart* had to say about the heart and human body is relatively straightforward. The work puts the heart at the centre of the vascular system, as well as the centre of consciousness. The latter idea, however, though most famously the same position as that of Aristotle and some of his fourth-century contemporaries (such as Diocles and Praxogoras), is *not* the position of any other Hippocratic authors, who overwhelmingly place the seat of cognition and thought in the brain (see *On the Sacred Disease* as an early example).

Within the work itself, the author describes the heart, along with the pericardium, the left and right ventricles, and at least two valves. Yet, due to the general vagueness of the language used as well as some rather elliptical syntax, there continue to be disagreements over even central points. My purpose in this chapter-by-chapter commentary is to consider the most current scholarship on *On the Heart*, focusing especially on the more obscure and complicated passages in the text and suggesting the most reasonable interpretations where appropriate. Since there is a recently published (2010) Loeb translation of the Greek text by Paul Potter, I have keyed my commentary to match it, mentioning deviations from his choices whenever necessary.<sup>4</sup>

## Dating

There is little consensus regarding the dating of this text, except that it is a relatively late composition, certainly after Hippocrates (circa 460–370 BCE).<sup>5</sup> Little else about the work is a matter of much agreement. Littré thought it later than Aristotle (384–322 BCE), since this text considers the heart as the centre of the vascular system, which Aristotle reports he himself discovered.<sup>6</sup> Fredrich instead rejected a post-Aristotle dating and thought its author to be Diocles of Carystus (circa 375–295 BCE) since this text does not reflect the difference Praxagoras (circa 350–300 BCE) maintained between arteries (which he thought issue from the heart) and veins (which he thought come from the liver), nor his idea that arteries only contained *pneuma* ('animal spirit'), not blood.<sup>7</sup> Wellmann cites a conjunction in the text between the cardiocentric theories of the Cnidian and Sicilian schools and an influence of Philistion of Locri (fourth century BCE).<sup>8</sup> Hurlbutt agrees with this reflection of an influence of the Sicilian school and suggests a date after Diocles.<sup>9</sup> Abel agrees that the text is post-Aristotle and likely Hellenistic (323–33 BCE), and its discussions of the valves in the heart point to a time after Erasistratus (circa 305–250 BCE).<sup>10</sup> Harris suggests a date during or after the Alexandrians (circa 300–250 BCE),

<sup>3</sup>See Duminil's introduction and notes for discussion: Marie-Paule Duminil (ed.), *Hippocrate. Tome VIII. Plaies, Nature des Os, Coeur, Anatomie. Texte établi et traduit*. Collection des Universités de France publiée sous le patronage de l'Association Guillaume Bude. (Paris: Les Belles Lettres, 1998), 161–186 and 237–258.

<sup>4</sup>Hippocrates, *Coan Precognitions. Anatomical and Minor Clinical Writings*. Translated by Paul Potter. Loeb Classical Library 509 (Cambridge, MA: Harvard University Press, 2010).

<sup>5</sup>Kurt Latte (ed.), *Hesychii Alexandrini Lexicon*. Vol. 1 and 2 (Copenhagen: Munksgaard, 1953–1966).

<sup>6</sup>According to Littré; cf. Émile Littré, *Oeuvres complètes d'Hippocrate*. Vol. 9 (Paris: Baillière, 1861 [repr. Amsterdam: Hakkert, 1962]), 80–92.

<sup>7</sup>Carl Fredrich, *Hippokratische Untersuchungen* (Berlin: Weidmann, 1899), 77.

<sup>8</sup>Max Wellmann, *Die Fragmente der sikelischen Ärzte Akron, Philistion und des Diokles von Karystos*, (Berlin: Weidmannsche buchhandlung, 1901), 95–107.

<sup>9</sup>Cf. Hurlbutt, *op. cit.* (note 2), 1104–13.

<sup>10</sup>Abel Karlhans, 'Die Lehre vom Blutkreislauf im Corpus Hippocraticum', *Hermes* 86 (1958), 192–219; note as well his observation that this is the first extant treatise that mentions the valves of the heart.

primarily because of the relative accuracy of the valves of the heart; he also suggests that the text is perhaps attributable to one of the early Pneumatists (circa first century BCE?),<sup>11</sup> whose fragmentary work made it into a late revision of the *Hippocratic Corpus*.<sup>12</sup> Lonie finds it ‘difficult to conceive that this portrait of the heart...should have been made before the work of Herophilus and Erasistratus’, and so (152) tentatively dates it within the first half of the third century BCE, that is, ‘shortly prior to the work’ of the Alexandrians, ‘prefiguring...the “classical” portrait of the heart’ we associate with them.<sup>13</sup> Finally, Nutton tentatively suggests a date in the 270s because the text reflects a clear interest in the internal workings and a description of the heart; in addition, considering the work’s language and syntax, he also proposes a Hellenistic dating.<sup>14</sup>

Regarding ancient references to the text, as Potter notes, the text was unknown to Erotian (first century CE), author of the *Collection of Hippocratic Words*;<sup>15</sup> Galen (129–210 CE) quotes it anonymously;<sup>16</sup> Plutarch (46–119 CE) seems to offer a similar view as that described in Chapter 2 of *On the Heart*;<sup>17</sup> and Hesychius (fifth century CE) seems to include four glosses on three words that may derive from the work.

It is important to note that there seems to be, as is pointed out by Harris and others, both a *general* influence—but also lack of detailed knowledge—of the discoveries of the Alexandrian physicians and researchers Herophilus (circa 330–260 BCE) and Erasistratus, as well as an absence of any of the specific medical terminology they developed that afterwards became cardinal nomenclature. The author of *On the Heart* discusses only one set of valves clearly, and not the inlet valves of Erasistratus, and, further, discusses them as moveable ‘gates’ or ‘doors’ (θύραι), not valves designed to ensure complete unidirectionality or irreversibility of blood flow. This suggests that the author was writing before or early in the third-century BCE Alexandrians, or in ignorance of the discoveries of the Alexandrian physicians—something implausible for Nutton, in particular. In the end, many issues regarding this text remain unresolved: for example, a definable Stoic influence, as argued, for example, by Lonie;<sup>18</sup> *definitive* proof of animal or human dissection; or any concrete affiliations with a particular ancient medical sect.<sup>19</sup>

## Summary and commentary by chapter

### Chapter 1. Shape and colour of the heart; pericardial sack and fluid

The author begins with a description of heart as a dark red pyramid.<sup>20</sup> There is mention of the pericardium (χιτών, literally: ‘tunic’) filled with a little ‘urine-like’ liquid, like a ‘bladder’ (κύστις;

<sup>11</sup>On the Pneumatists, cf. Lauren Caldwell, ‘Roman Medical Sects: The Asclepiadeans, the Methodists, and the Pneumatists’ in *Oxford Handbook of Science and Medicine in the Classical World* (Oxford UP, 2018), 637–54.

<sup>12</sup>Charles Reginald Schiller Harris, *The Heart and the Vascular System in Ancient Greek Medicine from Alcmaeon to Galen* (Oxford: The Clarendon Press, 1973).

<sup>13</sup>Cf. Lonie, 1973, 152; Iain M. Lonie, ‘The Paradoxical Text “On the Heart”, Part 2’, *Medical History*, 17.2 (1973), 136–153.

<sup>14</sup>Vivian Nutton, *Ancient Medicine* (London: Routledge, 2013), 139.

<sup>15</sup>Cf. Potter, 2010, 52–53; for Erotian, cf. Ernst Nachmanson, *Erotiani vocum Hippocraticarum collectio cum fragmentis* (Göteborg: Eranos, 1918), 3–96.

<sup>16</sup>Philip De Lacy (ed.), *Galen on the Doctrines of Hippocrates and Plato, Corpus Medicorum Graecorum V 4, 1, 2* (Berlin, 1978–84), 538 (= Galen vol. 5, 719).

<sup>17</sup>Cf. *Plutarch Table-talk* 7.3 (699c).

<sup>18</sup>Cf. Lonie, *op. cit.* (note 13), 149–51; however, Harris, *op. cit.* (note 12), 92 notes that the Stoic influence recorded by Wellmann is ‘obvious’; also cf. Nutton, *op. cit.* (note 14), 139: ‘indications of influence from Stoic philosophy are suggestive at best’.

<sup>19</sup>For general discussions of the dating of this text, cf. Harris, *op. cit.* (note 12), 83–5 and 89; Lonie, *op. cit.* (note 2 and 13), *passim*; and Nutton, *op. cit.* (note 14), 139.

<sup>20</sup>As Harris, *op. cit.* (note 12), 85 points out, this description mirrors terms often given in a modern textbook, as in Gray’s section on the heart: ‘The heart is a hollow muscular organ of a somewhat conical form’; Henry Gray, *Gray’s Anatomy: The Anatomical Basis of Medicine and Surgery* (Edinburgh: Churchill Livingstone, 1858), 669. Galen describes the heart as a cone that points down (cf. *Anatomical Procedures* Kühn ii 595, 3). Both descriptions have been in use for some time: ‘The present

i.e., the pericardial fluid).<sup>21</sup> The heart, after ‘sipping’ (λάπτουσα) from the lung,<sup>22</sup> sends out<sup>23</sup> just enough liquid to keep it from being ‘burned up’ or ‘ignited’ (πυρευμένη) from ‘leaping’ or ‘being tossed about’ (θρόσκη).<sup>24</sup>

The second person singular verb found here (‘you will think [δόξεις]...the heart dwells in a bladder...’) is an invitation for the reader to conceptualize the author’s illustrative metaphor; Potter translates: ‘so that you might imagine’. This type of vivid construction is used throughout the work.

Syntactic construction in this chapter suggests a teleological design, not uncommon in this text, which should not be overlooked: the heart enclosed in a smooth tunic of liquid ‘is so arranged in order that’ (γεγένηται δὲ τούτου ἔνεκα), which is a formulation that is suggestive of intentional design by some agent (for example, see the ‘good hand-worker’ who created the heart, Chapter 8, below).<sup>25</sup>

As Lonie (1973, 145) observes, ‘[a] feature of teleological explanations are *Technikvergleichen*, parts of the body being compared, in respect of form and function together, to familiar instruments or utensils’. We see in this chapter a reference to the heart resting in a ‘tunic’, but later we will find the throat compared to a ‘funnel’ in Chapter 2; and the left ventricle being like a ‘smooth stone’, or ‘mortar’ in Chapter 5. We will also find extended uses of natural object metaphors: for example, the ‘fountains’ of life in Chapter 7, and, in Chapter 10, our author will use ‘spider webs’ to illustrate the *chordae tendineae*. The tendency to use everyday objects metaphorically for the purpose of illustration goes back to Homer and is a tradition continued by the Presocratics (the example of rivers, for example, in Heraclitus). Use of metaphor to describe human anatomy begins with Empedocles (B 84 = D 215), who compares the function of the human eye to that of a lantern.<sup>26</sup> We find the same tendency in various Hippocratic texts, especially in the use of farming, or the behaviour of flora or horticulture in general, as explanations of the processes of the human body.<sup>27</sup>

## Chapter 2. The path of swallowed fluid

When we drink, the author continues, most of it goes ‘into the gut’ (ἐς νηδύν), since the ‘oesophagus’ (στόμαχος) is shaped like a funnel, and some goes in the small opening of the larynx or ‘windpipe’ (φάρυγγ). The ‘epiglottis’ (ἐπιγλωσσίς), however, stops an excess of the liquid from entering the lungs. The author offers an experiment to prove his point: ‘if someone were’ (ἦν γάρ τις) to give a pig dyed water to drink and cut its throat, some of the dyed water would be visible in its windpipe

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Outline, viewed apart from any preconceived notions, would suggest that the heart resembles a cone or a pyramid; William Ewart, *Cardiac Outlines for Clinical Clerks and Practitioners and First Principles in the Physical Examination of the Heart for the Beginner* (New York: Putnam, 1892), 26; Karl Gottlob Kühn, *Claudii Galeni opera omnia*, 20 vol. (Leipzig: Knobloch, 1821–1833) (repr. Hildesheim: Olms, 1964).

<sup>21</sup>All translations are mine, unless otherwise noted.

<sup>22</sup>In this chapter the heart ‘sips’; in Chapter 3, the individual partly ‘spits out’ (ἀποπτύει) liquid into the sheath of the heart. For a discussion of metaphoric language in this text, see the discussion in Chapter 8.

<sup>23</sup>Potter reads διουρέει (‘passed like urine’); Littré has διορροῖ (‘turned into serum’).

<sup>24</sup>Potter reads θ[άλλεται]ρόσκη (which he translates as ‘beating vigorously’); Littré has ἄλληται ῥωσκομένως (‘leaps strongly’; cf. LSJ s.v. ῥωσκομένως). The reading of manuscript V is θάλλεται ῥωσκημένως (‘swells strongly’).

<sup>25</sup>Some translations reflecting this idea can be found in Hurlbutt, *op. cit.* (note 2), 1109: ‘And this has come into being in order that...’; Lonie, 1973, 144: the pericardial fluid exists ‘for this purpose, that...’; and Lonie, 1983, 347: ‘The purpose of the fluid is...’; I.M. Lonie ‘Heart’ in G.E.R. Lloyd, J. Chadwick, and W.N. Mann, *Hippocratic Writings* (New edition, with additional material, reprinted in Penguin classics, 1983), 347.

<sup>26</sup>Cf. Marwan Rashed, ‘The Structure of the Eye and its Cosmological Function in Empedocles. Reconstruction of Fragment 84 D.-K.’, in *Reading Ancient Texts. Volume I: Presocratics and Plato*, Suzanne Stern-Gillet and Kevin Corrigan (eds.) (Leiden and Boston: Brill, 2007), 21–39.

<sup>27</sup>For example, cf. the Hippocratic *The Nature of Man* 6: ‘For just as things that are sown and grow in the earth, when they enter it, draw each that constituent of the earth which is nearest akin to it—these are the acid, the bitter, the sweet, the salt and so on—first the plant draws to itself mostly that element which is most akin to it, and then it draws the other constituents also’; and Celsus Proemium to *On Medicine*: ‘Just as agriculture promises nourishment to healthy bodies, so does the Art of Medicine promise health to the sick.’

(literally: ‘you would find this [sc. the trachea] coloured by the drink’). The author suggests that such an ‘operation’ or ‘surgery’ (χειρουργία) is not for every ‘man’ (άνήρ): that is, such messy anatomical demonstrations are not to everyone’s taste.<sup>28</sup> Finally, the author chides that ‘our’ (ἡμῶν<sup>29</sup>) opinion that what is drunk by a human being lubricates the windpipe should ‘absolutely not be dismissed (οὐκ οὐκ ἀπιστητέον)’.

The theory presented is that a small amount of liquid that enters the windpipe lubricates it. When too much liquid flows in, we are told, it collides with the breath coming out, and the person chokes. A smaller amount does not cause this problem, however, and eventually comes back out with the breath ‘along with the air’ (ἅμα τῷ ἠέρι). The idea that some of the liquid bypasses the epiglottis and enters the lung was denied by Erasistratus and accepted by Galen.<sup>30</sup> The theory of consumed liquid entering the lung is presented in the Hippocratic *On the Nature of Bones* 1 and Plato (cf. *Timaeus* 91a), though the idea is contrary to that of the Hippocratic author of *On Diseases* 4. The Plutarch reference often discussed alongside this section of *On the Heart* is from *Table Talk* 699c–d.<sup>31</sup>

The occasional first-person singular pronoun is used for emphasis in this text: in this chapter, we find: “Because, as I say” (οὐνεκα φημί) it collides with the breath coming out.’ In general, however, *On the Heart* is considered less rhetorically sophistic or polemic than many other Hippocratic texts, even humble in its proclamations. The pronouncement of universal laws is kept to a minimum,<sup>32</sup> as are specifically named scholastic adversaries.<sup>33</sup>

### Chapter 3. Function of air and moisture for the heart

Upon expiration, after the air has fulfilled its ‘office’ (θεραπεῖν<sup>34</sup>), ‘by necessity’ (ἀνάγκη) the individual ‘spits out’ (ἀποπτύει) some of the moisture into the pericardium; the rest of the air exits the oesophagus, raising the epiglottis. Air and water are thus shown to be useful to the vascular system—that is, for the purpose of cooling and lubrication, respectively—but are decidedly not sources of nutrients. As our author asks: ‘how could air and water be human nutriment, since they are “crude things” (τὰ ὠμά)?’ Rather, these elements are a ‘counterbalance to an inborn disposition’ (τιμωρή ζυγγενέος πάθης): that is, the natural heat of the heart.

The teleological construction in the first sentence of Chapter 3 is noteworthy and well reflected in Hurlbutt’s translation: ‘Now, therefore, the heart must, after the air has completed its remedial service,

<sup>28</sup>cf. Heinrich von Staden, ‘Experiment and Experience in Hellenistic Medicine’, *Bulletin of the Institute of Classical Studies*, 22 (1975), 178–99. Literally: ‘hand-work’ (χειρ[ός] + ἔργον); cf. LSJ s.v. χειρουργία: ‘esp. the art or practice of surgery, opp. the administration of medicine, χειρουργίη χρηθῆσθαι perform an operation, Hp. *Prog.* 23; LSJ = Henry George Liddell and Robert Scott, *A Greek-English Lexicon. Revised and Augmented Throughout by Sir Henry Stuart Jones with the assistance of Roderick McKenzie* (Oxford: Clarendon Press, 1940). Hurlbutt, *op. cit.* (note 2), 1110 notes: ‘Here is shown by the attitude taken toward the experiment on the animal that the experimental method was not common. This is one of the reasons why Greek medicine could not go farther. Convention was against its advance along that line.’ Alternatively, von Staden, 1975, 181 argues that the test in *On the Heart* seems to qualify as a scientific experiment, even though the author arrives at an erroneous generalization. According to von Staden, this experiment is inconclusive for the three reasons: 1. forcing a problematic analogy between pigs and human beings; 2. creating a generalization out of a hypothesis that holds in one instance but not in all instances; 3. arguing by affirmation of the consequent.

<sup>29</sup>In a letter to me, Luke Madson wonders whether this first-person plural pronoun suggests a school of thought, which certainly seems possible; alternatively, Nutton, *op. cit.* (note 14), 139 suggests that ‘whatever his date, he is apparently working away from any obvious centre’.

<sup>30</sup>Hurlbutt, *op. cit.*, 1110.

<sup>31</sup>Part of Plutarch’s longer section (*Moralia* 699d) reads: ‘...for the epiglottis lies in front of the windpipe as a barrier or chamber, so that drink may filter through gradually and a little at a time, and not, by being forced suddenly or all at once, do violence to the breath and disrupt its regularity’.

<sup>32</sup>For examples of such pronouncements, cf. the Hippocratic *Generation* 1, with the reading: ‘Law rules all things.’; and *Regimen* 1 11: ‘But human beings do not understand how to observe the invisible through the visible.’

<sup>33</sup>On the ‘matter of fact tone’ of *On the Heart*, cf. Lonie, 1973, 1.

<sup>34</sup>θεραπεῖν can also mean ‘aid’ as well as ‘medical or surgical treatment or cure’ (LSJ s.v. θεραπεία).

necessarily cast it forth by the same road whence it came.’ (Τὸν μὲν οὖν ἡέρα χρή, γενόμενον θεραπείην, ἀνάγκη ὀπίσω τὴν αὐτὴν ὁδὸν ἐκβάλλειν ἔνθεν ἤγαγεν.)<sup>35</sup>

Pace Lonie (1973), there does not seem to be reason to take the mention of *pneuma* (πνεῦμα) in this section of text as anything other than a synonym for ‘air’ (ἄνεμος), a use found just before it:

Now whereas a person must necessarily expel the ‘air’ (ἡέρα), after it has fulfilled its office back through the same passage by which they drew it in, the moisture is partly spit out into the sheath of the heart, and partly allowed to go back ‘with the air’ (ξὺν τῷ ἡέρι) to the outside, ‘the breath’ (τὸ πνεῦμα) in this process raising the extremity<sup>36</sup> [sc. of the epiglottis] as it flows back. It flows back ‘according to the normal course of events’ (κατὰ δίκην), for such substances are not nourishing to a man’s nature—indeed, how could ‘air’ (ἄνεμος) and water be human nutriments, crude as they are?<sup>37</sup>

The use of κατὰ δίκην<sup>38</sup> (Potter’s ‘according to the normal course of events’, above) to describe the flow of air back out of the body might be viewed as an example of early teleological tendencies in *On the Heart*.<sup>39</sup> The phrase describes what should happen, given the author’s conception of the human body (see chapter 9, below)—in this case, that water and air do not nourish the human body. Potter’s translation might seem more neutral; Hurlbutt translates ‘and it is proper...’, and Lonie gives: ‘Of course...’<sup>40</sup>

#### Chapter 4. Return to the discussion of the heart—it is a muscle; description of the ventricles

The text asserts that the heart is a strong muscle, not because its flesh is like a sinew or tendon (νεῦρον, ‘cord-like’), but because it is ‘thick’ (πύλημα, perhaps ‘compressed’).<sup>41</sup> This is noteworthy because Galen denied that the heart was a muscle at all.<sup>42</sup>

We then read a description of the left and right ventricles (γαστέρες, literally: ‘abdomens’ or ‘bellies’): the right ventricle lies on one vein (*vena cava*); has a ‘wide chamber’ (εὐρυκοῖλος); is ‘much slacker’ (λαγαραωτέρη πολλῶ) than the left ventricle; does not occupy ‘the extremity’ (τὴν ἐσχατὴν) of the heart, but leaves the ‘extremity’ (οὐραχόν, or ‘apex’) ‘solid’ (στερεόν); and looks ‘as if stitched on from the outside’ (ὥσπερ ἔξωθεν προσεραμμένη). (Later in Chapter 9, the author seems to assume that the right ventricle ‘enfolds’ [τὰ ἐπικείμενα] the left.)

As Harris notes, while it is unclear whether the author understands the difference between the different types of blood vessels, he does seem to know the difference between the *vena cava* and both arteries—the aorta, which connects to the left ventricle; and the pulmonary artery, which connects to the right—both of which he refers to as ‘aortas’ (ἄορταί).<sup>43</sup>

The phrases ‘on the one hand, with respect to this place...on the other hand, with respect to that place...’ (τὴν μὲν ἔνθα...τὴν δὲ ἔνθα...) in this chapter suggest to Hurlbutt that there was a lecture

<sup>35</sup>Hurlbutt, *op. cit.* (note 2), 1110.

<sup>36</sup>Potter prints and translates οὐραχόν (‘apex’, ‘extremity’); Hurlbutt (following Littré) translates οὐρανὸν (‘heaven’, ‘vault’) of manuscript V.

<sup>37</sup>Translation Potter, *op. cit.* (note 4), 61. Cf. Lonie, 1973, 147–50 for his discussion of the *pneuma* theory as it applies to *On the Heart*.

<sup>38</sup>LSJ s.v. δίκη: ‘κατὰ δίκην: “Adverb. usages...duly, rightly”’; but note also a use listed there from *On Head Wounds* (3): ‘“normal course of nature”, ἐκ τουτέων ὁ θάνατος οὐ γίνεται κατὰ γε δίκην, οὐδ’ ἦν γένηται’.

<sup>39</sup>Elizabeth Craik, ‘Teleology in Hippocratic Texts: Clues to the Future?’ in Julius Rocca (ed.), *Teleology in the Ancient World: Philosophical and Medical Approaches* (Cambridge: Cambridge University Press, 2017), 214.

<sup>40</sup>Hurlbutt, *op. cit.*, 1110; Lonie, *op. cit.* (note 23), 348.

<sup>41</sup>The observation of the ‘compactness of flesh’ here is ‘almost certainly’ suggestive of autopsy, according to Hurlbutt, *op. cit.* (note 2), 1110.

<sup>42</sup>Cf. *On the Usefulness of the Parts* vi 8, Kühn iii 437 f and *On Anatomical Procedures* vii 8, Kühn ii 609 f.

<sup>43</sup>Cf. Harris, *op. cit.* (note 12), 86; also Hurlbutt, *op. cit.* (note 2), 1106. On Herophilus’ differentiation between arteries and veins, cf. Lonie, *op. cit.* (note 1), 5–7.

demonstration involved with this text.<sup>44</sup> As he puts it, the correlatives ‘indicate that the lecture was executed by means of a blackboard or set of screens with a picture of the heart drawn in illustration’. He accordingly translates, ‘one on this side..., one on that side...’.

Potter’s reading and translation of the difficult second and third sentences in Chapter 4 avoid some of the problems found in other interpretations of the text, which have led to various deletions and emendations (examples include Littré’s and Hurlbutt’s omitting a final word and the addition of ‘vein’ by Harris).<sup>45</sup> Potter’s translation reads:<sup>46</sup>

καὶ δύο γαστέρας ἔχει διακεκριμένας ἐν ἐνὶ περιβόλῳ, τὴν μὲν ἔνθα, τὴν δὲ ἔνθα· οὐδὲν δ’ εὐόικασιν ἀλλήλησιν· ἢ μὲν γὰρ ἐν τοῖσι δεξιόσιν ἐπὶ στόμα κέεται ὀμιλέουσα τῇ ἐτέρῃ φλεβί, ἢ δὲ δεξιῇ φημί τῶν ἐν λαιοῖς· ἢ γὰρ πᾶσα καρδίη τούτοισι τὴν ἔδρην ἐμπεποιήται.

It has two ventricles divided from each other in one covering, one on the one side, the other on the other. These ventricles do not resemble one another at all, for the one in the right parts—the right I mean of the parts on the left, as the entire heart has its seat in these—lies up against an orifice, being in contact with one of the two veins (vena cava).<sup>47</sup>

### Chapter 5. Ventricles (continued)

The left ventricle is oriented toward the left side of the chest, where its ‘pulsation’ (ἄλμα; perhaps ‘leap’) is visible and lies ‘beneath (or “nearly underneath”) for the most part’ (ὑπένερθε...μάλιστα). Its wall is thick, and the interior is a ‘pit’ or ‘small trench’ (βόθρον), like a ‘mortar’ or ‘small, smooth stone’ (ὄλμος). The left ventricle is enclosed by the lung, which, as well as being further cooled by inhalation, by being ‘naturally cool’ (φύσει ψυχρός), counteracts the ‘unmixed quality of the heat’ (τὴν ἀκρασίην<sup>48</sup> τοῦ θερμοῦ) inside the left ventricle.

Aristotle’s *Parts of Animals* (2.7 652b23-6) and the Aristotelian *On Breath* (10.475b16) both acknowledge that the heart must be cooled externally (in the former, the brain performs that task). This external cooling is also necessary for the Hippocratic author of *On Skin* 6.3, though we might note that in that text, the author holds that air is ‘nourishment’ (τρέφον), as opposed to the arguments given in Chapter 3 above.

### Chapter 6. Interior of the ventricles

Both ventricles are ‘rough’ (or ‘shaggy’, δασεῖαι) and ‘so to speak, corroded’ (ὥσπερ ὑποδιαβεβρωμένοι) —the left ventricle even more than the right, which has no ‘inborn fire’ (ἐμφυτον πῦρ).<sup>49</sup> It is the left

<sup>44</sup>Cf. Hurlbutt, *op. cit.* (note 2), 1105.

<sup>45</sup>Potter, *op. cit.* (note 4), 61–3.

<sup>46</sup>Littré’s reading of the Greek is: Καὶ δύο γαστέρας ἔχει διακεκριμένας ἐν ἐνὶ περιβόλῳ, τὴν μὲν ἔνθα, τὴν δὲ ἔνθα· οὐδὲν δὲ εὐόικασιν ἀλλήλησιν· ἢ μὲν γὰρ ἐν τοῖσι δεξιόσιν ἐπὶ στόμα κέεται ὀμιλέουσα τῇ ἐτέρῃ [φλεβί], ἢ δὲ δεξιῇ φημί τῶν ἐν λαιοῖς· ἢ γὰρ πᾶσα καρδίη τούτοισι τὴν ἔδρην ἐμπεποιήται. Hurlbutt’s, 1939, 1110 translation: ‘...and it has two separate bellies in a single inclosure, one on this side, and one on that, but they are not all alike. For the one on the right lies in front, close to the other. I say “the right” of things on the left, for the whole heart, with reference to its location, is placed among these’; cf. Harris, *op. cit.* (note 12), 86 for discussion.

<sup>47</sup>Potter, *op. cit.* (note 4), 60–3.

<sup>48</sup>Potter translates ἀκρασία as ‘unmixed quality’, which coincides with the meaning found in the rest of the text; Hurlbutt, 1939, 111 gives ‘violence [of the heat]’. Cf. LSJ s.v. ἀκρασία: ‘bad mixture, ill temperature, opp. εὐκρασία, ἄ. ἀερος an unwholesome climate...διὰ τὴν ἀκρησίην [i.e., ‘uncompounded character’], of meats, Hippocrates *On Ancient Medicine* 7; χυμῶν ἀκρησία [‘acridness of humors’] *ibid.* 18’.

<sup>49</sup>For some Hippocratic authors, heat is the substance of life endowed with intelligence: cf. *Fleshes* (2, 6) and *Aphorisms* (1.14–5: ‘Growing creatures have the most ‘inborn heat’ [τὸ ἐμφυτον θερμόν]). For Aristotle, the animal body contains ‘innate *pneuma*’ (σύμφυτον πνεῦμα) (*On Breath* 4) or ‘some innate heat’ (τινὰ σύμφυτον θερμότητα) (*On Youth and Old Age. On Life and Death* 4); when the heart loses its heat, life departs (*ibid.*).

ventricle that is ‘filled with’ (ἐμπλήην) or ‘breathes’ (ἐσπνέουσιν)—on each reading, see below—this ‘unmixed’ (ἀκρήτου<sup>50</sup>) substance. Though there is no noun given that agrees with ‘unmixed’, since we find ‘inborn fire’ in the first part of the sentence, Potter reads ‘unmixed fire’.

There seem to be two main readings of this section. On the one hand, Hurlbutt, following Littré, retains the reading τὴν λαίην ἐσπνέουσιν ἀκρήτου and translates, (adding a question in a note): ‘breathing it in unmixed’ [his note: ‘inborn fire?’].<sup>51</sup> Similarly, Harris retains the same reading, summarizing this passage as: ‘[S]ince it [the left ventricle] breathes in air unmixed.’ On the other hand, Lonie, translates the reading τὴν λαίην ἐμπλήην οὔσαν as: ‘being filled as it is with untempered heat’.<sup>52</sup> Potter gives the same reading of the Greek, but translates: ‘[the left]...being filled as it is with unmixed fire’.<sup>53</sup> This leaves some unresolved issues. First, is the author of *On the Heart* suggesting that the substance is air, fire or heat? Second, whatever the substance, is it ‘being filled’ or is it ‘breathed in’?

Given what we learn in following chapters about the respiratory function of the auricles, it seems more likely that the ventricles ‘are filled’ rather than ‘breathe’: for our Hippocratic author, the ventricle does not have a respiratory function. Regarding the substance itself, as we saw above, a similar construction is found in Chapter 5 (‘the unmixed quality of its heat’ [τὴν ἀκρᾶσίν τοῦ θερμοῦ]). Both suggestions may add weight to Lonie’s translation of the phrase in this section: ‘...being filled as it is with untempered heat’.<sup>54</sup> Whatever substance is being referred to, the unmixed substance accounts for the thicker walls of the left ventricle for the ‘purpose of preserving’ (φυλακῆς εἵνεκα) ‘the strength of the heat’ (τῆς ἰσχύος τοῦ θερμοῦ) found there.

We should again note connotations of teleology and intentionality in the final sentence of Chapter 6: ‘For this reason’ (ταύτη) ‘it has been constructed within’ (ἐνδεδόμηται<sup>55</sup>) to be thick ‘for the purpose of’ (εἵνεκα) preserving the strength of its heat.

### Chapter 7. Valves of the ventricles

This chapter starts with another experimental argument, first given in the negative: ‘The mouths (στόματα) [sc. of the ventricles] do not lie open, unless someone clips off the apex of the auricles and the top part of the heart’; and then offered in the affirmative: ‘If someone does do this...the double orifices on the two ventricles will be revealed.’<sup>56</sup> This argument could reflect that the author’s understanding of the heart is driven by hypothetical instead of actual dissection.

In any case, this method is offered to see the openings of the ventricles; however, he continues, if one were to cut away the ‘wide vein’ (usually assumed to be the superior *vena cava*, but Hurlbutt—following Littré—suggests it is either the aorta or pulmonary artery), this view is ruined.<sup>57</sup>

In a metaphoric turn, ‘they’ [sc. the ventricles, not their openings] are described as the ‘fountains’ (πηγαί, ‘origins’ or ‘sources’) of the human being’s ‘nature’ or ‘constitution’ (φύσις), since these ‘rivers’ (ποταμοί) pass from them ‘throughout the body’ (ἀνά τὸ σῶμα) so that ‘the frame is watered’ (ἄρδεται τὸ σκῆνος<sup>58</sup>). These rivers ‘bring life to the human being’ (τὴν ζωὴν φέρουσι τῷ ἀνθρώπῳ); if they dry up, the person dies. (For the metaphoric language in this work, see the discussion in the following chapter.)

<sup>50</sup>LSJ s.v. ἀκρᾶτος: 1. ‘of liquids, unmixed, neat, esp. of wine, 2. of any objects, pure, simple bodies, 3. of qualities, pure, absolute, 4. of conditions or states, pure, untempered, absolute’.

<sup>51</sup>Hurlbutt, *op. cit.* (note 2), 1111.

<sup>52</sup>Lonie, *op. cit.* (note 23), 349.

<sup>53</sup>Potter, *op. cit.* (note 4), 63.

<sup>54</sup>Lonie, *op. cit.* (note 23), 349.

<sup>55</sup>I take this word as a form of ἐνδομέω (‘build in’), rather than ἐνδέμω (‘wall up’); the subject is likely the ventricle, or perhaps its wall.

<sup>56</sup>For the various interpretations that this passage refers to four or two orifices (i.e., the ambiguity of ‘a pair each’, meaning four, or ‘a pair’, in total, meaning two), cf. Lonie, 1973, 9 and notes.

<sup>57</sup>Hurlbutt, *op. cit.* (note 2), 1111.

<sup>58</sup>LSJ s.v. σκῆνος: ‘= σκηνή, hut, tent, CIG3071 (Teos). II. the body (as the *tabernacle* of the soul), Hippocrates *On the Heart* 7’.

Note again the absence of any reference to the atria: once the top of the auricles and top of the heart are cut away, the author believes that the valves of the ventricles of the heart are exposed.

### Chapter 8. The auricles

In this chapter the author notes that near the place where the ‘veins’ (φλέβες) grow out of the heart—‘bestriding the cavities’ (τῆσι κοιλίησιν ἀμφιβεβήκασι)—there are ‘soft, spongy’ (μαλθακά σπραγγώδεα) ‘bodies’ (σώματα) called ‘auricles’ (οὔρατα), which capture air (literally: ‘by which *nature* captures the air’) by acting like the bellows (φῦσαι) of a blacksmith.<sup>59</sup> ‘Handling’ (χειροῦται) the ‘respiration’ (πνοήν) of the heart, these ‘organs’ (ὄργανα) inflate and collapse individually, separate from the movement of the heart itself, which otherwise moves ‘as a whole’ (οὐλομελῆ).

The examination of the auricles in this chapter follows logically from their previous introduction within the discussion of the ventricles in Chapter 7. Moreover, these organs (cf. Chapter 7) were added quite by design: our author himself ‘thinks they are the creation of a good hand-worker’ (δοκέω τὸ ποίημα χειρώνακτος ἀγαθοῦ).<sup>60</sup> We are told that this hand-worker, ‘having recognized [through inspection]’ (κατασκευάμενος<sup>61</sup>) that ‘the inward part’ (τὸ σπλάγγνον) ‘would be’ (ἐσόμενον; a future tense) a ‘solid construction’ (σχήμα στερεόν), on account of the ‘thickness of what is inside’ (πλητικὸν τοῦ ἐγγύματος) ‘being entirely attracting’ or ‘attractive’ (πᾶν ἐδὼν ἐλκτικόν), then subsequently added the auricles, as air-bellows.

The author of *On the Heart* then provides ‘proof’ (τεκμήριον) of this general system: instead of understanding the heart as a two-stroke double pump—an idea stemming from the third-century BCE Alexandrian physicians<sup>62</sup>—the heart ‘as a whole’ (οὐλομελῆ) ‘moves’ or ‘is tossed about’ (ρίπταζομένη). The auricles themselves, however, move independently of the heart: they ‘individually inflate and collapse’ (κατ’ ἰδίην ἀναφυσόμενά τε καὶ ξυμπιπτοντα).<sup>63</sup> Again, the auricles are not considered to be part of the heart, *per se*, as is also the case for both Erasistratus and Galen.

Note that this author believes that the veins of the heart connect directly to the ventricles, instead of the atria. Modern medical textbooks often note that the auricles (the diminutive of *auris*, Latin for ‘ear’) are considered small muscular appendages to each atrium and can easily be confused with them, particularly on the left side of the heart. In *On the Heart*, however, the atria themselves are not explicitly recognized: in the previous chapter, the author states that to cut the top of the auricles exposes the openings of the ventricles.

In Dumini’s French translation, her section heading for Chapter 8 is ‘*Les oreillettes*’, which can translate to ‘auricles’ or ‘atria’ in modern French medical terminology but can also be translated, as I

<sup>59</sup>Note that Galen, following Erasistratus, thought the heart as a *whole*, ‘by dilating like the blacksmith’s bellows, draws in material and fills itself in diastole’; cf. Galen *De Placitis* 5, 548 = Erasistratus fr. 201 G; for discussion, cf. Lonie *op. cit.* (note 13), 136–42.

<sup>60</sup>For the heart as respiratory organ, cf. Armelle Debru *Le Corps Respirant* (Leiden: E.J. Brill, 1996), 100–18.

<sup>61</sup>Galen sometimes uses this term to refer to a medical examination (e.g., *On the Usefulness of the Parts* Kühn iii 439); LSJ s.v. κατασκοπέω; Karl Gottlob Kühn, *Claudii Galeni opera omnia*, vol. 3 (Leipzig: Knobloch, 1821) (repr. Hildesheim: Olms, 1964).

<sup>62</sup>Erasistratus was the first physician to recognize the heart as a ‘pump’ contracting perpetually, due to its ‘intrinsic force’; cf. Reinaldo Bulgarelli Bestetti, Carolina Baraldi A. Restini and Lucélio B. Couto. ‘Development of Anatomophysiology Knowledge Regarding the Cardiovascular System: From Egyptians to Harvey’, *Arquivos Brasileiros de Cardiologia*, 103 (2014), 538–45. Pace Craik *op. cit.* (note 35), 53, however, regarding *On the Heart*: ‘Blood enters the right atrium [*sic*] of the heart via the inferior and the superior vena cava, is pumped into the right ventricle... The oxygenated blood is then carried back to the left atrium [*sic*] of the heart via the pulmonary vein, is pumped to the left ventricle...’ (my emphases). But cf. Lonie, 1973, 140: ‘The conception of “On the Heart”, where there are only two valves, and no “action” of diastole and systole, is quite different from that of Erasistratus’. For discussion of Erasistratus’ conception of the heart as a pump, cf. Heinrich von Staden, *Body and Machine: Interactions between Medicine, Mechanics, and Philosophy in Early Alexandria* (Malibu: J. Paul Getty Museum, 1996).

<sup>63</sup>For Hurlbutt, *op. cit.* (note 2), 1111, ‘[t]his passage seems to point unquestionably to vivisection as well as dissection’; but also cf. Nutton, *op. cit.* (note 14), 139: for *On the Heart*, ‘not even this [an “Aristotelian programme of animal dissection”] is certain’.

would suggest, simply as ‘little ears’.<sup>64</sup> As Duminil puts it, ‘The air arrives, as we saw in c. 9, by the pulmonary veins and by the pulmonary artery and its flow *is activated by the auricles*’ (my emphasis).<sup>65</sup> But then she also explains (244–5 n.25):

One could object that the two vena cava arrive in the *auricle* and not in the ventricle, but we will see later (ch. 8) *that the auricles do not properly speaking form part of the heart and that they are only bellows*.<sup>66</sup> (my emphasis)

In other words, Duminil takes the author of *On the Heart* to understand the *oreillettes* as activating the heart’s required air flow, and are not strictly speaking part of the heart, as we saw above. Instead, they act simply as air-filled bellows.

That said, however, we are then provided with a comparison to help us understand this mechanism: these bellows function similarly to what bronze smiths do to their melting-pots in order that the heart ‘would be able to handle (“subdue”, “master”) the respiration’ (ὥστε διὰ τούτων χειροῦται τὴν πνοήν) drawn into it. As Lonie notes, *pace* Duminil’s interpretation, given the level of attraction of the heart, the author of this text is proposing that the bellows of the heart *control* respiration, not *create* it.<sup>67</sup> Galen also takes careful note of the attraction of the heart, which is so powerful that it could actually tear itself apart, were it not for certain provisions made by the creator or demiurge.<sup>68</sup>

Regarding the atria in particular, Craik, in her Preliminary Note on this work, observes that ‘[t]he heart...is a muscular pump with four chambers. The two upper chambers are known as atria... [...] Blood enters the right atrium of the heart...’<sup>69</sup> While all these statements have become standard in modern medical textbooks, none of them is reflected by *On the Heart*. Instead, the Hippocratic author of this work maintains that, as quoted earlier, the ‘soft, spongy’ auricles have only a respiratory function for the heart. And there is, as we saw above, no reference in this text to either of the atria.

As discussed by Lonie, the general assumption is that the auricles (‘ears’) in some way include the atria even though they are not mentioned, since: 1) there is nothing else that might refer to them in this work; <sup>70</sup> 2) the valves in Chapter 10 are considered the start of the two ‘aortae’ (the pulmonary and aortic valves) —again, we saw in the previous chapter that to cut off ‘the apex of auricles and top part of the heart’ is to expose ‘the orifices to the ventricles’; and 3) Erasistratus and Galen also both thought the auricles and atria (or some part of them) were of a single unit. For Galen in particular, the right atrium was the broadening of (or was part of) the vena cava.<sup>71</sup> Galen did not think the atria are part of the heart (*On the Usefulness of the Parts 6 passim*).<sup>72</sup> We should note that Lonie also argues that the atria are included when

<sup>64</sup>Duminil, *op. cit.* (note 3), 192. *Hippocrate: Plaies, Nature Des Os, Coeur, Anatomie*. Vol. 8, Collection Des Universités De France: Série Grecque, 387 (Paris: Les Belles Lettres, 1998).

<sup>65</sup>*Ibid.* 194 n.48: ‘L’air arrive, on l’a vu au c. 9, par les veines pulmonaires et par l’artère pulmonaire et son flux est activé par les oreillettes.’

<sup>66</sup>*Ibid.*, 244–5 n.25: ‘On pourrait objecter que les deux veines caves arrivent dans l’oreillette et non dans le ventricule, mais on verra plus tard (c. 8) que les oreillettes ne font pas à proprement parler partie du cœur et qu’elles ne sont qu’un soufflet.’

<sup>67</sup>Lonie, *op. cit.* (note 13), 142.

<sup>68</sup>*On the Usefulness of the Parts 6.15* Kühn iii 481: ‘It seems to me that when the heart exerts its full powers of attraction, it would actually tear a vessel to pieces if our Creator (ὁ δημιουργὸς ἡμῶν) had not in this instance too contrived a protection against such an accident by placing outside each opening that admits material another separate cavity like a storehouse for nutriment, so that the vessel may not be in danger of rupturing when at times the heart attracts suddenly and violently and the vessel alone, because it is so narrow, cannot furnish abundantly all that the heart demands. [...] Thus the auricles of the heart were not formed in vain, though no good sense was used in naming them...’ (translation by May, 316–7 [my emphases]; Margaret T. May, *Galen, On the Usefulness of the Parts of the Body*, vol. 1. (New York: Cornell University Press, 1968).

<sup>69</sup>Craik, *op. cit.* (note 50), 53.

<sup>70</sup>Lonie, *op. cit.* (note 1), 9; cf. also Lonie, *op. cit.* (note 23), 353: ‘Ous, plural *ōta*, and *gastēr*, plural *gasteres*. Literally “ear” and “belly”. In *The Heart* it is tempting to translate these as “auricle” and “ventricle” respectively, since the words contain the metaphor from which the modern terminology originated. But “auricle” would be definitely misleading, since the author clearly includes in the “ears” of the heart the atria, while “ventricle” implies the modern distinction between ventricle and atrium. “Cavity” seemed a safer translation here.’

<sup>71</sup>Cf. *On the Usefulness of the Parts 6.7* Kühn iii 436.

<sup>72</sup>*On the Usefulness of the Parts 6 passim*.

the author describes the auricles as *σηραγγώδεα*, which he translates as ‘cavernous’, but this Greek term can simply mean ‘full of holes’, as reflected in Potter’s translation: ‘spongy’.<sup>73</sup>

We might also note that Lonie writes both that the auricles are described in this text as ‘having cavities’<sup>74</sup> and that they are ‘cavernous [or porous] *bodies*’<sup>75</sup> (my emphases). The Greek text, however, can also simply be taken to mean that these spongy bodies ‘bestride’, ‘encompass’ or ‘enfold’ (*ἀμφιβεβήκασι*) the ‘cavities’ or ‘ventricles’ (*κοιλία*). This interpretation is reflected in Potter’s translation: ‘Near the place where the veins grow out of the heart are bodies bestriding the cavities...called auricles.’<sup>76</sup>

In this chapter, the reader is invited to ‘see for oneself’, constructed as a hypothetical possibility (Chapter 8, ‘proof of this theory:...as you could see’ [*τεκμήριον δὲ τοῦ λόγου...ἴδοις ἄν*])—a formulation designed to give an impression of experimentation.

Again, the notion of a creative agent (the ‘good hand-worker’) is worth noting, especially alongside the idea of the auricles allowing for ‘[N]ature (ἢ φύσις) to capture the air.’ Lonie (1973, 146) notes that this chapter seems to combine the agency of the demiurge of Plato with a similar role of nature (or Nature) in Aristotle in one breath.<sup>77</sup>

As an aside, a similar joke about these types of ‘auricles’ (*οὔατα*) not being able to hear anything—again, *οὔς* is the Greek word for ‘ear’—is also made in the Hippocratic *On Sacred Disease* 8.<sup>78</sup>

Up to this point in the text, the author has described the heart as a two-chambered, downward-pointing, pyramid-shaped muscle that has two external spongy respiratory organs on top of it called auricles, which operate independently of the heart’s ‘leap’.<sup>79</sup>

### Chapter 9. Air brought into the left ventricle

Chapter 9 is both elliptical and obscure in its meaning; below I primarily follow Potter’s reading of the Greek, his translations and suggestions.<sup>80</sup>

It is ‘for the same reason’ (*Διὰ τοῦτο*; that is, the work of the bellows) that respiration enters the left ventricle by the ‘small veins’ (*φλεβία*; plural: so, the pulmonary veins); and enters the right ventricle through the ‘artery’ (*ἀρτηρία*; pulmonary artery). Reflecting the elliptical nature of some of the syntax found in this chapter, the second phrase only gives: ‘and an artery, into the other’ (*ἀρτηρία δ’ ἐς τὴν ἄλλην*). A fuller version of this first sentence might be: ‘For this reason, I say (*φημι*) first that the small veins bring the respiration into the left ventricle, and second that the artery [brings the respiration] into the other [ventricle, the right one].’<sup>81</sup>

<sup>73</sup>Lonie, *op. cit.* (note 1), 9.

<sup>74</sup>Lonie, *op. cit.* (note 23), 349.

<sup>75</sup>Lonie, *op. cit.* (note 13), 141; cf. LSJ s.v. *σηραγγώδης*: ‘full of holes or caverns...2. porous, spongy, Hippocrates *De capitis vulneribus* [*On Head Wounds*] 1, al.; *θηλαί* [i.e., teats] Soranus 1.88; *νεῦρον* [i.e., nerve] Galen 10.968’.

<sup>76</sup>Potter, *op. cit.* (note 4), 65.

<sup>77</sup>Lonie, *op. cit.* (note 13), 146; as he writes (*ibid.*), ‘Plato’s DĒMIOURGOS becomes, for Aristotle, PHUSIS, nature, who as efficient cause (ARCHĒ KINĒSEŌS) and formal cause (EIDOS) combined, is in the living thing itself [Theiler, *op. cit.*, 90ff.]. We find this Aristotelian conception in ch. 8, already referred to: the auricles are “the instruments with which nature captures the air”-followed immediately by “the work of an expert craftsman”, just as on occasion Aristotle says “nature contrives” (PHUSIS DĒMIOURGEI PA 654B29, cf. Theiler, p. 89).’

<sup>78</sup>Hippocratic *Sacred Disease* 20: ‘Since it [sc. the diaphragm, from *dia* “apart” and *phragma* “a fence”] perceives nothing before the other parts in the body but is vainly given the name as though it were the cause [sc. of perception]; just like the parts by the side of the heart called “ears” (*οὔατα*), though they contribute nothing to hearing.’ The Greek word *φρένες* (*phrenes*) in ancient medical texts can mean either ‘sense’ or ‘diaphragm’.

<sup>79</sup>Compare Aristotle (*History of Animals* 1.17): ‘As I have already said, [the heart] has three cavities, the largest being on the right-hand side, the smallest on the left, and the medium-sized one in the middle.’ Galen, however, agreed with the author of *On the Heart*: for him, the heart had two chambers (cf. *On the Usefulness of the Parts* 4.50 and *Anatomical Procedures* 7.11).

<sup>80</sup>Potter, *op. cit.* (note 4), 64–5.

<sup>81</sup>Potter’s Greek text reads: *φλεβία μὲν ἐργάζεται τὴν ἀναπνοὴν ἐς τὴν ἀριστερὴν κοιλίην, ἀρτηρία δ’ ἐς τὴν ἄλλην*.

Air seems to enter the right side of the heart because not only is that ventricle ‘more fit to attract it’ (ἐλκτικώτερον)—again, reflecting a common notion of Hellenistic and Galenic mechanics: for example, Erasistratus’ vacuum (κενόν) and Galen’s theory of ‘attraction’ (ὀλκίη)—but it is also able to expand to receive it.<sup>82</sup> It is worth noting that the reason for this attraction—that is, what is *soft* is ‘more attractive and can expand’ (ἐλκτικώτερον καὶ ἐπιδόσιας)—seems to be at odds with the reason given for attraction in the previous chapter: that is, the *density* of its material.<sup>83</sup> This potential conflict might be the reason for the comparative form: both softness and density are attractive, but softness is *more* attractive, at least in this case.<sup>84</sup>

As Potter notes, the next sentence is ‘very turbid’.<sup>85</sup> Working with Potter’s translation, we might read: “It is more necessary in us” (ἔχρη δὲ ἡμῶν μᾶλλον, perhaps “for us”) for what “lies over” (perhaps “hangs over”) the heart<sup>86</sup> to be cooled, for heat is harmful to the right parts, so that through its disposition the organ there does not receive heat easily, in order not “to be completely subdued” (πάμπαν κρατηθῆ) by what comes into it.’

As Lonie notes, the corruption of this passage has been variously emended since Littré (perhaps most persuasively by Unger 1923).<sup>87</sup> His suggestion is, as we saw just above, that the heart draws respiration from both lungs into both ventricles—the left through the pulmonary veins, the right through the pulmonary artery. He continues:

But the right ventricle, having no ‘innate heat’ of its own, requires only a very small amount of air: hence, it is equipped with the thicker-walled artery (evidently the semilunar valves on the pulmonary artery, which in chapter 10 are said to fit less precisely than those on the aorta, admit the passage of air).

Both ventricles receive air from the lungs—the right less so because it does not run as hot as the left side of the heart. If it were to receive too much air, the right ventricle would be overwhelmed; for this reason, it is fitted with the less precise valve—the pulmonary valve.

If this is what this chapter is meant to convey, then there is a problem reconciling how this chapter fits in with the respiratory mechanics of the auricles from Chapter 8 (on which, see the discussion for Chapter 12, below.)

### Chapter 10. The hidden membranes

The ‘hidden membranes’ (ὕμενες ἀφανέες) of the heart are, according to the author, a ‘work very worth recounting’ (ἔργον ἀξιαπηγητότατον).<sup>88</sup> In this chapter he describes the membranes and ‘other structures’ (ἄλλοι τινές) in the ventricles as ‘spider-webs’ (ἀράχνα; *chordae tendinae*) that spread out to entirely encircle the ‘orifices’ (or ‘openings’, τὰ στόματα) and send ‘fibers’ (κτηδόνα; the papillary muscles) ‘into the

<sup>82</sup>For Erasistratus, cf. Sylvia Berryman, ‘Horror Vacui in the third century BC: When is a theory not a theory?’ in Richard Sorabji (ed.), *Aristotle and After* (London: Institute of Classical Studies, University of London, 1997), 147–57; for Galen, cf. Peter Scott Adamson, ‘Galen on Void’ in P. Adamson, R. Hansberger (eds), *Philosophical Themes in Galen*, Institute of Classical Studies, School of Advanced Study (University of London, 2014), 197–211.

<sup>83</sup>Recall from ch. 8: ‘...for when he recognized that the viscus was going to be of a solid frame (σχῆμα στερεόν, perhaps “dense in structure”) on account of the thickness of its substance, and then highly attractive, he added bellows to it...’

<sup>84</sup>This seeming contradiction led Unger (unnecessarily) to add a negative in the phrase in ch. 8: ‘...owing to the density of the insides of the heart, and in consequence not at all attractive...’ (my emphasis); cf. Lonie, 1973, 141–2 for discussion.

<sup>85</sup>Hurlbut, 1939, 1111–2, for his part, notes that ‘[t]he Greek here is obscure’, and, after giving a literal translation of the Greek text of Littré, *op. cit.* (note 6), writes: ‘This is also obscure.’

<sup>86</sup>In a note, Potter suggests ‘Perhaps the right ventricle’ and to see ch. 4.

<sup>87</sup>Lonie, *op. cit.* (note 23), 350; Friedrich Carl Unger, *Liber Hippocraticus Peri kardiēs’ Mnemosyne*, 51 (1923), 1–101.

<sup>88</sup>Again, the author seems to be emphasizing *production*, since ἔργον often connotes something wrought or made. (As Luke Madison has suggested to me, this phrasing sounds like it could be from an encomium to the heart.)

solid heart' (ἐς τὴν στερεὴν καρδίην).<sup>89</sup> These 'bands of the viscus and of the chambers' (per Potter) are the origins of the pair of 'aortae' (ἄορται<sup>90</sup>; the aortic and pulmonary valves). There are 'three membranes' (τρεῖς ὑμένεις) attached to the 'gates' (θύραι<sup>91</sup>) of this pair, rounded at their edges and semi-circular, which come together 'in a marvellous way' (θαυμάσιον) to close the openings, and set the limit of the aortae.<sup>92</sup>

Another argument based on experimentation follows: if someone knowledgeable of 'the ancient rite' (τὸν ἀρχαῖον κόσμον<sup>93</sup>) were to take out the heart of a dead man and position the membranes to touch,<sup>94</sup> neither forced water nor air would enter the heart. We are told that this phenomenon is more efficient on the left side; that valve is constructed to fit more tightly 'as is appropriate' (κατὰ δίκην), since the 'intelligence' (γνώμη) of a human being, which rules over 'the rest of the soul' (τῆς ἄλλης ψυχῆς), 'naturally exists' (πέφυκεν) in the left cavity.<sup>95</sup>

The possible interpretation that there are only two valve membranes or cusps—in the sentence after the discussion of the 'ancient rite'—suggests to some authors that this is a description of the bicuspid mitral valve between the atrium (which is not explicitly mentioned in the text) and the ventricle. For example, Potter's note for this section is: 'The mention of two rather than three valve cusps here suggests a knowledge of the mitral valve.'<sup>96</sup>

Harris finds a reference to the atrio-ventricular valves in this section 'quite incontestable'.<sup>97</sup> As he notes, though Deipgen and Diller maintain that the author knew only two of the heart's valves, Kapferer and Abel argue that this chapter of *On the Heart* describes both sets of valves, pulmonary and aortic, and both atrioventricular valves. As Harris himself points out:

Notwithstanding the fact that the author, after describing the valves and their attachments growing out of the solid wall of the heart, expressly states that they are the beginning of the aortas, Kapferer insists that it is the 'inlet' valves, the tricuspid and the mitral, that he is referring to, though he admits that it is the semi-lunar valves that are referred to in the following sentence.<sup>98</sup>

<sup>89</sup>Lonie, *op. cit.* (note 23), 350 suggests that the author seems to identify the *chordae tendineae* ('like spider-webs', tendon-resembling fibrous cords of connective tissue that connect the papillary muscles to the tricuspid valve and the mitral valve in the heart) with the *musculi papillares* ('fibers', one of the group of myocardial bundles that terminate in the *chordae tendineae* that attach to the cusps of the atrio-ventricular valves), and the *trabeculae carnae* (rounded or irregular muscular columns that project from the inner surface of the right and left ventricle of the heart).

<sup>90</sup>As Potter, *op. cit.* (note 4), 67 n.3 notes, 'ἄορτή is little more than a variant of ἀρτηρία, and in meaning both seem to occupy a middle ground between bronchus and artery; cf. the Hippocratic *Places in Man* 14, *Coan Prenotions* 394, and *Diseases* II 54.'

<sup>91</sup>Reading Potter's και θύρησι Potter; Linden prints αἱ θύρεσι from manuscript V.

<sup>92</sup>Regarding Galen's unambiguous attribution of the discovery of the valves of the heart to Erasistratus, one suggestion is that, while the author of *On the Heart* recognises the valves, by describing them as 'doors' or 'gates', he did not understand their movement or true purpose: that is, he did not understand them *as valves*. Erasistratus could still be thought to have discovered the valves of the heart, *qua* valves; cf. Lonie, *op. cit.* (note 23), 11–3.

<sup>93</sup>Per Hurlbutt, *op. cit.* (note 2), 1112: 'The "Ancient Method" refers to the procedure performed by augurs in their prophecies. The heart of the sacrificial animal was removed for inspection from the chest by cutting along the sternum. The heart could then be lifted out by reaching in from the incision, thus preventing fracture of any ribs.' For discussion, cf. Jacob Morton, 'The experience of Greek sacrifice: investigating fat-wrapped thighbones' in Margaret Miles (ed.), *Autopsy in Athens: Recent Archaeological Research on Athens and Attic*, (Oxford: Oxbow Books, 2015).

<sup>94</sup>Lonie, *op. cit.* (note 23), 350 helpfully provides: 'while propping up one membrane he leans the other against it'.

<sup>95</sup>Per von Staden, *op. cit.* (note 26), 184, it is a challenge to identify this as a test of a hypothesis or a method of discovery because the author has stated neither a goal nor the steps that led to the test, which he argues are usually found in descriptions of ancient scientific tests. Since tests can be themselves heuristic, he goes on to say, this test involving the membranes of the heart in ch. 10 *can* be classified as an experiment, 'regardless of its specific place or role in the scientist's procedure'. Alternatively, Jouanna, 2012, 466 n.70 finds the demonstrative value of the procedure 'disappointing', because it is impossible for even a small amount of liquid to pass into the trachea, which is the point of the experiment; cf. Jacques Jouanna, *Hippocrates. Medicine & Culture* (Baltimore: John Hopkins University Press, 1999).

<sup>96</sup>Potter, *op. cit.* (note 4), 67 n.4.

<sup>97</sup>Harris, *op. cit.* (note 12), 85; as he notes, though Deipgen and Diller maintain that the author knew only two of the heart's valves, Kapferer and Abel argue that this chapter of *On the Heart* describes both sets of valves, pulmonary and aortic, and both atrioventricular valves.

<sup>98</sup>Harris, *op. cit.* (note 12), 88. We might note that Hurlbutt's, *op. cit.* (note 2), 1112 version does not suggest the existence of only two membranes: '...takes up one of these membranes, and bends *another* up against it...' (i.e., not 'the other').

Harris goes on to provide a convincing translation of this sentence: ‘If a man, knowing the ancient order [rule] or custom, removes the heart of a dead man *and folds the membranes to*, neither can water get into the heart, not air, if blown against them...’ (my emphasis).<sup>99</sup>

We might compare Potter’s translation of the same sentence (slightly adapted):

And if someone knowledgeable of the ancient rite were to take out the heart of a man who had died, and on the one hand (τὸν μὲν) draw back one of these [sc. membranes] and on the other (τὸν δέ) incline the other one, neither water would be able to go through into the heart nor air that was being forced.<sup>100</sup>

The construction ‘on the one hand...on the other...’ (τὸν μὲν...τὸν δέ...) suggests that the author is describing the bicuspid or mitral valve. If the Hippocratic author had limited the passage by writing ‘one of two’ or ‘the other’ (e.g., ἄλλος), then the interpretation of this section as a reference to a two-membraned valve (for example, the mitral) would be clearer, especially given that the surrounding sentences refer to the two semi-lunar pulmonary and aortic valves, as Harris notes. Whatever the number, the experimenter would have to fold back all of the flaps in the valve for the experiment to work as described.<sup>101</sup>

Lonie notes that, while the author may or may not have seen the atrio-ventricular valves, what can be said with confidence is that he did not see them *as valves, per se*: understanding the coordination of the heart’s four valves would have to wait for Erasistratus in the third century BCE, along with his conception of the heart as a two-stroke double pump involving systolic and diastolic actions (see note 71, above).<sup>102</sup>

Given the information contained in this work concerning the valves of the heart—seemingly, only two—alongside the mention of the *chordae tendineae*, Wellman and Harris argue that the description of the heart in this work was based on a human rather than an animal heart.<sup>103</sup> Further, both authors point out that the description of the position of the heart with reference to the lungs and thorax is more accurate than Galen’s, which was based on the dissection of monkeys (noted also by Bidez and Leboucq<sup>104</sup>). Given von Staden’s extensive research on the history of human medical dissection in Greek antiquity, however, maintaining that *On the Heart* stems from an extra- and pre-Alexandrian source—for example, as reflecting an influence of the Italian physician Philistion (circa 427–347 BCE) (as Wellmann, Bidez, and Leboucq maintain<sup>105</sup>)—or dates to a time ‘shortly before Alexandrians’ (per Lonie) remains difficult.<sup>106</sup>

That the left valve has a tighter fit than the one on the right ‘as is appropriate’ (κατὰ δίκην; Potter translates ‘according to the normal course of events’) is another prominent example of the teleological

<sup>99</sup>Harris, *op. cit.* (note 12), 89.

<sup>100</sup>Potter’s Greek text is: καὶ τὴν καρδίην ἀποθανόντος ἦν τις ἐξεπιστάμενος τὸν ἀρχαῖον κόσμον ἀφελὼν τῶνδε τὸν μὲν ἀποσπῆρσιν, τὸν δὲ ἐπανακλίνῃ, οὔτε ὕδωρ ἂν διέλθοι εἰς τὴν καρδίην οὔτε φῦσα ἐμβαλλομένη.

<sup>101</sup>For a discussion of the arguments on both sides of this debate, cf. Lonie, *op. cit.* (note 1), 11–3, who writes, ‘[T]o suppose that “On the Heart” recognized only two of the valves, while Erasistratus recognized all four, would again fit into a neat historical schema, in which “On the Heart” would be prior to Erasistratus’. Alternatively, we might consider that the latter’s work was simply unknown to the former, but see the Introduction, above.

<sup>102</sup>Lonie, *op. cit.* (note 1), 12.

<sup>103</sup>Cf. Wellman, *op. cit.* (note 8), 94 and Harris, *op. cit.* (note 12), 89.

<sup>104</sup>Joseph Bidez and Georges Leboucq, ‘Une Anatomie Antique du Coeur Humain’, *Revue des Etudes Grecques*, 57 (1944), 7–40.

<sup>105</sup>Harris, *op. cit.* (note 12), 89 notes that Wellman ‘would seem to imply’ that human dissection was possible ‘in Sicily in the time of Philistion’, and ‘Leboucq, without producing any confirmatory evidence, maintains that Philistion, like Alcmaeon, did dissect human bodies...’

<sup>106</sup>Cf. Lonie, *op. cit.* (note 1), 1–15, and 1973, 136–53. Also cf. Heinrich von Staden, ‘The Discovery of the Body: Human Dissection and Its Cultural Contexts in Ancient Greece’, *The Yale Journal of Biology and Medicine*, 65 (1992), 223–41 and the Introduction to his *Herophilus: The Art of Medicine in Early Alexandria: Edition, Translation, and Essays* (Cambridge: Cambridge University Press, 1989), 1–34.

tendencies in *On the Heart*, especially coming after the introduction of the ‘good hand-worker’ in Chapter 8.<sup>107</sup>

### Chapter 11. Hidden membranes (continued), intelligence in left ventricle

As with the previous chapter, ‘this intelligence’ (which can be assumed to be the subject of this first sentence) is ‘nourished’ (τρέφεται) by a ‘pure and luminous’ (or ‘flame-like’, φωτοειδεί<sup>108</sup>) ‘abundance’ (περιουσίη) coming from a ‘separation’ (διάκρισις) of the blood ‘receiving its nourishment’ (εὐπορέει...τὴν τροφήν) ‘from that which [sc. blood] that is most near’ (ἐκ τῆς ἔγγιστα)<sup>109</sup> ‘by having transmitted its rays’ (διαβάλλουσα τὰς ἀκτῖνας). Intelligence (or perhaps ‘mind’) is ‘fed’ (νεμομένη) ‘as if’ (ὡσπερ) on nourishment from the stomach and intestines,<sup>110</sup> but ‘not in a way normal to nature’ (οὐκ ἔδον κατὰ φύσιν); that is, the substance found in the left side of the heart is not fed by the food and drink from the gut.

The next sentence is a problem.<sup>111</sup> Potter’s reconstruction of the Greek, however, helps clarify it.<sup>112</sup> A possible translation (based on Potter’s version) might be: ‘In order that the contents of the artery [i.e., aorta] do not hinder<sup>113</sup> the food in a state of turbulence, it [the valve] closes off the path to it [the ventricle or the artery].’ The reason given for this closure is that ‘the large artery’ (i.e., the aorta) is ‘fed’ (βόσκεται) by blood nourished by the stomach and the intestines, which is a process that is not appropriate for the intelligence or ‘ruling power’ (ἡγεμονικῆς<sup>114</sup>) found in the left ventricle.

It might not be worth pushing such a problematic passage too far, but perhaps the alternative between ‘ventricle’ or ‘artery’ given above is only one of perspective. If we take the valve as closing off the path ‘to that artery’ (following Lonie), then the direction is from the perspective of the left ventricle; there does not seem to be any reason to imagine that the inborn fire must be prevented from escaping into the aorta, since we are not told that such a thing is possible in the text. Alternatively, if the valve closes the path ‘to the left ventricle’ (following Hurlbutt, Harris, and Majno), the direction is from the perspective of the artery itself: that is, to keep undistilled blood from entering the left ventricle, a part of the heart where there should not be any. Whichever perspective we take, this process, our author states at the end of this chapter, is ‘the main reason’ (ἡ πρόφασις) ‘for the membranes’ (τῶν ὑμένων) ‘for this chamber’ (τούτω...τῷ ἀγγεῖῳ). In short, this restriction is understood as the reason for the existence of an aortic valve that prevents any flow from—or to—the left ventricle.

The author provides proof (δῆλον ὧδε: ‘it is clear from the following’) why a human being’s intelligence (again assumed as the subject of the sentence) is not nourished ‘by visible blood’ (βλεπομένῳ αἵματι). Once again, we are presented with experimental datum: when someone cuts open the left cavity in an animal that has ‘reached *rigor mortis*’,<sup>115</sup> no blood is found in its left ventricle—one finds only

<sup>107</sup> Cf. Craik, *op. cit.* (note 35), 214.

<sup>108</sup> LSJ s.v. φωτοειδής: ‘luminous, Hp. *Cord.* 11 [i.e., this text], Heraclit. (Ἡρακλειδης codd.) ap. Placit.4.3.6, Posidon. ap. S.E.M.7.93; flame-like, Alex. Aphr. in Sens.47.15, *de An.* 45.15; “τὸ φωτο-ειδές” Plu.2.382c, cf. Plot.4.4.24, 5.5.7’. For a discussion of this word in a medical context and possible connections with Stoic thought, cf. Lonie, 1973, 2–4 and Harris, *op. cit.* (note 12), 91–2.

<sup>109</sup> What the author might mean by the blood ‘that is most near’ is discussed below.

<sup>110</sup> τῶν ἐντέρων (i.e., ‘the intestines’) is deleted by Kudlien, 1962, 425 n.1, but kept by Potter; Fridolf Kudlien, ‘Poseidonios und die Ärzteschule der Pneumatiker’, *Hermes* 90 (1962), 419–29.

<sup>111</sup> *passage...très obscur* (Litttré); for discussion, cf. Lonie, *op. cit.* (note 1), 14, n.32 and Duminil, *op. cit.* (note 3), 256 n.55.

<sup>112</sup> Potter, *op. cit.* (note 4), 66: † ὄκως δὲ μὴ ἀνακωχῆ τὸ στίον τὰ ἐνεόντα ἐν τῇ ἀρτηρίῃ ἐν ζῶλῃ ἐόν†, ἀποκλείει τὴν ἐπ’ αὐτὴν κέλευθον.

<sup>113</sup> ‘Stay’ is a possible translation for ἀνακωχῆ; Potter’s ‘send back’ might be a step too far.

<sup>114</sup> LSJ s.v. ἡγεμονικός: ‘of or for a leader, ready to lead or guide; II. capable of command, authoritative...the authoritative part of the soul (reason), especially in Stoic philosophy...but also, the governing part of the universe, of the aether or sun’ (my emphasis).

<sup>115</sup> Potter’s translation for his reading of ἀποπαγέντος; Litttré reads ἀποσφαγέντος (‘having been slayed’ or ‘having had its throat cut’).

‘some serum and yellow bile’ (ἰχθῆρος τινοῦ καὶ χολῆς ζανθῆς). There is, however, blood in the left ‘artery’ (the aorta), as well as in right ventricle.

As mentioned in the summary at the start of this chapter, it is not immediately clear what the author means by the blood ‘that is most near’ the left ventricle: is it the blood found in the right ventricle or that found in the aorta?

For Hurlbutt, the ‘reservoir of blood right next to it’ (his translation) comes from the right ventricle; Lonie argues for ventricular communication to account for the left ventricle’s ‘nutriment’ (τροφὴν), which seems to be the argument as well of Mavrodi and Paraskevas.<sup>116</sup> As far as I can tell, only Harris suggests that the source for ‘a sort of fractional distillation derived from blood produces a pure and light-like “super-essence”’ is ‘presumably that in the aorta’.<sup>117</sup>

To answer this question, we might take a cue from Galen. In *On The Natural Faculties*, he argues that there are small *fossae* that appear in the middle of the separation of the heart, having been ‘created for communication’ for the mutual exchange of blood and *pneuma*.<sup>118</sup> He tells us that these pits are difficult to find, however, because they are quite small, especially once the corpse’s heart has cooled and collapsed after death.<sup>119</sup> It has been suggested by interpreters—but also by Galen himself<sup>120</sup>—that communication through the inter-ventricular septum is a logical necessity discovered by reason, and not found through autopsy. It may be that Galen was influenced by a text like *On the Heart*, which he knew to some extent, seemingly having quoted it without citation in his *On the Doctrines of Hippocrates and Plato*.<sup>121</sup>

We saw that in Chapter 10 of *On the Heart*, the author argues that the membranes of the left valve (the aortic valve) were constructed ‘more tightly’ than the right, to prevent anything from making its way into the left ventricle. When we apply this description to the current chapter, we can understand the lack of blood in the left ventricle in the expired animal as evidence of the valve’s successful function. One might imagine that there would be some explanation provided if anything complicated that interpretation, even if the exception to the closure of the valve were some sort of distillation of nourishment from the blood in the aorta. (A separate question remains why the blood would travel into the aorta just to be stopped there.) It seems more likely that the body’s intelligence found in the left ventricle is nourished through the inter-ventricular septum by the (as we know now: oxygenated) blood found next to the left ventricle—that is, by the blood found in the right ventricle.

The verbs used to describe the nourishment of the intelligence found in the left ventricle are relatively standard for the time period (τρέφω [‘maintain or support’]; εὐπορέω [‘furnish, supply’]; δέχομαι [‘receive’]; νέμω [‘distribute; tend, feed’]), but for the large artery the author uses only βόσκω, a word that is Homeric and tragic, and used sparingly in the *Hippocratic Corpus* (*de articulis* 8.22–23), but is found in Galen (e.g., *Two Books on Antidotes* 14.33, 34, 37).<sup>122</sup>

<sup>116</sup>Hurlbutt, *op. cit.* (note 2), 1112 and Lonie, *op. cit.* (note 1 and 13), 3 and 149. Cf. also Alexandra Mavrodi and George Paraskevas, ‘Morphology of the Heart Associated with its Function as Conceived by Ancient Greeks’, *International Journal of Cardiology*, 172 (2014), 23–8; for these authors, there is an assumption of communication between the two ventricles by means of an orifice and also that the existence of this orifice is ‘stated by the author’ (which to my mind does not seem to be the case, at least explicitly).

<sup>117</sup>Harris, *op. cit.* (note 12), 91.

<sup>118</sup>Galen, *On the Natural Faculties* (III xv 207–208): ‘Similarly, also, in the heart itself, the thinnest portion of the blood is drawn from the right ventricle into the left, owing to there being perforations in the septum between them: these can be seen for a great part [sc. of their length]; they are like a kind of *fossae* with wide mouths, and they get constantly narrower.’ (trans. Brock, with some alternations); Arthur J. Brock, *On the Natural Faculties*, *Loeb Classical Library* 71 (Cambridge, MA: Harvard University Press, 1916), 321.

<sup>119</sup>For discussion of this passage of Galen, cf. Plinio Pioreschi, *A History of Medicine: Roman Medicine* (Omaha: Horatius Press, 1996). For his part, Brock, 1916, 321 suggests that the *fossae* were probably the recesses between the *columnae carnae*.

<sup>120</sup>Cf. Galen, *On the Natural Faculties*: ‘Here, too, however, our “argument” (λόγος), starting from the principle that nothing is done by Nature in vain, discovers these anastomoses between the ventricles of the heart; for it could not be at random and by chance that there occurred *fossae* ending thus in narrow terminations.’ (trans. Brock, 1916, 321); for discussion, cf. Kühn ii 207.

<sup>121</sup>Galen *On the Doctrines of Hippocrates and Plato* 728M.

<sup>122</sup>*Hippocratic Corpus*: e.g., *de articulis* 8.22–23; and Galen: e.g., *Two Books on Antidotes* 14.33, 34, 37.

### Chapter 12. Connection between right ventricle and lung

In this chapter we read that the ‘vessel’ (the pulmonary artery is assumed to be the subject of Τὸ...φερόμενον) connected to the right ventricle is controlled by a valve that is not as tightly fitted, as we read in Chapter 10. In addition, the pulmonary artery opens into the lungs to provide them with blood, though the valve also allows some air to travel into the right ventricle. We know from prior chapters that the right ventricle does not need as much air as the left ventricle to act as a cooling agent because a) there is no inborn fire there (ch. 6); b) there is already the addition of the cooling admixture of air with the blood; and c) because blood is not warm by its nature—an idea, we are told, maintained by ‘many’ (οἱ πολλοί)—but rather becomes warm from the heat of the heart.<sup>123</sup> In our author’s system, the pulmonary artery provides blood to the lungs from the heart while simultaneously allowing some air back into the right ventricle. Interestingly, Galen, because of his own conception of cardiovascular mechanics, seems pressured to design a similar type of explanation, though on the other side of the heart: that is, the mitral valve, which for him necessarily draws air into the left ventricle, must also somehow expel waste products back into the lung.<sup>124</sup>

While it might be argued that the left auricle continues to act in coordination with the pulmonary veins to respire the left ventricle within the design of the heart in *On the Heart*, a different problem arises. Given new information presented by this chapter, the right auricle seems to have lost its original respiratory purpose from Chapter 8 and has basically fallen out of the cardiovascular system. In fact, Harris wonders whether the role of the right auricle as a bellows has been so completely abandoned that the reference in this section to ‘artery’ actually refers to the windpipe.<sup>125</sup> So, either nature has made something in vain (that is, the right auricle itself)—a less than ideal conclusion—or the right auricle ‘captures’ (ἀρπάζει, ch. 8) the respiration and then somehow adds that air to the air already provided to the heart through the pulmonary artery. This last suggestion, however, contradicts the argument that the right ventricle needs less air than the left, which we are told in the current chapter.

At the very least, we have not been told how the right auricle and pulmonary artery are able to communicate directly, since transferring air from the pulmonary artery to the right ventricle *through* the right auricle is impossible, as is the reverse.<sup>126</sup> As it stands, the text seems to leave respiratory elements of the right side of the heart relatively disconnected, as it were.

### Conclusion

As Lonie writes about this short work, it ends nearly as quietly and unassuming as it began—here, with its traditional title: ‘That is all I have to say “concerning the heart”’ (Περὶ δὲ καρδίας).<sup>127</sup>

As Harris and others note, it is noteworthy that *On the Heart* does not contain a doctrine of *pneuma*, which is so prevalent in some Hippocratic texts (especially, for example, *On the Sacred Disease*).<sup>128</sup> He goes on to suggest, though, that the pure, light-like nourishment of intelligence in this text could be the impetus for the Galen’s theory of the psychic *pneuma*.<sup>129</sup>

<sup>123</sup>Regarding this chapter and the previous one, Craik, *op. cit.* (note 50), 54 suggests that ‘[o]bservations based on dissection (verb σχάζειν) confirm that the account is based on practical cutting up of bodies at least animal and possibly also human (11–12)’. While Potter also reads σχασθείσης (from σχάζειν, ‘slit open so as to let something escape’), Littré reads σχισθείσης (from σχίζω, ‘split, cleave’).

<sup>124</sup>Harris, *op. cit.* (note 12), 91 n.2.

<sup>125</sup>Cf. *On the Usefulness of the Parts* vii 8 Kühn iii 537–9; for discussion, cf. Harris, *op. cit.* (note 12), 93–4.

<sup>126</sup>As Harris, *op. cit.* (note 12), 91 notes: ‘[H]ow the air passes from the pulmonary artery into the bellows of the auricle is a complete mystery’.

<sup>127</sup>Lonie, *op. cit.* (note 1), 1.

<sup>128</sup>Harris, 1973, 94. In particular, Lonie, *op. cit.* (note 13), 147 is unique in calling what nourishes the intelligence of a human being in this text *pneuma*; for his discussion of the theory of psychic *pneuma* in Greek and Roman medicine, cf. *ibid.*, 147–50.

<sup>129</sup>Or perhaps the vital *pneuma*; Galen himself is not consistent on this point. In *On the Usefulness of the Parts* (8.450), for example, he says that ‘air itself is conveyed through the lung to the heart, or if not the air itself, then certainly the essential quality of it’. In any case, for Galen the heart needs no other process of refrigeration.

As Harris mentions, it may be that this text raises more questions about the heart than it answers.<sup>130</sup> For example, how does blood get into the aorta from the right ventricle, since it cannot travel through the heart or the lungs? Where does the air that enters the left ventricle travel after it has cooled the innate heat there? And as mentioned previously, why would blood travel to the aorta only to be stopped there? All these questions skirt the significant challenge of the heart's 'pure and light-like super-essence' that rules over the rest of an individual's soul.

Speaking more generally, we are left to wonder how this work found its way into the *Hippocratic Corpus* at all. It is unlike any of those other sixty or so texts, even given their own diversity.

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<sup>130</sup>Harris, *op. cit.* (note 12), 94.