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Andrea Strazzoni

# THE MEDICAL CARTESIANISM OF HENRICUS REGIUS. DISCIPLINARY PARTITIONS, MECHANICAL REDUCTIONISM AND METHODOLOGICAL ASPECTS*

SUMMARY

This article explores the medical theories of the Dutch philosopher and physician Henricus Regius (1598-1679), who sought to provide clearer notions of medicine than the traditional theories of Jean Fernel, Daniel Sennert and Vopiscus Plempius. To achieve this, Regius overtly built upon the natural philosophy of René Descartes, in particular his theories of mechanical physiology and the corpuscular nature of matter.

First, I show that Regius envisaged a novel partitioning of medicine, intended to make it independent in exposition but conceptually grounded in natural philosophy. This served his overall purpose of making medicine a 'clearer' discipline. To this end Regius detaches the general notion of physiology as the study of the human body (which pertains to natural philosophy) from a medical physiology that concerns only health. Secondly, I show that Regius's notions of health, disease, temperament and medicaments were the product of a Cartesian interpretation of traditional concepts, which was influenced by Santorio Santorio's project of practicing medicine without occult elements. As a consequence, Regius's classification of these notions is largely traditional.

In conclusion, I show that Regius's method of investigation in the area of natural philosophy consisted of a problem-solving procedure based on sensorial ideas. This approach can be traced back to Descartes, but was grounded on a purely empirical theory of knowledge, by which he rejected Descartes's metaphysics. Regius's order of exposition in natural philosophy and medicine, on the other hand, proceeds by definitions and divisions, and omits proofs. The reasons why Regius adopted this order were: 1) his rejection of Descartes's metaphysical interpreta-

Forschungszentrum Gotha der Universität Erfurt, Hauptmarkt 40, 99867, Gotha, Germania: andrea.strazzoni@uni-erfurt.de

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tion of physics, and 2) his wish to emphasize the conceptual clarity and continuity of natural philosophy and medicine.

*Keywords*: Medicine; Natural philosophy; Henricus Regius; René Descartes; Santorio Santorio; Jean Fernel; Physiology; Health; Temperaments; Method; Analysis.

## 1. Introduction

### 1.1. *Pores and particles contra observation and mathematics*

In his *Oratio de viribus rationis* (1698), the Dutch philosopher Burchard de Volder (1643-1709) outlined two different approaches to the study of human body: 1) the attempt of Theodor Craanen to deduce the *corporis humanis fabrica* from the first principles of physics, using the notions of pores and particles; 2) the approach of Giovanni Alfonso Borelli and Lorenzo Bellini, who studied the human body by applying mechanical and geometrical principles to the empirical evidence gained in vivisections. For De Volder, the latter approach had to become the standard in natural philosophy, where it was already successfully practiced by Huygens and Galileo. As De Volder already pointed out in his earlier *Oratio de coniugendis philosophicis et mathematicis disciplinis* (1682), they correctly – and mathematically – described the laws of falling bodies, of pendulum vibration, and of the collision of bodies,[1] which Descartes notoriously failed to formulate in his *Principia philosophiae* (1644).[2] In attacking Craanen, De Volder was referring to a tradition of thought inaugurated by Descartes and Henricus Regius, whose writings Craanen was overtly building upon,[3] while, in praising Huygens, Galileo, Borelli and Bellini, he

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[1] Cf. Burchard de Volder, *Oratio de rationis viribus, et usu in scientiis, dicta publice cum rectoris Academiae Lugd. Bat. munere abiret*, Leiden, apud Fredericum Haringium, 1698, pp. 22-30; Id., *Oratio de coniugendis philosophicis et mathematicis disciplinis, cum philosophicae professioni adiunctam mathematicam rite auspicaretur*, Leiden, apud Jacobum Voorn, 1682, pp. 16-17.

[2] On the discovery of the laws of impact, see Peter Anstey – Dana Jalobeanu (eds.), *Vanishing Matter and the Laws of Motion: Descartes and Beyond*, London, Routledge, 2011.

[3] Cf. Theodor Craanen, *Oeconomia animalis ad circulationem sanguinis breviter delineata*, Gouda, ex officina Guilhelmi Vander Hoeve, 1685); Id., *Lumen rationale medicum, hoc est praxis medica reformata sive annotationes in Praxin Henrici Regii*, Middelburg, apud Johannem de Reede, 1686; Id., *Tractatus physico-medicus de homine, in quo status eius tam naturali, quam praeternaturalis, quoad theoriam rationalem mechanice demonstratur*, Leiden, apud Petrum vander Aa, 1689. On Craanen, see Antonie M. Luyendijk-Elshout, *Oeconomia animalis, Pores and Particles: The Rise and Fall of the Mechanical Philosophical School of Theodoor Craanen (1621-1690)*, in Theodor H. Lunsingh Scheurleer – Guillaume H.M. Posthumus Meyjes

refers to a kind of approach not yet accepted in Dutch Universities, dominated by Aristotelianism, on the one hand, and by Cartesianism on the other, both failing to successfully combine mathematics and physics.[4] De Volder's views, therefore, pose a question both to the historian of medicine, and to historian of philosophy and science: namely, can we oppose a 'Cartesian' approach in natural philosophy and medicine, to the mathematical-experimental methodologies that Galileo, Huygens, Borelli and Bellini used in physics and anatomy? This article aims at confronting this broad problem by exploring the first attempt to develop a full-blown medical theory on a Cartesian basis. This effort was not made by Descartes, notwithstanding his aim of developing the 'branch' of medicine out of the 'trunk' of natural philosophy,[5] but by the Dutch physician and natural

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(eds.), *Leiden University in the Seventeenth Century: An Exchange of Learning*, Leiden, Brill, 1975, pp. 294-307; Henri Krop, *Medicine and Philosophy in Leiden around 1700: Continuity or Rupture?*, in Wiep van Bunge (ed.), *The Early Enlightenment in the Dutch Republic, 1650-1750*, Leiden-Boston, Brill, 2003, pp. 173-196.

[4] On experimentalism at Dutch universities in late seventeenth century, see Gerhard Wiesenfeldt, *Leerer Raum in Minervas Haus. Experimentelle Naturlehre an der Universität Leiden, 1675-1715*, Amsterdam, Koninklijke Nederlandse Akademie van Wetenschappen, 2002.

[5] Cf. the *Lettre-Préface* to the French edition of Descartes's *Principia philosophiae*, in René Descartes, *Oeuvres*, ed. by P. Adam, C. Tannery, Paris, 1897-1913 (henceforth as 'AT'), IX-B, p. 16. Whilst devoting an important part of his researches to the study of the human body (as shown by Vincent Aucante in his monograph) – substantiated in the fifth part of his *Discours de la méthode* and in the posthumously published *L'homme* (1662, 1664) and *Description du corps humain* (1664) – Descartes never developed a practical medicine. His scattered medical advice is limited to his correspondence, and in 1646 he wrote, in a letter to Chanut, to have found it easier not to fear death than to preserve life (AT IV, pp. 440-442). Different explanations have been provided for the absence of a complete medical theory in Descartes's thought: Theo Verbeek has considered this as related to Descartes's lack of time, while Vincent Aucante has grounded such a lack in the absence, at Descartes's time, of a comprehension of human anatomy capable of unveiling the mechanisms underlying bodily processes, and by the fact that medicine had to rely on such an account of human nature hindered by the lack of clear and distinct knowledge of the union of soul and body: see Theo Verbeek, *Les passions et la fièvre. L'idée de la maladie chez Descartes et quelques cartésiens néderlandais*, «Tractrix», I, 1989, pp. 45-61; Vincent Aucante, *La philosophie médicale de Descartes*, Paris, Presses Universitaires de France, 2006, pp. 417-419. On Descartes's medical theories and their immediate reception, see also Thomas Hall, *Descartes' Physiological Method: Position, Principles, Examples*, «Journal of the History of Biology», III, 1970, pp. 52-79; Gerrit Lindeboom, *Descartes and Medicine*, Amsterdam, Rodopi, 1978; Annie Bitbol-Hespériès, *Le Principe de vie chez Descartes (et ses prédécesseurs)*, Paris, Vrin, 1990; Ead., *Descartes et Regius: leur pensée médicale*, in Theo Verbeek (ed.), *Descartes et Regius, Autour de l'Explication de l'esprit humain*, Amsterdam-Atlanta, Rodopi, 1993, pp. 47-68; Annie Bitbol-Hespériès, *Cartesian Physiology*, in Stephen Gaukroger – John Andrew Schuster – John Sutton (eds.), *Descartes' Natural Philosophy*, London-New York, 2000, pp. 349-382; Francesco Trevisani, *Descartes in Germania. La ricezione del cartesianesimo nella Facoltà filosofica e medica di Duisburg (1652-1703)*, Milan, Franco Angeli, 1992; Dennis Des Chene, *Life and Health in Cartesian Natural Philosophy*, in Schuster – Sutton (eds.), *Descartes' Natural Philosophy*, pp. 723-735; Dennis Des Chene, *Spirits and Clocks, Machine and Organism in Descartes*, Ithaca, Cornell University

philosopher Henricus Regius. This exploration will be carried out according to three main topics of investigation: 1) Regius's re-definition of the subject-matters of natural philosophy, physiology and medicine; 2) his application of Cartesian notions to the understanding of medical concepts, 3) the methodological aspects of his medicine and natural philosophy. Through this exploration, this article also aims at ascertaining whether this attempt was influenced by the quantitative approach to medicine of Santorio Santorio, correspondent of Galileo and teacher of Regius in Padua in the 1620s: namely, it sheds light on a possible 'Galileo-Santorio-Regius' connection at the roots of the Cartesian strand in medicine.

### 1.2. *The state of the question on Regius's philosophy and medicine*

Born in Utrecht in 1598, Regius had been one of the first teachers of Cartesian philosophy at a European Academy. After having studied philosophy in Franeker (1616), he matriculated at the medical faculties of Groningen, Leiden and Montepellier University, and graduated in Padua in 1623, where he had Cesare Cremonini, Santorio Santorio and Adrianus Spigelius as *promotores*. When he came back to Utrecht in 1634, he started to lecture privately on Cartesian topics in natural philosophy, to which Descartes's friend Henricus Reneri had introduced him.[6] Apparently, he was able to obtain a position at Utrecht University in 1638 – as extraordinary professor of theoretical medicine – thanks to such private teaching. Indeed, Reneri was among those who supported his candidacy for a chair in medicine at the Academy.[7] In his *Epistola ad Patrem Dinet*, moreover, Descartes reports that Regius was appointed at the medical

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Press, 2001; Lisa Shapiro, *The Health of the Body-Machine? Or Seventeenth Century Mechanism and the Concept of Health*, «Perspectives on Science», II:4, 2003, pp. 421-442; Géraldine Caps, *Les «médecins cartésiens». Héritage et diffusion de la représentation mécaniste du corps humain (1646-1696)*, Hildesheim, Olms, 2010; Susan Mills, *The Challenging Patient: Descartes and Princess Elisabeth on the Preservation of Health*, «Journal of Early Modern Studies», II:2, 2013, pp. 101-122; Justin E.H. Smith, *Heat, Action, Perception: Models of Living Beings in German Medical Cartesianism*, in Mihnea Dobre – Tammy Nyden (ed.), *Cartesian Empiricisms*, Dordrecht, Springer, 2013, pp. 105-123; Gideon Manning, *Descartes and the Bologna Affair*, «The British Journal for the History of Science», XLVII:1, 2014, 1-13; Delphine Antoine-Mahut – Stephen Gaukroger (eds.), *Descartes' Treatise on Man and its Reception*, Cham, Springer, 2016; Peter Distelzweig – Benjamin Goldberg – Evan R. Ragland (eds.), *Early Modern Medicine and Natural Philosophy*, Dordrecht, Springer, 2016, part II.

[6] See Robin Buning, *Henricus Reneri (1593-1639), Descartes' Quartermaster in Aristotelian Territory*, Utrecht, Utrecht University, Publications of the Department of Philosophy, 2013.

[7] Cf. *Testimonium Academiae Ultraiectinae, et Narratio historica qua defensae, qua exterminatae novae philosophiae*, Utrecht, s.n., 1643, p. 9, also in Theo Verbeek, *La Querelle d'Utrecht*, Paris, Les Impressions Nouvelles, 1988.

faculty because he had written a textbook on physiology after having read his *Discours de la méthode* and *Essais* (1637), and which he presented to the friends supporting him before the city authorities.[8] Eventually, the contents of Regius's teachings and textbook resulted in his disputation *Pro circulatione sanguinis* of 1640,[9] and in two series of disputations he held in 1641: his *Physiologia sive cognitio sanitatis*[10] and *De illustribus aliquot quaestionibus physiologicis*.[11] Later, he would incorporate large sections of these texts in his main treatises in natural philosophy and medicine: his *Fundamenta physices* (1646) – which is largely based on Descartes's *Principia philosophiae* (1644) – then expanded in his *Philosophia naturalis* (1654, 1661, and 1687),[12] and his *Fundamenta medica* (1647, 1657 and 1668), to which he added a *Praxis medica* in two further editions (1657 and 1668).[13]

These texts are representative of an attempt to connect medicine to natural philosophy, and at providing a clarification of the fundamental concepts of medicine on a Cartesian basis. In the dedicatory letter to his *Fundamenta medica*, indeed, Regius reveals that his first aim, as he assumed the chair of theoretical medicine in 1638, had been that of providing, «obscuris dilucidatis» and «methodice», an exposition of medicine after having been acquainted with Descartes's philosophy, and to solve the

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[8] AT VII, pp. 582-583. See Erik-Jan Bos, *The Correspondence between Descartes and Henricus Regius*, Utrecht, Utrecht University, Publications of the Department of Philosophy, 2002, p. 4 (note 9) and 40.

[9] This is an exposition of Descartes's theory of the circulation of the blood, to which Regius adds an account of respiration: see Bos, *Correspondence* (cit. note 8), pp. 46-47. The English physician Jacob Primrose would criticize this text in his *Animadversiones in theses D. Henrici le Roy*, Leiden, ex Officina Iohannis Maire, 1640; Regius would reply with his *Spongia qua eluuntur sordes Animadversionum quas Jacobus Primirosius* [...] *adversus Theses pro circulatione sanguinis in Academia Ultraiectina disputatas nuper edidit*, Leiden, ex Officina Wilhelmi Christiani, 1640.

[10] Henricus Regius, *Physiologia, sive cognitio sanitatis. Tribus disputationibus in Academia Ultraiectina publice proposita*, Utrecht, ex Officina Aegidii Roman, 1641, also in Bos, *Correspondence*, pp. 195-248. The series continued in 1643, covering all the subjects of medicine up to therapeutics.

[11] Henricus Regius, *De illustribus aliquot quaestionibus physiologicis*, Utrecht, ex Officina Aegidii Roman, 1641. This series includes references to Descartes's *Le monde*, which Regius could read in the Spring of 1641 (cf. AT III, pp. 374, and Theo Verbeek, *Regius's* Fundamenta Physices, «Journal of the History of Ideas», LV, 1994, pp. 533-551: 543-546).

[12] Henricus Regius, *Fundamenta physices*, Amsterdam, apud Ludovicum Elzevirium, 1646; Id., *Philosophia naturalis, editio secunda*, Amsterdam, apud Ludovicum Elzevirium, 1654; Id., *Philosophia naturalis, in qua tota rerum universitas, per principia, explanatur*, Amsterdam, apud Ludovicum et Danielem Elzevirios, 1661.

[13] Henricus Regius, *Fundamenta medica*, Utrecht, apud Theodorum Ackersdycium, 1647; Id., *Medicinae libri quatuor*, Utrecht, typis Theodori ab Ackersdijck, et Gisberti a Zijll, 1657; Id., *Praxis medica*, Utrecht, typis Theodori ab Ackersdijck, et Gisberti a Zijl, 1657; Id., *Medicina et praxis medica*, Utrecht, ex Officina Theodori ac Ackersdijk, 1668.

«mysteria» and the «abditissima» characterizing the medicine of his time. For this aim, Regius declares, he had published his natural philosophy, following an «expeditam et compendiariam viam».[14] Already in his *Physiologia* and *De illustribus quaestionibus phyiologicis*, in fact, «mysteria» and «sacra» characterized natural philosophy as such and, for Regius, were revealed by the «mystagogus» Descartes.[15] *Abdita*, on the other hand, were the occult causes of certain functions of the human body and properties of medicaments according to the standard physiology of his time.[16]

The orientation of Regius's natural philosophy, therefore, seems to have always been for the development of a clearer medicine, on a Cartesian basis. However, even if the literature on Regius is now abundant, there is no clear account of the relations between his natural philosophy and his medical theories. Karl Eduard Rothschuh and Paolo Farina have focused on the pre-Cartesian background of Regius's physiology, disclosing some of his sources, as Jean Fernel and Santorio Santorio, as well as on Descartes's influences, noticeable mainly in his theory of matter and in his account of the circulation of the blood.[17] Later, Theo Verbeek provided an account of the evolution of Regius's thought in the light of his quarrels with Gysbertus Voetius and with Descartes himself,[18] while Erik-Jan Bos edited the complete correspondence between Descartes and Regius.[19] More recently, two studies on the natural philosophy and physiology of Regius have been published by Delphine Bellis and Delphine Antoine-Mahut, focusing on the methodology employed by Regius in his *Fundamenta physices*. Bellis focused on the ways phys-

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[14] Regius, *Fundamenta medica* (cit. note 13), *Dedicatio*, pp. i-iv. I discuss the 'compendiary' character of Regius's texts in section 4 and in the conclusions.

[15] Regius, *Physiologia* (cit. note 10), pp. 1, 33; Id., *De illustribus quaestionibus* (cit. note 11), *secunda*, thesis 22.

[16] This is discussed *infra*, section 3.

[17] Karl E. Rothschuh, *Henricus Regius und Descartes. Neue Einblicke in die frühe Physiologie (1640-1641) des Regius*, «Archives Internationales d'Histoire des Sciences», XXI, 1968, pp. 39-66; Paolo Farina, *Sulla formazione scientifica di Henricus Regius: Santorio Santorii e il* De statica medicina, «Rivista Critica di Storia della Filosofia», XXX, 1975, pp. 363-399. Farina has also explored Regius's matter theory in the *Fundamenta physices*: Paolo Farina, *Il corpuscolarismo di Henricus Regius: materialismo e medicina in un cartesiano olandese del Seicento*, in Ugo Baldini – Paolo Farina – Francesco Trevisani – Giancarlo Zanier (eds.), *Ricerche sull'atomismo del Seicento*, Florence, La Nuova Italia, 1977, pp. 119-178.

[18] Theo Verbeek, *'Ens per accidens': le origini della* Querelle *di Utrecht*, «Giornale critico della filosofia italiana», LXXI, 1992, pp. 276-288; Id., *Descartes and the Dutch. Early Reactions to Cartesian Philosophy 1637-1650*, Carbondale-Edwardsville, Southern Illinois University Press, 1992; Id., *The Invention of Nature. Descartes and Regius*, in Gaukroger – Schuster – Sutton (eds.), *Descartes' Natural Philosophy* (cit. note 5), pp. 149-167.

[19] Bos, *Correspondence* (cit. note 8).

ical principles and explanations are to be provided in accordance with Regius's epistemological assumptions, that is, without the recourse to any innate idea and, in consequence, to Descartes's metaphysical foundation of physics.[20] Antoine-Mahut, on the other hand, has taken into consideration the role of dissection in the development of a Cartesian physiology, as this is expounded in the main editions of *Fundamenta*, and, concerning the topics of the beating of the heart, digestion, and muscular movement, showing how anatomical experiences served to confirm Descartes's account of the functioning of the body, as well as to detail it.[21] In fact, only one monograph has been provided on the whole medical thought of Regius, considering both its theoretical and practical aspects: the doctoral dissertation of Thomas Gariepy, *Mechanism without Metaphysics: Henricus Regius and the Establishment of Cartesian Medicine* (1990), which has however undergone criticism in more recent literature as it fails to recognize the originality of Regius's thought with respect to Descartes, given that Gariepy assumes that Regius relied on Descartes's *L'homme* in writing his *Physiologia* (1641). Gariepy does not deal in any detail with the foremost pre-Cartesian sources of Regius, such as Fernel, Ramus, Santorio, and Sennert, which, given Regius's limited acquaintance with Descartes's texts in the late 1630s and early 1640s (when he had read only Descartes's *Discours de la méthode* and *Essais*), are to be considered before any in-depth analysis of Regius's medicine as such.[22] This study was followed by the article by Annie Bitbol-Hespériès, *Descartes et Regius: leur pensée médicale* (1993), providing an analysis of the key notions of Regius's *Physiologia* (such as those of *cognitio* and *curatio*,

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[20] Delphine Bellis, *Empiricism without Metaphysics: Regius' Cartesian Natural Philosophy*, in Dobre – Nyden (eds.), *Cartesian Empiricisms* (cit. note 5), pp. 151-183.

[21] Delphine Kolesnik-Antoine, *Le rôle des expériences dans la physiologie d'Henricus Regius: les «pierres lydiennes» du cartésianisme*, «Journal of Early Modern Studies», II:1, 2013, pp. 125-145.

[22] Thomas Gariepy, *Mechanism without Metaphysics. Henricus Regius and the Establishment of Cartesian Medicine*, Yale University, Ph.D. dissertation, 1990. Descartes's *L'homme* was read by Regius only in 1646 (see Bos, *Correspondence*, p. xiii), while Descartes's *Le monde* was read by him in mid-1641: see *supra*, note 11. On Regius's reception of Descartes's *L'homme*, see Delphine Antoine-Mahut, *The Story of* L'Homme, and Tad M. Schmaltz, *The Early Dutch Reception of* L'Homme, both in Antoine-Mahut – Gaukroger (eds.), *Descartes' Treatise on Man and its Reception* (cit. note 5), pp. 1-29 and pp. 71-90; Tad M. Schmaltz, *Early Modern Cartesianisms: Dutch and French Constructions*, New York, Oxford University Press, 2016, chapter 5: *Cartesianisms in Dutch medicine*. Other studies which have touched upon Regius's medicine are Gideon Manning, *Naturalism and Un-naturalism Among the Cartesian Physicians*, «Inquiry», LI:5, 2008, pp. 441-463; Caps, *Les «médecins cartésiens»* (cit. note 5); Saskia Klerk, *Galen Reconsidered. Studying Drug Properties and the Foundations of Medicine in the Dutch Republic ca. 1550-1700*, Utrecht, Ph.D. dissertation, 2015.

and the classifications of the parts of the body), and discussing Regius's debts to Descartes's theory of the circulation of the blood in this text.[23] The disciplinary relations of natural philosophy and medicine as devised by Regius, and their methodological entailments, however, are still in a twilight zone in early modern scholarship.

### 1.3. *Contents of the article*

In order to fill this gap, in what follows I explore three different aspects of Regius's medical and philosophical thought:

– In section 2, I show that Regius envisaged a partition of medicine intended to make it independent in exposition, but conceptually grounded in natural philosophy. This was functional to his overall purpose of making medicine a 'clearer' discipline. For this purpose, Regius detaches the general notion of physiology as the study of the human body (which pertains to natural philosophy), from a medical physiology which concerns only the topic of health, and which is the first part of medicine. In this partition, Regius was building upon Sennert's considerations of the status of physiology, labelled, since Fernel, as the 'natural part' of medicine.

– In section 3, I show that Regius's basic notions in medicine, namely, those of health, disease, temperaments and of the powers of medicaments, results from a Cartesian interpretation of Sennert's and Fernel's conceptualization of these, mediated by Santorio's project of providing a medicine without occult qualities. As a consequence, Regius's classifications of these notions (and by extent, his medicine) is largely traditional, although its basic concepts are explained by a theory of matter inspired by Descartes.

– In section 4, and in the conclusions, I show that Regius's method of discovery in natural philosophy was not inspired by Santorio's quantitative approach, nor (via Santorio) by Galileo, but consisted of a problem-solving procedure based on the manipulation, by the faculty of the imagination, of sensorial ideas. This method traces back to Descartes, but is based by Regius on a different theory of knowledge, as Regius rejects Descartes's metaphysics. This original methodology resembles inference to the best explanation. Regius's order of exposition in natural philosophy and medicine, on the other hand, can be traced back to Galen's *doctrina definitiva*, and to Ramus's method of dichotomies. This order is combined by Regius with 1) the resolutive order usually

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[23] Bitbol-Hespéries, *Descartes et Regius: leur pensée médicale* (cit. note 5).

adopted in medical textbooks (which, in the hands of Regius, consists of proceeding from the definition of the ends to that of the means of medicine, by divisions and explanations), and 2) the compositive order used in Aristotelian natural-philosophical treatises, proceeding, by the same means, from the knowledge of the causes to that of the effects, and from the most general notions to the more particular ones. These two kinds of order are in fact used by Regius, who followed Zabarella in natural philosophy, and Sennert in medicine, by adopting the first order of exposition in his *Fundamenta physices*, and the second one in his *Fundamenta medica*. In turn, Regius's Ramist-definitive method is different from 3) Descartes's presentation of his natural philosophy as based on metaphysics. The reason for the adoption by Regius of this method was, on one hand, his rejection of Descartes's metaphysics and the acceptance of most of his physics. On the other hand, by using this order in both natural-philosophy and medicine, he aimed at emphasizing their conceptual continuity (explored in section 2), and at concealing the traditional character of his medicine (explored in section 3).

## 2. Natural philosophy, physiology and medicine in Regius's program

In his attempt to provide a 'clearer' medicine, Regius devised a new division of the contents of medicine, physiology and natural philosophy. At the beginning of his 1647 *Fundamenta medica*, Regius divides medicine into *cognitio* and *curatio*. *Cognitio* is divided into *physiologia*, or the knowledge of health, and *cognitio pathologica*, or the knowledge of diseases. Regius points out the continuity between *cognitio* and *curatio*, i.e. between what were traditionally – and improperly – labelled as 'theoretical' and 'practical' medicine, since the explanations of bodily functions in *cognitio* are in any case aimed at healing. Moreover, he rectifies what he labels as the 'vulgar' definition of physiology as the study of the human body as such, and concerning «elementa, temperamenta, partes, humores, spiritus, facultates, et functiones».[24] This is, for Regius, an imprecise definition of physiology, which concerns human health only. This idea of physiology, actually, can already be ascertained in Regius's earlier *Physiologia*, in which, although he had to deal with topics other than health (as he had not yet provided a treatise on natural philosophy, as he would do with his *Fundamenta physices*), he already pointed out that health is the first and foremost object of physiology: «physiologia sive cognitio san-

[24] Regius, *Fundamenta medica*, *Dedicatio* (cit. note 13), p. iii.

itatis».[25] For Regius, thus, there are two kinds of physiology: a general physiology, or the study of natural things in the human body (which is a branch of natural philosophy), and a medical physiology, concerning human health. Such a distinction prevents the repetition of the same notions in medical and physical treatises. Physics, though not aimed at a practical purpose in itself, is to be considered a premise necessary to medicine, from which it is detached only for pragmatic reasons, namely, not to repeat the same notions in physical and medical treatises.[26]

The presentation by Regius of the relation of medicine to natural philosophy testifies to a centuries-long debate on the ways of conceiving the subjects of physiology. At the time of Regius's studies in the Netherlands and in Padua, the founding text in physiology was still the *De naturali parte medicinae* (1542) of Jean Fernel, later included in his *Universa medicina* (1554), which went through several editions in the sixteenth and seventeenth centuries.[27] This treatise is part of Regius's background: Fernel, together with Santorio and Sennert, is one of the early modern medical authorities overtly referred to by the Dutchman.[28] Fernel established a notion of *physiologia* as the study of the healthy man – thus concerning the whole structure of the human body rather than health

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[25] See *supra*, note 10.

[26] Regius, *Fundamenta medica* (cit. note 13), pp. 1-3. In the second edition of *Fundamenta medica*, Regius underlines that he had to repeat some notions already developed in physics in order to make the treatise more understandable: Id., *Medicinae libri quatuor* (cit. note 13), p. 3.

[27] For a bibliographical overview, see Charles Sherrington, *The Endeavour of Jean Fernel, with a List of the Editions of His Writings*, Cambridge, Cambridge University Press, 1946. On Fernel's theories, see the *Introduction* of John Forrester and John Henry to *Jean Fernel's On the Hidden Causes of Things. Forms, Souls, and Occult Diseases in Renaissance Medicine*, ed. and trans. John Forrester, John Henry, Leiden-Boston, Brill, 2005, and Hiro Hirai, *Medical Humanism and Natural Philosophy*, Leiden-Boston, Brill, 2011, chapter II.

[28] Cf. Regius, *Physiologia* (cit. note 10), pp. 13-14; on Santorio, see *infra*, note 110. Sennert is mentioned in the *Corollaria* of the last disputation of Regius's *Physiologia*, *De therapeutica* (Utrecht, ex Typographia Ioan. a Noortdyck, et Whilelmi Strick, 1643). As I show elsewhere, Sennert's atomistic theory of generation may have inspired Regius's corpuscular account of generation as well: see Andrea Strazzoni, *'How did Regius become Regius?'*, «Early Science and Medicine», forthcoming. On Sennert's atomism and physiology, see Antonio Clericuzio, *Elements, Principles and Corpuscles: A Study of Atomism and Chemistry in the Seventeenth Century*, Dordrecht, Kluwer, 2000, chapter I; Christoph H. Lüthy, *Daniel Sennert's Slow Conversion from Hylemorphism to Atomism*, «Graduate Faculty Philosophy Journal», XXVI:2, 2005, pp. 99-121; William R. Newman, *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution*, Chicago, University of Chicago Press, 2006, chapter II; Hirai, *Medical Humanism and Natural Philosophy* (cit. note 27), chapter VI. On Regius's debts to the theories of Fernel and Santorio, with special attention to their ideas on matter, see the studies of Rothschuh and Farina already mentioned, and Strazzoni, *'How did Regius become Regius?'*: in this article I explore those aspects of Regius's physiology related to his theory of matter rather than its disciplinary and methodological aspects.

alone – and preceding pathology or the study of diseases, diagnostics, which concerns their signs, hygiene or the study of the conservation of health, therapeutics or the healing of diseases.[29] The former three parts, for Fernel, concern the cognition of the body, whereas the latter ones concern actions: together, they form 'theoretical' and 'practical' medicine, according to a distinction rejected by Regius. Fernel's physiology thus concerns the parts, elements, temperaments, spirits, humors and innate heat of the human body, the faculties of the soul, and the generation of man.[30] Fernel's systematization of the subject of physiology, in turn, consisted of a re-working of the ideas of Hippocrates, (pseudo-) Galen and Avicenna on physiology. In the pseudo-Galenic *Definitiones medicae*, for instance, physiology is defined as the study of the power of nature that orders the functioning of the human body, and is the first part in the five-fold division of medicine. In the pseudo-Galenic *Introductio sive medicus*, in turn, physiology is divided into a theory of the elements of the human body, of the formation of the foetus, and the investigation of the parts of the body. On the other hand, in his *De partibus artibus medicativae* Galen assumed a broader notion of physiology, as the study of the nature of any thing, which would be of little use for medicine itself, but praises the physiology of Hippocrates as it concerns elements, qualities, mixtures and humors. Eventually, in Avicenna's *Canon medicinae* physiology is dealt with in the first part of medicine: the first part of the first book of the *Canon* includes six *doctrinae*, namely, the definition and the scope of medicine, a general cosmology i.e. a theory of the four elements, the theory of temperaments, the humoral theory, anatomy and a theory of the powers of living beings: plants, animals and man. The physiology of Fernel thus set a clearer definition and organization of this matter: with respect to Avicenna's *Canon*, a new section on innate heat is added, and anatomy is dealt with in the first book of physiology; moreover, the cosmological theory is omitted.[31]

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[29] Regius's division of medicine parallels this canonical division of medicine, according to which diagnostics is a part of pathology, and hygiene is kindred to therapeutics – as they both form *curatio*: Regius, *Fundamenta medica* (cit. note 13), p. 120.

[30] I refer to Jean Fernel, *Universa medicina*, Lyon, sumptibus Alexandri Marsilii, 1578 (first published as *Medicina*, Paris, apud Andream Wechelum, 1554; for a list of all the editions of this work, see Sherrington, *The Endeavour of Jean Fernel*, cit. note 26, *Praefatio*, pp. iii-iv. On Fernel's idea of *physiologia* as a theoretical discipline, see Andrew Cunningham, *The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800: I: Old Physiology – the Pen*, «Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences», XXXIII:4, 2002, pp. 631-665.

[31] I owe the references to ancient medicine to Vivian Nutton, Physiologia *from Galen*

After Fernel, the subject matter he established became standard in the sections on physiology in medical textbooks. We find these subjects, for instance, in Vopiscus Plempius's *De fundamentis medicinae* (1638) whose section on physiology matches the order of topics mentioned by Regius in is *Fundamenta medica*.[32] However, this standard did not come uncontested. In his new disciplinary division, Regius could indeed rely on Daniel Sennert's *Institutiones medicinae* (1611): his characterization of the subjects of physiology and division of medicine as practical and theoretical, in fact, had already been corrected by Sennert, who moreover maintained that the first part of medicine – *physiologia* – concerns health as the end of medicine, since a general physiology is already provided in books of anatomy. And yet, Sennert, too, like Regius, devoted the book on physiology of his *Institutiones* to provide the reader with an explanation of the functioning of the human body as such, by considering, in the different chapters of the book, health (chapter III), temperaments (4), innate heat and radical humidity (5) spirits (6), the parts of the body (7), faculties and actions of the soul (8).[33] Santorio, in turn, in his *Commentaria in Artem medicinalem Galeni* (1612) maintains that the subject matter of medicine, in Galen's *Ars parva*, is not the human body, which is the subject of philosophy, but rather the preservation of health, which is also the end of medical art.[34] And yet, in his *Commentaria in primam Fen primi libri Canonis Avi-*

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*to Jacob Bording*, in Manfred Horstmanshoff – Helen King – Claus Zittel (eds.), *Blood, Sweat and Tears. The Changing Concepts of Physiology from Antiquity into Early Modern Europe*, Leiden-Boston, Brill, 2012, pp. 27-40. See also Nancy Siraisi, *Avicenna in Renaissance Italy: The Canon and Medical Teaching in Italian Universities after 1500*, Princeton, Princeton University Press, 1987.

32 Fortunatus Vopiscus Plempius, *De fundamentis medicinae libri sex*, Leuven, typis ac Sumptibus Iacobi Zegersii, 1638. Plempius quarrelled with Descartes on the topic of the cause of blood circulation: see Lucian Petrescu, *Descartes on the Heartbeat: The Leuven Affair*, «Perspectives on Science», XXI:4, 2013, pp. 397-428.

33 I refer to Daniel Sennert, *Institutionum medicinae libri quinque*, Wittenberg, apud Zachariam Schurerum, 1620[2] (1[st] ed. Wittenberg, apud Zachariam Schurerum, 1611), book II, chapters II-III. See p. 5: «etsi a nonnullis medicina dividatur in partem theoreticam et practicam, tamen illa divisio accurata non videtur [...]. Tota enim medicina est una disciplina, et unus habitus per unum finem», and p. 7: «partes [medicinae] ut iam ordine [...] tractemus, a physiologia incipiendum est: et primo quidem subiecti, quod est corpus humanum, explicatio praemittenda esset. Verum cum hac de re in omnium manibus sint et veterum et recentiorum libri plurimi, locupletissimi, et plenissimi, ex quibus corporis humani cognitio hauriri potest: de corpore humano, quae alias prolixior est, [...] tractationem praetermittimus, atque ad libros anatomicos [...] remittimus, et recte ad finis medicinae, quae est sanitas, tractationem accedimus».

34 Santorio Santorio, *Commentaria in Artem medicinalem Galeni*, Venice, apud Iacobum Antonium Somaschum, 1612, col. 15.

*cennae* (1625) he follows Avicenna in maintaining that physiology, i.e. the first part of medicine, concerns elements, temperaments, humors, the parts of the body, faculties, spirits and operations, while the subject of medicine as a whole is the human body, which however is also the subject of natural philosophy, so that these two disciplines are distinguished only by their end, which in the case of medicine is finding a way to heal and preserve the human body.[35] Thus, we can assume that Regius leaned more on Sennert than on Santorio, as to the subject matter of physiology.

The methodological entailments of the re-definition of the subject matter of physiology will be discussed in section 4: for the moment, it is more urgent to ascertain the impact that Descartes had on Regius's medical program. It is after the appearance of Descartes's *Principia philosophiae* in 1644, indeed, that one can find a full declaration of (medical) intent by Regius in his *Fundamenta medica*, although pre-dated by his definition of *physiologia* as «cognitio sanitatis». Moreover, Regius himself appropriated Descartes's *Principia* in writing his own natural-philosophical premise to medicine, namely, his *Fundamenta physices* (1646). In sum, Descartes played the role of a driving force in the implementation of Regius's program. In turn, Regius's re-thinking of physiology led to his own completion of Descartes's plan for philosophy, overtly devised in the metaphor of the tree.[36] Descartes's *Principia philosophiae*, indeed, lacks a section on plants, animals and man – the three domains of life already present in the general physiology of Avicenna – as a consequence, for Descartes, of the lack of sound experiences available in these fields.[37] These are developed by Regius in the *Fundamenta physices* as the result of his own elaboration, though mediated by Descartes's assistance in the writing of *Physiologia*, written without the acquaintance of Descartes's *L'homme*, which Regius was only able to read in 1646.[38]

Regius's *Fundamenta physices* includes many of the natural-philosophical principles and topics of Descartes's *Principia*, such as Descartes's

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[35] Santorio Santorio, *Commentaria in primam Fen primi libri Canonis Avicennae*, Venice, apud Franciscum Brogiollum, 1660[3] (1[st] ed. Venice, Apud Iacobum Sarcinam, 1625), cols. 5-6, and 13. These positions are re-stated in Id., *Commentarii in primam sectionem Aphorismorum Hippocratis*, Venice, apud Marcum Antonium Brogiollum, 1629, *quaestio* III, cols. 9-10, and *quaestio* V, cols. 11-12.

[36] See *supra*, note 5.

[37] See Stephen Gaukroger, *Descartes' System of Natural Philosophy*, Cambridge, Cambridge University Press, 2002, pp. 180-246.

[38] See *supra*, notes 11 and 22.

theory of matter and space,[39] circularity of motion,[40] the laws of conservation of state,[41] rectilinear motion,[42] and conservation of the quantity of motion in collisions,[43] the vortex theory of planetary motions, the theory of comets,[44] the explanation of terrestrial phenomena such as magnetism and tides.[45] Besides the absence of a metaphysical section (which will be considered in section 4), Regius's *Fundamenta physices* diverges from Descartes's *Principia* as Regius insists on the treatment of the traditional four elements (chapter III), qualities and temperaments (V), and ends with the treatment of the general features of living bodies (VIII), plants (IX), animals (X-XI), and man (XII). In his *Principia*, in fact, Descartes does not reserve to the four elements a separate consideration: rather, he considers the three kinds of particles constituting the whole universe as forming the visible elements devised by Aristotle.[46] In his endeavour, therefore, Regius re-interprets what would be then the basics of his medicine: qualities (heat, dryness, humidity and coldness, and the derived qualities of fluidity, hardness, density, rarity, and so on) and temperament or *temperies*, no longer defined as a 'harmony' of the first, traditional qualities – as it was for Fernel[47] – but as the *contextus* of the movement, rest, position, figure and size of the unobservable particles forming visible bodies, whose behavior follows «leges mechanicae».[48] The notions of these features, as well as the idea of matter as a three-dimensional, corporeal substance, were appropriated by Regius from Descartes since the appearance of Descartes's *Essais* and *Discours*

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39 Regius, *Fundamenta physices* (cit. note 12), pp. 2-3, 34-35.

40 *Ibid.*, pp. 24-25.

41 *Ibid.*, p. 1.

42 *Ibid.*, p. 17.

43 *Ibid.*, pp. 7-8. This principle is stated also in Regius's *De illustribus quaestionibus*, *secunda*, theses 22-23, based on *Le monde*'s account (see *supra*, notes 11 and 22). Regius, however, does not include Descartes's laws of collision in his texts.

44 Regius, *Fundamenta physices*, pp. 47-67.

45 *Ibid.*, pp. 77-79.

46 Cf. Descartes's *Principia philosophiae*, III, §§ 45-47 (on air), § 48 (on water).

47 Fernel, *Universa medicina* (cit. note 30), p. 57. On the traditional notions of qualities, *temperies* and mixture, see Robert Pasnau, *Metaphysical Themes. 1274-1671*, New York, Oxford University Press, 2011, pp. 461-468.

48 Regius, *Physiologia* (cit. note 10), p. 5; Id., *Fundamenta physices* (cit. note 12), pp. 495-497. The reference to «leges mechanicae» can be found in Regius's *Spongia*: «sanguinem pelli et in caput et in pedes, sed diversimode, propterea quod vasa et vae in illas partes spectent; illaeque non semper eodem modo sint constitutae; et praeterea quod sanguis in corde ebulliens magna vi expellatur, cuius variae particulae pro agitationis suae varietate in varias partes secundum leges mechanicae distribuuntur», Id., *Spongia* (cit. note 9), p. 17.

of 1637.[49] To these features Regius reduces all the traditional qualities, both the 'first' and the 'derived' ones, and makes them the basis of his account of health, disease, bodily temperaments and medicaments. Accordingly, Regius completed Descartes's plan for natural philosophy, and made it fit to provide medicine with its basics. What is to be asked, therefore, is how he used his natural-philosophical notions in medical physiology and in the other parts of medicine.

## 3. Regius's explanation of medical notions

For Regius, medical physiology concerns health only. In his *Fundamenta medica* (as well as in his earlier *Physiologia*) health is defined as the disposition of the parts of the human body capable of performing actions in the right way. Such parts are observable (*sensibiles*) or not observable (*particulae insensibles*), which are infinitely divisible.[50] In turn, a living body is defined in the *Fundamenta physices* as a corporeal substance whose parts are 'tempered' in such a way that they can preserve its continuously dissipated matter. Health or disposition of parts consists of their *temperies* (which characterizes unobservable parts) and their conformation (characterizing observable ones). Such general dispositions, encompassing both visible and invisible parts, makes life possible and is equated by Regius with vegetative *vis* itself, whose operations, like those of *vis sensitiva*, are equated with those of clocks and *automata*.[51] The operations traditionally pertaining to the sensitive soul, namely, sense perception, imagination and memory, are reduced to purely bodily operations, which gain from the mind or rational soul (which in the *Physiologia* is still conceived as a separate substance, *à la*

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[49] Regius was first able to read this set of qualities in Descartes's *Dioptrique* and *Météores*: «selon l'opinion de plusieurs Philosophes, tous ces corps ne sont faits que des parties des éléments diversement mêlées ensemble; et selon la mienne, toute leur nature et leur essence, au moins de ceux qui sont inanimés, ne consiste qu'en la grosseur, la figure, l'arrangement et les mouvements de leurs parties», AT VI, p. 227. Cf. also *ibid.*, pp. 233-239. On Regius's theory of matter, see the studies of Rothschuh and Farina, and Strazzoni, *'How did Regius become Regius?'* (cit. note 28).

[50] Regius, *Fundamenta medica* (cit. note 12), p. 3; cf. Id., *Physiologia*, pp. 1-2.

[51] Regius, *Fundamenta physices* (cit. note 12), p. 145. This notion is used first in his *Physiologia*, p. 15, where Regius refers, rather than to vegetative soul, to vegetative *vis*. The example of clocks and *automata* can be found in *Physiologia*, pp. 15-16, and *Fundamenta physices*, p. 153. For a full account of Regius's theory of vegetative and sensitive faculties, see Rothschuh, *Regius und Descartes* (cit. note 17); Farina, *Il corpuscularismo di Henricus Regius* (cit. note 17); Kolesnik-Antoine, *Le rôle des expériences* (cit. note 21).

Descartes),[52] their 'perfection', whereas vegetative functions (i.e. nutrition, growth and generation) are only mechanical, i.e. the mind does not intervene in their performance.[53] It is worth quoting Regius's words on vegetative and sensitive *vis* from the *Physiologia*, where he provides a clear-cut summary:

vis autem vegetandi, et corporis movendi, quae in plantis et brutis anima vegetativa et sensitiva appellantur, in homine [...] animae in ipso non sunt appellandae, quia [...] toto genere differunt ab anima rationali. [...] Vis autem vegetativa in homine nihil aliud est, quam certa partium corporis constitutio, qua substantiae corporeae [...] perpetuam dissipationem per succum a corde praeparatum, et in partes impulsum, conservamus, et ex semine nostri simile procreamus. [...] Vis autem sensitiva est partium humani corporis in spiritus, nervos et alia sensoria: item fibras, musculos, et artus talis conformatio, qua homo ab obiectis, tum internis, tum externis, variis motibus citra cogitationem, affici, totoque corpore se de loco in locum movere potest. [...] Hae duae itaque [...] nihil aliud sunt, quam corporis humani apte conformati apta temperies: quandoquidem omnes illarum operationes ab hac ita fieri queunt, ut in horologio et aliis automatis plurimae actiones admirandae a sola partium conformatione peraguntur.[54]

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[52] «Anima rationalis est substantia incorporea, qua actiones cogitativas exercemus», Regius, *Physiologia* (cit. note 10), p. 16. In his *Fundamenta pysices*, Regius will still maintain that soul is a separate substance, albeit on the grounds of Biblical Revelation: cf. Regius, *Fundamenta medica* (cit. note 13), pp. 245-246.

[53] «Naturales sunt quae a sola partium natura seu temperie et conformatione fiunt et perficiuntur. Dico fiunt et perficiuntur, ad discrimen actionum animalium: hae enim a naturali quidem corporis dispositione fiunt, sed ab anima cogitativa, seu rationali, quae sola a me anima appellatur, perfectionem accipiunt», Regius, *Physiologia*, p. 17. In his *Fundamenta physices* Regius will omit any reference to purely intellectual perception, which is still maintained in the *Physiologia* as to the perception of immaterial entities: cf. Regius, *Physiologia*, p. 33, with Id., *Fundamenta physices* (cit. note 12), pp. 251-252. On such variations in Regius's theory of knowledge, see Erik-Jan Bos, *Henricus Regius et les limites de la philosophie cartésienne*, in Delphine Kolesnik-Antoine (ed.), *Qu'est-ce qu'être cartésien?*, Lyon, ENS Editions, 2013, pp. 53-68. On the ontological entailments of Regius's theory of knowledge, see Andrea Strazzoni, *The Crypto-Dualism of Henricus Regius*, in Stefano Caroti – Mariafranca Spallanzani (eds.), *Individuazione, individualità, identità personale*, Florence, Le Lettere, 2014, pp. 133-151. See also Vlad Alexandrescu, *Regius and Gassendi on Human Soul*, «Intellectual History Review», XXIII:2, 2013, pp. 1-20.

[54] Regius, *Physiologia* (cit. note 10), pp. 15-16. In his *Fundamenta physices* Regius replaces 'vis' with 'facultas', as he discusses the same topics in chapter X, *De animalibus* (Id., *Fundamenta physices* (cit. note 12), pp. 153-154). In the *Fundamenta medica* the account is more abridged: cf. Id., *Fundamenta medica*, p. 5. The potentially fruitful exploration of Regius's uses of mechanics as a source of inspiration for what he calls 'faculties', which in early modern mechanics included simple machines, like pulleys and wedges (whose powers are dealt with in the first chapter of his *Fundamenta physices*), is beyond the scope of the present article.

On this basis, Regius divides the notion of health into *bona temperies* and *apta partium conformatio*. *Bona temperies* is the convenient «constitutio» of the traditional, sensory qualities of heat, cold, humidity and dryness, as well as thickness, tenuity, density and so on.[55] Regius's terminology, so far, is traditional. These qualities, however, are re-interpreted as the result of the different *contextus* of the real (and Cartesian) primary qualities of movement, rest, position, figure and size of the insensible particles. These, by interacting, constitute visible bodies characterized by the sensory qualities, and these notions are used by Regius to replace the traditional idea of *temperies* as a combination of the four Aristotelian qualities, which no longer have a primary status as all perceivable qualities can be derived from the actual «primae qualitates».[56] The *apta partium conformatio*, in turn, is the right constitution (*conveniens adaptatio*) of the sensible parts of the body according to their quantity, figure and construction.[57] Consequently, disease or *morbus* – the subject of pathology, or the second part of medicine – is the disposition of the parts of the body hindering the performance of right actions, and consists of *intemperies* and *prava conformatio*, which has three kinds: *mala figuratio*, *iniusta quantitas* and *prava constructio*, i.e. the deformation of the sensible parts of the body according to their figure, quantity and construction.[58]

Regius's notions of health and disease arise from a 'particularist' interpretation of different accounts at stake at the time of Regius's medical education. If we look at Fernel, we can find an account of health in his dialogue *De abditis rerum causis* (1548), his defense of the use of occult qualities in natural philosophy and medicine). Fernel distinguishes between the health of *partes similares* – retaining a similar form among each other, as the parts of bones – and *partes organicae* of the body.[59] The health of the latter consists in their figure, size, number and position, while that of the former is determined by the good constitution and moderateness of 1) their *temperies* of primary qualities (heat, cold, humidity and dryness), 2) their material substrate, characterized by the derived qualities of thickness, tenuity, density and so on, and 3) the total substance of the body[60] (which includes the innate spirit and heat, the

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55 Regius, *Fundamenta medica* (cit. note 13), pp. 3-4.

56 *Ibid.*, p. 4; cf. Id., *Fundamenta physices* (cit. note 12), pp. 95-97; Id., *Physiologia* (cit. note 10), pp. 4-8.

57 Regius, *Fundamenta medica* (cit. note 12), pp. 3-4; cf. Id., *Physiologia* (cit. note 10), p. 1.

58 Regius, *Fundamenta medica* (cit. note 13), pp. 10-11.

59 This distinction traces back to Aristotle and Galen.

60 Jean Fernel, *De abditis rerum causis libri duo*, in *Universa medicina*, Paris, apud An-

faculties and the form of the body),[61] whose moderateness and good constitution however concern the occult qualities that one can experiment with, for instance, in those powers of medicaments that cannot be explained by such manifest qualities.[62] If we look at another of Regius's sources, namely, Sennert's *Institutiones medicinae*, we do not find remarkable conceptual differences with respect to Fernel's account (although his terminology is more akin to Regius's). Also Sennert, actually, was a defender of the use of occult qualities in physiology. In the first book of his *Institutiones*, indeed, Sennert strongly defends the use of occult qualities in medicine, quoting Scaliger's *Exercitationes* in a passage where the rejection of occult qualities is labelled as a «summa impudentia»: for Sennert, indeed, the human body is not only composed of elements, like all other mixtures, but is provided with a vital heat, a vivifier spirit, a primeval humidity, and a substantial form.[63] On this basis, Sennert defines health as the power of the body to perform actions, resulting from the natural constitution of its parts. This principle is characterized in three ways. First, it consists of the *dispositio* of the accidents and qualities of such parts. The parts of organs can be *similares*, as the parts of the bones, characterized by a *temperies* of the four qualities, their health being thus the *iusta temperies*. However, the human body is also provided with higher principles such as vital heat, spirit, radical humidity, and has an overall form i.e. a soul from which occult qualities flow. These are to be considered as characterizing human health in the second place. Thirdly, Sennert defines health in the light of the figure, conformation

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dream Wechelum, 1567[6] (1st ed. Paris, Excudebat Christianus Wechelus, 1548; for a list of all the editions of this work, see Sherrington, *The Endeavour of Jean Fernel*), pp. 89-92. Also in *Jean Fernel's On the Hidden Causes of Things. Forms, Souls, and Occult Diseases in Renaissance Medicine*, ed. John M. Forrester and John Henry, Leiden-Boston, Brill, 2005, pp. 519-539.

61 «Totius vero substantiae nomine et insitum spiritum, et divinum illius calore, et facultates ipsamque formam complectimur», Fernel, *Universa medicina*, p. 341. See Linda A. Deer Richardson, *The Generation of Disease: Occult Causes and Diseases of the Total Substance*, in Andrew Wear – Roger K. French – Iain M. Lonie (eds.), *The Medical Renaissance of the Sixteenth Century*, Cambridge-New York, Cambridge University Press, 1985, pp. 175-194.

62 These are presented in his *Universa medicina*, pp. 392-393, and are are i. *evacuantia* (as emetic, laxative), ii. *alterantia*, which can modify the whole substance of the body: these are poisons, antidotes and *antipharmaca*.

63 «Verum cum, ut recte J.C. Scal. Exerc. 218 sect. 8 ait, *omnia ad manifestas qualitates reducere velle, summa impudentia sit*, atq. corpora nostra non simpliciter et proxime, ut mista, ex elementis constent, sed sua proxima principia habeant, et calore quondam vitali, spiritu vivifico, humidoque primigenio praedita sint, et formam suam atque animam obtineant, a quibus multae nobiles qualitates fluunt», Sennert, *Institutionum medicinae libri quinque* (cit. note 33), p. 10; cf. Julius Caesar Scaliger, *Exotericarum exercitationum liber XV, de subtilitate, ad Hieronymum Cardanum*, Paris, ex officina typographica Michaelis Vascosani, 1557, p. 291.

and size of body parts, which characterizes them as organic i.e. as provided with a function, regardless of their similarity or dissimilarity. Their health *qua* organic health depends on their conformation, i.e. figure and quantity, and on their unity and continuity in forming an organ.[64] Regius's approach is clear: his notion of health is traditional, but reinterpreted in terms of his *qualitates primae* only, and deprived of occult qualities, in accordance with what he openly states in the dedicatory letter of his *Fundamenta medica*.[65] Moreover, this plan was Cartesian in execution: the primary features of matter are found by Regius in texts by Descartes he was able to read in 1637. Yet, as Rothschuh has pointed out, Regius could not have embraced Cartesianism if he had not previously 'become Regius', grown to intellectual maturity and forming his own ideas before he encountered Descartes.[66] The foremost pre-Cartesian sources of Regius shaping his acceptance of Cartesianism, according to Rothschuh, was his *promotor* Santorio. Indeed, one can find, in Santorio's *Methodi vitandorum errorum omnium, qui in arte medica contingunt libri* (1602 or 1603), a comparison of the functioning of the animal body to that of the clock, in which one does not need to suppose the existence of any occult quality, nor *temperatura* of the traditional four qualities in order to explain its functioning.[67] The metaphor of the clock, as seen above, is also present in Regius's *Physiologia*, along with an overt attack on substantial forms, which are rejected on the basis of the principle of economy.[68] Yet, as Farina has pointed out,[69] the use of this metaphor by Santorio does not entail a rejection of the standard notion of temperament as the combination of the four, traditional qualities. In Santorio's *Methodi libri*, the metaphor is aimed at the rejection of Fernel's use of occult faculties, which Fernel

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64 Sennert, *Institutionum medicinae libri quinque* (cit. note 33), pp. 9-14.

65 See *supra*, note 14. In his *De illustribus quaestionibus*, Regius claims that occult qualities are those perceivable qualities we cannot yet trace back to the five, real primary qualities: Regius, *De illustribus quaestionibus*, *prima*, thesis 5.

66 «Regius wäre also nicht (vor bergehend) zum Gefolgsmann von Descartes geworden, wenn er nicht schon vorher ein Regius gewesen wäre», Rothschuh, *Regius und Descartes*, p. 53. See also Farina, *Sulla formazione scientifica di Henricus Regius*, and Strazzoni, *'How did Regius become Regius?'*.

67 Santorio Santorio, *Methodi vitandorum errorum omnium, qui in arte medica contingunt libri quindecim*, Venice, Apud Franciscum Barilettum, 1603, p. 160*r*.

68 «[...] ita ut non opus sit aliquam substantialem incognitamque formam hic vel alibi in similibus fingere, entiaque contra verissimum philosophiae dictatum, multiplicare absque necessitate», Regius, *Physiologia*, p. 16. This passage follows that one quoted *supra*, note 54. The passage disappears in the *Fundamenta physices* (cf. Id., *Fundamenta physices*, pp. 145-147).

69 Farina, *Sulla formazione scientifica di Henricus Regius* (cit. note 17), pp. 368-373.

used to explain animal motion,[70] rather than at the establishment of a 'mechanical' physiology. For Santorio, in the same way as in explaining the function of the clock we look only at the disposition and conformation of its parts, and not at its *temperatura* of four qualities, we can explain – in principle – the motion of animals by looking at the conformation and disposition of their parts, rather than at their occult qualities.[71] However, Santorio does not invoke this reductionism for all the notions of physiology, as he maintains the validity of the traditional *temperies* of four qualities as a reliable explanatory source as well.[72] Like Regius, Santorio also rejects the recourse to occult qualities, so he may well have inspired Regius's reductionism of the notion of health to *temperies* and conformation, without recurrence to the idea of the 'total substance' of the body, as Fernel does, or to the 'higher principles' of Sennert. Moreover, if we look at his *Ars de statica medicina* (1614), Santorio describes *sanitas* in terms of the addition of what the body lacks and elimination of what is excessive, which is made by *perspiratio insensibilis*,[73] i.e. the exhalation of the results of digestion as an imperceptible breath which may be quantitatively determined by his scale, and is mentioned by Regius in his *Physiologia* and *Fundamenta physices*.[74] As seen above, Regius defines a living body in terms of its capacity to preserve itself despite the loss of matter. This can be a further source of inspiration for Regius, for whom the *perspiratio insensibilis* is also responsible for our perception of cold, which results from a movement of the particles of skin, stimulated by the excess materials which cannot get out of the body as the pores are obstructed.[75] Yet, it is not Santorio's notion of perspiration, which is consistent with the traditional notion of *temperies*, that persuaded Regius to reinterpret the basic concepts of physiology in a corpuscular or 'particularist' perspective: quite the contrary, Regius re-interpreted Santorio's *transpiratio insensibilis*, and his notion of health, from such a perspective.

To sum up, Regius offers a reinterpretation of the traditional accounts of health. How reductionist, however, is Regius's medicine? This

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70 Fernel, *De abditis rerum causis* (cit. note 60), p. 87; *Jean Fernel's On the Hidden Causes* (cit. note 60), pp. 504-506.

71 See *supra*, note 67.

72 Santorio, *Methodi vitandorum errorum libri* (cit. note 67), pp. 158*v*-159*r*.

73 Santorio Santorio, *Ars de statica medicina, sectionibus aphorismorum septem comprehensa*, Venice, apud Nicolaum Polum, 1614, aphorisms 1-3.

74 Santorio, *Ars de statica medicina* (cit. note 73), aphorisms 5, 11, 19-21. Cf. Regius, *Physiologia*, p. 29; Id., *Fundamenta physices*, p. 205. I will consider the methodological entailments of Santorio's quantitative approach in the next section.

75 Regius, *Physiologia*, pp. 6-7.

may be judged from his treatment of some basic notion of general and medical physiology, of which I give here a brief specimen. First of all, Regius's general explanation of *temperies* underlies, in his *Physiologia* and *Fundamenta physices*, his accounting for different kinds of temperament of the human body. The following table summarizes Regius's bipartite exposition, in which the four traditional qualities (and corresponding humors) still have the foremost place, with the exception of the notion of *temperies moderata* and *immoderata*:[76]

| | |
|---|---|
| *Temperies moderata*: equilibrium of all sensory qualities (heat, cold, dryness, humidity, asperity, levity, rarity, density, and so on). | *Immoderata*: excess of one or more of such qualities. |
| | |
| *Totalis*: predominance of one humor (melancholic, biliary, *pituitosa*, bloody). | *Partialis*: equilibrium or excess among four traditional qualities (heat, cold, dryness, humidity) in a part of the body, whose nature consists also of its density, tenuity and so on. |
| | |
| *Nativa*: acquired before birth; it is soft, humid and cold in women, hot and dry in men. | *Adscitia*: changing through aging, it is either cold, hot, humid, dry. |
| | |
| *Fugiens*: proper to living bodies, it is cold, hot, humid, dry. In this case, heat is perpetually maintained by blood circulation.[77] | *Permanens*: enduring after death, it is cold, hot, humid, dry. |

As Regius comes to the use of the notion of *temperies* in medical physiology, i.e. in dealing with the kinds of health,[78] one can still find the

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76 Regius, *Physiologia* (cit. note 10), 9-12. In his *Fundamenta physices*, Regius restates the same account of *temperies*: Id., *Fundamenta physices* (cit. note 12), pp. 107-108, p. 160.

77 In accordance with his reductionist standpoint, Regius sharply rejects the distinction between 'innate' and 'elementary' heat: Regius, *Physiologia* (cit. note 10), pp. 12-14.

78 It is worth noting that, as highlighted by Gideon Manning, Descartes maintained that animals, as parts of matter in motion, cannot be intrinsically labelled as 'healthy' or 'sick'. In the case of man, however, such denominations can be intrinsic, because man consists of a soul and a body, so that «we human beings have an intrinsic nature susceptible to corruption. When we have erroneous desires, desires that draw us toward what is in fact bad for us, we are ill», Gideon Manning, *Descartes' Healthy Machines and the Human Exception*, in Sophie Roux – Daniel Garber (eds.), *The Mechanization of Natural Philosophy*,

traditional predominance of the four, traditional qualities, while *conformatio* is restricted to rarity and density: [79]

| | | |
|---|---|---|
| *Sanitas accurata*: the condition of perfectly performing actions; consisting of *bona temperies* and *apta conformatio*. | *Sanitas deflectens*: exceeding in heat, cold, humidity and dryness (as to *temperies*), or rarity and density (as to *conformatio*). | |
| | *Sanitas deflectens firma* | *Sanitas deflectens vacillans* (condition of being prone to disease) |

Finally, in dealing with disease (*morbus*), Regius provides in his *Fundamenta medica* the following conceptualization of its kinds, as depending on [80]

| *Intemperies* | | | | | *Prava conformatio* | | |
|---|---|---|---|---|---|---|---|
| *Manifesta* | | *Occulta* (i.e. depending on total substance) | | | *Mala figuratio* (undue asperity, levity, etc.) | *Iniusta quantitas* (undue number and dimension) | *Prava constructio* (undue position and connection of parts) |
| *Simplex*: excess of heat, cold, humidity, dryness, rarity, density, asperity, levity, softness, hardness. | *Composita*: combination of excesses of such qualities. | *Venenata* | *Contagiosa* | *Pestilens* | | | |

Regius, accordingly, still has recourse to occult qualities as explanatory principles, as he proposes a three-fold characterization of disease,

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New York, Springer, 2013, pp. 237-262: 259; cf. Descartes's *Meditatio sexta*, AT VII, pp. 85-86. Regius does not take into account the notion of soul in defining 'health': it applies to the animal-machine in so far as health is intended as the maintenance of the substance of the body, which is perpetually consumed. And yet, he does not clarify whether this denomination is intrinsic or extrinsic, or just arbitrary: generally speaking, he could not rely on a theory of mind-body union like that of Descartes, so that an exploration of this problem (which would involve an analysis of Regius's whole theory of 'animated' bodies) would be promising in order to provide a full account of Regius's originality.

[79] Regius, *Physiologia* (cit. note 10), pp. 48-49; Id., *Fundamenta medica* (cit. note 13), p. 8.

[80] *Ibid.*, pp. 11-16.

notwithstanding his aim of depriving medicine of its *abdita*.[81] Moreover, in his account density, rarity, and similar qualities characterize both *temperies* and *conformatio*. With his Cartesian reinterpretation of the notion of *temperies*, therefore, the distinction between traditional 'primary' and 'derived' qualities, and between the two notions of health (and disease) tends to collapse, although the four traditional qualities are still the most used explanatory concepts. His actual innovation, in fact, seems to consist mostly in providing a more simplified account of temperaments, health and disease. This is evident if one compares the notions of temperaments of Regius, with those of Fernel and Sennert. In his *Universa medicina*, Fernel divides bodily temperaments into:

<table>
<tr><td>*Temperamentum* of singular parts: hot, cold, humid, dry.</td><td colspan="3">*Temperamentum* of the whole body. It depends on 1) compensation of temperaments of singular parts (i.e. a temperament of temperaments), 2) innate or vital health, and consists of:</td></tr>
<tr><td></td><td>Temperament of solid parts: immutable</td><td colspan="2">Temperament of fluid parts: mutable, according to</td></tr>
<tr><td></td><td></td><td>External causes, such as hydration</td><td>Internal causes, i.e. variations of innate heat and dryness through age</td></tr>
</table>

Fernel rejects the notion of the temperament of the whole body as based on the four humors, since these are only parts of the body.[82] This is, on the other hand, maintained by Sennert as he provides the following account of the temperaments: [83]

<table>
<tr><td colspan="2">*Temperamentum* of whole man (hot and humid), consisting of:</td></tr>
<tr><td>*Temperamentum* of body as such (*corpus simplex*), given by hot, cold, humid and dry</td><td>*Temperamentum* of living body, given by innate heat</td></tr>
</table>

[81] See *supra*, notes 14 and 65.

[82] Fernel, *Universa medicina* (cit. note 60), pp. 57-59, 61-67.

[83] Sennert, *Institutionum medicinae libri quinque* (cit. note 33), pp. 19-27.

| | | |
|---|---|---|
| | *Temperamentum insitum* of main parts (as the heart), to which vital heat is innate | *Temperamentum influens*, coming from the main parts to the rest of the body |
| | Influenced by age (i.e. variation of innate heat and radical humidity) | |
| Such *temperamentum* of the whole man is determined by: | | |
| *Temperamentum* of blood. This is primarily *sanguineum* (as blood is humid and hot), and, insofar as blood can be tempered in different ways, *biliosum*, *pitutiosum*, *melanchonicum* – and influenced by sex: more biliary, cold, soft and humid in women. | Occult qualities, such as the influence of the stars. | |

Eventually, if one looks at Regius's account of the powers of medicaments in his *therapeutica*, or the last part of medicine, one finds a traditional classification of qualities. For Regius, the powers of all these faculties are traced back to the disposition of insensible particles i.e. to *temperies*, although their powers are recognizable by experience only (in perfect agreement with the medical tradition).[84] Like Sennert and Fernel,[85] Regius distinguishes between 1) primary faculties, which act on the first qualities of bodies (hot, cold, dry and humid), and 2) secondary ones, acting qualities such as softness, hardness, and so on. Such secondary faculties are a combination of primary ones: *emollientia*, for instance, result from the mediocrity of the heating and humidifying faculty, *indurantia* from heating and refrigerating. 3) Thirdly, medicaments are provided with tertiary faculties, which are *alterantia* or *evacuantia* with respect to certain humors or parts of the body, or which make the body

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[84] Regius, *Fundamenta medica*, pp. 142-143. See Philip J. van der Eijk, *Medicine and Philosophy in Classical Antiquity: Doctors and Philosophers on Nature, Soul, Health and Disease*, Cambridge, Cambridge University Press, 2005; Klerk, *Galen Reconsidered* (cit. note 22), and Elaine Leong – Alisha Rankin, *Testing Drugs and Trying Cures: Experiment and Medicine in Medieval and Early Modern Europe*, «Bulletin of the History of Medicine», XCI:2, 2017, pp. 157-182.

[85] For Sennert's account, cf. Sennert, *Institutionum medicinae libri quinque* (cit. note 33), pp. 840-845, 847-848; for Fernel's, see *supra*, notes 60-62.

resistant to poisons.[86] For Fernel and Sennert, these were occult faculties flowing from the total substance of the body or from its 'higher principles'.[87] For Regius, these are to be traced back to the features of matter composing the parts of the body. So, for instance, *evacuantia* are formed by parts interacting with the harmful humors present in the body, and forcing them to be separated from the blood: yet Regius does not provide any description or account of how their particles interact.[88] Nominally, therefore, Regius got rid of occult qualities in the explanation of medicaments: yet, his 'hierarchical' classification was still traditional.[89]

As an intermediate conclusion, therefore, we may note that Regius used a Cartesian-inspired theory of matter, based on the notions of quantity, movement, rest, figure and position, to attempt to get rid of the use of occult qualities in medicine. On this basis, he also provided a more 'flattering' view of matter, as he does not avail himself of a hierarchy between first qualities such as heat, cold, humidity and dryness, and the derived qualities of density, rarity, and so on. More than providing a full mechanization of the basic notions of medicine, therefore, Regius attempted to reduce any medical concept to manifest qualities, but not necessarily geometrical ones. In practice, however, Regius frequently relies on the traditional primacy of heat, cold, humidity and dryness in his general and medical physiology. On the other hand, a more evident innovation brought about by Regius was the simplification in the presentation of human temperaments and, in general, of all medical notions. We have seen above that the simplification of medicine, i.e. its detachment from a 'natural-philosophical' physiology, had already been attempted by Sennert. Regius continued this effort by, besides detaching the two notions of physiology, giving a presentation of the contents of medicine mostly through a series of dichotomies.[90] This method of presentation bears witness to the method of dichotomies standardized

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86 Regius, *Fundamenta medica* (cit. note 13), pp. 148-150, 170-172.

87 See *supra*, notes 59-64.

88 Regius, *Fundamenta medica* (cit. note 13), pp. 176, 187, 206.

89 I subscribe to Klerk's statement, according to which «Regius did indeed remove existing obscurities in understanding the properties of drugs, but did not introduce new issues», Klerk, *Galen Reconsidered*, p. 154. Gideon Manning argues that Regius's foundation of medicine on philosophy and the introduction of the notion of law into medicine have brought medicine to the level of certitude of physics: however, this had no consequences for practical medicine itself. See Manning, *Naturalism and Un-naturalism among the Cartesian Physicians* (cit. note 22), p. 455.

90 The Ramist derivation of Regius's method of exposition was first indicated in Verbeek, *The Invention of Nature* (cit. note 18).

by Pierre de la Ramée, whose dialectic was taught in Franeker just before Regius came to study there in 1616,[91] and which was then used in the seventeenth-century systematizations of Keckermann and Alsted.[92] It is to be asked, then, why he adopted a method of exposition relying on bipartite divisions. Regius's simplification of medicine, accordingly, leads us to the problem of the method he used in medicine and natural philosophy, in discovery and presentation, and – by extension – to the potential influence on him of Santorio's 'quantitative approach' and of Galileo.

## 4. The methods of medicine and philosophy

As shown in section 2, the medical interests of Regius determined the choice of themes in his natural philosophy. So, we need to ask whether Regius's medical interests can account for his method of discovery and order of exposition in natural philosophy and medicine. In order to answer this question, we need to look again at his background.

### 4.1. *Fernel and Sennert on the method of medicine*

Fernel and Sennert provided only scattered considerations on the method of medicine. In his *Universa medicina*, Fernel claims that medicine, in its entirety, is an art: it does not have a contemplative aim and is not a *scientia* like natural philosophy, theology and mathematics.[93] Medicine follows an analytical method, which consists of the resolution of the most general notion of the body into the ideas of its parts, down to the *minima* which cannot be observed and can be grasped only by reason. This method goes from what is composite to what is simpler, i.e. from effects to causes.[94] Yet, Fernel does not clarify the relation between natural philosophy and medicine: since physiology is the 'natural part'

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[91] In Franeker, Lollius Adama (who died in 1609) showed sympathies for Ramus's dialectic. Until 1612 the teaching of logic was fulfilled by Frederic Stellingwerff, who was an overt Ramist. See Theo Verbeek, *Notes on Ramism in the Netherlands*, in Mordechai Feingold – Joseph S. Freedman – Wolfgang Rother (eds.), *The Influence of Petrus Ramus*, Basel, Schwabe Philosophica, 2001, pp. 38-53; Christoph H. Lüthy, *David Gorlaeus (1591-1612). An Enigmatic Figure in the History of Philosophy and Science*, Amsterdam, Amsterdam University Press, 2012, pp. 72-73.

[92] See Howard Hotson, *Commonplace Learning: Ramism and its German Ramifications, 1543-1630*, Oxford, Oxford University Press, 2007.

[93] Fernel, *Universa medicina*, *Praefatio* (cit. note 60), pp. ii-iii.

[94] *Ibid.*, pp. 1-2.

of medicine, it seems that no methodological difference is implied by Fernel's view: in both disciplines, in principle, one would assume an analytical or resolutive method.

A distinction between natural philosophy and medicine, on the other hand, can be found in Sennert's considerations. As he distinguishes medicine and its five parts from philosophy as *scientia*,[95] he states that medicine does not deal with first causes, which are the matter of physics and are assumed by physicians as *praecognita*.[96] So medicine is only practical, and not theoretical. Sennert does not clarify the method of medicine in his *Institutiones*: however, his attempt to detach medical and general physiology, and his emphasis on the practical nature of medicine, which starts from a consideration of health as its end rather than from the consideration of the human body, bespeak their methodological distinction. In his *Epitome naturalis scientiae* (1600), indeed, he maintains that natural philosophy follows a compositive method, opposite to the one adopted by Fernel in physiology: according to this method, one proceeds from what is more simple, namely body as such, to what is more complex, namely, animals.[97]

### 4.2. *Zabarella on resolution, composition and regressus*

More insights on the methods of medicine and natural philosophy were provided at the Padua medical and philosophical schools. In Padua, methodological questions were discussed by Jacopo Zabarella, predecessor of Regius's *promotor* Cesare Cremonini as professor of natural philosophy. In his *De methodis* (1578), Zabarella argues that medicine and natural philosophy follow different *modi considerandi*, both in discovery and in exposition. In philosophy one has to use a compositive order of exposition, going from causes to effects; in medicine, a resolutive one, going from the definitions of the practical ends to those of the principles of their accomplishment. The first part of medicine, physiology, has an intermediate status: as this concerns the knowledge of the human body and health only, it does not differ from natural philosophy and adopts a compositive order of presentation. However, since such knowledge is assumed as a *praecognitum* of medicine and its truth is not demonstrated by the physician, it can be considered as the first part of a resolutive or-

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95 Sennert, *Institutionum medicinae libri quinque* (cit. note 33), pp. 6-7.

96 *Ibid.*, pp. 3-4.

97 I refer to Daniel Sennert, *Epitome naturalis scientiae*, Wittenberg, impensis Caspari Heiden, 1618[2] (1st ed. 1600, Wittenberg, typis S. Gronenbergii), p. 29.

der. The knowledge of the body and health, indeed, entails that of the ends of medicine, which consists, in its other parts, of their resolution into the principles of healing.[98]

As to the method of discovery (*inventio*), Zabarella maintains that contemplative disciplines such as natural philosophy follow the method of *regressus*. This method consists of two parts: first, a resolutive process, which is the inference of the existence of the cause from the effect, either by *inductio* (which, however, declares what is already known by experience), or by a *demonstratio ab effectu*, or *quia*, which makes known something previously unknown, though still obscurely. Secondly, *regressus* entails a compositive process, i.e. the inference of the effect from the cause, which makes clear what was obscurely known by the *demonstratio ab effectu*. This is the *demonstratio propter quid*. The whole method of *regressus* is made possible by an *examen mentale*, that is, the discovery – by means of analysis of the effect – of the existence and the essence of its cause, and the comparison of these with the effect itself, which confirms the validity of the process of analysis.[99] On the other hand, according to his commentary on Aristotle's *Analytica posteriora* (1582), medicine as a practical art does not truly rely on a method of discovery which includes both resolution and composition, but on the resolution from the knowledge of health and sickness to that of the causes of disease and cures for the body, which has some 'conjectural' character. This conjectural character follows from the fact that physicians merely 'help' nature in pursuing the end of restoring the health of patients. As a consequence, physicians cannot have a perfect knowledge of the outcome of their practices.[100]

### 4.3. *Santorio on quantification and orders of presentation*

While the successor of Zabarella in Padua and *promotor* of Regius, Cesare Cremonini, devoted scattered comments to the relation be-

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98 I refer to Jacopo Zabarella, *De methodis*, in Id., *Opera logica, editio tertia*, Cologne, impensis Lazari Zetzneri, 1597 (1st ed. Venice, apud Paulum Meietum, 1578), pp. 181-187, 193-198 (esp. 198), and 222.

99 Zabarella, *De methodis* (cit. note 98), pp. 264-271, and Id., *De regressu*, *ibid.*, pp. 480-489. See Giovanni Papuli, *La teoria del regressus come metodo scientifico negli autori della Scuola di Padova*, in Luigi Olivieri (ed.), *Aristotelismo veneto e scienza moderna: atti del 25° anno accademico del Centro per la storia della tradizione aristotelica nel Veneto*, 2 volumes, Padua, Antenore, 1983, vol. I, pp. 221-277.

100 Jacopo Zabarella, *In duos Aristotelis libros Posteriores analyticos commentarii*, in *Opera logica* (cit. note 98), pp. 1162-1163. See Heikki Mikkeli, *An Aristotelian Response to Renaissance Humanism: Jacopo Zabarella on the Nature of Arts and Sciences*, Helsinki, Societas Historica Finlandiae, 1992, pp. 113-117.

tween philosophy and medicine,[101] and Spigelius mostly focused on anatomy,[102] Santorio devoted extensive consideration to the method of medicine. His writings, moreover, are interesting as they may reveal some connection between the mechanical and mathematical approach ascribed by De Volder to Galileo, Huygens, Borelli and Bellini, and the Cartesian strand in medicine. Indeed, it is well known that Galileo was a correspondent of Santorio, and that he even sat on his *statera medica*, aimed at quantifying the *persipiratio insensibilis*. As has been recently shown, however, the medical instruments described by Santorio in his *Methodi libri*, in his commentaries on Galen (1612), Avicenna (1625), and in his *De statica medicina* – besides his *statera*, the *pulsilogium* and the thermometer – were developed and used in a way independent from Galileo's scientific practices. Santorio, indeed, used the pendulum to measure the pulse, while Galileo studied its isochronism by comparing it with the pulse, and they both probably relied on pendulum clocks built in Germany at the end of the sixteenth century. Moreover, while Santorio's thermometer measured degrees of temperature, Galileo's thermoscope showed only variations in temperature, and they were constructed by following the *Pneumatica* of Herons of Alexandria.[103] Therefore, an influence of Galileo on Regius, via Santorio, can be excluded. Moreover, the influence of Santorio on Regius, as far as the practice and method of medicine is concerned, was limited. This is evident if we look at his medical program and methodological considerations.

As shown above, the foremost interest of Santorio was for the exact quantification of certain physiological processes, namely perspiration, fever and pulse. His program to develop a «mathematica medica», as he

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101 In his *Explanatio prooemii librorum Aristotelis: De physico auditu*, Cremonini points out that medicine begins where natural philosophy ends, that is, after the treatment of life, death, youth, health and sickness – provided in Aristotle's *Parva naturalia*: Cesare Cremonini, *Explanatio prooemii librorum Aristotelis: De physico auditu*, Padua, apud Melchiorem Nouellum, 1596, pp. 33-34. More conspicuous is his treatment of anatomy: in his *Apologia dictorum Aristotelis de origine, et principatu membrorum adversus Galenum* (1627), he states that anatomy is not useful for medicine, as it only provides matters to be explained in natural philosophy, and not even for surgery, as it concerns little details of the body. Anatomy, according to Cremonini, is not an *ars in se*, it does not have a practical function but serves to contemplation of nature. Accordingly, it has no direct relation to medicine: Cesare Cremonini, *Apologia dictorum Aristotelis de origine, et principatu membrorum adversus Galenum*, Venice, apud Hieronymum Piutum, 1627, pp. 50-52.

102 Cf. Adrianus Spigelius, *Opera quae extant omnia*, Amsterdam, apud Iohannem Blaev, 1645.

103 See Fabrizio Bigotti, Mathematica medica. *Santorio and the Quest for Certainty in Medicine*, «Journal of Healthcare Communications», vol. I, IV:39, 2016: pp. 1-8.

states in his letter to Senatore Settala of 1627,[104] however, did not entail a full mathematization of medicine, but it concerned those aspects related to the individual constitution of each body: namely, the quantities of diseases, cures and faculties, which for Galen made medicine a conjectural discipline.[105] What were, however, Santorio's ideas on the overall method of medicine? And how did his quantifications fit into these? Insights on the different orders of exposition of medicine and natural philosophy are provided in his 1612 commentary to Galen's *Ars parva*, where Galen distinguishes between three *doctrinae*, or orders for teaching, namely, the analytic (i.e. the resolution of the components of the idea of an aim or end), the compositive (i.e. the composition of the results of analysis), and the definitive (i.e. the dissolution of definitions).[106] As for Zabarella, according to Santorio's commentary medicine follows a resolutive *ordo* or *doctrina*, which proceeds from the knowledge of the ends to that of the means. Natural philosophy follows a compositive order, which proceeds from the knowledge of the principles to that of more complex subjects, as in physics one starts with the knowledge of the body and ends with the knowledge of animals. For this reason, when Avicenna included in physiology topics belonging to natural philosophy, he followed a compositive order.[107] On this basis, Santorio faces the problem of the relation of the two orders, and of *inventio*. He asks how one can develop a compositive doctrine or order on the basis of what is 'invented' by resolution. Santorio solves the problem by remarking that Aristotle distinguished the *ordo artis docentis* from the *ordo artis operantis*. While the first proceeds, for example, from the knowledge of the end of building a house, to the knowledge of its components, in the second, i.e. in practice, one starts with the knowledge of such parts, and ends with having a house. In this case, the inversion of resolution is possible.[108] On the other hand, in *scientiae* as natural philosophy one cannot use a resolutive order because this depends on the notion of ends; moreover, the resolutive order is not the inverse of the composite: animals, for instance, are not the 'ends' of natural philosophy, but only the last topic to be dealt with.

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104 Carlo Castellani, *Alcune lettere di Santorio Santorio a Senatore Settala*, Milan, Tipografia G. Bianchi, 1958, p. 5.

105 I refer to Santorio, *Commentaria in primam Fen* (cit. note 35), cols. 299-301.

106 See William F. Edwards, *Paduan Aristotelianism and the Origins of Modern Theories of Method*, in Olivieri (ed.), *Aristotelismo veneto e scienza moderna* (cit. note 99), I, pp. 206-220, and Timothy J. Reiss, *Neo-Aristotle and Method. Between Zabarella and Descartes*, in Gaukroger – Schuster – Sutton (eds.), *Descartes' Natural Philosophy* (cit. note 5), pp. 195-227.

107 Santorio, *Commentaria in Artem medicinalem Galeni* (cit. note 34), cols. 25-28, 35.

108 *Ibid.*, cols. 33-34.

Composition and resolution, therefore, are two different kinds of order or doctrine.[109] Besides these, Santorio considers the *doctrina definitiva*, or the teaching by means of definitions.[110] Santorio criticizes Zabarella, for whom this doctrine cannot be distinguished from the compositive or resolutive orders, as they both start with definitions.[111] Instead, Santorio argues that it is possible to follow a definitional order by proposing definitions and the explanations of what their terms mean, without considering the nature of the things themselves. This kind of order can be used in all arts and sciences, insofar it serves to abridge vaster bodies of knowledge.[112] Yet, he rejects the idea of a *doctrina divisiva* as an independent, fourth kind of order. For him, division serves for all doctrines, but, in itself, it does not teach anything, as it presupposes what is already known.[113]

The two other commentaries of Santorio, on Avicenna[114] and Hippocrates,[115] report the same positions on the orders of medicine and

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109 *Ibid.*, cols. 35-36.

110 On the pre-Cartesian notions of method, see John Herman Randall, *The Development of Scientific Method in the School of Padua*, «Journal of the History of Ideas», I, 1940, pp. 177-206; Neal Gilbert, *Renaissance Concepts of Method*, New York, Columbia University Press, 1960; John Herman Randall, *The School of Padua and the Emergence of Modern Science*, Padua, Editrice Antenore, 1961; Wilhelm Risse, *Die Logik der Neuzeit. Band 1, 1500-1640*, Stuttgart, Friedrich Frommann, 1964; William F. Edwards, *Randall on the Development of Scientific Method in the School of Padua – a Continuing Reappraisal*, in John P. Anton (ed.), *Naturalism and Historical Understanding: Essays on the Philosophy of John Herman Randall*, Albany, State University of New York Press, 1967, pp. 53-68; Wilhelm Risse, *Die Logik der Neuzeit. Band 2, 1640-1780*, Stuttgart, Friedrich Frommann, 1970; Antonino Poppi, *La dottrina della scienza in Giacomo Zabarella*, Padua, Antenore, 1972; Olivieri, *Aristotelismo veneto e scienza moderna*; Mikkeli, *An Aristotelian Response* (cit. note 100); Peter Dear, *Method and the Study of Nature*, in Daniel Garber – Michael Ayers (eds.), *The Cambridge History of Seventeenth-Century Philosophy*, 2 volumes, Cambridge, Cambridge University Press, 1998, vol. I, pp. 147-177; Reiss, *Neo-Aristotle and Method* (cit. note 106); Marco Sgarbi, *The Aristotelian Tradition and the Rise of British Empiricism. Logic and Epistemology in the British Isles (1570-1689)*, Dordrecht, Springer, 2013.

111 Zabarella, *De methodis* (cit. note 98), pp. 318-320.

112 Santorio, *Commentaria in Artem medicinalem Galeni* (cit. note 34), cols. 41-42.

113 *Ibid.*, cols. 45-46.

114 In his commentary on Avicenna, Santorio restates the existence of these three *doctrinae*, and rejects (like Regius and Sennert) the distinction between theoretical and practical medicine, for the reason that whole medicine is an art and considers the human body only for the end of preserving its health: Santorio, *Commentaria in primam Fen* (cit. note 105), cols. 36, 52-54.

115 In his commentary on Hippocrates (1629), Santorio maintains the distinction between medicine as *ars* and philosophy as *scientia*. They have two different *modi considerandi*, or order of exposition of their contents: as for Zabarella, philosophy follows a compositive order, and medicine a resolutive one – though they are both orders that concern essences and not particular things, and provide universal conclusions. Therefore, medicine is, in part, an *ars coniecturalis*: it conjectures, as stated above, the quantities in diseases, remedies, and

natural philosophy: however, in these commentaries he emphasizes that medicine is conjectural to the extent that a physician, as reported by Galen, relies on a conjectural estimation of the quantities of disease, cures and faculties.[116] This conjectural character finds a solution in his instrumental approach, whose scientific character is provided with a methodological justification in his *Methodi libri*, where he deals with the problem of discovery. In his *Libri*, Santorio maintains that, since the physician is a «sensatus philosophus», he tries to disclose *a posteriori*, by considering the *signa*, what is unknown. Such an *a posteriori* disclosure has a demonstrative value («vim dimonstrativam») if it proceeds from five kinds of signs: 1) lesions in actions, 2) changes in excretions, 3) changes in bodily quality, 4) changes in the disease (whether it is acute or chronic), and 5) what harms or helps the body.[117] The changes in excretions and qualities were indeed quantified by Santorio with his instruments. Their 'demonstrative force', however, does not depend on the exactness of measurement. This can be noted from Santorio's presentation of the three, traditional sects of physicians. Santorio distinguishes between the *empirici*, who rely only on analogy and experience, without considering the causes of disease; the *methodici*, who reduce all diseases to the qualities of *densum* and *laxum*, and the *dogmatici* – among whom Hippocrates, Galen, Avicenna are to be counted – who relied both on experience and demonstration. Besides the approach of the *methodici*, which does not allow distinguishing between the different species of disease, Santorio's main polemical target is the *empirici*. First, they relied on the «analogismus empiricum», which has only the role of example, and cannot provide knowledge of causes. Secondly, they used «experientia sine demonstratione» which is *inductio*: this concerns only individuals, and does not lead to the knowledge of causes from that of effect, but only from the knowledge of effects to that of a particular subject. Accordingly, one cannot provide a real *regressum* to causes by experience only.[118] However, even if excluding experience and analogy as sufficient conditions for science, Santorio maintains that experience and *inductio* can help the discovery of causes, for intellect is induced («excitatur») to separate the universal from the individual nature, and lead to universal knowledge. This is attained by an *argumentum a contrariis*, namely, when one can

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faculties, as these depend on the individual bodies: Santorio, *Commentarii in primam sectionem Aphorismorum Hippocratis* (cit. note 35), cols. 10-12, 20-21, 23.

116 See the previous note, and *supra*, note 105.

117 Santorio, *Methodi vitandorum errorum libri* (cit. note 67), p. 7*v*.

118 *Ibid.*, pp. 171*r*-172*v*, 188*v*.

show that what contradicts a certain conclusion is in itself contradictory: this grants, for Santorio, the universal character of science, and the same kind of certainty one has in metaphysics and logic.[119]

In sum, the methodological considerations of Santorio, compared with his attempt to quantify perspiration, fever and pulse, show that a quantitative approach can be the basis for the attainment of universal knowledge, although measurements alone do not guarantee such an attainment. Santorio's quantifications, as well as his methodological considerations, however, have little place in Regius's medicine. In dealing with the different kinds of excretion, Regius refers to Santorio's discovery that *perspiratio* is the biggest loss of matter by the body.[120] Also, in attacking the recourse to heat, cold, humidity and dryness as primary qualities, Regius addresses, in particular, those who tried to provide a quantification of such qualities «sine accurato examine».[121] Yet, if we look at his *Fundamenta medica*, we do not find any quantification of qualities, not even when he comes to deal with the investigation of diseases according to their *magnitudo*, in diagnostics.[122] Regius deals with *pondera* only with regard to recipes, in therapeutics, but he does not provide a method for their quantification in singular cases.[123] Regius's medicine, therefore, is still conjectural as to the quantification of cures and diseases.

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119 «Intellectus vero primo proprio lumine a conditionibus individuantibus naturam universalem toties per inductionem oblatam secernit. Secundo logicis praeceptionibus promptius eam exquirit: afferatur exemplum, scio per experientiam quod vesicantia attrahunt, sed haec propositio, quod vesicantia attrahant, confirmabor tamen, quod omnia talia sint, si viderimus, quod causa attractionis universalis sit, quod scilicet attrahant, quia omnia calida, et dolorifica attrahant. Confirmabor adhuc melius argumento a contrariis: qua contrariorum eadem est disciplina, dicendo, si omnium frigidorum proprium fuit repelere, omnium calidorum erit attrahere, et inde omnia vesicantia attrahent. Denique, ut omnis scrupulus auferatur confugere possumus ad contradictionis principium, cuius virtute logicus, et metaphysicus potest convincere protervos. Exempli causa, dicimus, aliquod calidum attrahit, haec est vera et omnibus nota. Ea igitur posita et concessa dicimus, quod eius contradictoria sit falsa, qua est nullum calidum attrahit, quae propositio, quamvis sit negativa, est universalis et virtute huius principii sine inductione cognoscitur. Similiter dicimus, quod haec propositio est falsa, aliquod vesicans non attrahit, dicimusque quod ex necessitate eius contradictoria debet esse vera, quae est omne vesicans attrahit. Ecce igitur quo pacto virtute logica, et metaphysica possimus universales propositiones pernoscere», Santorio, *Methodi vitandorum errorum libri* (cit. note 67), pp. 189*v*-190*r*.

120 «Vaporosum excrementum est, quod instar vaporis aut fumi, tum per os, aliosque patentiores meatus, tum per poros cutis perpetuo excernitur. Hoc omnes sensibiles excretiones superat: ita ut si alimentum sumatur uno die ab lib. octo, transpiratio insensibilis, aut vaporosi excrementi soleat nonnumquam ascendere ad libras quinque, ut testatur experientia statica Sanctorii praeceptoris quondam nostri», Regius, *Physiologia* (cit. note 10), p. 27.

121 *Ibid.*, p. 8.

122 Regius, *Fundamenta medica*, pp. 98-102.

123 *Ibid.*, pp. 209-212.

Moreover, if we look at his methodological considerations, we will find that his whole natural philosophy also has a conjectural, or rather provisional character.

### 4.4. *Regius and Descartes on discovery and exposition*

In order to 'place' Regius within early modern discussions over the method and order of medicine and natural philosophy, we need to look at his clash with Descartes, which took place in 1645. When the first draft of Regius's *Fundamenta physices* was submitted to Descartes before publication, the Frenchman distanced himself from Regius's notion of the soul, and from his order of presentation of natural philosophy. In a letter of July 1645, Descartes objects to Regius 1) that he maintains that the soul is an accident of the body,[124] and 2) he has not provided adequate proofs for his physics, as Regius displays definitions and divisions, going from the general to the particular, without grounding them in adequate *probationes*. Descartes maintains that such an order of presentation may be used to exhibit the results of physics to those people who are already acquainted with his philosophy. To others, however, Regius's statements would appear paradoxical.[125] There are two main reasons for the lack of such *probationes*. To understand them, we need to look at Regius's methods of discovery and presentation.

Through the various editions of his *Fundamenta physices*, Regius provides an account of philosophical truths according to which they have a provisional status. At the end of his book, he states that his arguments are not intended to be compulsory for everyone, because human temperaments are various and no argument can convince everyone in the same way,[126] moreover, one may be influenced by diseases such as apoplexy

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[124] AT IV, p. 250; see Bos, *Correspondence* (cit. note 8), p. 188.

[125] «Sed quantum ad me, nihil mihi magis vitandum puto, quam ne opiniones meae paradoxae videantur, atque ipsas nunquam in disputationibus agitari velim, sed tam certas evidentesque esse confido, ut illis a quibus recte intelligantur, omnem disputandi occasionem sint sublaturae. Fateor quidem eas per definitiones et divisiones, a generalibus ad particularia procedendo, recte tradi posse, atqui nego probationes debere tunc obmitti. Scio tamen illas vobis adultioribus, et in mea doctrina satis versatis, non esse necessarias. Sed considera, quaeso, quam pauci sint illi adultiores, cum ex multis philosophantium millibus vix unus reperiatur qui eas intelligat, et sane qui probationes intelligunt, assertiones etiam non ignorant, ideoque scripto tuo non indigent. Alii, autem legentes assertiones sine probationibus, variasque definitiones plane paradoxas, in quibus globulorum aethereorum, aliarumque similium rerum, nullibi a te explicatarum, mentionem facis, eas irridebunt et contemnent, sicque tuum scriptum nocere saepius poterit, prodesse nunquam», AT IV, pp. 248-249; see Bos, *Correspondence* (cit. note 8), pp. 187-188.

[126] Regius, *Fundamenta physices* (cit. note 12), pp. 305-306.

and epilepsy.[127] In the second edition of the book (1654), Regius adds that both false and true judgements may be equally evident.[128] These statements are justified on the basis of his rejection of the existence of a pure understanding, «intellectum purum», which can carry out any reasoning independently of its conjunction with the body.[129] Moreover, he negates the existence of any intentional species, rejecting as well, on this basis, the Aristotelian theory of knowledge. The result is a form of 'radical empiricism'.[130] On this basis, Regius intends to provide a physical theory not different, in most of its contents, from Descartes's, but meant only as a provisional explanation of phenomena and not based on innate principles and eternal truths.[131] Regius's epistemology, therefore, can be defined according to the model of inference to the best explanation. In his 1654 *Philosophia naturalis* he clarifies his method of discovery in natural philosophy, which consists of 1) formulating a problem for the explanation of an effect, 2) discovering an intelligible cause, 3) excluding other causes, until a better cause is found:

cum enim problema aliquod in physicis proponitur solvendum, primo excogitanda est causa intelligibilis, qua effectum, in problemate proposito observa-

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127 *Ibid.*, p. 246.

128 Regius, *Philosophia naturalis, editio secunda* (cit. note 12), p. 347.

129 Regius openly rejects the existence of an *intellectum purum* from the second edition of his *Fundamenta physices*: Regius, *Philosophia naturalis, editio secunda*, p. 404. For a full account of Regius's theory of understanding, see Bellis, *Empiricism without Metaphysics* (cit. note 20), pp. 169-172, and Erik-Jan Bos, *Henricus Regius et les limites de la philosophie cartésienne*, in Kolesnik-Antoine (ed.), *Qu'est-ce qu'être cartésien?* (cit. note 53), pp. 53-68.

130 Regius, *Fundamenta physices* (cit. note 12), pp. 253-254. See Bellis, *Empiricism without Metaphysics* (cit. note 20), pp. 154-159, 163.

131 Regius rejects the doctrine of eternal truths in *Philosophia naturalis, editio secunda*, pp. 357-358. As to the degree of certainty of Descartes's natural-philosophical theories, for Descartes not all the contents of his physics are metaphysically true, given the absolute power of God. And yet, the whole chain of reasoning he adopted, and based on metaphysical truths, makes them absolutely certain: see § 206 of his *Principia*: «praeterea quaedam sunt, etiam in rebus naturalibus, quae absolute ac plusquam moraliter certa existimamus, hoc scilicet innixi metaphysico fundamento, quod Deus sit summe bonus et minime fallax, atque ideo facultas quam nobis dedit ad verum a falso diiudicandum, quoties ea recte utimur, et quid eius ope distincte percipimus, errare non possit. Tales sunt mathematicae demonstrationes, talis est cognitio quod res materiales exsistant, et talia sunt evidentia omnia ratiocinia, quae de ipsis fiunt. In quorum numerum fortassis etiam haec nostra recipientur ab iis, qui considerabunt, quo pacto ex primis et maxime simplicibus cognitionis humanae principiis, continua serie deducta sint» AT VIIIa, p. 328. On Descartes's theory of deduction, experience, and use of hypotheses, see Desmond M. Clarke, *Occult Powers and Hypotheses. Cartesian Natural Philosophy under Louis XIV*, Oxford, Clarendon Press, 1989; Id., *Descartes' Philosophy of Science*, Manchester, Manchester University Press, 1992; Sophie Roux, *Le scepticisme et les hypothèses de la physique*, «Revue de Synthèse», s. IV, II:3, 1998, pp. 211-255.

tum, commode et intelligibiliter peragi possit. Deinde circumspiciendum, an non alia commodior vel aeque commoda queat inveniri. Quae si inveniatur, commodior priori est praeferenda, aequalis vero ipsi aequiparanda. Sin alia commodior vel aeque commoda excogitari nequeat, solutioni inventae tamdiu acquiescendum, donec melior vel aequalis alia fuerit inventa.[132]

The main cognitive processes involved in the formulation of such intelligible, causal explanations are imagination, induction and analogy, which draw their contents from experience only. In accordance with his 'radical empiricism', in Regius's *Fundamenta physices* all intellective processes are reduced to *sensus cogitativus*, – i.e. the four senses – *reminiscentia* and *imaginatio*.[133] Imagination grounds *inductio*, which makes possible the abstraction of general ideas from particular sense data.[134] Moreover, it is by the *intellectus* based on imagination that one can hypothesize, by means of an analogy, the existence of insensible particles behaving in the same way as the observable parts of matter.[135] This method is far from Zabarella's theory of *regressus*, although Zabarella's *examen mentale* is similar to Regius's *excogitatio* and *circumspectio*, and they both rely on induction as the process of inference of a general idea from observable effects. However, in Regius's account no universal conclusion can be provided, nor there is a two-fold process, such as resolution and composition. In fact, Regius's method of discovery is only analytical, although not in the sense of Zabarella's resolution. A more kindred method of discovery can indeed be found in Descartes's method of analysis, which is, like Regius's, a problem-solving method. Descartes's analytical method of discovery, as shown by Stephen Gaukroger, had a mathematical origin and was appropriated from Pappus. In particular, it amounts to Pappus's 'problematical analysis', in which he 1) poses a problem, 2) proceeds by unfolding its sub-problems, until 3) he finds a question whose solution is clear, according to the accepted criteria of truth, such as – for instance – what is evident according to experience. In the hands of Descartes, this method amounts to 1) observing a phenomenon, 2) formulating an hypothesis which is consistent with the first principles of physics, and through which one can derive different effects related to the same phenomenon and 3) testing this hypothesis by experience. This is the case, for instance, with Descartes's law of refraction, which is

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132 Regius, *Philosophia naturalis, editio secunda* (cit. note 12), p. 441.

133 Regius, *Fundamenta physices* (cit. note 12), pp. 252-253.

134 *Ibid.*, p. 285.

135 *Ibid.*, p. 95. See Bellis, *Empiricism without Metaphysics* (cit. note 20), pp. 170-171.

consistent with his principle of the conservation of the quantity of motion.[136] As a problem-solving approach, this method of discovery does not serve to find first principles in physics, nor does it consist of the deduction of a particular phenomenon from such first principles – namely, as a derivation of conclusions from a theorem –[137] but it provides explanations of phenomena, consistent with such principles. The methods of Regius and Descartes in natural philosophy,[138] therefore, are both analytical in this sense, namely, they are problem-solving methods. Their difference, accordingly, does not concern their method of discovery but rather the absence, in Regius's natural philosophy, of a metaphysics upholding such explanations. This may be a reason for Descartes's criticism of Regius's *Fundamenta physices* as lacking *probationes*: Regius's Cartesian physics is not proved by metaphysics. However, Regius was also omitting another kind of *probatio*. What is missing in Regius's account, indeed, is not only Descartes's metaphysics, but also his cosmogony: namely, Regius presents Descartes's vortex theory without explaining, as Descartes does in his *Le monde* and *Principia*, how the different kinds of parts of matter (the matter of skies, the subtle matter of stars, and the gross matter of terrestrial bodies) are formed by an initial continuum of matter, as a result of the scratching and rounding of its parts, and in according with his principles of motion.[139] This cosmogony, the

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136 Stephen Gaukroger, *Cartesian Logic. An Essay on Descartes's Conception of Inference*, Oxford, Oxford University Press, 1989, pp. 73-88, 110-114. It is worth quoting Gaukroger's words in full: «the approach, as Descartes outlines it, in the case of the discovery of the sine law, the calculation of the angles of the bows of a rainbow, and the solution of Pappus's locus-problem, is the same, and in each case it consists purely in analysis. In each case we take a specific problem bequeathed by antiquity and solve it using procedures compatible with the basic precepts of Cartesian science. We then try to incorporate the solution within a general system which has as its foundations those truths which we cannot doubt because we have a clear and distinct grasp of them (and because God guarantees those truths of which we have such a grasp)», *ibid.*, p. 114; see Descartes's *Dioptrique*, AT VI, pp. 97-100.

137 This amounts to, for Descartes, a synthetic method: cf. his replies to the second objections to his *Meditationes*: AT VII, pp. 155-156. On the problem of synthesis in Descartes's thought, see Daniel Garber, *Descartes Embodied. Reading Cartesian Philosophy Through Cartesian Science*, Cambridge, Cambridge University Press, 2001, pp. 52-63.

138 As far as Regius's medical theories are concerned, Regius does not address the problem of the method of discovery. In principle, his physiology and pathology still include natural-philosophical topics, so that their method is not different from the problem-solving one of natural philosophy. As to the more practical parts of medicine, Regius is silent as well: in fact, the ascertainment of the actual method of discovery he adopted in formulating both his physical and medical theories (and therefore, his debts to Descartes himself, and to the traditional medical theories he aimed at revising), would require a separate treatment.

139 On Descartes's cosmogony, see Gaukroger, *Descartes' System of Natural Philosophy*

lack of which Descartes complains of as he criticizes Regius for using the notion of *globuli aetherei* without giving explanations of them,[140] is not based on Descartes's metaphysics, but rather on his principles of motion, which are included by Regius in his *Fundamenta physices*, and proved on the basis of experience.[141] So, why did Regius omit proof of his vortex theory? We can answer this question by looking at his order of presentation in natural philosophy. The method of presentation he follows, as he declares in his 1661 *Philosophia naturalis*, is appropriated from the arts and is analytic as it consists of proposing a series of general definitions and explaining them: «traditio fit per definitiones, distributiones, et additas dilucidationes, analytica methodo procedentes. Haec enim est clarissima et brevissima».[142] This kind of analysis, however, is not the mathematical-heuristic one of Pappus and Descartes, nor the medical one of Zabarella and Santorio, but is rather derived from Ramus's method of dichotomies, based on definitions, divisions and explanations,[143] and from the *doctrina definitiva* indicated by Santorio as useful to abridge large bodies of knowledge in teaching, aided by division. So, Regius was merely, and overtly, abridging Descartes's *Principia*.[144] Moreover, if we look at the series of subjects of Regius's *Fundamenta physices* and *Fundamenta medica*, we find, in the former, a compositive order, as Regius starts by considering the general notion of matter and its primary qualities (movement, rest, position, figure and dimension), (chapter I) and ends by dealing with man (chapter XII): namely, he proceeds from the most simple (or general) to the more complex (or particular) subjects, following such a compositive order as that outlined by Zabarella and Santorio as proper to medicine. In the *Fundamenta medica*, on the other hand, we find a traditional, 'medical' resolutive order, for Regius starts by dealing with health as the end of medicine, and ends with the means of healing, in accordance with his purely 'medical' notion of physiology, built upon that of Sennert. The common *modum considerandi* which is at work in these disciplines, therefore, concerns only their being taught by definitions, divisions and explanations.

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(cit. note 37); John A. Schuster, *Descartes-Agonistes. Physico-mathematics, Method & Corpuscular-Mechanism 1618-33*, Dordrecht-Heidelberg-New York-London, Springer, 2012.

140 See *supra*, note 125.

141 See *supra*, notes 41-43.

142 Regius, *Philosophia naturalis, in qua tota rerum universitas* (cit. note 12), pp. 476-477.

143 On Ramus's method, see Walter J. Ong, *Ramus, Method, and the Decay of Dialogue. From the Art of Discourse to the Art of Reason*, Cambridge (MA), Harvard University Press, 1958.

144 See *supra*, note 14.

## 5. Conclusions

In order to come to some conclusion, we can connect all the different research results gained in the different stages of our exploration. In section 2, it was ascertained that Regius's views on the subject matter of physiology, functional to his aim of providing a clearer medicine, were in fact part of a long process of re-definition of the boundaries of natural philosophy and medicine. In particular, Regius built upon Sennert's idea of physiology, which loses its ambiguous status of *naturalis pars medicinae*. In section 3, it was shown how Regius built upon Descartes's theory of matter in order to explain the traditional notions of physiology – health, temperaments – as well as those of disease and medicaments. Through his efforts, Regius provides a 'particularist' reinterpretation of such notions, and claims, on the one hand, that the traditional hierarchy of sensory qualities has to be rejected, and on the other that no occult qualities can be admitted in medicine. Yet, once he comes to deal with the different kinds of temperament, health, disease and medicaments, Regius still maintains the traditional primacy of heat, cold, humidity and dryness. Therefore, his explanation of medical notions does not lead to any actual innovation in medicine, but only to simplification in its presentation. Moreover, he scarcely recurs to the *mathematica medica* of Santorio, although his rejection of occult qualities is pre-dated by that of Santorio himself. In section 4, I have dealt with the different, possible sources of Regius's methods of discovery and presentation in his natural philosophy and medicine. As to the first, we can label it as a combination of Descartes's analytical, problem-solving method with a 'radically empirical' approach, as Regius negates the existence of a pure understanding and of intentional species. As to the second, he was adopting a Ramist method of exposition, abridging Descartes's text, and omitting certain proofs. In section 4 I advanced the hypotheses that he did so because he could not provide his physics with a metaphysical foundation, given his 'radical empiricism'. In the light of the research results summarized in this section, I advance a further hypothesis. Namely, that Regius adopted the same *methodo definitiva* and *divisiva* in natural philosophy and medicine in order to emphasize their theoretical continuity, and to conceal the traditional character of most of his medical theories. The alleged clarity of his exposition, which he proposes in the dedicatory letter to his *Fundamenta medica*, indeed, is not the metaphysically-grounded clarity of Descartes, which he rejects as determined by temperaments and bodily conditions: rather, it consists of the brevity of his definitions, divisions and explanations. Already in

his *Physiologia*, indeed, Regius indicated the brevity of his exposition, and associated it with the clarity of his principles: «atque ita cognitionem physiologicam per nostra perspicua principia, pro brevitate qua hic utimur, expedivimus».[145] This passage would be attacked by the Reformed theologian Martin Schoock, for whom Regius's «perspicua principia», i.e. the five primary features of matter borrowed by Regius from Descartes, cannot be taught «compendiosiori methodo», as their validity must be demonstrated.[146] Such brevity could have served Regius not only to conceal the absence of a metaphysical demonstration of the validity of his natural-philosophical principles, but also the traditional character of his medicine, which was, in fact, more Ramist in exposition, than Cartesian in content. The combination of Cartesian analysis in the discovery, and the Ramist dichotomous order in the presentation, per se, did not result from Regius's rejection of Descartes's metaphysics: yet, the use of Ramist means in order to teach Cartesian philosophy perfectly fitted his conceptual abridgement of Descartes's philosophy (including the truncation of its metaphysical roots). Last but not least, in Regius's education Ramism was one of his first acquaintances – well before his mature appreciation of Cartesianism.

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145 Regius, *Physiologia* (cit. note 5), p. 50.

146 Martin Schoock, *Admiranda methodus novae philosophiae Renati des Cartes*, Utrecht, ex officina Joannis van Waesberge, 1643, pp. 200-201. See Massimiliano Savini, *Le développement de la méthode cartésienne dans les Provinces-Unies (1643-1665)*, Lecce, Conte, 2004, pp. 132-133.