Descartes on the Heartbeat: The Leuven Affair

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This paper presents the reactions to Descartes' account of the heartbeat expressed by the Leuven professors Fortunatus Plempius and Libertus Fromondus, reactions that also involved the Utrecht professor Henricus Regius. I show that the letters exchanged between Descartes and the two Leuven professors in 1637–1638 stirred a continuous debate, followed through a series of publications, up to the condemnations of Cartesianism in 1662–1663. I investigate the extent to which the reception of Descartes' account of the heartbeat contributed to the initial rejection of Cartesianism in Leuven and how physiological arguments were motivated by theological concerns throughout these exchanges.

1. Introduction

There is an interesting historical detour in the dissemination of one of the seventeenth century's most praised discoveries: the reception of Harvey's account of the circulation of the blood is closely intertwined, especially in the Low Countries, with Descartes' account of the origin of the heartbeat. Descartes was one of the first figures to support the circulation of the blood and to give credit to Harvey for it, although he presumably arrived at the same conclusion independently through his own anatomical experiments. He did so while vocally rejecting Harvey's views on the muscular nature of the heart and his explanation of cardiac motion, to promote his own mechanistic solutions instead. Although Descartes' mechanical physiology had been generally well received, particularly in the Northern

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Netherlands, and had quickly become a vehicle for Harvey's account of the circulation, this reception was not at all linear; it also generated controversy among the more theologically minded physicians.[1] I present here a sustained exchange over Descartes' account of the heartbeat that had its epicenter in Leuven and that, I argue, is not disconnected from the events that led up to a famous series of condemnations of Cartesianism in 1662–1663. The events leading up to these condemnations are more complex and had multiple motivations, but I hope that the re-examination of the controversy generated by Descartes' account of the heartbeat will shed more light on the extent to which his physiology contributed to the initial reception (and rejection) of Cartesianism in the Southern Netherlands.

The history of the propagation of Harvey's medical discovery and its connection to Descartes has been explored in a number of works. Reception studies tell us how conservative or progressive these physiological ideas were on one side of the English Channel or the other. The greater success of Descartes' mechanism of the heart, as compared to Harvey's account, has been reported to parallel the success of mechanism vs. vitalism, with the complexities that this entails.[2] More recently, Marjorie Grene has suggested that Descartes' account of the heartbeat amounts to "a conservative innovation," when compared to Harvey's. That is, "his position proved more acceptable also because, in its medical details, it was more conservative."[3] This is one side of the story; Descartes' physiological information and his scientific results may have been more traditional. But the philosophy behind it certainly was not, and perhaps this weighed more for his readers. It is true that Descartes retains a number of "conservative" facts in his study of the heart, and most strikingly the Galenic thesis of the

1. Scholars tend to acknowledge that Descartes' account of the motion of the heart was more successful than that of Harvey. Fuchs (2001), p. 2: "Harvey's discovery, as well as Harvey himself, was and is seen chiefly from a perspective that was determined to a great extent not by him, but by Descartes." French (1989), p. 47: "The doctrine of the circulation of the blood had its greatest impact in the Low Countries in conjunction with Cartesian mechanism." Grene (2005), p. 93: "as the idea of the circulation came to be accepted, it was in fact Descartes' view of the heart's motion that was, in many cases, accepted as the more persuasive account."

2. See Fuchs (2001). Fuchs speaks of "the vital aspect of the circulation" (Part C, "Harvey") and of "the mechanical aspect of the circulation" (Part D, "Descartes and his followers"). The classic study of Étienne Gilson (1930) is the first to have explored the issue in depth. Weil (1957) contains a useful list of early works referencing Harvey's *De Motu.* For more recent studies, see French (1989, 1999); Grene (1993, 2005); Gorham (1994); Anstey (2000); Aucante, "Appendice 6" in Descartes (2000). For recent studies on Descartes' physiology in general, see Bitbol-Héspèries (1990) and Aucante (2006).

3. Preface to Fuchs (2001) xiii, a thesis developed in Grene (2005).

simultaneity of the systole and the diastole in the heart and the arteries. However, Descartes' mechanical explanations and the conceptualization of the "fire without light," which is the core of the Cartesian account, appeared to be unheard of: "nova est ac inaudita, et prorsus absurda [opinio]," cried a scandalized reader.[4]

My revision of the Leuven affair concentrates on the philosophical issues that determined the reception of the Cartesian account of cardiac motion. It supports the view that Descartes' account of the heartbeat, given the philosophical and theological implications of its medical details, was to a great extent contrary to the medical tradition established in the university; that this tradition reacted strongly against it, largely on theological grounds; and that the same medical establishment preferred Harvey's physiology as the more conservative one, against Descartes. The circulation of the blood is in itself metaphysically neutral; it can be taken to appeal both to an Aristotelian and an anti-Aristotelian.[5] Descartes' explanation of cardiac motion is not. The Leuven reception will show that Descartes' account of the heartbeat was read and discussed not simply as a medical explanation, but as committing one to particular Cartesian theses on the nature and functioning of the soul, even before Descartes developed these theses in his later works, like the *Meditations* or the *Passions of the Soul.*

I start by briefly recalling the physiological matter at hand in Harvey and Descartes, and then explore the first reactions to Descartes' physiology of the heart from 1637–1644. In doing so, I follow a debate on the heartbeat between Descartes, Plempius and Regius, and I analyze it as motivated by commitments over the nature of the soul. In the third part I look at the theological reactions stirred by Descartes' account of the heartbeat from Fromondus and follow the development of Plempius' campaign against Cartesianism up to the 1662–1663 condemnations. Monchamp's *Histoire du cartésianisme en Belgique* remains an unrivalled source for the events leading up to the condemnations, which have not been explored extensively since (Monchamp 1886). Armogathe and Carraud document the Leuven condemnations of Cartesianism of 1662–1663 through a presentation of the relevant texts, together with previously unedited ones (Armogathe and Carraud, 2001). Ariew has brought forward a number of arguments related to the extension of the universe in the Leuven condem-

4. Riolan (1649), p. 44, inGilson (1930), p. 96.

5. I use "Aristotelian" as a label much in the loose sense that the seventeenth-century anti-traditionalist rhetoric used it; here it should pick up authors adhering to the Aristotelian-inspired doctrine of the tripartite function of the soul.

nations (Ariew 1994 and 2011, pp. 241–267). The texts of 1662–1663 condemn, among other things, Descartes' physiology: the motivations and context of this historical detail will be explored here.

2. Descartes on the heartbeat

Evidence that Descartes read Harvey's *De Motu* appears in his correspondence in late 1632.[6] For Harvey, the heart is an empty contracting muscle, which stirs the blood into motion by its beating and pushes it in and out.[7] Descartes' expressed dissatisfaction with Harvey's account is that it does not explain the origin of the beating of the heart, so that we would need a "pulsific faculty" to account for the beating.[8] In Descartes' account, the bedrock of the explanation is moved from a pulsific faculty of the muscle to the innate heat within the heart.[9] While praising publicly Harvey on the matter of the circulation itself, Descartes maintained his own explanation of the heartbeat throughout his career, from the *Treatise of Man* (written in 1632), through the *Discourse,* in his correspondence and until as late

6. Gassendi read Harvey and wrote about it to Mersenne, who then asked Descartes what he thought of it (AT I 264). Descartes responded in November or December 1632: "J'ai vu le livre *de motu cordis* dont vous m'aviez autrefois parlé, et me suis trouvé un peu différent de son opinion, quoique je ne l'aie vu qu'après avoir achevé d'écrire de cette matière" (AT I 263). Descartes is taken to have written the *Treatise on Man* before reading Harvey. Cf. Descartes to Mersenne, dated 1635–1636: "An non nosti Londini celebrem quendam medicum nomine Hervæum, qui librum de motu cordis et circulatione sanguinis conscripsit? quis homo est? Equidem de motu cordis nihil dicit, quod in aliis iam non extaret, neque illi per omnia assentior; sed quantum ad circulationem sanguinis, triumphat, ipsique honor debetur quod fuerit primus inventor, in quo Medicina ei multum debet" (AT IV 699–700).

7. As a reminder, a central passage: "First of all, the auricle contracts, and in the course of its contraction throws the blood [. . .] into the ventricle, which being filled, the heart raises itself straightway, makes all its fibres tense, contracts the ventricles, and performs a beat, by which beat it immediately sends the blood supplied to it by the auricle into the arteries." Harvey (1989), p. 31. For a good comparative account of the two theories of the heartbeat, see Anstey (2000), pp. 421–423.

8. Descartes is explicitly arguing against Harvey on several issues in the account from the *Description du corps humain,* AT XI 239–244. Cf. pp. 243–244: "Now supposing that the heart moves in the way that Harvey describes, not only must we imagine some faculty which causes the movement, the nature of which is much more difficult to conceive than what it is invoked to explain: we must also suppose the existence of yet other faculties that alter the qualities of the blood while it is in the heart." Trans. by S. Gaukroger in Descartes (1998), p. 181 (the passage in CSM I 318 is a little obscure; where not specified otherwise, translations are mine.) The "pulsific faculty" was familiar from Galen, who used it to explain the motion of the arteries, as a faculty residing in the arterial walls.

9. For Descartes' mechanization of the idea of innate heat, see among others Hall (1970) and Bitbol-Héspèries (1990), pp. 67–102.

as the *Description of the Human Body* (1647) and the *Passions of the Soul* (1649).[10] One can argue that Descartes' explanation was better at accommodating the corpuscularian physics that was gathering steam in the 1630s and 1640s. From Descartes' point of view, Harvey's account poses a problem of conceivability that can be addressed by Descartes' physics: how are we to "conceive" a discrete motion of a muscle, as Harvey does, given that each local motion of a body is accounted for in terms of the communication of another local motion of a different body? Moreover, Descartes' thermogenic account also went along with the established medical knowledge in placing the vital heat within the heart and not in the blood itself (see Grene 2005 for details on this point). It seemed like the perfect move for Descartes: to explain new scientific facts through his physics while at the same time keeping the phenomenon in concert with the medical tradition.

The importance and degree of certainty that Descartes accords to his account of the heartbeat cannot be overemphasized. Descartes reiterates every chance he gets, that his explanation of cardiac motion sits at the very core of his physiological endeavors. "It is so important to know the true cause of the heart's movement that without such knowledge it is impossible to know anything which relates to the theory of medicine. For all the other functions of the animal are dependent on this," he states in the *Description of the Human Body* (AT XI 245 / CSM I 319). In the *Discourse* of 1637: "Being the first and most widespread movement that we observe in animals, it [the motion of the heart and blood] will enable us to decide how we ought to think about all the others." (AT VI 46–47 / CSM I 134) The motion of the heart, giving rise to a circular motion of the particles of the blood, is the paradigm for explaining all bodily motions. Again, in the *Passions of the Soul,* the "continuous heat of our heart" is said to be the "corporeal principle" of all the motions of the body (AT XI 333). And at one point he speaks about his account in terms of its lying at the heart of his entire "Plan of a Universal Science": "I am prepared to admit that if what I have written on this topic [the cardiac cycle] or on refraction turns out to be false, then the rest of my philosophy is entirely worthless," he says to

10. *Treatise on Man:* AT XI 123–127, *Discourse:* AT VI 46–55, *Description of the Human Body:* AT XI 228–245, *Passions of the Soul:* AT XI 331–334; Letter to Beverwijk, 5 July 1643, AT IV 3–6. A. Georges-Berthier's thesis (Georges-Berthier 1914), that Descartes was not too concerned with the origin of the heartbeat in his early writings, has been rejected by Aucante in Descartes (2000), p. 245, who points to two early fragments (AT XI 524). Aucante takes the first redaction of the *Description* to be immediately after the *Discourse* and to continue in 1638, which is consistent with the discussion from 1637–1638 that I am following (Descartes 2000, p. 19).

Mersenne in a letter of 1639 (AT II 501 / CSM III 134).[11] Descartes' pronunciations in these passages suggest that the explanation of cardiac motion is not just one particular physiological account that can be discussed within the Cartesian system, and accepted or refuted; it is a key piece of the natural-philosophical project applied to the knowledge of the human body, and in turn validates that natural-philosophical project. That the explanation is closely linked to other fundamental tenets of the Cartesian program will appear clear to its very first readers.

With this in mind, I turn to the immediate reaction to his account of the heartbeat, coming from the briefly influential physician Fortunatus Plempius. The debate with Plempius is followed up through Descartes' disciple at the time, Henricus Regius and, in parallel, through a brief exchange with Libertus Fromondus. There are two main letters from Plempius and Descartes respectively discussing the physiology of the heart, all in a sustained correspondence of 1637–1638.[12]

3. Fortunatus Plempius (1601–1671) and Henricus Regius (1598–1679)

According to his own testimony, Plempius met Descartes sometime in the early 1630's, while exercising his medical profession in Amsterdam, and kept in touch with Descartes through the second half of the 1630's, when he became professor of medicine at Leuven. In his colorful depiction, Plempius compared their meeting to that of a Hippocrates meeting a Democritus.[13] At the time, Plempius was already a well-bred and mildly

11. AT VI 46–47 / CSM I 134. "Projet d'une science universelle" is the projected title for the book of 1637, as per the letter to Mersenne of March 1636, AT I 339 / CSM III 51.

12. Descartes sent Plempius three copies of the *Discourse* and *Essays,* out of which Plempius sent one to Fromondus and one to the Jesuit François Fournet (AT I 399). A letter from Fromondus to Plempius for Descartes, 13 September 1637 (AT I 402–409) sends a number of the theologian's objections on the book (see infra section III). Descartes responds to Fromondus' objections through Plempius in the letter of 3 October 1637 (AT I 413–431). Fromondus does not respond, but the discussion continues with Plempius: Descartes adds to Plempius some reflections on Fromondus' objections in a letter of 20 December 1637 (AT I 475–477) and asks from Plempius his comments on the motion of the heart. Plempius replies through a letter from January 1638 (AT I 497–499), advancing brief objections on both the motion of the heart and the circulation of the blood. Descartes replies at length with a letter from 15 February 1638 (AT I 521–534), to which Plempius replies in March (AT II 52–54) and obtains a second reply from Descartes on 23 March 1638 (AT II 62–69). A reply from Plempius from 20 April 1638 was lost. Descartes thinks about publishing the exchange (see the letter to Plempius from August 1638, AT II 343–345), but Plempius backs off, only to publish it himself.

13. Plempius testifies that he frequented Descartes in Amsterdam in the early 1630, while Descartes was living in a street of butchers to have easy access to dissection material; see Plempius (1653), p. 375 and AT I 401. Baillet (1691), vol. 1, p. 312 writes: "M. Des-

influential physician. Born in Amsterdam but educated in Catholic colleges and universities (Ghent, Leuven, Padoua, Bologna), he took up a chair in the faculty of medicine at Leuven in 1633, and he converted to Catholicism.[14] He published his first medical manual, covering the first year of the medical *cursus* at Louvain, under the title *De Fundamentis Medicinae libri sex,* in 1638 (Leuven: Zegers). The *Fundamenta* is, in the words of one historian, "one of the most clear and complete works" of seventeenth-century medicine (Tricot 2000, p. 14). Plempius' book appeared in 1638, a year after Descartes' *Discourse.* He had most likely already finished writing it when he started his correspondence with Descartes, earlier in the same year, but he added part of that exchange in the published book. We do not have definite proof that Descartes knew of the preparation of Plempius' book when their correspondence started, but given that he had known Plempius for a number of years before this, the odds are that he did. He certainly knew of Plempius' opposition to the theory of circulation, for he urged him several times to send him his objections.[15]

In the letter to Descartes of January 1638, Plempius brings forward three experimental objections against the circulation of the blood, all of which are refuted by Descartes, and four against Descartes' explanation of cardiac motion. The second letter, of March 1638, drops the discussion on the circulation while continuing that on cardiac motion.

Against the circulation of the blood, Plempius objects: that the arterial blood and the venous blood would have to be the same; that intermittent fevers, which are caused by localized matter (*materia febrilis*) in the veins, should travel along with the blood and cause many fever attacks instead of just a regular number per day; and that if one ligatures the veins of the leg of an animal while leaving the arteries free, the leg should swell considerably because of the incoming flow of blood, which does not happen.[16]

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cartes contait alors Plempius parmi l'un de ses meilleurs amis, et Plempius ne dissimulait à personne l'honneur et l'avantage qu'il croyait recevoir de cette amitié."

14. On Plempius, see Tricot (2000); Monchamp (1886), passim; Aucante (1999); French (1999); Descartes (2003), pp. 287–288; Vanagt (2011). CSMK 389 wrongly gives 1661 as the year of Plempius' death. For a general overview of philosophy at the University of Leuven during this time, see de Wulf (1908), pp. 454–473 and Monchamp, (1886), pp. 3–27.

15. 5 October 1637: "Quæ de motu cordis muginari te scribis avidissime expecto," AT I 411; 20 December 1637: "Ideoque etiam tuas de motu cordis avide expecto," AT I 477.

16. AT I 499: "Contra sanguinis circulationem, quam cum Hervæo adstruis, hæc habeo: 1. Sanguis arteriosus et venosus sic plane similis esset, imo idem, quod repugnat autopsiæ. Ille flavior et floridior, hic nigricantior et tristior est. 2. Materia febrilis consistens alibi in venulis a corde remotis, quæque adeo febrem intermittentem tantum efficit, deberet plures de die accessiones facere, toties scilicet, quoties fit sanguinis illius et simul

Descartes' answers on these matters are arguably convincing. First, he says, one could object to Harvey that his explanation does not account for the difference between arterial blood and venous blood, but not to him, who explains a transformation of the blood in the heart itself. The rarefaction of the blood in the heart makes the arterial blood brighter, and thinner.[17] For the second point, Descartes appeals to Fernel and his theory of intermittent fevers, a good authority to bring in, and dismisses the objection as a side issue. The ligature experiment, he points out, is precisely one that shows the circulation, for if one would cut open one of the free arteries, the blood would flow more forcefully (AT I 531–534).[18]

Descartes' answers on the circulation were well received by Plempius: "As to the others things that you bring forward in favor of the circulation of the blood, they are sound enough (*satis bene se habent*), and that opinion [of the circulation] does not really displease [me]."[19] The exchange on the experimental evidence for the circulation of the blood seemed to end on Descartes' terms and Plempius did later become an advocate of Harvey. But the other matter raised in the correspondence did not have the same outcome: when it comes to explaining the origin of the motion of the heart, Plempius was more resilient to Descartes' arguments. For Descartes, the two issues—the circulation of the blood and the motion of the heart—were inseparable; not so for Plempius.

The discussion over the motion of the heart from the two letters (January and March 1638) is considerably lengthier. I will only give a brief summary. Plempius' comments are prefaced by a general remark, which is telling for his subsequent points: it is true that Aristotle talks about a certain heat in the heart, says Plempius, but "our Galenus, contrary to this opinion, taught that the heart is moved by a certain faculty, and this is what all we medical men have been teaching up until now."[20] Not only is he minimizing Descartes' contribution by reducing it to that of Aristotle, but also dismisses Aristotle's position as false according to Galen. In Janu-

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humoris febrilis reditus in cor; ponis autem reditum istum fieri centies, imo ducenties per diem. 3. In vivo animali ligatis venis plerisque ad crus tendentibus, liberis relictis arteriis, deberet crus illud brevi temporis spatio mirum in modum tumescere, eo quia sanguis continenter per arterias influeret per venas. Atqui tantum abest ut hoc fiat, ut potius, si diu sinas ligatas venas, pars extenuetur defectu nutrimenti."

17. This argument is already given in the *Discourse,* AT I 52.

18. I refer to Grene (1993) for more details on these arguments; here I am more concerned with the discussion on the origin of motion in the heartbeat.

19. AT II 54: "Cætera quæ dicis pro circulatione sanguinis, satis bene se habent, neque ea sententia valde displicet." For Aristotle, see *De Respiratione,* 20, 480a.

20. AT I 497: "Galenus noster contra a facultate aliqua cor moveri docuit, et omnes hactenus id docemus Medici, a quibus quod adhuc stem hæ faciunt ratiunculæ."

ary, Plempius lays out a Galenist attack on the position that motion must be generated by a certain faculty, both in the heart and in the arterial walls. He offers a famous Galenic experiment with ligatures intended to show that the arteries pulsate in virtue of something flowing through the arterial walls, not in virtue of the flow of the blood through them. Descartes proves the experiment wrong according to "the laws of my mechanics."[21] Next, Plempius questions Descartes' "mechanics" itself: the process of fermentation through which Descartes explains the rarefaction of the blood is a much slower process in nature than what we would need for the heartbeat. Rarefaction is gradual. Descartes answers to this point at length and brings in an analogy with certain fluids, which, once they have reached a certain degree of heat, burst out of the pot, very quickly. He does not go so far as to reproduce experimentally the rarefaction of the blood though. Again, Plempius serves another objection from mechanics: the communication of motion from the heart to the arteries would not be transmitted throughout the body instantaneously, which would account for the simultaneous pulse of the vessels, but only to the neighboring arteries. Descartes refers back to his anti-Galenic experiments for this: the blood pushed through the arteries neighboring the heart would in turn push out the rest of the blood; according to Descartes, the communication of motion through the body is without loss.

The details of these arguments are important for the experimental exposition of Descartes' account, one of the best he ever gave, and they have been justly exploited by the literature.[22] But I would like to call attention to one point detailing the instantaneous rarefaction. According to Plempius, a heart freshly extracted from a living body continues to beat: how is this possible for Descartes, if the blood is no longer there to entertain fermentation? Descartes gave several experimental answers to this: that there always remains some blood, as he had seen in his observation on fish, developed his theory of instantaneous rarefaction and that of the yeast that remains in the extracted heart to entertain fermentation. The interesting bit however is that Descartes uses Plempius' own observation against him, as an argument against the motor force of the sensitive soul: the soul is in fact not supposed to remain and act in a dead heart.

> This objection, he says, seems to me much more damaging to the view, which is commonly held by others, that the movement of the heart is due to some faculty of the soul. For how, I ask, can the movement which occurs in the cut-up bits of the heart depend on

21. The experiment is a common place for early modern Galenists. See Grene (1993), pp. 327–328, for a report on it.

22. See especially Gilson (1930) and Grene (1993).

> the human soul, when it is taken as an article of faith that the rational soul is indivisible, and has no sensitive or vegetative soul attached to it? (AT I 523 / CSMK 80–81).

This point marks a shift in the argument from scientific (experimental) evidence to broader concerns. The objection forces Plempius to reply, in his second letter, that even if the soul goes away, its "power," some of the soul's faculty or "instrument," lingers:

> I think nevertheless that one can save the common opinion [of the faculties of the soul]: even though the soul in a human heart extracted from a living body is no more, and consequently neither the faculty, there remains however for a certain time the instrument of the soul, i.e. the spirit which acts in virtue of the soul. Thus I retain that in the corpse of a freshly beheaded man contractions, digestions and assimilation of food take place, just as in a living man, for as long as the heat and the vivifying spirit remain in it.[23]

The separation between the motor function or instrument of the soul and the soul itself plays right into Descartes' hand. Ontologically, this entails that a quality or power of a substance remains while the substance is gone. Descartes' reply is unforgiving, in a change of tone uncharacteristic for what was until now a courteous exchange:

> In order to explain how a human heart cut from a corpse can move when the soul is no longer present, you resort to the idea that heat and vital spirits cause the movement by operating as instruments of the soul. Now is this not resorting to desperate measures? For if these instruments should sometimes suffice on their own to bring about this effect, why not always? And why should you imagine that when the soul is absent, these effects should occur through some power of the soul, when you think that no such power is needed to bring them about when the soul is present? (AT II 65 / CSMK 94).

In a rare moment of open attack on Aristotelianism, Descartes compared Plempius' objections with that of army captains who want to defend

23. AT II 53: "Nihilominus ego vulgarem opinionem salvam facere mihi posse videor; nam etsi in corde humano exempto anima non sit, nec consequenter etiam facultas, instrumentum tamen animæ illi aliquantisper inest, spiritus scilicet in virtute animæ agens. Sic existimo in cadavere hominis subito decollati fieri attractiones et coctiones et assimilationes alimenti perinde uti in vivente, quandiu calor et spiritus vivificus cadaveri inest."

themselves with poor ammunition, and fire everything they have rather than capitulate.[24]

The exchange ended here, although Plempius sent another reply, now lost. As mentioned, Plempius quoted and reported arguments from Descartes' letters in his *Fundamenta Medicinae* later in the year (1638). Descartes also entertained the idea of publishing the exchange, but meanwhile these letters circulated widely. Descartes' physiology, before the publication of the *Passions of the Soul* and the *Treatise on Man,* is known to the learned world through the *Discourse* and through the letters to Plempius.[25]

The second edition of Plempius' *Fundamenta medicinae,* of 1644, marked Plempius' conversion to Harveyan circulation. After presenting an interesting story of his troubles with the theory, he admitted bluntly that, although he did not like this novelty at first, having been trying to refute Harvey's "praiseworthy arguments," he realized that he came to refute himself. And then he set out to probe them through his own vivisections of dogs, which finally forced him to admit the circulation of the blood.[26] It is a resonant

24. AT II 64–65: "Verum imitari vis egregios illos belli duces, qui cum arcem aliquam, quæ male munita est, servandam susceperunt, licet obsidentibus resistere se non posse agnoscant, non tamen ideo protinus ijs se dedunt, sed malunt omnia prius tela consumere, et extrema quæque experiri: unde fit, ut sæpe, dum vincuntur, plus gloriæ quam ipsi victores reportent." Descartes was receiving at the same time the same line of argument from Fromondus, see infra; this may have prompted this rebuttal, and the use of the plural can be read as addressing to both Fromondus and Plempius.

25. Years later, in 1643, a Dutch physician, Johan van Beverwijck (Beverovicius, 1594–1647), shows an interest in this exchange and asks from Descartes his letter to Plempius regarding the circulation of the blood, alluring Descartes with the intention of publishing it in a *Recueil* of letters of "important men." Descartes sends him the entire dossier: the two letters from Plempius and his response letter together with the minutes he had taken of their encounter. Van Beverwijck indeed publishes them in his edition of *Epistolicæ Quæstiones* (1644; translation in Post 1979). Later on, Princess Elisabeth of Bohemia shows knowledge of the exchange in her letter to Descartes of May 24, 1645 (AT IV 210). Harvey himself recognizes the importance of Descartes' version of the circulation in his second letter to Jean Riolan of 1649, and the English edition of the *De Motu Cordis* cites, in De Back's appendix, Descartes' experiment of the vivisected beating heart of the eel from his correspondence with Plempius: Harvey (1653) p. 118. Cf. AT I 508, 515, and pp. 651–652 for other mentions of the letters in the correspondence. AT IV 180 finds reference to the Plempius letters in the Descartes-Voetius debate from the *Admiranda methodus* of Martin Schook.

26. *Fundamenta medicinæ* (1644), 115a: "Primum mihi inventum hoc non placuit, quod et voce et scripto publice testatus sum, sed dum postea ei refutando et explodendo vehementius incumbo, refutor ipse et explodor; adeo sunt rationes ejus non persuadentes, sed cogentes: diligenter omnes examinavi, et in vivis aliquot canibus eum in finem a me diffectis verissimas comperi."

conversion for the medical world.[27] Plempius also published here, for the reader to judge for himself, Descartes' letters to him in their entirety.

Although Plempius cites only Harvey as having convinced him, the context of the heated discussion with Descartes during this time should have played a significant role in his making up his mind.[28] This has led most commentators to conclude that it is the exchange with Descartes that convinced Plempius accept to the theory of the circulation, sending to Plempius' letter to Descartes from March 1638, where he showed himself satisfied with the answers.[29] The basis for this assessment is too thin in my opinion to be conclusive.

Firstly, the phrasing of Plempius in the March 1638 remark, "neque ea sententia *valde* displicet," suggests to me that his opposition to the circulation of the blood at that time was not so strong to begin with. Plempius has a schoolman's mind: the objections he brings against the circulation, after hesitating to do so at Descartes' invitation, should be taken in a scholastic context, where exposing objections does not necessarily entail an assent to those objections. This is confirmed by his retraction when Descartes proposes to publish the exchange: Plempius agrees to the publication, but he asks Descartes to leave out his objections concerning the circulation. Descartes, reluctant to do so, proposes to insert a mention that would say that those objections were made "animi gratia" and only in order to satisfy Descartes' request, and not because Plempius thought them to be true.[30] The same factor should be taken into account when assessing the published textbook. Secondly, in his public confession from 1644, while publishing Descartes' letters in their entirety, Plempius does not

27. See Harvey (1653), Wood's preface, p. 12, on Plempius' conversion: "Here is a great change in his judgment. Hence I begin to hope for equity in others, that laying aside all hatred, and acknowledging their error, they will at last with Plempius begin to think well of Harvey." Wood quotes the entire passage from Plempius (pp. 11–12).

28. Idem. On Walæus' experiments with ligatures confirming Harvey (1641), see Pagel (1976), pp. 113–135. Plempius, a Dutchman, probably made Walæus' acquaintance while in Leiden or in Amsterdam in the early 1630's.

29. Fuchs (2001), p. 129: "In fact, Descartes was able to persuade Plemp to accept Harvey's doctrine of the circulation." Grene, "Translator's Forward" to Fuchs (2001), p. xii: "Indeed, Plemp, who had raised numerous objections to the notion of the circulation, was converted, presumably by Descartes' arguments (and observations!)" Gorham (1994), p. 216, n. 22: "Descartes eventually manages to convert Plempius on the circulation hypothesis."

30. "Quantum vero ad eas, quæ spectant circulationem sanguinis, quas velles me omittere, faciam omnino in hoc prout tibi visum fuerit; verum certe illas pluris facio, quam tu, et merito possum inter validissimas, quas acceperim, reponere; quapropter si velles, mallem nihil immutari; nisi si verba quædam hic illic, prout erit in rem, inserantur, quibus profitearis te animi gratia, aut a me rogatum illas proponere, potius quam quod illas veras existimes." AT II 344. This is a reply to a lost letter from Plempius.

rest his change of mind on Descartes' arguments against his objections. He never mentions Descartes as having convinced him in any way, although he certainly had the opportunity to do so. Nor do his contemporaries read him as someone who had been influenced by Descartes on the matter: Jean Riolan, when presenting Plempius' account of the circulation right after that of Descartes, does not send back to Descartes, but invokes Plempius' experiments, "quae sunt ab Harveo et Vallaeo proposita et observata" (Riolan 1649, p. 45). The section on circulation from Plempius' *Fundamenta* of 1644 contains no trace of Descartes (pp. 115–118). He quotes 1) Harvey; 2) Johannes Walaeus, who published his experimental results confirming Harvey in 1640, and whom he knew from Leiden; 3) his own scholastic exercises trying to refute Harvey, in writing and in the classroom; and 4) his vivisections. The exchange with Descartes contributes to 3): it is one of the factors in a more complex process. Between the exchange with Descartes over the circulation and the public conversion in the *Fundamenta* of 1644, Plempius nevertheless published the first edition of the *Fundamenta* in 1638, where he continued to doubt Harvey. Granted, the circulation of the blood and Harvey's contribution had gained a lot more exposure by 1644 than they had in 1638, and perhaps Plempius, as a newly minted professor, could not allow himself to approve of the doctrine in 1638, but could do so in 1644. Thus in 1638 Plempius told Descartes that "this opinion does not really displease me," that he had only made those objections "animi gratia," while at the same arguing against the opinion in his book. There is no other exchange between him and Descartes from 1638 to 1644, so that no other arguments for the circulation are brought forward from Descartes' side. Moreover, when Plempius decided to publish Descartes' letters in 1638, he chose to leave out precisely his arguments for the circulation of the blood. If Plempius revised his opinion in 1644 while meditating on Descartes' arguments from 1638, which he decided to leave out in the *Fundamenta* 1638, there is no trace of this in his writings. Descartes' arguments for the circulation of the blood may very well have contributed to Plempius' conversion, together with other factors; but they can hardly be seen as the decisive factor.[31]

Whatever the reasons behind the conversion, it is the way in which Plempius presented it that mattered, and he gave the entire credit to Harvey. Plempius chose to publish Descartes' letters in 1638 truncated: he

31. I am in agreement with French (1989), p. 79, who derives from extrinsic arguments (the medical tradition to which Plempius was faithful) that Plempius "has been won over by Harvey, not by Descartes." My view is stronger than French's: that it is the confrontation with Descartes that pushes Plempius to embrace Harvey, via the heartbeat issue, as a way to counter a perceived materialism in Descartes.

only retained the arguments concerning the origin of the motion of the heart, and left out completely the arguments concerning circulation itself. What interested him in 1638 in this exchange with Descartes was not the circulation: it was the motion of the heart. The second edition of the *Fundamenta medicinae* (1644) displays an extensive attack against Descartes' account of the motion of the heart in favor of a Galenic "pulsific faculty." The fifth chapter of the second book is devoted to the "vital faculty" and is subtitled: "the motion of the heart is caused by the pulsific faculty, not by the fermentation of the heart, against Aristotle and Descartes."[32] In addition to reporting the arguments from the letters, Plempius clarified his position against Descartes in important ways in this second edition. His new argument here is the following. There are two separate contrary motions in the heart: a contracting and a distending motion. This would call for a redoubling of the pulsific faculty: a contracting faculty and a distending faculty. He admits though that there can be no distending faculty, since the dilation of the heart can be explained through the influx of the blood, as per Harvey's demonstrated circulation. It remains nevertheless to explain the contracting faculty: rejecting the Cartesian "vaporization" of the blood, Plempius can still hold that for the systole one needs to pose a pulsific faculty, like the one we have in the muscles (p. 160).[33] Thus the motion of the heart is entertained by this pulsific faculty, contracting and releasing the cardiac muscle.

Plempius correctly identified both Harvey and Descartes as adversaries of the Galenic "pulsific faculty" (p. 150); but he chose to argue at length against Descartes, not against Harvey, and his argument drew heavily from Harvey's analysis of the systole. Harvey showed how the heart works rather by contracting than by dilating the chambers, and how the violence of the blood's exit is the main driving force of the circulation. Plempius' argument, at face value, weighs against the rhythmical pulsific faculty of the Galenists just as much as that of Harvey: there is no rhythmic dilation and contraction due to a pulsific faculty, but there is contraction. What he

32. "Quid facultas vitalis. Est duplex: utraque dici potest naturalis facultatas. Motus cordis sit a facultate pulsifica, non a fervore sanguinis, contra Aristotelem et Cartesium. Harvei sententia vera de motu arteriarum. Facultas pulsifica duplex in corde." *Fundamenta medicinæ* (1644), 150b. For the pulsific faculty (which causes the muscle of the heart to move simultaneously with the motion of the arteries), see Galen, *De usu partium,* lib. VI, cap. XVII.

33. Cf. Harvey's text from *De motu cordis:* "From these particulars it appears evident to me that the motion of the heart consists in a certain universal tension–both contraction in the line of its fibres, and constriction in every sense. It becomes erect, hard, and of diminished size during its action; the motion is plainly of the same nature as that of the muscles when they contract in the line of their sinews and fibres." Trans. R. Willis in Harvey (1989), p. 22.

adds to Harvey is a proper cause for the contraction, one which Descartes himself had identified with a "pulsific faculty" when reading Harvey. For Plempius, Harvey is the *via media.* Just as Descartes had read the pulsific faculty in Harvey's forceful systole, Plempius effectively uses the same reading as a way to counter Descartes. His conversion to Harvey in 1644 enhances his position against Descartes on the matter of the heartbeat, which can be seen as yet another motive behind his choice for Harvey's version of the circulation.

A second historical detail of the 1644 publication of the *Fundamenta* is telling for the follow up of the exchange. The precise instrumental cause for which Plempius published Descartes' letters here was that he was summoned to do so by one of Descartes' disciples at that time: Henricus Regius. The second publication of the letters was not meant to support his conversion as coming out of the exchange with Descartes, as one would have thought: he only published the exchange again as an answer to Regius' interpellation.

Descartes was left in August 1638 with no reply from Plempius concerning the plans for the publication of the exchange, and he did not learn of the publication of extracts of his letters in the 1638 *Fundamenta* until later in the spring of 1640, when Henricus Regius, at the time Descartes' close disciple and early promoter of Cartesianism in the Northern Netherlands, sent him a letter informing him of the matter. The letter is now lost but, according to Baillet, Regius reported on the matter in terms difficult to reproduce.[34] Not only so, but Regius set out to hold in Utrecht a disputation on the circulation of the blood defending Descartes' account of the heartbeat. Before sustaining the disputation, Regius sent his theses to Descartes for approval, and Descartes made comments on each of them (see AT III 726). The disputation took place on 10 June 1640, through one of Regius' students, Johannes Hayman. In the text of the printed theses, Regius reported Plempius' dishonest publication of 1638 of Descartes' letters to him in harsh terms.[35]

34. Monchamp (1886), p. 137, states wrongly (and uncharacteristically for his usual accuracy) that Regius wrote the letter to Plempius, citing Baillet. Baillet (1691), vol. 2, pp. 36–37 is explicit on the fact that Regius wrote to Descartes, not to Plempius: "M. Regius fut outré d'une conduite si malhonnête, et ayant confronté son livre avec les réponses que M. Descartes avait faites près de deux ans auparavant à ses objections, il ne put retenir l'indignation qui lui fit prendre la plume pour en marquer ses ressentiments à M. Descartes. Les couleurs qu'il donne dans sa lettre à l'ingratitude et à la mauvaise foi de M. Plempius sont si vives, qu'on ne peut les exprimer de sa langue en la nôtre sans entrer dans de semblables transports de colère contre une conduite si lâche."

35. *Disputatio medico-physiologica pro sanguinis circulatione (. . .) sub præside D. Henrici De Roy (. . .) Exercitii gratia, Publice defendere conabitur Iohannes Haymannus (. . .) ad diem 10. Iunii* (Utrecht: 1640). The text is reprinted in AT III, pp. 727–734.

Regius' disputation gave Descartes' account of the motion of the heart almost exactly as per the *Discourse* (thesis III, AT III 728–729). It also quoted a passage from Aristotle's *De Respiratione,* 20, about the heart's pulse as an ebullition, to support Descartes' account (AT III 730). This is the same passage quoted by Plempius in his first letter to Descartes on the circulation (AT I 497). In a clever re-appropriation, Regius thus took up the passage from Plempius, with Descartes' approval, as a support for the Cartesian account of the heartbeat. Next, in thesis VII, Regius held a paragraph vilifying Plempius' publication of Descartes' letters: "He partly mutilated and perverted the responses at objections and instances, and he omitted some. Such that whoever will compare his account with the letters written two years before this publication, will be able to tell."[36] Descartes had instructed Regius to put his true name, "Descartes." instead of the Latin Cartesius, and had asked him to temper his adjectives and to give examples of the mutilation (AT III 68). Regius conformed to the recommendation only partly.

This disputation is quoted by Plempius in the *Fundamenta* of 1644 when publishing anew Descartes' letters, this time unabridged. His gesture here is an answer to the Descartes-Regius attack from the disputation of 1640.[37] It is thus through Regius that the dispute with Descartes continued in 1644, and Plempius answered to this renewed attack from Descartes' side. Regius' involvement and Plempius' 1644 edition makes explicit the shift of the dispute from the issue of the circulation of the blood to the more theologically informed issue of the cause of the heartbeat. What started in 1638 as a dispute over the theory of the circulation of the blood became by 1644 a dispute over the status over the powers of

36. AT III 732: "Hanc verissimam Viri Nobilissimi et Incomparabilis D. Renati des Cartes sententiam nuper litteris familiaribus labefactare conatus est Plempius *in Lovanensi Academia Medicinæ Professor.* Quamvis autem sollidissime ad argumenta, quæ proposuit, ipsi sit responsum, et plus quam satisfactum: placuit tamen ipsi rem privatim actam, inscio Renato, publicam facere Doctorumque circulo arbitrandam subjicere. Ut itaque Disputationis hujus Moderator etiam suum hic interponat arbitrium, videtur *non tantum per compendium (ut ipse ait), sed cum veritatis dispensio, nec satis bona fide, res ab ipso,* in libro quem *Medicinæ Fundamenta* appelat, *fuisse ennarata:* Responsiones enim ad objectiones et instantias, *partim mutilaverit et pervertit,* partim artificio quodam præteriit." Emphasis added.

37. "*Quod non tantum per compendium (ut ego ais) sed cum veritatis dispensio, nec satis bona fidem responsiones ennaraverim, ac partis eas mutilaverim et perverterim, partim artificio quodam praeterierim." Fundamenta medicinæ* (1644), p. 152a, emphasis in the original. This is a direct quote from Regius' disputation quoted in the previous note (AT III 732). Cf. Descartes to Berwerwijk, 5 July 1653, where he complains again about Plempius in the same terms: "Sed nonnullæ objectiones, ad ipsam pertinentes, mihi missæ sunt Lovanio ante sex annos, ad quas tunc temporis respondi, et quia earum auctor meas responsiones *mala fide distortas et mutilatas* in lucem edidit." AT IV 6, my emphasis.

the soul. The *Fundamenta* (1644) continued to defend the positions on the functions of the soul expressed by Plempius in his 1638 letters and expanded on them. In the letters, Plempius had given a vivid idea of how the life-responsible "faculty" of the soul operates (a "vivifying spirit"): one can see it in freshly extracted hearts, or in freshly beheaded bodies, which continue to function and even digest food in virtue of the soul's lingering "spirit." The *Fundamenta* of 1644 presents the same "facultas vitalis" as a faculty of the soul. It is in fact now *duplex: vivificatrix,* which produces the vital spirits, and *pulsifica,* which entertains the motion of the heart by provoking the systole (*Fundamenta* 1644, p. 150). At the same time, he did not shy away from acquiescing to Harvey's mechanical explanation of the motion of the arteries (p. 160) and to his explanation of the diastole. It is not mechanism by itself that Plempius resists, but precisely the rejection of the "pulsific" faculty as a source of motion. As he told Descartes in 1638, both of them carry amphorae impregnated with different odors.[38] The 1644 publication looks like an anti-Cartesian treatise.

Descartes' use of Regius in the debate warrants more consideration for the history of the reception of his account of the heartbeat, because Regius did not always conduct himself as docilely as in this attack. Through his reactions to Plempius and his sustained series of publications radiating from the northern Netherlands, he can be seen as a catalyzer for the precipitation of the Leuven affair, precisely because of his growing heterodoxy with respect to the medical establishment while professing Cartesianism. From proposing a radicalized version of Descartes' physiology in the 1640s and giving a summa of Cartesianism that Descartes never wrote (*Fundamenta physices,* 1646, with enlarged editions in 1653 and 1661) Regius would evolve to depart from Descartes and eventually oppose him with an alternative account of the motion of the heart.

Already in the lost letter reported by Baillet, of 1640, Regius is reported to have questioned Plempius' understanding of the Cartesian account of the cause of the heartbeat: "Where Mr. Descartes reports multiple causes which, taken together, produce the heartbeat, Plempius only retains one of them, namely heat."[39] This phrase testifies for the fidelity of Baillet's report on the letter, as indeed Regius will continue in his publications to report a number of "secondary causes" for the heartbeat.[40]

38. "Sed tamen aliter sentimus, quia dum testæ recentes eramus, alio odore imbuti fuimus, quem servamus." AT I 400.

39. Baillet (1691), vol. 2, p. 37: "Qu'à l'endroit où M. Descartes rapporte plusieurs causes qui jointes ensemble produisent le battement du cœur, Plempius n'en rapporte qu'une qui est la chaleur."

40. On Regius, see De Vrijer (1917); Verbeek (1988), (1992), (1994); Gariepy (1990); Alexandrescu (2012), pp. 155–186.

In a second disputation he sustained in Utrecht on the circulation of the blood, in April 1641, Regius gave the Cartesian heating account (*coctio*) as the cause for the motion of the blood, with a twist: there occurs a "sanguification" in the heart through the process of a "pulsific ebulition."[41] The "pulsific ebullition," not a Cartesian notion, is nothing more than a barbarism meant to replace Plempius' "pulsific faculty" with chemical ebullition. Descartes comments on Regius' phrasing and speaks of a "general *coctio*" (AT III 67), but he will not use this phrase in the accounts published in the *Passions of the Soul* or in the *Description.* One "sanguification." following Regius, occurs through ebullition in the right ventricle, and another one in the left ventricle. The cause of the motion of the heart and arteries, while it consists essentially (*causa continens*) in the ebullition of the blood already found in the heart before the new blood flows in, relies nevertheless on a fourfold complex of concurrent, helping causes: 1) the "aptitude" and the composition of the blood; 2) the heat of the heart; 3) the part of the blood which remains in the heart after the beating to act as a ferment; 4) the disposition of the vessels of the heart; and, he adds, "not [on] some particular pulsific faculty located in the heart and communicated by it to the arterial walls."[42] This disputation was still directed against Plempius, who had maintained a pulsific faculty communicated through the arterial walls in his letters to Descartes and in his *Fundamenta medicinae* (1638).

In his *Fundamenta physices* (1646), Regius presented the account of the motion of the heart, as a good Cartesian, in the chapter on animals.[43] He restated the four remote causes from the 1641 disputation, but added as a second proximate cause for the heart's motion, alongside the rarefaction of the blood: the animal spirits gathered in the fibers of the heart.[44] The ad-

41. "In corde fit coctio, cum chymus sanguini a reliquo corpore ad cor redeunti permistus, et simul cum eo in Hepate præparatus, in verum et perfectum sanguinem, per ebullitionem pulsificam, commutatur." *Physiologia* (1641), 20, in Bos (2002), p. 213.

42. "Admirandus igitur ille Cordis arteriarumque motus, præter sanguinis in corde existentis ebullitionem, quæ causa ejus continens est, a quatuor antecedentibus perficitur causis; primo a sanguinis cor ingredientis ad dilatationem aptitudine; Secundo a cordis calore: Tertio a parte sanguinis, quæ post singulos pulsus ardens, aut tanquam fermentum, in corde remanet: quarto a cordis vasorumque ipsius conformatione; non autem a peculiari facultate pulsifica cordi insita, et arteriarum tunicis ab ipso communicata." *Physiologia* (1641), 21 in Bos (2002), p. 214.

43. p. 181. The chapter treats of animals in general, and then we get separate chapters on irrational animals (*De Bestiis*) and rational animals (*De Homine*).

44. "Itaque admirandus ille cordis arteriamque motus, præter sanguinis in corde existentis rarefactionem, spirituumque animalium in fibras cordis influxum, quæ eius causæ sunt proximæ, etc.", idem, p. 181.

dition of the motion of the spirits in the account of cardiac motion is a development that seems Cartesian in spirit but not *in littera:* the motor action of the animal spirits, although recognized by Descartes, is never taken by him to be a cause of the circulation. The propagation of the blood through the entire body is accounted for mechanically as the communication of motion (both the motion of the blood and that of the spirits) down to every vessel, and this explains how some dying people continue to exhibit a spontaneous contraction and expansion of sanguine vessels, although their heart and their blood flow had stopped.[45] At this stage, this can be seen as a development building on Descartes, in tune with the contemporary trends in the medical discourse; Descartes will present himself a developed account of the motion of animal spirits in his *Passions of the Soul* of 1649.

The letter from 1640 that Baillet reported already suggested this development, as we have seen. But there is one further evolution in Regius' physiology, which makes him less of a follower of Descartes. Up to 1661, his account for the origin of motion in the heart consists in Cartesian fermentation plus this agitation of the animal spirits, a double cause, sustained by certain dispositions found in the cardiac apparatus. However in the third edition of his *Philosophia naturalis,* of 1661, Regius introduces a passage arguing that the agitation of the animal spirits is the "principal" (*praecipua*) cause for the circulation, for the fermentation of the blood is too weak to push the blood throughout the body. He argues now explicitly against Descartes' account: "it is not the rarefaction of the blood in the heart, but instead the movement of the animal spirits in the fibers of the heart, that which should be taken as the main cause between the proximate causes of the pulse." And he develops:

> Among the proximate causes of the motion of the heart, the main one, established here with necessity, is the very powerful flow back and forward of the animal spirits from the brain through the nerves in the fibers of the heart; for the rarefaction, the effervescence or the swelling of the blood which generally takes place in the heart is too thin, and thus too weak to be the main proximate moving principle, and much less the only one, needed to push and repel all of the blood from the heart back and forward, through all of the arteries and veins of the animal (as Aristotle in his *De Respiratione* and Descartes in the *Discourse on Method* state).[46]

45. Idem, p. 182.

46. *Philosophia naturalis* (1661), pp. 305–306: "Inter causas proximas cor moventes, præcipua, et necessario hic statuenda, est satis validus spirituum animalium e cerebero per

Let me venture an interpretation: Regius' addition of the flow of the spirits as a concurrent cause for the motion of the heart, and subsequently as its main cause, is meant to counter increasing attacks against Descartes' account with an alternative mechanical explanation.[47] Regius continued Descartes' project to replace Aristotelian-inspired Galenic physiology with mechanism, be it with certified Cartesian explanations or not. Seventeenth-century Aristotelian physiology of the soul maintained a number of proximate causes subordinated to the original motor cause, the sensitive soul. Regius' strong materialist developments made clearer Descartes' opposition to the traditional Aristotelian views on the soul by explicitly using Aristotelian jargon. In doing so, he read closely the formulations of Aristotelian physiology and replaced every one of them with Cartesian ideas, including the Aristotelian complex of proximate causes subordinated to one primary cause. "The life of the animal," Regius says, "or its vivifying faculty (*facultas vivendi*), consists in this, that there is in it a certain part equipped with fire, which is called the heart, so hot that it heats up the nourishing juices flowing through the veins and parts of them are pushed out through the arteries, and then, after they are heated again, these juices flow back to the heart through the connected veins, continuously." Circulation is thus not more, nor less than what the faculty of life consists in, sustained by the heat of the heart. More of this: "The faculty of sense and movement, that people call the sensitive soul, *is* the arrangement and conformation of the parts of the animal in spirits, nerves and other sensitive organs," etc. (my emphasis).[48]

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nervos in cordis fibras reciprocus influxus: cum rarefactio, effervescentia, sive intumescentia, sanguinis, quæ communiter in corde fit, sit tantum exigua, et proinde nimis debilis, quam ut totum sanguinem, per totius animalium corporis arterias et venas, a corde et ad cor reciproce, tanquam præcipuum, nedum solitarium, (ut Aristoteles *lib. de respirat.* et Cartesius *discurs. de Method.* statuunt), proxime movens principium, pellat atque repellat."

47. The passage I bring forward from the 1661 edition should be added to Thomas Fuchs' account of Regius' physiology of the heart (Fuchs 2001, pp. 146–148). Regius' addition is distinctly intercalated as a paragraph into text from previous editions. While Fuchs does bring forward Regius' account of the animal spirits as a concurrent cause for the motion of the heart, he fails to add Regius' anti-Cartesian stance from 1661, and reads him as a Cartesian throughout. See also de Vrijer (1917), p. 215 "In zijn grootere werken heeft Regius die cartesiaanische physiologie bijgehouden," etc.

48. *Fundamenta physices* (1646), 153: "Vita animalis, seu ejus vivendi facultas, in eo consistit, quod quædam in eo sit pars igne, tantum calido, instructa, quæ cor dicitur, in quam alimentarius succus per venas influens incalescit, et in partes alendas per arterias impellitur, ac deinde, ut rursus incalescat, per continuas venas ad cor perpetuo refluit. [. . .] Facultas sentiendi et movendi, quæ anima sensitive vulgo dicitur, est partim animalis in spiritus, nervos, et alia sensoria [. . .] attemperatio et conformatio."

Regius continued to push his anti-Aristotelian physiology through the 1660s explicitly against Descartes. Descartes had always been careful not to openly provoke the Aristotelianism of the schools, largely by ignoring its theses in his published work. It is precisely Regius' open attack that guardians of orthodoxy such as Plempius feared from the Cartesian mechanical explanation of the cardiac motion: it undermined the hylomorphic structure of living bodies that was the framework and reference for their medical science. Not long after the quarrel with Plempius of 1640, Regius acquired a reputation for endangering the union of the body and soul by defending an accidental psychophysical union, which stirred a heated and famous controversy in Utrecht throughout the 1640s and occupied much of Descartes' energy for the remainder of his life. The Utrecht quarrel must have had a certain echo in Leuven. The Leuven theological reactions to which I turn next are best seen against Regius' move of developing from Descartes' physiology an upfront attack against Aristotelianism.

4. Libertus Fromondus (1587–1653) and the Leuven condemnations (1662–1663)

When Plempius received the *Discourse* and *Essays* in 1637, he forwarded one copy to his colleague and former teacher, Libertus Fromondus, as instructed by Descartes.[49] Fromondus was a good candidate for Descartes to win over, as the head of theological studies at a powerful Catholic university. He was also a respected man of science. By 1637 he had an established reputation as a defender of the integrity of the Catholic body of knowledge and was certainly the voice to be feared at Leuven from the Aristotelian camp.[50]

Fromondus replied to Descartes rather bluntly and dismissed him as an atomist—as courtly and mischievously as possible. He even sent him a treatise against atomism he had written.[51] Granting him, almost sarcastically, the glory of a second Pythagoras or Epicurus in his endeavor to put

49. Plempius calls Fromondus his "parent" (*parens*), AT I 399.

50. Fromondus has played his part in the history of Jansenism: disciple and intimate friend of Cornelius Jansenius, he helped with the revision and publication of the *Augustinus* and was engaged in a famous controversy with the Calvinist Gijsbertus Voetius in 1635–1636 on Jansenist theses. He had come close to heresy yet again in his youth in a tortuous seduction story with Galileo and Copernicanism, finishing by notoriously refuting both. See Pantin (2001). On Fromondus' career, besides Monchamp, see Ceyssens (1963) and Garber (1988). Fromondus held the chair of theology in Leuven since 1634, before having passed through the chairs of rhetoric and philosophy.

51. *Labyrinthus sive de compositione continui* (Antwerp 1631). The book is used by Leibniz as a compendium of arguments in the *Nouveaux Essais* (2, 23, 31) and the *Essais de théodicée* (*Discours préliminaire,* 24).

all science on an entirely new track, he also added that, as clear as the author's ingenuity was, as obscure was the truth in his writings. He feared that Descartes may fall into the "crass philosophy" of Epicurus, without realizing it.[52]

Fromondus brought forth 18 articles of contention: three on the general philosophy of the *Discourse,* six on the *Dioptrics* and nine on the *Meteors.* First of all, it is the approach that fails: the reduction of real qualities to the mechanical principles goes sometimes too far.[53] As he moved on to attack Descartes' explanations throughout the book, he raised objections to animal automatism and to the Cartesian theory of sensitivity. Objecting to the mechanics of the heart as responsible for bodily sensations, his concern was for safeguarding the sensitive soul: "the heat of the heart, without it being a sensitive soul, can exert in the body all the functions of the sensitive soul, apart from those of the rational soul." And he continued in proper Aristotelian parlance:

> He [Descartes] seems to say that heat, as that from heated hay, can exert in the human body all the animal operations, except for the operations pertaining to the rational soul. Thus the heat of the hay, without any other sensitive soul, can see, hear, etc. Such noble operations do not seem to be able to proceed from such a humble and brute cause.[54]

One could push this line of argument and ask why would the heat of the hay not make the hay itself see and hear? Descartes would probably answer that this is precisely what happens, once a certain level of complexity in the organized matter is achieved (the machine metaphor). The issue at stake is double: Descartes' account cancels both the divide between the sensible world and the material world and that between the sensible animals and the rational ones. The second consequence is more threatening

52. Descartes publicly tries to save face, saying to Huygens that "the dispute between us was more like a game of chess; we remained good friends", AT II 660. Cf. AT I 449: "Et en effet je me réjouis, lorsque je vois que les plus fortes objections qu'on me fasse, ne valent pas les plus faibles de celles que je me suis fait à moi-même, auparavant que d'établir les choses que j'ai écrites." He does sends to Huygens though the replies he had given to Fromondus and to which the latter did not deem to answer, and at some point contemplates their publication—as per the letter to Plempius from AT II 345.

53. AT I 408: "Nimis multa sperat se expediturum per solum situm, aut motum localem, quæ sine realibus qualitatibus aliis non possunt, aut nihil intelligo."

54. AT I 403: "videtur dicere quod calor, qualis in fœno calefacto, possit exercere omnes operationes animalis in corpore humano, exceptis actionibus propriis animæ rationalis. Ergo calor fœni, sine alia anima sensitiva, potest videre, audire, etc. Tam nobiles operationes non videntur posse prodire ex tam ignobili et bruta causa."

for Fromondus. Descartes' mechanics of the heart and the reduction of the animal soul opens the path to a dangerous materialism: if one says that some of the operations normally attributed to the soul actually take place as a result of the functioning of a mechanism, then we are in danger of explaining all operations of the soul, including its purely intellectual ones, through this mechanism. It "opens the way to the atheists, so that similar causes [motion provoked by heat] are assigned to the rational soul."[55] He preemptively congratulated Descartes at the end of his letter for still holding the thesis of the immortality of the soul, as if it were something to be congratulated for, somewhat in spite of his other commitments.[56] Fromondus' worries will take a clear shape shortly after, in the writings of Henricus Regius, as we have seen earlier.

Descartes himself would, however, painstakingly keep away from such impious implications. Since the matter is not only about the physiology of the heart, his avoidance of materialism and struggle to stay away from heresy will lead him to argue for the explanation of cardiac motion through a theory of the operations of the soul and a theory of sensations. Descartes undertakes for Fromondus this route, only too briefly. The explanation of the vision without intelligence, which Descartes puts forward for Fromondus as a reply to his suspicions of heresy, is the best argument that Descartes makes in this exchange and the key to his defense. He argues that mechanically explained sensations, such as those we find in animals, are not the same as sensations explained through the psychophysical union in man, which display the work of the rational soul:

> He [Fromondus] supposes that animals see just as we do, i.e. being aware or thinking they see, which is said to have been Epicurus' view and is still almost universal. But [. . .] I explain quite explicitly that my view is that animals do not see as we do when we are aware that we see, but only as we do when our mind is elsewhere. [. . .] In such a case we too move just like automatons, and nobody thinks that the force of heat is insufficient to cause their movements.[57]

55. "Hinc etiam fortassis via sternetur atheis, ut etiam animæ rationalis operationes simili causæ tribuant, et eam corpore humano excludant, aut saltem materialem animam vice immaterialis nobis infarciant." AT I 403.

56. "Delectat etiam me magis quod fide catholicus et spem nobiscum habeat post hanc vitam brevem æternæ." AT I 408.

57. AT I 413 / CSMK 62. Cf. the Replies to Hobbes, on the distinction between images and thought, esp. Descartes' reply to Hobbes's sixth objection, AT VII 182 / CSM II 128: "brute beasts cannot affirm or deny, even in thought; and hence cannot make judgments," etc.

Furthermore, Descartes continued, the animal soul (i.e. the Aristotelian vegetative and sensitive functions) is nothing else but pure blood, and he conveniently and heavily cites the Bible on that.[58] There is no soul-like faculty that would give rise to motion in living bodies, and hence Descartes' physiology of the heart is warranted to posit a naturally mechanical source of motion. Fromondus' point is to say that postulating this continuity between beasts and man through the mechanical physiology of the heart gives way to a dangerous materialism. Descartes' response is, on the one hand, to make clear where the line stands between the corporeal functions and the operations of the rational soul, and on the other hand to counter-attack by turning Fromondus argument against him, showing how his own account is the orthodox one and the Aristotelian conception of the soul is the truly heretic one: "Since these people posit so little difference between the operations of a man and of an animal, I do not see how they can convince themselves there is such a great difference between the natures of the rational and sensitive souls." He even offers a rare critique of the conceptual inconsistency of a sensitive soul: "On their view, when the sensitive soul is alone, its nature is corporeal and mortal; when it is joined to the rational soul, it is spiritual and immortal." Its functioning approaches ridiculousness: "it seems that on their view sensation in animals is closer to cognition in God and the angels than human reasoning is" (AT I 415 / CSMK 62).

Fromondus is not alone in warning of the danger of Descartes' physiology. Gassendi, Hobbes, Bourdin or the sixth objectors, they all make the point that denying the animal soul and mechanizing the human sensitive soul is endangering the gap between animal and man and is offering to an atheistic mind the opportunity to extend that mechanism to the very operations of the rational soul. Descartes will dismiss this as a misunderstanding of the scope of his project, but the stigma remained. However, the proposal of a mechanistic vital principle—heat, or fermentation—is not only a dangerous step towards mechanizing vital functions, but can be used with equal value as an argument for the psychophysical distinction, a point which Descartes made to Fromondus. The argument will be brought forward by Regius in his *Fundamenta physices* of 1646, and will be used by Cartesian apologetics throughout the rest of the century:

> It is certain that if we attribute to animals a sensual, imaginative or any kind of intellect, be it a very low one, or any sort of cognition,

58. AT I 414 : "cum Sancta Scriptura firmiter credo et, ni fallor, dilucide explicui, *animas brutorum nihil aliud esse quam sanguinem,* nempe illum qui, illorum corde calefactus et attenuatus in spiritum, ab arteriis per cerebrum in nervos et musculos omnes se diffundit," etc.

> then there would be no natural cause through which one could say that the human mind is less corruptible than the soul of a dog, a fox or a monkey.[59]

Regardless of Fromondus' opposition, by the end of the 1640s, Descartes' major publications were on the market and Cartesianism was gaining strength in Leuven. If professors like Arnold Guelincx, Gérard Van Gutschoven or Guillaume Philippi were professing Cartesian thesis, the opposition was still strong.[60] In 1653, Plempius, holding his ground, initiated a campaign to get Cartesianism ousted from the University. His efforts amounted to not much: he sent a circular letter to a number of professors asking them to comment, censure and condemn Descartes' writings, and he published the letters he received as an appendix to his old anti-Cartesian treatise, the *Fundamenta* (1653 edition: *Doctorum aliquot in Academia Lovaniensi Virorum Iudicia de Philosophia Cartesiana,* pp. 375–387). The intent was to gather personal attacks in the form of "censurae" from Leuven professors, as a plea for an official condemnation of the Cartesians in the university: will Leuven stand still and allow this new philosophy to chase away its Aristotle, when Utrecht and Leiden have already condemned it?[61]

Plempius' own letter serves as a preface to the small anti-Cartesian tract. His starting point is that Descartes' philosophy amounts to a revival of Democritus and should be treated as such; the rest of the letters are meant to detail this judgment. Out of the forgettable names that Plempius recruited, we will retain Fromondus' censorship as pointing out in detail the theological danger posed by Descartes. Leaving aside the contentious issue of the Eucharist, to which the bigger part of the letter is devoted, Fromondus nevertheless starts with combating the physiological point of the non-existence of animal souls, which contravenes the Holy Writ. The argument is interesting. The fact that the death of humans and the death of mules is said to be *unus* by the Holy Writ (p. 379a, *unus interitus est hominis et iumentorum*) entails according to Fromondus the fact

59. *Fundamenta physices* (1646), 242: "Et certe si bestiis sensualem, imaginativum vel quemlibet alium etiam vilissimum intellectum, vel qualemcunque cognitionem attribuamus, nulla causa naturalis dari potest, cur hominis mentem magis, quam animam canis, vulpis, vel simiæ incorruptibilem esse dicamus." On Cartesian apologetics and the arguments defending his conception of the soul, see Fowler (1999).

60. See Monchamp (1886), ch. XII (Arnold Guelincx), XV (Gérard Van Gutschoven), XVI (Guillaume Philippi), et passim. On the contrary, the Carmelite professor François Crespin (Bona-Spes) mentions in his *Commentarii in universam Aristotelis Philosophiam* (1652) Descartes as having rejected substantial forms and "nec multum abest Fromondus" (Monchamp 1886, p. 211).

61. *Fundamenta* (1653), 377b.

that the souls of humans and mules act as *forma informans:* the destruction of man is the separation of the soul from matter, i.e. the end of the process of in-formation of the matter by the soul; the Council of Vienne stated, against the Averroists, that the human soul is a *forma informans,* not a *forma assistens,* as the Cartesian-Democritean position could be interpreted; this entails that the soul of the mule is also a *forma informans,* informing matter, otherwise its destruction would not be the same with the destruction of man (p. 379a). Fromondus was actually reflecting here on his exchange with Descartes through Plempius (he states so himself, p. 378b) and he answers through this argument to Descartes' comment to Plempius mentioned earlier on the inconsistency of the Aristotelian position on death (AT I 514). But Fromondus goes on to expresses a very lucid grief against the Cartesians from his own university: in following Descartes, they fail to teach their pupils about the range of faculties and vital functions of the soul, things that are of utmost necessity if they are to progress towards theological studies. Pupils understand Saint Thomas and the scholastics easier, says Fromondus, just as they understand Galen in medicine easier, because they treat the various powers and faculties of the soul at length. Entering theology from a Cartesian training, one would be struck dumb by the proliferation of functions and the paraphernalia of powers of the soul needed there, and would not understand it, or worse, would become reluctant towards it. This seems like a very old-school position from Fromondus, a medieval view well alive in the middle of the seventeenth century: physiology is not a science for itself; it should serve as a preparation to theology, and explaining the vital functions through motion alone does not help. The enquiry as to whether the faculties are distinct from the soul *a parte rei* or just objectively should be done in theology, not in physiology; otherwise, it is like a harvesting a field too soon.[62]

Fromondus died before his letter appeared in print (in 1653), but his anti-Cartesian position is consistent throughout his career from the moment he laid his eyes on Descartes' writings. His publication of a textbook on *The Christian Philosophy of the Soul* in 1649 should be weighed in this anti-Cartesian context.[63] Monchamp (1886, pp. 151–156) takes out a number of passages from this manual that seem directed against Descartes, but the fact is that Fromondus never mentions Descartes' name in

62. *Fundamenta medicinæ* (1653), p. 380b: "Interim adolescens philosophus S. Thomam et Scholasticos in Theologia, Galenum et Medicos in vestra Medicina facilius intelliget, qui de potentiis et facultatibus animæ tam multa et varia disserunt: ne adolescens, ubi ex ludis illis philosophicis, qui per motus locales, aut sicsehabentias satis explicare confidunt, ad superiores Scholas ascenderit, et de varia istarum animæ facultatum supellectile loquentes audierit, obstupescat et sine conceptu remaneat"; cf. Monchamp (1886), pp. 253–256.

63. *Philosophiæ Chrisitanæ de Anima libri IV* (Leuven: 1649).

his published books.[64] With his characteristic sensibility towards the ancients and from the high seat of his Leuven chair, Fromondus directs his *De Anima* against the Democriteans of the day and their Epicurean disciples, of various incarnations. This is not a polemical treatise; but it is not hard to see in this publication a reaction to the danger of Cartesianism creeping up in Leuven classrooms, if we look at it from the retrospective of the 1653 letter. The publication of the book, in those years, seems to act as a theological complement to Plempius' *Fundamenta Medicinae.*

Meanwhile, Rome itself became interested in the Leuven affair. On 3 July 1662 the Faculty of Arts of the University of Leuven held a meeting debating the installation of Cartesian doctrines in the university, as a response to an inquiry from the papal nuncio. It was only the beginning of a series of such meetings. In August, a bachelor student held and published a series of Cartesian medical disputations. The Apostolic Nuncio, having seen the student's placard, wrote a warning letter to the university rector, citing the Cartesian theses put forward there: "that the arguments which give a soul to animals are not probable; that it is doubtful that animals live; that there is nothing new under the sun, except for the rational soul, i.e. [. . .] that no other [kind of] soul or qualities are produced anew, because there are none."[65] The recently recovered reports by the censors in Rome that motivated the decrees of condemnation issued by the Holy Congregation of Cardinals in 1662 and 1663 mention the same danger of the lack of the animal soul. The report on the *Passions of the Soul,* of the Roman censor Stephanus Spinula, alongside the condemnation of the account of the passions through the movements of the spirits, puts forward as a censorship-worthy thesis the following: "that no movement of the members of the body originates from the soul; and it is an error to believe that the soul gives motion and heat to the body."[66] Plempius will report in high spirits on the condemnation in his fourth edition of the *Fundamenta medicinae* (1664), which by now has become almost the equivalent of a journal series on anti-Cartesianism.[67]

64. Monchamp (1886), pp. 151–156.

65. Letter of de Vecchi, in Monchamp 1886, pp. 362–364 and Armogathe and Carraud (2001), p. 130: "Argumenta quæ brutis animam asserunt, non esse probabilia. Dubium esse an bruta vivant. Nihil sub coelo esse novi, seposita anima rationali—videlicet prout intelligi puto ab Authore—nullas animas, nullas qualitates de novo produci, quia nullæ sint."

66. Armogathe and Carraud (2001), p. 112, give the text of the censure of Stephanus Spinula: "3. Nullum motum corporalem membrorum oriri ab anima; quin erroneum esse credere animam dare motum et calorem corpori."

67. "C'est ainsi que ce qui a été commencé à Louvain par la sacrée Faculté de Théologie, fille de l'Église romaine, appui du Siège apostolique, gardienne des dogmes véritables, a été

5. Conclusion

The widespread view of the unorthodoxy of the animal-machine doctrine passed through the reduction of the sensitive soul that Descartes had accomplished in his account of the heartbeat. From this review of the anti-Cartesian reception in "the Leuven affair," assessing the motivation leading up to the condemnation of Descartes' physiology should take into account the following: the debate starts off with Fromondus' and Plempius' letters from 1637–1638, drawing on Descartes' physiology from the *Discourse;* the exchange from 1637–1638 shifts quickly from an academic-style dispute about the circulation of the blood to the philosophical implications of Descartes' account of the heartbeat, where the real disagreement lies; the concerted rejection of Descartes' physiology from 1637–1638 will be sustained by the two professors' subsequent publications; Fromondus' letter makes explicit the theological implications of Descartes' account on the heartbeat that Plempius opposed; Descartes' debate with Plempius over the heartbeat is continued through Regius' disputations and publications from 1640–1641; Plempius' use of Harvey's analysis of the systole is yet another way to counter Descartes, and his conversion to the circulation of the blood theory should be seen against this background, rather than as a victory of Descartes; Plempius' anti-Cartesian campaign peaks in the edition of 1653, with Fromondus' theological condemnation. Finally, Rome confirms Plempius' efforts in 1662–1663.

Thomas Gariepy has shown that for the first generation of Cartesians in the Northern Low Countries it was the Cartesian reading of Harvey's account of the circulation of the blood that represented "the cornerstone of a mechanical physiology" (Gariepy 1990, p. 316). The Leuven reception supports this view. When reading the first reactions to Descartes' cardiology, one assessment stands out: the medical explanation for the origin of motion in the heart and blood sits at the core of Descartes' project of rejecting the hylomorphic metaphysics of the Aristotelian sensitive soul, and it is immediately perceived as an attack on the medical establishment that went beyond the physiological matter. Descartes' account is read and discussed by careful defenders of the Aristotelian tradition such as Plempius or Fromondus and as putting forward a materialist danger discernible very early in Regius. Harvey's discovery of the circulation of the blood will be drawn into this Cartesian controversy and will be used by Aristotelian-minded physicians against Descartes, as Plempius does. At this stage, Descartes' argument for the theological good use of his physiol-

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achevé par la sacrée Congrégation des cardinaux." *Preface* to the 1664 edition, xx quoted by Monchamp (1886), p. 392.

ogy, expressed also by Regius, does little more than put fuel on the fire.[68] This comes to show how far along a physiological account can go, and the extent to which the propagation of Harvey's discovery of the circulation of the blood through Descartes is determined by theological constraints. Perhaps unintentionally, Descartes is not far from historical clairvoyance when saying that the acceptance or rejection of his explanation of the motion of the heart will determine the faith of his philosophical project.

References

Alexandrescu, Vlad. 2012. *Croisées de la Modernité. Hypostases de l'esprit et de l'individu au XVIIe siècle.* Bucharest: Zetabooks.

Anstey, Peter. 2000. "Descartes' cardiology and its reception in English physiology." Pp. 420–444 in *Descartes' Natural Philosophy.* Edited by S. Gaukroger, J. Schuster and J. Sutton. London and New York: Routledge, 2000.

Ariew, Roger. 1994. "Quelques condamnations du cartésianisme: 1662–1706." *Bulletin cartésien XXII, Archives de philosophie* 57: 1–6.

Ariew, Roger. *Descartes among the Scholastics.* 2011. Leiden, Boston: Brill.

Armogathe, Jean-Robert and Carraud, Vincent. 2001. "La première condamnation des *Œuvres* de Descartes, d'après des documents inédits aux Archives du Saint-Office." *Nouvelles de la République des Lettres* 2: 103–137.

Aucante, Vincent. 1999. "Les médecins et la medecine." Pp. 607–625 in *La biografia intellettuale di Descartes attraverso la* Correspondance. Edited by J.-R. Armogathe, G. Belgioioso, C. Vinti. Naples: Vivarium.

Aucante, Vincent. 2006. *La philosophie médicale de Descartes.* Paris: Presses Universitaires de France.

Baillet, Adrien. 1691. *Vie de Monsieur Descartes,* 2 vol. Paris: chez Daniel Horthemels.

Van Beverwijck, Johan. 1644. *Epistolicae quaestiones, cum doctorum responsis.* Rotterdam: A. Leers.

Bitbol-Héspèries, Annie. 1990. *Le Principe de vie chez Descartes,* Paris: J. Vrin.

Bos, Jan Jacobus Frederik Maria. 2002. *The Correspondence between Descartes*

68. Later on, Descartes' defence will catch on, to a certain degree. Antoine Arnauld's advocacy of Cartesianism shows how it can be taken as being a better position than either Aristotelianism or Thomism to explain both the gap between the animal kingdom and rational man and the separability of the human soul, with a simpler, upfront explanation that was virtually susceptible of being shown through experiments such as vivisections. On Arnauld's arguments, essentially the same as Regius' ones I reported, see Fowler (1999), chapter 3.

and Henricus Regius. Utrecht: Zeno, The Leiden-Utrecht Research Institute of Philosophy.

Ceyssens, Lucien, O.F.M. 1963. "Le janséniste Libert Froidmont (1587–1653)." *Bulletin de la Société d'Art et d'Histoire du Diocèse de Liège,* 43: 1–46.

Descartes, René. 1964–1976. *Oeuvres de Descartes.* 11 vols. Edited by Charles Adam and Paul Tannery. Paris: Vrin. (AT).

Descartes, René. 1984–1985. *The Philosophical Writings of Descartes.* 2 vol. Edited and translated by J. Cottingham, R. Stoothoff, and D. Murdoch. Cambridge: Cambridge University Press. (CSM).

Descartes, René. 1991. *The Philosophical Writings of Descartes Volume III.* Edited and translated by J. Cottingham, R. Stoothoff, and D. Murdoch and A. Kenny. Cambridge: Cambridge University Press. (CSMK).

Descartes, René. 2000. *Écrits physiologiques et médicaux.* Edited by Vincent Aucante. Paris: Presses Universitaires de France.

Descartes, René. 2003. *The Correspondence of René Descartes: 1643.* Edited by Theo Verbeek, Erik-Jan Bos, Jeroen van de Ven with contributions of Henk Bos, Carla Rita Palmerino, Corinna Vermeulen. Utrecht: The Leiden-Utrecht Institute for Philosophy.

Descartes, René. 1998. *The World and Other Writings.* Translated by S. Gaukroger. Cambridge: Cambridge University Press.

Fowler, Colin F., O.P. 1999. *Descartes on the Human Soul, Philosophy and the Demands of the Christian Doctrine.* Dordrecht, Boston, London: Kluwer Academic Publishers.

French, Roger. 1989. "Harvey in Holland: Circulation and the Calvinists." Pp. 46–87 in *The Medical Revolution Seventeenth Century.* Edited by Roger French and Andrew Wear. Cambridge: Cambridge University Press.

French, Roger. 1999. *Dissection and Vivisection in the European Renaissance.* Aldershot and Brookfield, VT: Ashgate.

French, Roger. 2006. *William Harvey's Natural Philosophy.* Cambridge: Cambridge University Press.

Fuchs, Thomas. 2001. *The Mechanization of the Heart. Harvey and Descartes.* Translated by Marjorie Grene. Rochester: The University of Rochester Press.

Garber, Daniel. 1988. "Descartes et les aristotéliciens en 1637." Pp. 201–206 in *Problématique et réception du* Discours de la méthode *et des* Essais. Edited by H. Méchoulan. Paris: J. Vrin.

Gariepy, Thomas Peter. 1990. *Mechanism Without Metaphysics: Henricus Regius and the Establishment of Cartesian Medicine.* PhD Dissertation, Yale University.

Georges-Bethier, Auguste. 1914. "Le méchanisme cartésien et la physiologie." *Isis* 2/1: 37–89.

Gilson, Etienne. 1930 (1984[5]). "Descartes, Harvey et la scolastique." Pp. 51–100 in *Études sur le rôle de la pensée médievale dans la formation du système cartésien.* Paris: Vrin.

Gorham, Geoffrey. 1994. "Mind-Body Dualism and the Harvey-Descartes Controversy." *Journal of the History of Ideas,* 55: 211–234.

Grene, Marjorie. 1993. "The Heart and the Blood: Descartes, Plemp and Harvey." Pp. 324–336 in *Essays on the Philosophy and Science of Rene Descartes.* Edited by Stephen Voss. Oxford: Oxford University Press.

Grene Marjorie. 2005. "Descartes and the Heart Beat: A Conservative Innovation." Pp. 91–97 in *Wrong for the Right Reasons.* Edited by J. Z. Buchwald and A. Franklin. Dordrecht: Springer.

Hall, Thomas S. 1970. "Descartes' Physiological Method: Position, Principles, Examples." *Journal of the History of Biology,* 3: 53–79.

Harvey, William. 1653. *The Anatomical Exercises of Dr. William Harvey,* London: F. Leach.

Harvey, William. 1989. *The Works of William Harvey.* Translated by Robert Willis. Philadelphia: University of Pennsylvania Press.

Monchamp, Georges. 1886. *Histoire du cartésianisme en Belgique.* Brussels: Hayez.

Plempius, Vopiscus Fortunatus. 1638. *Fundamenta medicinae.* Leuven: J. Zegers.

Plempius, Vopiscus Fortunatus. 1644. *Fundamenta medicinae.* Leuven: J. Zegers.

Plempius, Vopiscus Fortunatus. 1653. *Fundamenta medicinae.* Leuven: H. Nempaeus.

Plempius, Vopiscus Fortunatus. 1654. *Fundamenta medicinae.* Leuven: H. Nempaeus. [Identical with the previous.]

Plempius, Vopiscus Fortunatus. 1664. *Fundamenta medicinae.* Leuven: H. Nempaeus.

Pagel, Walter. 1976. *New Light on William Harvey.* Basel: S. Karger.

Pantin, Isabelle. 2001. "Libert Froidmont et Galilée: l'impossible dialogue." Pp. 615–635 in *Largo campo di filosofare. Eurosymposium Galileo 2001.* Edited by José Montesinos et Carlos Solis. Orotava: Fundación Canaria Orotava de Historia de la Ciencia.

Post, L. A. 1979. Appendix. Pp. 104–122 in G. A. Lindeboom, *Descartes and Medicine.* Amsterdam: Rodopi.

Regius, Henricus. 1640. *Disputatio medico-physiologica pro sanguinis circulatione.* Utrecht: Romanus. (Reprinted in AT III 727–734).

Regius, Henricus. 1646. *Fundamenta physices.* Amsterdam: L. Elzevier.

Regius, Henricus 1654. *Philosophia naturalis.* Amsterdam: L. Elzevier. [Second and enlarged edition of the previous.]

Regius, Henricus 1661. *Philosophia naturalis.* Amsterdam: L. Elzevier.

Riolan, Jean. 1649. *Opuscula Anatomica Nova.* London: M. Flesher.

Tricot, J.-P. 2000. "Vopiscus Fortunatus Plempius," *Vesalius,* VI/1: 11–19.

Vanagt, Katrien. 2011. *De emancipatie van het oog: V. F. Plempius's Ophtalmographia en de vroegmoderne medische denkbeelden over het zien.* PhD Dissertation, Universiteit Twente.

Verbeek, Theo. 1988. *La Querelle d'Utrecht.* Paris: Les Impressions Nouvelles.

Verbeek, Theo. 1992. *Descartes and the Dutch: Early Reactions to Cartesian Philosophy, 1637–1650.* Carbondale and Edwardsville: Southern Illinois University Press.

Verbeek, Theo. 1994. "Regius' *Fundamenta Physices," Journal of the History of Ideas,* 55: 533–551.

De Vrijer, J. A. 1917. *Henricus Regius. Een "cartesianisch" hogelaar aan de Utrechtsche hogeschool.* The Hague: M. Nijhoff.

Weil, Eric. 1957. "The Echo of Harvey's *De Motu Cordis* (1628). 1628 to 1657," *Journal of the History of Medicine and Allied Sciences,* XII/4: 167–174.

de Wulf, Maurice. 1908. "Le Mouvement philosophique en Belgique (suite et fin)," *Revue de néo-scolastique,* 60: 454–473.