Chapter 3
Sanctorius's Galenism

Abstract The chapter deals with Sanctorius's intellectual background and places his book *De statica medicina* within the framework of contemporary Galenic medicine. Usually, the book is celebrated for its innovative quantitative approach to medicine yet read in isolation from its broader context. However, as I will show, an analysis of this context is crucial to understanding how Sanctorius developed his novel ideas and revised the medical knowledge of his day. Of particular importance in this regard are the dietetic doctrine of the "six non-natural things" and the concept of insensible perspiration, an invisible excretion of the human body. Potential relations of Sanctorius's notions to the doctrine of the ancient medical school of the Methodists and to corpuscular ideas are also scrutinized. The chapter concludes with an analysis of the *De statica medicina* itself, focusing on the conceptual backdrop against which Sanctorius developed his weighing procedures, the results of which he presented in the book. References to Sanctorius's other publications help set his ideas in the broader context of his endeavors and contribute to an understanding of the theoretical context in which the *De statica medicina* emerged.

Keywords Dietetics · Galenic medicine · Humoral theory · Perspiration

If one thinks of medicine and medical practitioners in the early modern period, very diverse images may spring to mind: the apothecary amidst bottles and jars full of different tinctures and remedies, the woman healing her family members and other sick people at home, with poultices and herbal infusions, the town physician examining his patient's urine, the surgeon setting broken bones, or the charlatan trying to cure with dubious remedies. There is some truth to all of them, and many more characters could be added to the list. The European medical world was highly diverse, comprising different areas of knowledge, various intellectual interests, and a broad range of commitments within a variety of institutions, occupations, skill sets, and activities. However, there was a large body of shared knowledge, too, and the boundaries between the different actors were often blurred. Medicine was a craft, a profession, and a scholarly activity. It is within this context that Sanctorius and his work must be considered.

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With his medical university education, Sanctorius belonged to a privileged group and enjoyed a special status at the top of the hierarchy of medical practitioners. As soon as he became university professor of theoretical medicine, he climbed even further up the ladder, personally teaching a new generation of physicians. Theoretical medicine (*theoria*) at the time included the teaching of the nature of medical science, the position of medicine in the hierarchy of arts and sciences, and the proper relationship of medicine and philosophy, as well as the basic principles of physiology, pathology, and regimen (Siraisi 1987: 10; 2012: 492–514).[1] All of this was taught against the backdrop of the medical tradition—Galenic medicine.

Galenic Medicine as the Leading Authority For more than thirteen centuries, the medical system known as *Galenism* prevailed in Western and Arabic medical thought. Its influence began to slowly decline during Sanctorius's lifetime, but was still substantial, especially in the universities. It goes back to the Greek physician Galen of Pergamon (ca. 129–ca. 216 CE), who practiced mainly in Rome. He was one of the most prolific writers of Western antiquity and many of his works survive. Galenism refers to the school of thought that emerged from Galen's work. This differentiation is important, so as not to confuse the historical figure and his original works and doctrines with the transformations that the latter underwent over time. There are many "Galens," namely reshaped and updated versions of the ancient original, and thus they are by no means all identical. So which Galen did Sanctorius encounter in Padua? And what kind of Galenism did he later teach his students? These are not easy questions and it would probably take at least another monograph to answer them in full. In the following account, therefore, I mainly rely on secondary literature to outline the intellectual framework in which Sanctorius was trained at the University of Padua (Temkin 1973; Salmón 1997; Arrizabalaga et al. 2002; Singer 2016). To this end, I address Galen's scientific output insofar as this enhances understanding of the Renaissance teaching derived from it. Rather than studying the phenomenon of Galenism in Padua at the turn of the seventeenth century in its own right, this chapter aims to analyze Sanctorius and his work against the backdrop of this medical tradition. Sanctorius is my point of departure in this endeavor to add another piece to the enormous puzzle of Renaissance Galenism.

Sanctorius's publications are all deeply informed by Galenic medicine. This is no surprise, especially in the case of his three commentaries—on Galen's *Ars Medica*, Avicenna's *Canon,* and Hippocrates's *Aphorisms*. These reflect his teaching as a professor of *theoria* in Padua and therefore necessarily refer to the medical tradition. But his other works—the *Methodi vitandorum errorum,* the *De statica medicina,* and the *De remediorum inventione*—likewise pursue this same theoretical thrust. This is well worth emphasizing given that the image of Sanctorius as an innovator who promulgated a new medical science *at the expense of* Galenic medicine still haunts the literature. The *De statica medicina*, Sanctorius's most famous work, is usually celebrated for its innovative quantitative approach to medicine, in isolation

[1] For the distinction between theoretical medicine (*theoria*) and practical medicine (*practica*), see Sect. 2.1, fn. 8.

from its broader context. However, the book's very structure is modelled on an ancient concept that originated in Galen's work and is fundamental to the Galenic tradition. It serves insofar as an introduction to the intricate world of Galenism.

3.1 The "Six Non-Natural Things"

The *De statica medicina* is divided into seven sections: *De ponderatione insensibilis perspirationis* (weighing of insensible perspiration), *De Aere & aquis* (air and water), *De Cibo & potu* (food and drink), *De Somno & vigilia* (sleep and wake), *De Exercitio & quiete* (exercise and rest), *De Venere* (coitus), *De Animi affectibus* (affections of the mind) (Fig. 3.1) (Sanctorius 1614: index).[2] While this may not ring a bell with the modern reader it surely did among his contemporaries; for sections II to VII correspond to the list of the so-called six *res non-naturales*, albeit in slightly altered fashion. These six non-natural things were of great importance in traditional dietetic medicine, as they were considered to be the main determinants of health and disease. They are categories of factors to which human beings are unavoidably exposed in the course of daily life and that influence health or disease, depending on the circumstances of their use or abuse. Generally, they are classified as follows: (1) air, (2) food and drink, (3) sleep and wake (or: wakefulness), (4) motion and rest, (5) evacuation and repletion, (6) passions of the mind. Management of the patient's regimen (that is, of these six sets of factors) was for centuries the physician's most important task (Rather 1968: 337; Jarcho 1970: 374). Thus, Sanctorius used a common concept of dietetic medicine to structure his work with the weighing chair.[3] However, as the first section implies, he shifted the focus to the *perspiratio insensibilis*, an insensible perspiration of the human body, and to how its excretion is affected by the non-naturals. More will be said about this later.

3.1.1 The Origin of the "Six Non-Natural Things"

The expression "six non-natural things" was so familiar to scholars until the end of the eighteenth century, and so embedded in the Galenic medical tradition, that it was usually not explained in more detail, nor were clues given as to its origin. Therefore,

[2] As a response to a harsh critique by Ippolito Obizzi, a physician and philosopher of Ferrara, who attacked the *De statica medicina* violently in his work *Staticomastix sive staticae medicinae demolitio* (The Scourge of Statics, or the Demolition of Static medicine) (Obizzi 1615), Sanctorius added an eighth section to his book, called *Ad Staticomasticem* (To the Scourge of Statics). It was often reprinted as a supplement to the original work. The earliest edition I could find of the *De statica medicina* with the additional eighth section dates from 1634 (Sanctorius 1634). However, a statement by Sanctorius in the *Commentary on Avicenna* implies that he had published his defense against the *Staticomastix* before 1625 (Sanctorius 1625: 81). See also Sect. 5.3.2.

[3] In the following, I refer to the "six non-natural things" as a "concept," or a "doctrine," but it is important to note that they comprise normative, practical, and theoretical aspects.

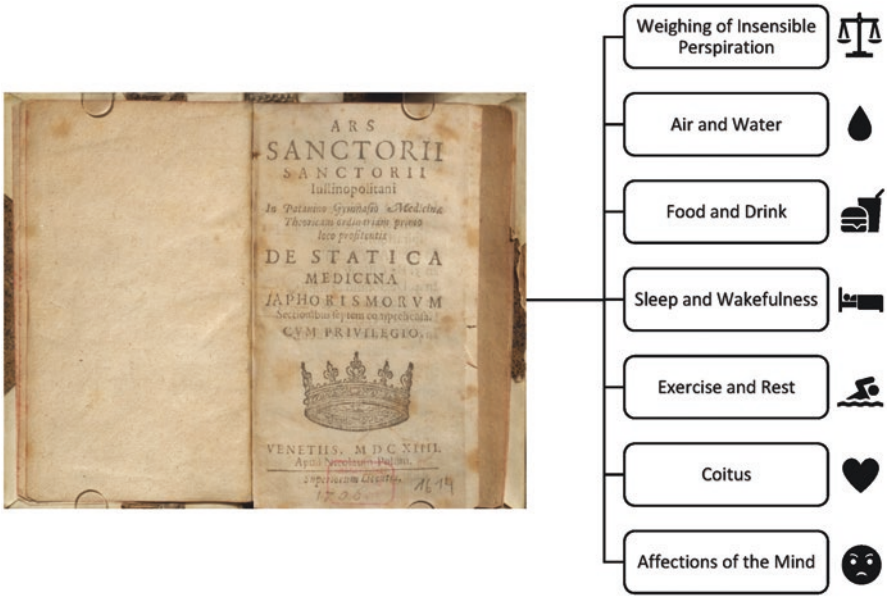

Fig. 3.1 The subjects and their order, as presented in the *De statica medicina* (Sanctorius 1614). Image of the frontispiece courtesy of Universitätsbibliothek Erlangen-Nürnberg, TREW.Xx 400

once the term had been largely forgotten, it was very difficult for historians to trace where it originally came from. In 1970, Saul Jarcho set out to do so and finally found the decisive clue in the writings of the famous anatomist Giovanni Battista Morgagni (1682–1771) (Jarcho 1970). In his posthumously published lectures on Galen's *Ars medica*, Morgagni discussed, amongst other things, the six non-naturals. Following up on this clue, Jarcho continued his research in the Galenic corpus and was successful.[4] The relevant passage reads:

> Accordingly, some of the changes of the body are necessary and some are not. I call 'necessary' those which it is impossible for a body not to be associated with and 'not necessary' the rest. Thus constant contact with the ambient air, eating and drinking, waking and sleeping are necessary to it whereas constant contact with swords and wild animals are not necessary, whence the art devoted to the body resides in the first class of causes whereas the

[4] In 1968—two years before Jarcho, but unbeknown to him—L.J. Rather had traced the source of the doctrine of the six non-naturals to Galen's *Ars medica*. See: Rather 1968: 341. In 1988, Galen's authorship of the *Ars medica* was called into doubt for the first time in the history of medicine by Jutta Kollesch (Kollesch 1988). A few years later, García-Ballester supported Kollesch's hypothesis in his study *On the origin of the "six non-natural things" in Galen*, which was first published in 1993 (García-Ballester 2002: 114 f.). Boudon-Millot examined the matter of authenticity again in 1996 and came to the conclusion that there was no reason to doubt Galen's authorship (Boudon-Millot 1996). In the introduction to the recent edition and English translation of the *Ars medica*, Johnston makes no mention of any uncertainty regarding the authenticity of the work (Galen and Johnston 2016: 137–55). In the present account, I follow Boudon-Millot and Johnston in assuming that Galen was the author of the *Ars medica*.

> second doesn't apply any more [i.e., in the first class of causes but not in the second there is an art devoted to the protection of the body]. And so, if we distinguish all those changes of the body which are necessary, we shall discover, in respect of each of them, some specific class of causes of health. There is, then, one from association with the ambient air, another from movement and rest of the whole body and its parts, a third from sleeping and waking, a fourth from those things taken in, a fifth from those things excreted or released, and a sixth from the affections of the soul (Jarcho 1970: 376; Galen and Johnston 2016: 247 ff.).

Interestingly, Morgagni's commentary on this passage leads to another famous scholar who had been appointed professor at the University of Padua exactly a century before him: Sanctorius Sanctorius. A look at Sanctorius's *Commentary on Galen* shows that Morgagni copied this and other comments almost word for word (Morgagni 1965: esp. 83–100)—and thus, that a professor at the University of Padua one hundred years later, in 1712, still found Sanctorius's thoughts on the subject so relevant that he did not care even to revise them. Of course, one could argue that Morgagni relied so heavily on Sanctorius's work in his lectures on the *Ars medica* because he felt that teaching Galen's classic was a mere formality, a statutory obligation inherited from the past, but barely worth any effort. Nancy Siraisi has shown, however, that Morgagni supplemented his lectures on another traditional textbook, Avicenna's *Canon*, with lengthy descriptions of contemporary physiological ideas and thus evidently was prepared to introduce new material into his teaching on established subjects. In fact, Morgagni's lectures on the *Canon* dealt only cursorily with traditional ideas, and it was for these precisely that he relied heavily on Sanctorius's *Commentary on Avicenna*. This further suggests that Morgagni considered parts of Sanctorius's work useful to eighteenth-century students. In fact, of the many commentaries on the *Ars medica* that existed in Morgagni's time, Morgagni advised students to choose only three—among them, Sanctorius's *Commentary on Galen*—and "to keep them day and night within arm's reach" (Morgagni 1965: 23; Siraisi 1987).[5]

With respect to the six non-naturals, it is striking that Morgagni, who is regarded as the founder of anatomical pathology and follower of the new quantitative approach introduced by Sanctorius, referred neither to insensible perspiration nor to the *De statica medicina*.[6] What this implies for the reception of Sanctorius's thoughts will be scrutinized later. However, it already hints at the problem of applying the

[5] "Quamobrem hos tres ultimos Enarratores, ex omnibus electos Vobis propono quos nocturna diuturnaque manu prae caeteris versetis." See: Morgagni 1965: 23 and also 18, 30. The two other commentaries on Galen's *Ars medica* that Morgagni suggested to his students were the commentaries of Francisco Vallés (1524–1592) and Luca Tozzi (1638–1717) published in 1567 and 1703 respectively.

[6] In the two volumes of Morgagni's lectures on Galen's *Ars medica,* edited by Adalberto Pazzini, Morgagni referred only rarely to the *De statica medicina* and not in the context of the doctrine of the six non-natural things (ibid.: 343, 351, 355, 359, Morgagni 1966: 568, 674, 688 f., 710 f., 751). The respective passages show that Morgagni accepted Sanctorius's static doctrine yet did not discuss it at length. In the second volume, Morgagni mentioned Sanctorius's *pulsilogium*, but it seems that he did not use a similar instrument himself. For more information on Giovanni Battista Morgagni, see: Ongaro 2012.

categories of tradition and innovation retrospectively to the knowledge and work of historical figures. Did Morgagni differentiate between Sanctorius, the Galenist, and Sanctorius, the pioneer? Why did he rely so heavily on Sanctorius's commentaries precisely for the "traditional" thoughts that refer to Galenic medicine? Why did he not focus instead solely on the more "innovative" thoughts? The discussion of these and similar questions is postponed until the end of this book (Chap. 8). At this point, a closer look needs to be taken at what Sanctorius himself had to say on the concept of the non-natural things.

As is apparent from the citation above, Galen did not use the expression "non-natural" nor the phrase "six non-naturals" in the *Ars medica*. Instead, he discussed these factors in terms of "necessary" and "non-necessary" causes. Sanctorius explained that it was the Arabs (*Arabes*) who introduced the term. Galen, he wrote, had used the expression "non-natural" only in his work *De pulsibus ad tirones* (On the Pulse for Beginners), in reference to the causes of alteration in the pulse. The non-naturals, so Sanctorius, were explained by such an indefinite denomination, because their proper name was unknown; for they were factors which produced not only health but also disease, depending on their use respectively their abuse (Sanctorius 1612b: 19; 1625: 59). Indeed, later medical historical research confirmed that Arabic Galenism connected the necessary causes mentioned in the *Ars medica* with the non-natural causes referred to in the *De pulsibus ad tirones*. However, according to L. J. Rather, it seems unlikely that the Arabic authors used a term equivalent to "non-natural" with reference to Galen's six necessary causes. More probably, the term was introduced into the Western European medical vocabulary in Latin translations of Arabic works largely based on Galen (Rather 1968: 341).[7]

Sanctorius also referred to other passages in Galen's works, in which the latter expressed similar ideas to those in the *Ars medica*. In Galen's treatises *De sanitate tuenda* (Hygiene) and *Thrasybulus,* a similar group of factors was mentioned but they were divided into four groups instead of six and they were called neither "non-naturals" nor "necessary." The classification is as follows: (1) things administered (food, drink, drugs), (2) things evacuated (the bodily secretions and excretions), (3) things done (exercises, wake, insomnia, sleep, sexual activity, anger, anxiety, bathing), and (4) things befalling a person externally (air, water, seawater, olive oil, etc.) (Galen & Johnston 2018b). Sanctorius explained that Galen defined here the "non-natural" factors more broadly, and pursued a different aim than with the sixfold division. The fourfold classification was the most universal, per Sanctorius, because it comprised more causes that effect health or disease than any other classification

[7] The designation "non-natural" has often led to discussion, because the factors it describes seem among the most "natural" things in our experience. One explanation for the term was that the six things are non-natural in the sense that they can be manipulated by humans for the purpose of prophylaxis or cure (Strohmaier 1996: 172 f.). For a more comprehensive analysis of the development of the term "non-natural" and the phrase "six non-natural things," see: Rather 1968, Niebyl 1971.

scheme and included every conceivable non-natural thing (Sanctorius 1603: 98v–99r; 1612b: 20; 1625: 60).

As Sanctorius indicated, Galen had introduced these two categories in different contexts. While in the *Ars medica* (citation above), he highlighted the role of the non-naturals in pathology as inevitable causal factors, he focused in the *De tuenda sanitate* (Hygiene) and the *Thrasybulus* on their therapeutic role. In the latter case, they are understood as regulators of human life for the preservation of health, as aspects of diet and regimen demanding special medical attention (Rather 1968: 341; García-Ballester 2002: 106). With regard to pathology, Sanctorius stressed the occasional character of the six non-naturals as causes of disease. In his *Commentary on Galen*, he wrote:

> From the six non-naturals nothing certain can be obtained, because they do not necessarily cooperate in the production of internal affections. Sometimes we see men slip into cachexia and anasarca in the summer and after using strong wine and aromatics. In the winter some old men occasionally develop ardent fever after taking cold liquids. For this reason Hippocrates and Galen did not want to call these non-natural things causes in any way, but *προφασεις*, i.e., occasions [in the sense of *a juncture of circumstances*] (Sanctorius 1612a: 173).[8]

Thus, Sanctorius warned that our involvement with these factors was purely fortuitous. Even though they played a substantial role in the causal system of Galenic pathology, there were other aspects to be considered when searching for the causes of a disease; and so Sanctorius reminded his students to not treat them in isolation (Sanctorius 1603: 99v; 1612a: 173; 1625: 47).

In the above citation, Sanctorius also pointed to the possible source of the non-naturals in Galen's works, namely Hippocrates.[9] In his last work, *De remediorum inventione*, Sanctorius wrote that Hippocrates had dealt with the six non-natural things in the *Libri epidemiorum* (Books on Epidemics) (Sanctorius 1629b: 144). What is more, when discussing issues related to the non-naturals in his *Commentary on Hippocrates* and his *Commentary on Avicenna*, Sanctorius referred to Galen's commentaries on *Epidemics* and on two other Hippocratic works—*De victus ratione in morbis acutis* (On Regimen in Acute Diseases) and *De natura humana* (On the Nature of Man) (Sanctorius 1625: 59 f.; 1629a: 100, 389). The assumption that

[8] "… ex rebus non naturalibus nihil certi colligi potest, quia hae in affectuum internorum productionem non necessario conspirant: videmus enim aliquando homines tempore aestivo post unum [sic] generosi visi [sic], & aromatum in cachexiam, & anasarcam praeterlabi: & tempore hyberno senes aliquos post usum frigidorum aliquando in ardentem febrem incidere: Quo fit ut Hippocrates, & Galenus noluerint has res non naturales ullo modo appellare causas, sed προφασεις, idest occasiones: …." See: Sanctorius 1612a: 173. In this edition, there is an error in pagination; the correct page number would be 169. The English translation was made on the basis of Jarcho 1970: 376, who refers to Morgagni's comment, which is, however, nearly identical to the passage in Sanctorius 1612a, see: Morgagni 1965: 85.

[9] Around 60 medical treatises attributed to Hippocrates have been handed down to us, compiled in the so-called *Corpus Hippocraticum*. It is difficult to determine exactly which works of the *Corpus* are his, but it has been proved that not all of the treatises were written by the same author (Jouanna 1996: 38 f.).

Galen developed concepts on the basis of Hippocratic ideas that were subsequently systematized as the "six non-naturals" is further supported by recent historical research. Luis Garcìa-Ballester revealed that Galen considered the contents of the doctrine of the non-natural things in commentaries on various works by Hippocrates: Epidemics I and VI, *De aere, aquis et locis* (On Airs, Waters, and Places), and *De natura hominis* (On the Nature of Man) (García-Ballester 2002: 108). An analysis of the respective passages in the Hippocratic works in connection with Galen's commentaries still remains to be done.

But whatever the influence of Hippocrates's thoughts on Galen may have been in this regard, it was through a study of Galen's works that later generations established the doctrine of the six non-natural things. Sanctorius's statements illustrate how Galen's thoughts on the matter, scattered throughout various works, were collected, interpreted, and further developed. Although Galen's apparently imprecise and unsystematic treatment of these concepts gave rise to discussion—for example, as in the different listings (fourfold and sixfold) and their respective functions in pathology and therapy—the doctrine of the six non-naturals remained intact for centuries and was dealt with under both headings, pathology and therapy. And, as mentioned above, Morgagni held the exact same lecture on the subject as Sanctorius one hundred years before him (García-Ballester 2002: 105, 115; Rather 1968: 341).[10]

The relevance of the doctrine of the six non-naturals for Sanctorius is evident from his decision to structure the results of his weighing procedures around it. In doing so he wittingly or unwittingly tied in with the literary genre of *Regimina sanitatis*—a medieval tradition of rules of health, which followed the organizational criterion of the six non-natural things. In what way the *De statica medicina* resembles these writings on hygiene will be outlined in Sect. 4.1.2. Here, it is important to note that even though Sanctorius's use of the six non-naturals as a structural element in his work was not unique, the fact that he considered this of all concepts suitable for the presentation of his new quantitative findings is of interest. What is more, the six non-naturals may even have played a crucial part in the preparation and conduct of his weighing procedures. Hence, this is a striking example of the way in which Sanctorius integrated innovative ideas into the traditional framework of Galenic medicine. To understand how Sanctorius organized his static medicine around the doctrine of the six non-naturals and what this implies, one has to dig deeper and scrutinize the contents of the doctrine. Therefore, the next sections analyze the effect of the six non-natural things on the body and how they restored health and produced disease.

[10] For more information on the origins and the development of the doctrine of the "six non-natural things," see: García-Ballester 2002, Ottosson 1984: 253–70, Bylebyl 1971, Niebyl 1971, Jarcho 1970, Rather 1968.

3.1.2 The Role of the Non-Naturals in Pathology

In line with the well-known Hippocratic tradition, according to which moderation was praised as a key to good health, every excess in the non-natural things was thought to harm the body. This view was embedded in Galenic humoral theory, which was likewise based on Hippocratic ideas. Here, it is important to remind ourselves that Galen's views of Hippocrates and Hippocratic medicine were very influential in the Renaissance. Scholars trusted that he followed the teachings of Hippocrates accurately, that he understood the works of the Corpus, and knew which were authentic and which were not. Hence, whenever Sanctorius referred to Hippocrates or the Hippocratic teachings, it can be assumed that he was guided by Galenism. This is not to say that he did not have the Hippocratic Corpus at hand, but rather that he read these works through Galenic lenses. Thus, for example, although Galen attributed the four humors theory to Hippocrates, it is clear to us today that this famous theory was expounded in fact by Polybos, a student of Hippocrates (Sanctorius 1612b: 37 f.; Smith 1979: 13; Jouanna 1996: 38 f.).

In fact, the idea that human bodies contain fluids which affect their physiology and their state of health can be found in various Hippocratic treatises; yet these diverged regarding the number of humors contained in the body. As already indicated, Galen identified the four main kinds of humor, blood, phlegm, yellow bile, and black bile, as the Hippocratic humors. Ever since, the four humors theory has been the standard form of humoral theory. The various schemes included in this theory and addressed in the following paragraphs were shared by different physicians and medical schools, and are to be found not only in the Hippocratic Corpus. Thus, the humoral theory that Galen presented was rather eclectic and it is very difficult to pinpoint Galen's particular contributions. Galen himself specifically identified Hippocrates, Plato (ca. 429–347 BCE), and Aristotle (384–322 BCE) as his precursors in adopting this concept (Temkin 1973: 18 ff.; Siraisi 1990: 104 f.; Galen & Johnston 2016: xxviii). But I will not dwell on these issues any further here. In the following, some basic features of the theory will be outlined, also in the context of Sanctorius's understanding and adoption of it. The origins of certain ideas will be touched on only where Sanctorius's statements demand this clarification.

According to Galenic humoral theory, the four humors were each related to a vital organ: blood to the heart, phlegm to the brain, yellow bile to the liver, and black bile to the spleen. The humors were also linked to the primary qualities of hot, cold, moist, and dry, which in turn characterized the four elements of the macrocosm: fire, air, water, and earth (Fig. 3.2). Health was thought to consist of a balanced mixture of the four humors (*eucrasia*), whereas an imbalance of the humors (*dyscrasia*), caused for example by an excess or deficit of one or more of the humors, was thought to be the direct cause of all disease. The qualities of the humors influenced the nature of the diseases they caused. Hence, balance and moderation were crucial to maintaining health. The non-naturals could change the balance of the

Fig. 3.2 Diagram of Galenic humoral theory: elements, humors, qualities, temperaments, seasons, ages, winds, and organs. Diagram made with resources from Freepik.com, designed by macrovector/Freepik

primary qualities and thus influence the character of the humors and the state of the humoral balance (Rather 1968: 339; Temkin 1973: 17 f., 103; Gourevitch 1996: 141).

Therefore, it was important that they were used in moderation, which means in due quantity and quality, as Sanctorius further specified. Referring to Galen, he explained that food was healthy for those who fasted, or whose body had just evacuated, whereas it was unhealthy for replete bodies. In the same way, moderate exercise was beneficial, but became harmful if done to excess (Sanctorius 1612b: 49). With regard to quality, Sanctorius wrote in the *De statica medicina*:

> Cold air and cold baths heat up robust bodies and render them lighter by removing [whatever is] superfluous. They cool weak bodies and render them heavier by prevailing over their heat (Sanctorius 1614: 20r).[11]

Hence, cold air and cold baths could have both wholesome and harmful effects, depending on the physical constitution, i.e., on the bodies' individual balance of the primary qualities. In Galenic medicine, this balance was called complexion (*complexio*), or temperament, and was believed to result from the mixture of the elements in the human body.[12] Every individual had their own innate complexion, acquired at the moment of conception and persisting throughout life. Accordingly, some people were hotter than others, and this characterization would apply to them their whole life long. Moreover, there was a second type of complexion, which Sanctorius called adventitious constitution. According to Sanctorius, this complexion could be attained by using the six non-natural things and was the one that physicians should use to assess every affection of the body. While the innate constitution could hardly be changed, the adventitious constitution was permanently influenced by the use of the six non-naturals and the habits associated with them. A body with a healthy innate complexion could still be affected by a disease that was introduced through an error committed in the six non-naturals. Hence, the adventitious constitution represented a person's current state of health (Sanctorius 1603: Book IV, esp. 81v, 82r, 97r; 1612a: 117 f.).

The well-balanced complexion, which is to say, a good mix of the four humors, was vital for good health. If the complexion was out of balance, meaning that it was too hot, cold, moist, or dry, weakness occurred. But the boundaries between a "balanced" and an "imbalanced" complexion were vague; no absolute measure of the healthy complexion existed. Instead, there was a spectrum of health, ranging from the ideal condition to that where the functions of the body were disturbed such that one could definitely speak of disease. In between there was thought to be a neutral state (Temkin 1973: 18; Grendler 2002: 315).

Sanctorius's statement shows how the non-natural pair, air and water, had a different influence on a body with a strong and very healthy complexion than on a body with a weaker complexion that was further removed from the ideal constitution.[13] In his *Commentary on Galen*, Sanctorius explained that, according to Galen, those who knew best how much (*quantum*) and in what way (*quomodo*) the six

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[11] "Aer frigidus, & lavacra frigida corpora robusta calefaciunt, eaque; auferendo superfluum reddunt leviora. Debilia refrigerant, eaque; vincendo calorem ponderosiora efficiunt." See: Sanctorius 1614: 20r.

[12] Danielle Jacquart introduced a distinction between *complexio* (complexion), connected with the doctrine of qualities, and *temperamentum* (temperament), based on humoral theory (Jacquart 1984, see also García-Ballester 1992: 129, n. 19). For the sake of simplicity, I use these terms interchangeably in the present work.

[13] Sanctorius added water to the first category, "air," of the traditional list of the six non-naturals. In this, he may have been inspired by the *Isagoge Johannitii*, a standard introductory textbook at medical university faculties, where the list of the non-naturals included as special categories also "coitus" and "bath" (Ottosson 1984: 254). For more information on the *Isagoge Johannitii*, see: Temkin 1973: 104–8.

non-natural things heated, cooled, moistened, and dried the body, knew how to preserve the health of bodies that were out of balance as well as how to return them to a better condition. Hence, the correct quantitative and/or qualitative management of each of the six non-natural things was virtually a guarantee of maintaining a suitable standard of health. Conversely, incorrect management of these factors—quantitative and/or qualitative, here too—led to a pathological state. In this context, Galenic physiology distinguished the non-natural things from the natural things (for example, humors, complexions, or members) as well as from the contra-natural (*praeternatural*) things, which were pathological conditions of all kinds (Sanctorius 1612b: 19, 111).[14]

Sanctorius, still expounding Galen's teachings in the *Ars medica*, pointed out that bodies with an optimal complexion could autonomously prescribe themselves the proper quantity and quality of all the non-natural things as well as their proper timing.[15] Thus, they needed neither a supervisor nor doctor to monitor the management of the six non-naturals, per Sanctorius, as they were able to do this perfectly well on their own. But this optimal complexion was an ideal that could only be approximated and probably never reached. As a result, all people needed support in managing their health, i.e., in regulating their lifestyle in line with the concept of the non-naturals (Sanctorius 1612b: 79; Siraisi 1990: 101–23; García-Ballester 2002: 105).

3.1.3 The Role of the Non-Naturals in Therapy

According to Galenic medicine, therapeutics were divided into surgery, drug lore, and dietetics.[16] While the non-naturals were rather insignificant for surgery, they were all the more important for drug lore and dietetics. It is the latter category that I will focus on first. In his *Commentary on Hippocrates*, Sanctorius pointed to the double meaning of the word "diet" (*victus* or *diaeta*) in the works of Hippocrates and Galen. On the one hand, diet was understood in the context of dietetics and included the six non-naturals. On the other hand, diet simply meant food (Sanctorius 1629a: 100).[17] The first meaning reflects the integration of nutrition into a broader

[14] This division can be traced back to Galen's work *De pulsibus ad tirones*, in which Galen used the expression "non-natural" as an intermediate category between "natural" causes and *praeternatural* causes that change the pulse. See: Galen. 1997b: 462–73, Sanctorius 1612b: 19, García-Ballester 2002: 106 f.

[15] Time appears here as a third category, alongside quantity and quality. Sanctorius explained that this third category had been introduced by Galen only for teaching purposes, to simplify his doctrine. In fact, so Sanctorius, the opportune time was necessarily integral to the other two factors, quantity and quality, because only if these coincided with the opportune time (i.e., if their timing was right) could they be said to occur in an appropriate way (Sanctorius 1612b: 51 f.).

[16] Sanctorius mentioned this tripartition in his *Commentary on Avicenna*, see: Sanctorius 1625: 4.

[17] See also Sanctorius 1629a: 389.

concept of a healthy lifestyle that included, among other things, the influence of environmental factors, like climate and weather (represented by the first non-natural pair, air and water). The six non-naturals provided Hippocratic dietetics with a doctrinal framework that guided patient and doctor in their pursuit of a healthy regimen. Moreover, the concept integrated these aspects of Hippocratic medicine into Galenic complexional theory as a system of explanation providing the rational link between disease and therapy. Thus, besides the treatment of disease, the preservation of health through a preventive health regime was the main task of the physician.

The physician had to tailor the use of the non-naturals to every individual patient so as to maintain him or her with the optimum complexion. He needed to identify how much and what kind of food, exercise, sleep, etc. was beneficial or harmful to the respective person and would accordingly have a positive or negative effect on the qualities of his or her complexion. Contrariwise, the effect of the non-naturals revealed to the physician the complexion of his patient. Identifying the general complexion was particularly complex because each organ of the human body was considered to have its own complexion. Adding to the complexity, bodily parts each had their own predominant complexional quality. Hence, the heart was hotter than the brain, the brain was colder than the heart, and so on. Medical textbooks helped the physician not lose track by providing long lists of body organs and their predominant qualities. Moreover, some general rules could be applied to different groups of people. Young people were thought to have a warm and moist complexion that, over time, gradually turned into a cold and dry complexion in old age. Women were thought to be colder than men and complexion varied also among geographical regions (Sanctorius 1612a: 107, 531; 1625: 382–6; 1629a: 293 f.).

If the physician detected a complexional imbalance, i.e., ill-health, he tried to restore the balance by changes in the six non-naturals according to the theory of cure by contraries. A body that was too hot had to be cooled down. A body that was too dry had to be moistened. With regard to the non-natural pair of exercise and rest, Sanctorius wrote:

> If whoever lies in bed for a long time suffers from pain in the feet, walking will cure them: if those who travel suffer, the remedy is rest (Sanctorius 1614: 63v–64r).[18]

The principle that every cure is effected by contraries and every conservation by similarities was fundamental to Galenic medicine (e.g., Sanctorius 1612a: 606). However, the physician had to be careful when changing the lifestyle of his patient. Sanctorius, referring to Hippocrates, explained that a faulty but habitual regimen was less harmful to one's health than a suddenly switch to a better regimen. A body had to be slowly accustomed to changes in the non-natural things, as for example to more or less exercise, warm or cold food, longer or shorter sleep, and so on (Sanctorius 1629a: 413).

As reflected in the double meaning of the word "diet" that was addressed at the beginning of this section, the third non-natural thing, food and drink, was a special

[18] "Si diu iacenti dolores pedum superveniant, remedio est ambulatio: si iter facienti, quies." See: Sanctorius 1614: 63v–64r.

category and one often considered individually. It is closely connected to the second form of therapy of interest here, namely drug lore. Sanctorius wrote:

> Or the name diet is used in its meaning of food, just as Hippocrates does in this place. In his commentary, Galen divides this food according to its differences, without a distinct knowledge of which sick people, suffering from an acute disease, cannot be managed and healed (Sanctorius 1629a: 100).[19]

Thus, foodstuffs were used to heal diseases, just as drugs were. Both were *complexionate*, meaning that they were characterized by the same qualities (hot, cold, wet, dry) as the four humors of the body. Moreover, drugs were closely related to food by their mode of administration, i.e., ingestion. In this way, the actions of drugs and food were integrated into the Galenic theory of digestion, affecting the complexion of the person who ingested them. Spices and various vegetables were sometimes counted as food, sometimes as drugs. In the *Commentary on Avicenna*, Sanctorius explained that food (*alimentum*) could be either considered in the strict sense, according to which it nourished the body by increasing its substance, or with regard to its ability to change the body; and in this latter sense, it qualified not as food, but as a drug. The close connection between food and drugs is further emphasized by the fact that Galen put both into the same category in his quadruple classification of the non-naturals in his work *Thrasybulus*. Yet there were differences too. The decisive criterion was the direction of their action. As suggested by Sanctorius in the aforementioned statement, while the body acted upon foodstuffs by digesting, i.e., assimilating them, drugs acted upon the body, and their respective impact indicated their place on the broad spectrum from food-like drugs to detrimental poisons. Dietetic treatment, conceptualized in the doctrine of the six non-naturals, mainly sought to preserve health. Drugs, on the contrary, were used to counteract the noxious impact of an illness (Sanctorius 1612b: 42; 1625: 63; Siraisi 1990: 100–23; Touwaide 1996: 289 f.; Vogt 2008: 304, 306 f.; Galen and Johnston 2018b: 295).

With this overview of the role of the non-naturals in Galenic pathology and therapy at hand, one can more readily tackle Sanctorius's special use of the doctrine of the non-naturals, namely the shift in focus to the *perspiratio insensibilis*. By means of his weighing chair, Sanctorius claimed to be able to measure this physiological process and to argue, on a quantitative basis, for its central role in health and disease. His new findings made him reconsider the doctrine of the six non-naturals and readjust the rules for a healthy lifestyle. Innovative ideas thereby met long-established concepts and instead of displacing each other, they intermingled and started evolving into something new: static medicine. To understand this process, a closer look into the development and content of the concept of *perspiratio insensibilis* is necessary. The theoretical backdrop against which Sanctorius developed his concept of *perspiratio insensibilis* and the way he presents it in his works have to be analyzed.

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[19] "Vel sumitur nomen diaetae, pro ut significat cibum, sicuti in hoc loco sumitur ab Hippocrate quem cibum Galenus in comm. Dividit in suas differentias, sine quarum distincta cognitione aegri acuto morbo laborantes regi, & sanari non possunt." See: Sanctorius 1629a: 100.

3.2 The Concept of *perspiratio insensibilis*

According to Sanctorius, the constant supervision of bodily discharges was essential for the preservation of health. In keeping with Galenic humoral theory, he conceived of health as an ideal balance between ingestion and excretion, meaning that the quantity of substances consumed by the organism should be proportionate to the amount of substances rejected by it. In Galenic medicine, this equilibrium was thought to be an expression of the balance of the humors. The measurements Sanctorius is said to have conducted with the weighing chair demonstrated that a large part of excretion takes place invisibly through the skin and lungs. He wrote: "Insensible perspiration alone is usually much more abundant than all sensible evacuations taken together" (Sanctorius 1614: 2r).[20] Thus, in Sanctorius's view, the monitoring of the *perspiratio insensibilis* by means of systematic weighing was fundamental to the preservation of health; a very strong claim indeed.

3.2.1 Early Ideas on perspiratio insensibilis

The conception of an insensible perspiration of the body—*perspiratio insensibilis*—dates back to ancient times. Mystical and religious beliefs have always linked the life principle to air, breath, and breathing. Here may lie the origin of the early conviction that not only the lungs but the whole body breathed in and out. Hence, expressions related to the Latin term *respiratio* (breathing), such as *transpiratio*, *exhalatio,* or *perspiratio,* were used for this activity of the body. And, perhaps to emphasize its invisible nature, it was sometimes referred to as *insensibilis (occulta) transpiratio*, *exhalatio*, or *perspiratio*.[21]

In the Hippocratic writings, numerous references to an imperceptible, vaporous excretion of the body attest that Hippocrates and his followers had knowledge of this phenomenon. The following passage is taken from the treatise *De alimento* (Nutriment):

> Porosity of a body for transpiration is healthy for those from whom more is taken; denseness of body for transpiration is unhealthy for those from whom less is taken. Those who transpire freely are weaker, healthier, and recover easily; those who transpire hardly are stronger before they are sick, but on falling sick they make difficult recovery (Hippocrates and Jones 1923: 353).

From citations and references in the Galenic corpus, it is known that in the third century BCE, ideas of *perspiratio insensibilis* also existed in the Alexandrian medical school. Erasistratus demonstrated material losses by weighing fowls and their food and excreta, and explained them by the existence of an insensible perspiration

[20] "Perspiratio insensibilis sola solet esse longe plenior, quam omnes sensibiles simul unitae." See: Sanctorius 1614: 2r.

[21] The focus in this section is on Latin terminology, as this is the language Sanctorius wrote in.

in animals. Further ideas on the matter were expressed by Theophrastus (ca. 370–ca. 297 BCE), Aristotle, and Aretaeus of Cappadocia (second century CE), to name but a few. Galen finally systematized the scattered notions and integrated them into his physiology. But it was not until more than a millennium later that the concept of *perspiratio insensibilis* gained considerable attention (Renbourn 1960: 135–39).[22]

3.2.2 *Sources of Sanctorius's Concept of* perspiratio insensibilis

In a letter Sanctorius sent together with a copy of his *De statica medicina* to Galileo Galilei, he explained that his work was based on two principles: first, Hippocrates's view that medicine is essentially the addition of what is lacking and the removal of what is superfluous; and second, experience (Sanctorius 1902).[23] In contrast to most studies on Sanctorius, I focus in the following first on the medical tradition to which Sanctorius referred, an aspect that has hitherto been analyzed only marginally; and in a later chapter treat the second principle, experience, which has already gained the attention of many scholars (Sect. 7.5).

In the first aphorism of the *De statica medicina*, Sanctorius wrote:

> If there is daily an addition of what is wanting and a removal of what abounds, in the required quantity and quality, lost health will be restored and the present [health] always preserved (Sanctorius 1614: 1r).[24]

Sanctorius further explained in the letter to Galileo:

> That this art, by me invented, should be important is clear, because I am able accurately to measure insensible transpiration, which if altered or impeded, according to the opinion of Hippocrates and Galen, is the origin of nearly all ills; …. That this art is alluded to by Galen is clear in many places, and especially in the sixth [book] of *De tuenda sanitate* cap. 6, where may be read these words: *Whenever those things dispersed in vapor from the body*

[22] For more information on ancient concepts of *perspiratio insensibilis*, especially on Galen's, see: Debru 1996: 178–210. I thank Caroline Petit for drawing my attention to this work. A comprehensive historical study on the medical concept of *perspiratio insensibilis* still remains to be written. For a short historical survey of the topic, see: Renbourn 1959 and Renbourn 1960. Weyrich 1862 prefaced his physiological study on insensible perspiration with a historical overview that contains a more detailed analysis of the concept in Galen's works and in Sanctorius's *De statica medicina*. The most recent study is Stolberg 2012, which focuses on early modern meanings of sweating and transpiration and the theories and practices surrounding them.

[23] "L'opera è ridotta in afforismi, i quali nascono da due principii certissimi. Il primo è la diffinition della medicina, proposta da Hippocrate nel libro *De flatibus*, dove dice: *Medicina est additio et ablatio: additio eorum quae deficiunt, et ablatio eorum quae excedunt* …. Il secondo principio di quest'arte è l'esperienza …." See: Sanctorius 1902. For a transcription, see: Sanctorius and Ongaro 2001: 34–8 and for an English translation, see: Castiglioni 1931: 773 f.

[24] "Si quanta, & qualis oporteat, quotidie fieret additio eorum quae deficiunt, & ablatio eorum quae excedunt, sanitas amissa recuperaretur, & praesens semper conservaretur." See: Sanctorius 1614: 1r.

> *are less than those things taken in, the plethoric diseases arise. What must be preserved, then, is the balance between foods and drinks, on the one hand, and those things evacuated, on the other. There will be balance when we give consideration to the quantities in each* (Sanctorius 1902).[25]

Thus, without any doubt, Sanctorius learned from the teachings of Hippocrates and Galen about the *perspiratio insensibilis* and its effects on health and disease. However, in the preface to the *De statica medicina*, he also pointed out the novelty of his work: the exact weighing of insensible perspiration (Sanctorius 1614: Ad lectorem).[26] The sheer volume of fluid that the body excreted insensibly everyday showed the outstanding importance of insensible perspiration and made Sanctorius claim that it needed particular attention and care. Outshone by the quantitative method, Sanctorius's clearly articulated adherence to the Galenic conception of *perspiratio insensibilis* took a back seat in the reception of the *De statica medicina*. If mentioned at all, it was usually subject to criticism.[27] Contrary to this, I think it is crucial to include exactly these aspects that are often dismissed as old-fashioned Galenism in the analysis of Sanctorius's works, in order to understand their content and the scientific legacy of Sanctorius. This is the aim of the following sections.

3.2.3 Sanctorius's Conception of perspiratio insensibilis

To the *perspiratio insensibilis* Sanctorius gave different synonymous expressions: *perspirabile*, *perspirabilis* (matter of perspiration), *perspirantia*, *perspiratio insensibilis* or *transpiratio insensibilis*, *halitus invisibilis*, *insensibilia excrementa* or *insensibilis excretio*, *evacuatio insensibilis*, *exhalatio*, *difflatio*, *occulta perspiratio*, or simply *perspiratio* and *transpiratio*.[28] The variability in nomenclature makes it difficult to grasp Sanctorius's understanding of insensible perspiration. Are the

[25] "Che quest'arte, da me inventata, veramente sii importantissima, è cosa chiara, perchè può distintamente mesurar l'insensibile transpiratione, che, alterata o impedita, secondo l'opinion d'Hippocrate et Galeno, è origine quasi de tutti i mali; … Che quest'arte sii accennata da Galeno, è cosa chiara in molti luoghi, et spetialmente nel sesto *De tuenda sanitate*, cap. 6°, dove si leggono queste parole: *Ubi quod ex corpore exhalat minus est iis quae accepit, redundantiae oriri morbi solent; ergo prospiciendum est, ut eorum quae eduntur ac bibuntur, respectu eorum quae expelluntur, conveniens mediocritas servetur. Sane is modus servabitur, si ponderabitur a nobis in utrisque quantitas.*" See: Sanctorius 1902. For a transcription, see: Sanctorius and Ongaro 2001: 34–8 and for the English translation, see: Castiglioni 1931: 773 f. For the English translation of the passage quoted here by Sanctorius from Galen's *Hygiene*, see: Galen and Johnston 2018b: 153. Original emphasis.

[26] "Novum atque inauditum est in medicina posse quēpiā ad exactam perspirationis insensibilis ponderationem pervenire …" See: Sanctorius 1614: Ad lectorem.

[27] An important exception is Paolo Farina's paper on the influence of Sanctorius on his disciple Henricus Regius (1598–1679), in which the author repeatedly points out Sanctorius's strong adherence to Galenic medicine (Farina 1975).

[28] This is not a comprehensive list and I still find some other variations in Sanctorius's works.

different expressions interchangeable? Or are they connected to different aspects of insensible perspiration? When Sanctorius omitted adjectives like *insensibilis*, *invisibilis* etc., he often still referred to *insensible* perspiration. However, the exact meaning has to be deduced from the context. This can be said also with regard to the interchangeability of the different expressions. Generally, Sanctorius used them synonymously, but caution is still needed, as there are always exceptions to the rule. When he wrote, for example, of *meatus insensibilis*, he referred to the insensible channels or pathways in the body through which humors, vapors, and insensible perspiration passed (e.g., Sanctorius 1629a: 82, 472). However, *meatus* can also be translated with "a going" and therefore describe perspiration itself.

3.2.4 The Dual Origin of perspiratio insensibilis

In the beginning of the first section of the *De statica medicina,* Sanctorius explained the dual origin of insensible perspiration:

> Insensible perspiration either occurs through the pores of the body, which is completely transpirable and covered by the skin like a net; or it occurs by means of respiration that is made through the mouth, which usually amounts to about half a pound during one day; the drops on a mirror placed in front of the mouth actually indicate this (Sanctorius 1614: 2r).[29]

Thus, according to Sanctorius, insensible perspiration was generated either through the pores of the skin, or through the mouth. In the quoted aphorism, he even noted the quantity of daily respiration. This suggests that he differentiated between the two different forms of *perspiratio insensibilis* in his weighing experiments.[30] However, when explaining the difference between sensible and insensible evacuations in his *Commentary on Avicenna*, Sanctorius wrote quite plainly: "… but it is insensibly [evacuated] through the pores of the skin" (Sanctorius 1625: 60). Hence, from a conceptual point of view, Sanctorius seems here to be somewhat inconsistent. What this implies for his measurements will be explored in a later chapter (Sect. 7.5.5).

The dual origin of *perspiratio insensibilis* mentioned by Sanctorius hints at the Galenic conception that insensible perspiration resulted from the respiratory and digestive activities of the body. These were the physiological processes responsible for ingestion and excretion and therefore crucial to keep the balance between the substances ingested by the body and those excreted by it (Weyrich 1862: 5). As the precondition of health was, above all, a proper and regular evacuation of the

[29] "Perspiratio insensibilis vel fit per poros corporis, quod est totum transpirabile, & cutem tanquam nassam circumpositam habet, vel fit per respirationem per os factam, quae unica die ad selibram circiter ascendere solet; hoc enim indicant guttae in speculo, si ori apponatur." See: Sanctorius 1614: 2r. The measurements used by Sanctorius will be discussed in Sect. 5.4.2, fn. 39.

[30] The method Sanctorius used to measure respiration as distinct from insensible perspiration of the skin is far from clear and will be analyzed in Sect. 7.5.5.

consumed material, it is worth considering the processes of digestion and respiration in more detail.

3.2.5 Digestion

In line with Hippocratic ideas, digestion was understood as a cooking by means of heat and subsequent refinement, for use by the body. Hence, the Latin terms *coctio* (coction) or *concoctio* (concoction) and the verb *concoquere* (to concoct) were used to describe this process.[31] Fundamental to this concept was the idea that every living being is the product of heat and moisture. In this context, the human body was often compared to an oil lamp—a metaphor that Sanctorius employed as well. At birth, every living being acquired a certain amount of radical moisture, corresponding to the oil in a lamp. Throughout life this moisture was consumed by an inborn, or innate heat (*calor nativus*), just as is the oil in a burning lamp. With age, the radical moisture and innate heat decreased and the body naturally became colder and drier. Food was needed in order to maintain the heat by replenishing the substance of the body that had been consumed. During digestion, food was transformed into the body, becoming flesh itself (e.g., Sanctorius 1612a: 313, 348, 610; 1625: 351, 357; 1629a: 290).

However, there were always elements that withstood incorporation. Hence, on the one hand, food contained the nutriments needed to replace the natural deterioration of the body. But on the other hand, it also contained superfluities, which could harm or destroy the body. The evacuations helped the body to get rid of the superfluities and waste and to keep the blood pure. Sanctorius explained in the *Commentary on Galen* that digestion fulfilled three purposes: to transform or convert nutritive food into body substance, to separate useful material from useless material, and to expel those excrements which were useless. The digestive process, Sanctorius continued, took place in three steps while each step produced different excreta. After chewing, the food entered the stomach, where it was concocted by means of heat. This first step was crucial, as a bad concoction could never be corrected later. What was more, the digestive process could only continue after the food was fully concocted. In the process, food was transformed into *chyle* and solid waste was produced and expelled in the form of stools.[32] Then, the *chyle* was directed to the liver,

[31] Sanctorius differentiated between "digestion" and "concoction." While the former described the transmission of nutrition from the stomach to the liver, to the guts, or to the skin and then into the ambient air, the latter referred to the transmutation of substance, of food into *chyle* and *chyle* into blood (Sanctorius 1612a: 611, Sanctorius 1629a: 305, 312). As Ken Albala has argued, this distinction was common in Renaissance nutritional theory, even though Roman authors used the term "digestion" in its broader sense, applying it to the whole process (Albala 2002: 54). Sanctorius, however, did not consistently make the distinction and sometimes referred to the whole digestive process as *coctio* or *concoction* (see e.g., Sanctorius 1612b: 84, Sanctorius 1625: 589 f.).

[32] *Chylus* from the Greek *chylos* was the synonym for the masticated food turned into a fluid state. See: Orland 2012: 465.

where in the second stage of digestion it was converted into blood. The residual matter was excreted via the urinary tract. The final step in the digestive process took place in the organs and at the bodily periphery, and its excreta were insensible perspiration and filth (*sordes*), or sweat. The blood, generated in the liver, was now distributed throughout the body via the venous system. At this stage the blood was, however, impure, still containing in it the other unrefined humors. As Sanctorius explained in the *De remediorum inventione*, it was refined in three organs close to the liver: the gallbladder, the kidneys, and the spleen. Accordingly, the spleen, for example, generated in, or purged from, the blood, melancholy, i.e., black bile. Apart from entering the organs, the blood could also make its way from the liver to other parts of the body, including the heart. It was in the former that assimilation took place and the nutrients were converted into flesh (Sanctorius 1612b: 70, 84; 1625: 465, 589; 1629a: 276; 1629b: 45 f.; Albala 2002: 17–64; Kuriyama 2008: 430; Stolberg 2012: 505).

3.2.6 Respiration

In addition to food, the body continuously takes in air. In line with the teachings of Galen, the main functions of breathing were, so Sanctorius, to cool the heart, to nourish the vital spirits, and to cleanse the body from smoky vapors. During inspiration, air was drawn from the lungs into the left ventricle, where vital spirits were generated.[33] This happened simultaneously to the diastole of the heart and the distension of the arteries. During the formation of the vital spirits, smoky vapors were produced. Throughout systole, i.e., the compression of the arteries, which coincided in Galenic medicine with expiration, the smoky vapors were expelled. Spirit (*spiritus*, the Greek *pneuma*) was thought to be an exhalation (*halitus*) itself, a very fine vapor essential for maintaining life. The vital spirits were carried by the blood through the arterial system and reached via the carotid arteries the *retiform plexus*, a network of fine arteries at the base of the brain. Here, they were prepared to become animal spirits, which were finally generated in the ventricles of the brain from the vital spirits, from inhaled air, and from the surrounding substance of the brain.[34] According to the Galenic teachings, the brain itself was able to "breath" and

[33] Rudolph E. Siegel argued that according to Galen, air as a substance could not be absorbed by the body. Thus, only an invisible quality of heat, which Galen considered to be the predominant component of air, was absorbed from the inhaled air (Siegel 1968: 151, 155, 158). Julius Rocca did not refer to an invisible quality of heat, but explained that, in the opinion of Galen, inspired air was altered in the lungs into a "pneuma-like" substance (Rocca 2012: 637). Sanctorius simply explained that the vital spirit was created in the left ventricle by the inhaled air and the pure blood of the right ventricle (Sanctorius 1625: 367).

[34] In the sixteenth century, the existence of the retiform plexus (*rete mirabile*) was challenged, because anatomists could not observe it in the human brain. However, as Andrew Wear has argued, the existence of the animal spirits that were produced in the retiform plexus according to the Galenic teachings was not denied. Wear also analyzed Sanctorius's thoughts on the issue, who had

thus the anterior ventricles of the brain performed the actions of inspiration and expiration. During inspiration, the brain attracted the outside air, necessary for the generation of animal spirits. In the process, smoky vapors were produced and expelled by the diastole, i.e., the expiration of the brain, just as happened in the heart, when vital spirits were generated. Sanctorius described that the air, necessary for the formation of the animal spirits, was inhaled by the brain through the mamillary processes (*processus mamillares*). Accordingly, he stated that the smoky vapors, produced during the formation of the animal spirits, were expelled by means of the mamillary processes. Different from today's meaning of mamillary process, Sanctorius understood by *processus mamillares* the olfactory tracts located directly above the ethmoid bone. Thus, air was drawn into the brain via the nasal passages and the residual vapors were expelled the same way through the nose (Sanctorius 1612a: 258, 261, 356, 443, 447 f.; 1612b: 58; 1625: 209 f., 319 f., 367; 1629a: 362).[35]

The generation of the spirits was thought to be analogous to the notion of the concoction of nutriment. It therefore was connected to the concept of combustion, which explains the formation of *smoky* vapors as residual matter of the processes of the formation of the two spirits.[36] The animal spirits resided in the ventricles of the brain and spread through the nerves and the spine. They provoked sensation and voluntary motion, whereas the vital spirits served to nourish the animal spirits and to heat the body (Sanctorius 1612a: 422; 1625: 298, 319 f.; 1629a: 362; Rocca 2003: 65, 211–27).[37]

Sanctorius did not describe in detail the process of respiration via the skin pores. In the *Methodi vitandorum errorum*, he plainly explained that "the whole body is transpirable," just as he referred in the citation, quoted above (Sect. 3.2.4), to "the body, which is completely transpirable."[38] In the *De statica medicina*, Sanctorius was a little more explicit when stating that the external air passed through the arteries into the body. Thus, here again, Sanctorius seems to be true to the teachings of Galen, according to which, during diastole, the arteries attracted some air from the

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stated that the retiform plexus was conspicuous. See: Wear 1981: 233–7; 251 ff. and Sanctorius 1612a: 260, Sanctorius 1629a: 363 as well as Sect. 4.2.1. Julius Rocca pointed to the controversy and confusion that the doctrine of the retiform plexus caused for later physicians and gave a survey of some of these later Galenic accounts. See: Rocca 2003: appendix two.

[35] Sanctorius's anatomical knowledge and experience will be treated later in Sect. 4.2.1.

[36] In his commentaries, Sanctorius denied the existence of a third *natural* spirit (Sanctorius 1612a: 257–61, Sanctorius 1625: 51, Sanctorius 1629a: 360–5). This is exceptional, as Galenic pneumatology was usually interpreted as a tripartite system and much of the secondary literature follows this assumption. In fact, Owsei Temkin, Rudolph E. Siegel and Julius Rocca have shown that there is no reason to postulate the existence of a natural spirit in Galen's physiology (Temkin 1951, Siegel 1968: 186, Rocca 2012).

[37] According to Sanctorius, it was not the animal spirits themselves which provided sensation and voluntary motion, but an incorporeal radiation emanated by them. Similarly, he thought that incorporeal radiation of the vital spirits produced the faculties responsible for the systole and diastole in the arteries. See: Sanctorius 1612a: 255 ff.; 424 ff., Sanctorius 1625: 93 f., 298, 650 f., 749 ff., Sanctorius 1629a: 364 f.

[38] "totum enim corpus est transpirabile …." See: Sanctorius 1603: 31r.

outside through the pores of the skin, in a manner similar to the thoracic movements which caused air to enter the blood through the pores of the terminal bronchial tubes. Throughout systole, residual vapors, like the smoky vapors produced during the formation of the two spirits, were expelled not only into the lungs, but also through the skin pores (Sanctorius 1612a: 257; 1614: 20v; Renbourn 1960: 136; Siegel 1968: 103).

In this light, Sanctorius's comparison of the skin to a net (Sect. 3.2.4) is instructive, as it provides some insight into his understanding of skin. The analogy might reflect the influence of the Italian physician Girolamo Mercuriale, who, drawing on Plato's *Timaeus*, defined the skin as a fisherman's net (*nassulae piscatoriae*). Just as a net, he thought, the skin was a common bond holding together the separate body parts. According to Mercuriale, the only function of the skin was to receive waste materials. Sanctorius's reference to the analogy of a net implies that he shared Mercuriale's conception of the skin as an inherently porous layer of interchange between body and environment (Te Hennepe 2012: 526). This is further reinforced by the fact that Sanctorius organized the *De statica medicina* according to the six non-naturals, which, as was already shown, included also environmental and meteorological aspects that served Sanctorius to examine how the skin and its excretion of *perspiratio insensibilis* were affected, for example, by the climate in which a person lived and the weighing took place.

To put it in a nutshell, according to Sanctorius, insensible perspiration resulted from the respiratory and digestive activities of the body. It expelled the residual matter of both, respiration and digestion, thereby cleansing the body of superfluous matter. The distinction between the two different forms of *perspiratio insensibilis*, through the mouth and through the pores of the skin, will be of interest again in a later chapter, when it comes to the question of how to quantify them (Sect. 7.5).[39]

3.2.7 Perspiratio insensibilis *and Sweat*

Besides the two origins of insensible perspiration (the skin and the mouth), Sanctorius referred to two different kinds of *transpiratio insensibilis*. One was generated during sleep, when the body concocted, and it increased strength. The other was generated while awake and arose from a crude (unconcocted) humor through violent motion, which was why it decreased strength. This illustrates the close connection between insensible perspiration and digestion.[40] For Sanctorius, the

[39] In her analysis of Galen's concept of perspiration, Armelle Debru differentiated between *perspiratio insensibilis* and cutaneous respiration, the latter of which fulfilled the same functions as oral respiration (Debru 1996: 178–210). I do not follow this distinction here, because Sanctorius did not explicitly refer to cutaneous respiration. Therefore, I subsume any perspiration that occurs via the skin under *perspiratio insensibilis*.

[40] In the context of sleep, Sanctorius pointed to the difference between digestion and concoction in several passages in his works (see also Sect. 3.2.5, fn. 31). He explained that concoction, per

differentiation between insensible perspiration during sleep and during wake was linked to the rest or motion of the body. In the *Commentary on Galen*, he explained that sleep was a type (*species*) of rest, while wake corresponded to movement. While the body rested during sleep, digestion was carried out undisturbed. As soon as a person woke up, movement occurred and, with the movement, violence. The greater the movement, the greater the violence with which digestion took place. It was due to this violence that crude material was expelled from the body (Sanctorius 1612b: 38; 1614: 5r; 51v–52r). Sanctorius wrote:

> That which is evacuated through the pores during violent movement is sweat and occult perspirable matter; but being violent, it is for the most part raised by uncooked juices. For there is seldom collected in the body as much cooked perspirable matter as is evacuated by means of violence (Sanctorius 1614: 61r–61v).[41]

With violent motion, another excretion occurred: sweat. In the works of Galen, the relation between *perspiratio insensibilis* and sweat (*sudor*) is far from clear. Galen sometimes put forward the view that sweat simply came through the skin pores in the form of small drops of liquid. On other occasions, he insisted that sweat arose from the insensible perspiration caused by a thickened skin or through the condensing effect of a cold air. In his commentary on the Hippocratic Aphorisms, Galen referred to the claim of Diocles of Carystos (ca. 375–ca. 300 BCE), that liquid sweat was pathological (*preternatural*), a diagnostic sign of excess fluid in the whole body. Only if it occurred due to violent movement, hot baths, or summer heat was it healthy. In normal circumstances, the innate heat was strong enough to transform the superfluous humors into such fine, subtle parts that they escaped notice. Sweat was produced only under conditions of great external heat, such as body heat increased by violent exertion or fever, or arose from considerable weakness in the expelling force. As Michael Stolberg has pointed out in his article, Galen did not argue against this idea, but he still had his doubts (Stolberg 2012: 506).[42]

According to Sanctorius, sweat always originated from a violent cause and could impede the insensible excretion of concocted perspirable matter (*perspirabilium*). Due to the violence, the three stages of digestion could not be concluded and the body expelled crude, unconcocted matter in the form of insensible perspiration and, above all, sweat. In the *Commentary on Galen*, Sanctorius agreed with Diocles that sweat was always pathological (*praeter naturam*), because it only emerged with

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Galen, occurred during sleep, while digestion occurred during wake (Sanctorius 1612a: 513, Sanctorius 1612b: 39, 76, Sanctorius 1614: 149, Sanctorius 1629a: 305). This implies that during sleep only the transmutation of substances took place, while the transmission of nutrition was carried out only while awake. Following this argument, *perspiratio insensibilis* was expelled only in a waking state. This, however, is contrary to Sanctorius's statement that the body perspired insensibly during sleep twice as much as while awake (Sanctorius 1612b: 40, Sanctorius 1614: 52r).

[41] "Quod in motu violento per poros evacuatur, est sudor & perspirabile occultum: sed ut violentum magna ex parte elevatur ex incoctis succis: raro enim tantum cocti perspirabilis in corpore colligitur, quantum per violentiam evacuatur." See: Sanctorius 1614: 61r–61v.

[42] An overview of ancient notions of sweat has been given by Armelle Debru, who, however, only briefly described Galen's concept of sweat. See: Debru 1996: 187–90.

violence. However, Sanctorius also referred to the beneficial effects of sweat—the evacuation of potentially harmful matter. Especially during the *crisis*, the decisive phase of a disease, a "critical sweat" could free the patient of the morbid matter.[43] Thus, Sanctorius's conception of sweat and sweating was ambivalent, probably reflecting the ambiguity of the issue found in Galen's works (Sanctorius 1612b: 62; 1614: 61v; 1629a: 285).

Insensible perspiration and sweat ultimately originated from the same matter as did urine. The three evacuations only differed in their refinement. Urine was the least refined, whereas insensible perspiration excreted the finest and more volatile parts of serum, which heat had resolved into vapors. The evacuations could also substitute for each other. Sanctorius wrote in the *De statica medicina* that people, who urinated more than they drank, perspired less or not at all. Moreover, abundant perspiration could not occur simultaneously to abundant sensible evacuations (Sanctorius 1614: 3v–4r; Renbourn 1959: 206; 1960: 136; Stolberg 2012: 504–7).

3.2.8 The Composition of perspiratio insensibilis

According to Sanctorius, *perspiratio insensibilis* always consisted of heavier parts and lighter parts. If the heavier parts accumulated, they could give rise to creatures such as bugs and lice, or even to contagious infections. Sanctorius thought that the lighter parts "flew away," whereas the heavier parts stayed and vitiated the body. There was also a connection between the emotions of a person and the two parts of perspiration. In sadness and fear the lighter parts of the perspiration were evacuated, but the heavier parts remained. And correspondingly, the heavier perspirable matter that was excessively retained brought about sadness and fear. Thus, the subtler the perspiration, the healthier it was. Sanctorius also differentiated between thick (*crassus*) and fine (*tenuis*) parts of *perspiratio insensibilis*. They seem, however, to correspond to the heavy and light parts of perspiration (Sanctorius 1614: 6r, 18r, 75r–76r, 79r) (Sect. 3.3.6).

In his article, Michael Stolberg has explained that Galen, and early modern physicians with him, described sweating as an excretion of thin serous humors. This suggests that sweat and insensible perspiration were closely related to the bodily humor serum. Even though I could not find this description in Sanctorius's works, a closer look at the idea might help to understand his concept of the composition of *perspiratio insensibilis*. The meaning of the Latin term *serum* is "whey," the watery residue from making cheese. In early modern medical writing, it was commonly used to describe the thinner, more watery parts of the blood. As Stolberg has pointed out in his article, the pores of the skin were thought to act like the kidneys, as a

[43] The so-called *crisis* was thought to be the turning point of an illness, leading toward recovery or death. It usually took the form of a sudden excretion of "bad humors" like a heavy sweat, vomiting, diarrhea, or the onset of menstruation (Siraisi 1990: 135). Sanctorius dealt with the topic in his *Commentary on Hippocrates*, see: Sanctorius 1629a: 195, 263 f., 438–47.

"sieve" for the serum. Hence, only the very watery, fine parts of the blood passed through the narrow pores, while the coarser parts were retained. However, depending on the width of the pores, the quality of the blood, and the strength of the expelling forces, sweat and insensible perspiration could sometimes also contain larger or thicker parts. This understanding of perspiration as a process of "sieving" the blood and of separating the serum also pointed to the danger of a defective skin function resulting in the accumulation of heavier, thicker material that could pollute the body. These residues could lead to the obstruction of the pores or invisible channels through which humors, vapors, and insensible perspiration passed (Stolberg 2012: 504–8).

3.2.9 Perspiratio impedita

Since antiquity, hindered or blocked perspiration (*perspiratio impedita*) had been identified as a major cause of illness and death. Accordingly, the concept of *perspiratio insensibilis* was an important factor in Galen's humoral pathology and therapy. Sanctorius, too, repeatedly warned of the effects of impeded perspiration. In the *De statica medicina* he wrote:

> If nature is hindered in the function of perspiration, it immediately begins to fall short of many things (Sanctorius 1614: 9v).[44]

> The complete hindrance of insensible perspiration, not only of the principal parts, but also of one single lower part, takes away life. With regard to the principal parts, it produces an apoplexy in the brain, palpitation in the heart, polyemia in the liver, suffocation in the womb; in the lower parts it produces a gangrene (Sanctorius 1634: 13r).[45]

Hence, it was crucial that during the third stage of digestion (Sect. 3.2.5), insensible perspiration was properly produced, not only in the organs, but also in the parts of the body. The skin pores needed to be open, as insensible perspiration and sweat provided one of the principal pathways through which morbid matter was evacuated, and prevented harmful substances from accumulating. But there were more things to be considered. In the *De remediorum inventione* Sanctorius criticized the view, "wandering through the schools," that putrefaction caused by hindered perspiration could always be reduced to obstruction. In fact, Sanctorius explained, a contraction of the narrow passages in the body through which the perspirable matter

[44] "Natura, dum in perspirandi officio est impedita, incipit statim in multis deficere." See: Sanctorius 1614: 9v.

[45] "Perspiratio insensibilis non solum principum, sed unius partis infimae omnino vetita vitam tollit. Principum dum in cerebro fit apoplexia, in corde palpitatio, in iecore polyaemia, & in utero praefocatio: Infimae partis gangraena." See: Sanctorius 1634: 13r. I refer here not to the first edition of the *De statica medicina*, because Sanctorius added the quoted aphorism, along with further 107 aphorisms, only to later editions of the work. My citation is from the earliest edition of the *De statica medicina* that I could find containing the added aphorisms (ibid.). Whenever I refer to this later edition of the *De statica medicina*, I allude to the added aphorisms unless otherwise indicated.

passed, their compression, coalescence, subsidence, or occlusion, could also impede perspiration. Accordingly, the physician had to know that a pathological tumor, compressing the passages, just as the outside cold contracts the skin, could be the cause of a hindered perspiration in his patient. Hence, he had to be careful in choosing the right remedy, knowing exactly the variety and specifics of the affection (Sanctorius 1629b: 75–81; see also Stolberg 2012: 511–5).

3.2.10 The Doctrine of Sympathy

To make things more complicated, "sympathy" or "consent" between different parts of the body also had to be taken into account. Along traditional Galenic lines, Sanctorius thought that a relationship exists between the organs and their secretions in health and in disease. Thus, harmful substances that accumulated due to defective evacuations could be directed from one part to another, affecting it as well. Sanctorius wrote in the *De statica medicina*:

> No cause more frequently disturbs sleep than a corruption of food: this happens because of the sympathy that exists between the stomach and the brain (Sanctorius 1614: 56v).[46]

In the *Commentary on Galen*, Sanctorius discussed as many as 60 possible sympathies, for example between the spleen and the stomach, the scalp and the neck, or between the septum, intercostal muscles, and nerves. Referring to Hippocrates and Galen, he described four forms of "consent" in his work *De remediorum inventione*. The first consent emerged from the continuous parts by contact, the second from vapors. The third arouse from a transfer of the humors brought about by "insensible channels" (*meatus insensibiles*). The fourth emerged from humors that flowed from one part to another due to the insensible channels of the vessels. In another passage, he warned that if the channels were open (*meatus apertos*), the humors that were discharged would thereby accumulate and cause disease (Sanctorius 1612a: 724–46; 1629b: 37 f., 42).[47]

Without going deeper into the details of the doctrine, the idea of sympathy explains that the fear of blocked pores or channels was connected to the fear that either absorbed miasmas or retained morbid putrescent matter could produce affections, like fevers and inflammations that might be directed to other parts of the body and affect those parts as well. Blocked substances might be transferred to the lungs with a cough and inflammation, to the nose with a catarrh or nose bleed, or to the stomach with a disturbed appetite or vomiting (Renbourn 1960: 138).

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[46] "Nulla causa saepiùs somnum interturbat quàm ciborum corruptela: id efficit quae est inter stomachum & cerebrum sympathia." See: Sanctorius 1614: 56v.

[47] Sanctorius dealt extensively with the concept of "sympathy" in the second book of *Methodi vitandorum errorum*, see: Sanctorius 1603: 28r–58v, esp. 31r–31v. For an account of the doctrine in Galen's works and its further development, see: Siegel 1968: 360–82.

3.2.11 The Influence of Medical Methodism

In the context of blocked perspiration (*perspiratio impedita*), one repeatedly comes across the doctrine of *strictum et laxum* (tightening or loosening of atoms, corpuscles, pores, or ducts) as a cause of health and disease. It was developed by the medical school of the Methodists, which was founded in the first century BCE by the Greek physician Themison of Laodicea. His successors, Thessalus of Tralles (first century CE) and Soranus of Ephesus (ca. 98–138 CE) refined the doctrine. Methodism was a dominant medical school in Rome for over three hundred years. It represented one of the three ancient sects, together with the dogmatic, or rational, and the empirical sect. At the basis of the methodic doctrine lay the assertion that illnesses were ultimately forms of three different conditions: constriction (*strictum*), laxity (*laxum*), or a mix of these. The Methodists adopted these categories from Asclepiades of Bithynia (124–ca. 40 BCE), who argued that all diseases derived from blockages and flows of corpuscles in the invisible passageways of the body. Thus according to the methodic theory, the states of *strictum* and *laxum* refer to the tightening or loosening of atoms, corpuscles, pores, or ducts. Accordingly, fevers or inflammations were thought to arise from pores being too wide or narrow, blocked by cold air, or by excretions too abundant or too thick to pass through the pores (Renbourn 1960: 136; Webster 2015: 658 ff.).

A lot of information about the methodic sect was passed down by Galen, who, however, was mostly skeptical of their doctrine. Still, he adopted some of their ideas. In Book III of *Hygiene*, he wrote:

> I term in this way [*stegnosis*] damage of the pores due to which the superfluities are prevented from being dispersed. This arises through blockages or constriction (condensation) which people also call occlusion of the pores. Blockage arises from viscid or thick superfluities when they come to be overly collected together in the skin, while constriction arises due to astringents and cooling agents (Galen & Johnston 2018a: 319).

In the sixteenth century, discussions of corpuscular ideas arose in medical circles in Italy, when Girolamo Fracastoro (1470–1553) published his book *De contagione* (On Contagion, 1546).[48] In this work, Fracastoro defined attraction and sympathy, interpreted in quasi-mechanistic and atomistic terms, as a basic phenomenon in nature.[49] In the same decade, the French physician Jean Fernel (1497–1558), whose own concept of the elements was unconventional but not atomist, drew attention to the ideas of Democritus (ca. 460–ca. 370 BCE) and the corpuscularism of the

[48] For an overview of late medieval and early modern corpuscular matter theories, see: Lüthy et al. 2001.

[49] Fracastoro treated the issue of contagion as one of a larger class of sympathies and antipathies. In doing so he tried to remove it from the realm of magic, given that contagion was often conceived as an occult force at the time. Contrary to this view and with reference to the atomism of Lucretius, Fracastoro explained sympathy as a mechanical attraction resulting from a flow of particles between objects. According to him, contagion was carried by especially fine *seminaria* or seed particles with the ability to cover great distances and to penetrate the bodies they struck. See: Copenhaver and Schmitt 1992: 305 f.

ancient medical Methodists. He indicated that the number of adherents to the school of the Methodists (which he confused with the atomists) was considerable in his time. Even though Fernel did not follow them, he did not escape their influence, as he sometimes explained phenomena by means of pores. Shortly after, there was an actual revival of Empedoclean corpuscular theory among physicians. At the beginning of the seventeenth century, in the very year Sanctorius began teaching *theoria* in Padua, a colleague of his, Prospero Alpini (1553–1617), a lecturer on simples, and prefect of the botanical garden in Padua, published his treatise *De medicina methodica* (1611).[50] Interestingly, Alpini was friends with a family to which Sanctorius, too, had a special connection: the Venetian Morosini.[51] Hence, the two of them might have encountered each other in the *Ridotto Morosini* (Sect. 2.3), potentially discussing ideas connected to Alpini's publication. Directed to the Methodists, it marked a comeback of the ancient solidist and therefore anti-humoralistic and anti-Hippocratic medicine. It must be noted, though, that besides the Methodist doctrine, Alpini always referred to the Hippocratic-Galenic conceptions as well, and aimed for a certain reconcilability that he finally achieved (Hooykaas 1949: 74; Rothschuh 1978: 227; Siraisi 1987: 242; 2012: 513; Sanctorius and Ongaro 2001: 40; Garber 2006: 33 f.). Sanctorius was well aware of Alpini's treatise and referred to the *De medicina methodica* in his *Commentary on Galen*. In the first part of the commentary, when Sanctorius wrote about the medical sects, he stated:

> Lately, Prosperus Alpinus published a most sophisticated book about this sect, in which the principles of this sect are most completely declared (Sanctorius 1612a: 52).[52]

With "this sect," Sanctorius alluded to the *thessalici*, meaning the disciples of Thessalus and hence to the Methodic sect. E. T. Renbourn has argued in his article that Sanctorius's concept of the *perspiratio insensibilis* was also influenced by ideas attributed to the medical Methodists. He went as far as to identify Sanctorius's medical doctrine as "New Methodism" and a "resuscitated Methodic doctrine" (Renbourn 1960: 139, 142). In the *Commentary on Galen*, Sanctorius wrote:

> Thessalus reduces the whole art to laxity [*laxum*], and constriction [*densum*], or mixed, and from these he collects three remedies, which he says are sufficient to remove all pathological affections. But they are most vain [statements] and those, who would like to penetrate

[50] The lectures on simples (*lettura dei semplici*) were part of the teaching of the medical faculty at Italian universities from the sixteenth century onward. This teaching was an intermediate between what we call today botany, pharmacognosy, and pharmacology. See: Treccani enciclopedia on line 2019.

[51] Alpini dedicated his work *De medicina aegyptiorum* to Antonio Morosini (Alpini 1591: dedication). A collection of copied letters by Andrea Morosini, containing many letters to Prospero Alpini, can be found in the library of the Museo Correr in Venice, see: BMCVe-a.

[52] "Edidit his diebus de hac secta Prosperus Alpinus librum eruditissimum, ibique huius sectae principia plenissimè declarantur." See: Sanctorius 1612a: 52.

> the vanities of the grand Thessalus, shall read Books 1 & 2 of *Methodus medendi*, where Galen carefully refutes him (Sanctorius 1612b: 318).[53]

This statement makes clear that Sanctorius did anything but identify with the methodic doctrine. However, just as in the case of Galen, this does not mean that he did not adopt some of their ideas. From the previous analysis it has become clear that Sanctorius shared the idea that the tightening or loosening of pores or ducts was a cause of health and disease. Moreover, in his view, the observation and regulation of bodily evacuations contributed more to the preservation of health and cure of diseases than any other means. But Sanctorius strongly adhered to Hippocratic-Galenic conceptions and integrated his new finding, the large quantity of insensible perspiration, into this theoretical framework. Only very few references to corpuscles, atoms, and small parts, or particles (*minima partes*, *minimae particulae*) can be found in his works.[54] The *De statica medicina*, his major publication on the causes and effects of *perspiratio insensibilis*, does not contain a single mention of corpuscles, particles, and the like. Hence, to classify Sanctorius's medical doctrine as "New Methodism" is far-fetched.[55]

3.3 The Non-Naturals Reconsidered

In the preceding account of *perspiratio insensibilis*, one repeatedly comes across the non-natural factors. This is consequential, as the subject was dealt with through the perspective of Sanctorius, who was original in examining the non-naturals with regard to their effect on insensible perspiration. When considering that, in Galenic

[53] "Thessalus totam artem ad laxum, & densum, vel mixtum ex his referebat, & ex his colligebat tantum tria remedia, qua dicebat sufficere pro auferendis universis affectibus praeter naturam: Caeterum haec vanissima sunt, & qui vult vanitatem Thessali altius penetrare, legat lib. 1. & 2. methodi medendi, ubi Galenus exactissime illum conuincit." See: Sanctorius 1612b: 318.

[54] Sanctorius used the term *corpusculum* in his works only when he discussed the doctrine of Asclepiades, see ibid.: 36, 399, Sanctorius 1629b: 9. With regard to his employment of the term *atomus*, there is only one passage in his works, in which Sanctorius did not connect it to a refutation of ancient atomism, but used it in a discussion on the transparency of the air: "Nec mirum est, quod vitreus ex se transparens in oculi profunditate gerat vicem cubiculi umbrosi: quia etiam aer ipse in sua immensitate diminuit transparentiam, vel fiat hoc propter atomos, vel propter alias causas." See: Sanctorius 1625: 762 and Bigotti 2017: 10, fn. 19. Sanctorius used more often the terms *particula minima*, *pars minima,* or simply *minima* (Sanctorius 1603: 158v, 218v, Sanctorius 1625: 167–70, 176, 186, 218, 385, 426, 430, 455, 466, 472, 476, 561, 690 f., 728).

[55] The same applies to Fabrizio Bigotti's argument that Sanctorius adopted a corpuscular theory that pre-empts both Galileo Galilei and Daniel Sennert (1572–1637) (Bigotti 2017). There is no hint that Sanctorius connected his quantitative approach to corpuscular ideas or that such influenced his static medicine and his new approach to the six non-natural things. Nowhere in his works did Sanctorius connect his concept of *perspiratio insensibilis* to corpuscular notions and the *De statica medicina* shows no trace of corpuscular ideas. In 1975, Paolo Farina also argued against a corpuscular theory of Sanctorius, highlighting instead his strong adherence to Galenic medicine (Farina 1975: esp. 369–74, 377).

dietetics, evacuations were closely connected to the processes of digestion and respiration, i.e., to air, food, and drinks, and were influenced also by the motion or rest of the body, the examination of insensible perspiration in the context of the six non-naturals does not come much as a surprise. What is more, according to the traditional list, "evacuation and repletion" constituted a non-natural thing itself. As Ken Albala has explained, the details of evacuation were usually not included in treatises on the digestive process, but considered rather in the frame of the doctrine of the six non-natural things, as a process believed to be controllable by external factors (Albala 2002: 60). From this, it is easy to understand why Sanctorius chose this of all concepts to structure the results of his weighing experiments. And from this, it is also clear that evacuations had a distinct place in the medical literature, even in the time before the *De statica medicina* was published.

In his study of sweat, Stolberg argued that early modern medical literature dealt considerably with sweat, but not especially prominently (Stolberg 2012: 504). To accurately identify the role that *perspiratio insensibilis* played in early modern medicine, especially in the times before and contemporary to Sanctorius, further research is needed. Based on Stolberg's study, it can be assumed that the phenomenon was usually treated within the context of sweat, or, as the analysis of the doctrine of the six non-naturals has shown, in the context of the fifth non-natural factor "evacuation and repletion." Moreover, a treatise on sweat, interestingly published by a Neapolitan physician in the same year as the *De statica medicina*, gives some insight into the topicality of *perspiratio insensibilis* at this time (Baricellus 1614).

Without deeply analyzing the more than 400-page work, a look into the table of contents shows, on the one hand, that the non-natural things, like motion, food, and environmental factors, were discussed, and on the other hand, that insensible perspiration—*transpiratio insensibilis* appeared only twice. The author, Julius Caesar Baricellus, explained in the preface that he set out to write a treatise on sweat, because physicians did write nothing or only deceiving and unnecessary things on the topic. But when carrying out the task, he soon discovered that many of the wisest men dealt with *sudorific matter* and much more was contributed to the topic than he had expected. This is very much in line with Stolberg's assessment of the non-prominent place of sweat in early modern medical writing. At the beginning of the fourth book, Baricellus wrote that the physicians of his time rarely used sweats in their treatments, while this had been commonly done in antiquity. This implies that he was not acquainted with Sanctorius's weighing procedures. The fact that Baricellus mentioned Sanctorius's work *Methodi vitandorum errorum* in the context of the mixtures of the humors and of tastes reinforces this impression. As the *De statica medicina* was published in the same year as Baricellus's book on sweat, it can be assumed that the two works were conceived independently of each other (Baricellus 1614: index, 2 f., 165, 358). Hence, apparently there was a general awareness at the time of the important effects that sweat and perspiration had on health and disease. By focusing on insensible perspiration specifically and, even more so, by adding a quantitative dimension to the study of the phenomenon, Sanctorius gave new relevance to the topic.

The next paragraphs consider these new approaches from a conceptual point of view. The focus is on the way in which Sanctorius connected the traditional doctrine of the non-natural things with insensible perspiration. Rather than fully analyzing the content of the *De statica medicina*, I will focus on those factors that are relevant to understanding the conceptual backdrop against which Sanctorius developed his weighing procedures. References to Sanctorius's other books will help set his ideas in the larger context of his endeavors. In doing so, I seek to contribute to an understanding of the theoretical context in which the *De statica medicina* emerged, and of how a new medical idea, the quantification of insensible perspiration, was integrated into a well-established Galenic doctrine. In my opinion, this understanding is fundamental to comprehending the practical and material dimensions of static medicine, which are inextricably interwoven with theoretical medical knowledge. Therefore, before analyzing the weighing of *perspiratio insensibilis*, I will pay attention to this hitherto neglected aspect of Sanctorius's work: his reinterpretation of the six non-natural factors.[56]

3.3.1 Air and Water

After the first section of the *De statica medicina,* which deals with the weighing of insensible perspiration and will be considered in later chapters, Sanctorius proceeded to the non-natural pair, air and water (Fig. 3.1). It is striking that these two non-natural factors represented also two of the four elements and, as such, not only formed part of the complexion of human bodies, but were the unifying explanatory model for all nature. However, insofar as air and water changed the body, preserved health, and led to diseases, they were compiled among the non-natural things, as Sanctorius explained in his *Commentary on Avicenna*. While air was the common first thing of the non-naturals, water was usually not contained in the list. This can be explained by the fact that the traditional concept of "air" included considerations of pollution, seasonal variations, climate, and region—and might be described in modern terms as "environment." In pointing explicitly to water, Sanctorius might have been inspired by the *Isagoge Johannitii*, a standard introductory textbook at medical university faculties, where the list of the non-naturals included also "bath" as a special category (Sanctorius 1625: 70).[57]

Air In the account of the respiration process (Sect. 3.2.6), the importance of air for the human body has already become clear. Indeed, medieval and Renaissance dieticians agreed that it is the most important particular factor among the six non-naturals. In his *Commentary on Galen* Sanctorius too concluded that, compared to the other non-natural things, air changed the body the most (Sanctorius 1612b: 58).

[56] In the following sub-chapters, my references to the traditional Galenic teaching of the six non-natural things are mainly based on Sotres 1998 and Albala 2002.

[57] For more information on the *Isagoge Johannitii*, see: Temkin 1973: 104–8, Ottosson 1984: 254.

Hence, in the *De statica medicina* he showed how the quality of the air influenced body weight and the amount of *perspiratio insensibilis*:

> The external air, which passes through the arteries into the depths of the body, may render the body lighter and heavier. Lighter, if it is fine and warm; heavier, if it is thick and moist (Sanctorius 1614: 20v).[58]

> External cold, by concentrating heat, renders the nature so much more robust, that it can carry, in addition to the usual weight, also around two pounds of repressed perspirable matter (Sanctorius 1614: 30v).[59]

The first citation shows the different effects of fine and warm air in contrast to thick and moist air. Just as Sanctorius described liquid excretions as heavier than solid ones, and liquid food as heavier than solid food elsewhere in the *De statica medicina*, he thought that moist air made the body heavier. Therefore, dry weather was healthier than continuous rain, making the bodies lighter. The second citation might explain why balanced bodies were, according to Sanctorius, around three pounds lighter in summer than in winter. Due to cold air, the skin contracted and correspondingly the pores narrowed, which made it difficult for the perspirable matter to leave the body. In summer, on the contrary, when the pores widened because of the warm air, perspirable matter could be excreted more easily. However, cold air did not only affect the pores of the skin, but also the internal heat of the body. As has been explained, inspired (inhaled) air served to cool the heart and the blood and hence, the colder the air that entered the body, the more it concentrated the latter's heat. The concentration of heat was directly related to the robustness of a body, and Sanctorius stated that external coldness impeded perspiration in weak people, because it dissipated their heat. In robust people, on the contrary, cold air increased perspiration, as their heat was drawn back deep into the body, where it doubled, the nature of the body strengthened, and shortly after, the weight of the repressed perspirable matter was consumed and the body became and felt lighter. This is why insensible perspiration was, in robust bodies, greater in winter than in summer (Sanctorius 1614: 6r–6v, 16r–16v, 24v–25r; 1629a: 382).

These examples illustrate that the qualities of the air could affect the body not only *per se*, insofar as warm air heated the body, but also indirectly (*per accidens*) when for example the humidity of the air obstructed insensible perspiration and generated putrefaction. By the same token, warm air sometimes dissipated internal heat and cooled the body, and cold air sometimes warmed the body by concentrating or compressing heat (Sanctorius 1603: 9r; 1612b: 25, 27). This feature applied to the other non-natural things, too.

Changes in the Air In his *Commentary on Galen*, Sanctorius named three causes that changed the air: region, time of the year, and the constitution of the heavens. With regard to the latter, Sanctorius was very critical of astrology and thus allowed

[58] "Aer externus per arterias in profundum corporis penetrans, potest reddere corpus levius, & gravius: levius si tenuis, & calidus; gravius, si crassus, & humidus sit." See: Sanctorius 1614: 20v.

[59] "Externum frigus concentrando calorem reddit naturam tantò robustiorem, quanto ultra solitum pondus ferre quoque possit duas libras circiter retenti perspirabilis." See: ibid.: 30v.

air to serve as a medium only for the celestial influences of light and movement. In the *Commentary on Avicenna*, he explained that air contained so much light that it always dried, even though its nature was actually exceedingly humid. It has already been indicated above how the seasons and the weather affected insensible perspiration and body weight. Accordingly, perspiration decreased daily by around one pound from the autumnal equinox to winter solstice, whereupon it began to increase until the vernal equinox. Time of day also played its part. Robust bodies perspired more during the day in the summer, while in winter they perspired more during the night. In Galenic medicine, each season corresponded to a complexion. Spring air was hot and moist, and blood dominated. Summer was connected to yellow bile, with the air being hot and dry. Fall was the season of black bile, with the predominating qualities of dry and cold. In winter, cold and moist phlegm prevailed (Fig. 3.2) (Sanctorius 1603: 137v; 1612b: 25; 1614: 27r, 28v; 1625: 61).

According to Sanctorius, all philosophers and physicians agreed that spring air was the most temperate of all the seasons, but they argued about the most temperate climate or region. This discussion was, however, fruitless, because there was not one absolute temperate climate; rather, each climate had its own temperate climate, depending on the complexion of its inhabitants. Thus, there was the idea that a population adapted to the region and climate it lived in. The complexion of someone living in the German territories was totally different from the complexion of someone living on the African continent. In this context, geographical differences like proximity to the sea or the mountains were important, as they influenced the quality of the air. They also affected the movement of the air and the wind a population was exposed to. And so Sanctorius explained that windy air might harm one person, but benefit another. Wind blowing from the north was healthy, whereas south wind was harmful. With regard to insensible perspiration, he concluded that wind which was colder than the skin always blocked and harmed, especially the head, because this body part was the most exposed (Sanctorius 1603: 137v, 138v; 1612b: 62; 1614: 24v; 1625: 212, 225, 245 f.). This hints at the importance of clothing. As a means to protect oneself from the immediate environment, from bad weather, from heat, and from cold, clothes also affected the excretion of insensible perspiration:

> Because of cold air that follows on heat, those who take off clothes usually perspire in the course of one day about less than two pounds without noticing any trouble (Sanctorius 1614: 22v).[60]

> Those body parts which are covered perspire healthier. But if they are discovered bare after sleep, their pores are compressed by very warm air, too (Sanctorius 1634: 28v).[61]

Hence, clothing promoted insensible perspiration during the day and night, which was why Sanctorius suggested covering the body also during sleep.

[60] "Ob aerem frigidum supervenientem calori, vestibus denudatus, minùs duabus libris circiter diei cursu perspirare solet, nulla ab ipso animadversa molestia." See: ibid.: 22v.

[61] "Corporis partes tectae salubriter perspirant: Si verò à somno detectae inveniantur, etiam ab aere calidissimo eorum pori condensantur." See: Sanctorius 1634: 28v.

Pure Air and Plague Another important aspect was the idea of pure or clean air. In line with the teachings of Avicenna, Sanctorius conceived of air as pure when it was not mixed with any extraneous vapors, any type of smoke, or any harmful substance. Accordingly, muddy air impeded insensible perspiration and the retained matter harmed the body. Therefore, country air was preferable to thick city air.[62] Being exposed to impure air could have serious consequences, as plague and other diseases were thought to stem from miasmas or foul vapors contaminating the air (Sanctorius 1612b: 27; 1614: 16r, 22r; 1625: 64; 1634: 28v). Interestingly, Sanctorius added to the 1634 edition of the *De statica medicina* a subsection with the title *De peste* (On plague) (Sanctorius 1634: 17v–20r).[63] Published 3 years after the plague raged in Venice, this most likely reflects Sanctorius's experiences during the epidemic (Sect. 2.7). Contrary to what one might expect, the added aphorisms were not included in the discussion of air, but were printed as a sort of appendix to the first section that deals with the weighing of insensible perspiration. Even more curious is that none of the 15 aphorisms relates to either weighing or insensible perspiration. Instead, there is a clear connection to air:

> The plague is conveyed not by contact, but by inhalation of pestilential air or by the vapor of furniture. It happens like this: the vital spirit is infected by the air, from the infected spirit the blood coagulates, which, pushed to the external parts, produces plague spots [*carbones*], black papules, and buboes; if it remains inside, it brings about death; if everything is thrust out, we survive (Sanctorius 1634: 18r).[64]

Thus, Sanctorius opposed the view that plague was a contagious disease.[65] According to him, plague resulted from bad air that first corrupted the vital spirit, then the blood. People with a *loose* lung were more prone to infection than people with a *compact* lung, and wind was a means of spreading the pestilential rays, which were similar to light rays (Sanctorius 1634: 19r). The closest one comes to any idea of

[62] In his analysis of *Regimens of Health*, Pedro Gil Sotres argued that medieval physicians considered the city a far more hygienic place to live than the unhealthy countryside (Sotres 1998: 302 f.). Ken Albala drew a different picture in his study on Renaissance dietary works and referred to practices of purifying city air (Albala 2002: 116–20). Hence, the conception of the beneficial and harmful effects of city and country air seems to have changed during this period.

[63] The following statements are partly based on a talk given by Vivian Nutton at the international conference *Humours, Mixtures, Corpuscles* and the ensuing discussion (Nutton 2017).

[64] "Peste non tactu, sed inspiratu aeris pestiferi, vel halitus supelectilium inficimur: Sic fit: spiritus vitalis ex aere inficitur ab infecto spiritu congelatur sanguis, qui extrapulsus carbones, nigras papulas, & Bubones, si manet intus, mortem: si totus pellitur ad extra, evadimus." See: Sanctorius 1634: 18r.

[65] In his study on the perceptions and reactions of university medical practitioners with regard to the Black Death, Jon Arrizabalaga argued that air spread and contagion had not been contradictory views of the diffusion of pestilence, but rather referred to two different and successive stages of its dissemination (Arrizabalaga 1994: 259 f., 287). In this context, it is interesting that, even though Sanctorius denied that plague was transmitted by contact, in another of the plague aphorisms he blamed the authorities for not shutting down the poultry market, as handling of chickens by infected persons transmitted the disease (Sanctorius 1634: 19v–20r).

quantification, or rather mechanization, is Sanctorius's comparison of the course of the plague with the movement of a clock:

> Things that are infected with plague corrupt as long as the remote causes persist. If, however, only one of the causes is missing, the venom diminishes, like the movement of a clock, which stops when a single tooth of the cogwheel breaks down (Sanctorius 1634: 17v–18r).[66]

Without reading too much into the analogy that Sanctorius employed elsewhere in his works to the body and its physiology (Chap. 8), it further confuses matters. And even more so, when Sanctorius wrote in another aphorism that there was no cure for the plague; one could only evade it (Sanctorius 1634: 19v). This remarkably pessimistic attitude leaves one to wonder whether Sanctorius's plague aphorisms reflect his devastating experiences and the general sense of helplessness and resigned fatalism that crept into the Venetians in view of the epidemic, or whether they are related to the fact that Sanctorius was already an old man, sensing probably that he was facing the end of his life, or whether they truly reveal his notions of the plague.[67] One should not forget here that Sanctorius was among those physicians, who persistently denied the existence of the plague in Venice, until the many deaths proved them to be wrong (Sect. 2.7). Maybe for this reason he did not want to remain silent on the topic later. But why then, one is inclined to ask, did he choose the *De statica medicina* to present his thoughts on the disease? Given the fact that he did not refer to *perspiratio insensibilis* or the weighing procedures, this choice seems rather peculiar. It might have been practical reasons, the aphoristic form, or the popularity of the *De statica medicina*, that led him to this decision. This, however, is pure speculation. In fact, the consideration of plague in the frame of the six non-natural things was fairly common. In the fourteenth century, in line with the medieval rules of health (Sect. 4.1.2), even a new literary genre was created—that of the plague *regimina*.[68] Nevertheless, Sanctorius did not add his plague aphorisms to the section on air, nor did he consider the disease in the context of the other non-natural things. Thus, his true motives behind the plague aphorisms remain a puzzle yet to be solved.

Water In the preceding section, it has already become clear how water, insofar as it affected the climate, had an important influence on the complexion of the body and the excretion of insensible perspiration. Lakes, rivers, and the sea determined the quality of the air and shaped the weather in different regions. But water could also directly act on the body through baths and swimming. In the *De statica medicina* Sanctorius explained that hot baths, just as hot air, promoted perspiration. But he also warned that perspiration provoked by the force of hot air or water was harmful, except when its damage was compensated by a much greater benefit. Relating

[66] "Res peste infectae inficiunt quousque durant proximae, & remotae causae: unica tamen deficiente ceßat virus ad instar motus horologij, dum rotarum unico irrito dente quiescit." See: Sanctorius 1634: 17v–18r.

[67] For more information on the Venetian plague of 1630–31 and the trauma of the Venetian population, see: Preto 1984: 379, 384. See also Sect. 2.7.

[68] For more information on plague *regimina*, see: Zitelli and Palmer 1979: 24–37, García-Ballester 1992: 120, Arrizabalaga 1994: 273.

to the non-natural pair of exercise and rest, he advised against a swim in cold water after a violent exercise, for this was "most pleasant, but lethal," because these were two opposed movements (Sanctorius 1614: 20r–20v, 23r–23v, 27r). Overall, Sanctorius treated water only very briefly in the second section of the *De statica medicina*, while he dealt more extensively with air. In addition to the possible influence of the *Isagoge Johannitii*, the close connection between water and air with regard to climate and region, as well as Sanctorius's interest in the weight not only of air, but also of water, which will be considered later (Sect. 5.3.2), might have made him include water in the list of the non-natural things, pairing it with air.

In conclusion, Sanctorius followed traditional Galenic notions in his account of air and water, but reconsidered their influence on the human body by focusing on body weight and insensible perspiration. The fact that he paired water with the first non-natural thing, air, is unusual and indicates that Sanctorius considered it important with regard to the quantity of *perspiratio insensibilis*.

3.3.2 Food and Drink

As a product of the digestive process, insensible perspiration was necessarily closely connected to the food and drink ingested by the body. The quantity of *perspiratio insensibilis* depended on the digestive power, which therefore had to be taken into account when prescribing food and drink. This power in turn was determined by an individual's innate heat—the hotter it was, the greater the power to concoct and digest more food (Sanctorius 1629a: 300). Referring to Galen, Sanctorius wrote: "nourishment must be proportionate to difflation" (Sanctorius 1629a: 382) and in the *De statica medicina* he advised: "One should only ingest such a quantity of food that nature can concoct, digest, and perspire" (Sanctorius 1614: 39r).[69] Hence, the more a body perspired, the more food it needed. But it was not as simple as that. In keeping with the doctrine of the non-natural things, multiple factors continuously influenced the body and its digestive power.

Meals and Mealtimes In summer, for example, when the stomach was thought to be colder and the forces weaker, one should not eat an abundant meal, but rather several sparse meals. In winter, on the contrary, when the stomach was thought to be hotter and the forces stronger, bigger but few meals were recommended. The same applied to regions. In hot regions, one should eat little and often, whereas in cold regions, one should eat a lot, but rarely. According to the Hippocratic teachings, the four seasons corresponded to the four regions, to the four ages of man, to the four complexions, to the four humors, to the four elements, and to the four times of day, which was why, so Sanctorius, it was enough for the physician to know what

[69] "… alimentum debet proportionari difflationi." See: Sanctorius 1629a: 382. "Illa cibi copia est ingerenda, quam natura potest coquere, digerere, & perspirare." See: Sanctorius 1614: 39r.

arrangement of meals applied to one of these factors, because from this, he could infer what he had to recommend with regard to the others (Fig. 3.2) (Sanctorius 1629a: 382, 410, 423).

Generally, Sanctorius thought that several meals a day were healthier than only one. A body, for example, was weighted down more by eight pounds of food that were eaten in one meal, than by ten pounds that were eaten in three separate meals. And as the fullness of the stomach took the insensible evacuation away, a meal of around four pounds was harmful when it was taken all at once, but beneficial when divided into two or three meals. Moreover, the amount of food for each meal had to be equally divided. Instead of eating six pounds at lunch (*prandium*) and two pounds at supper (*caena*), it was healthier to eat four pounds at each, both lunch and supper. This, however, contradicts Sanctorius's statement in the *Commentary on Galen*, according to which one should eat more for supper than for lunch. Referring to the ongoing discussions on the topic among medieval and Renaissance dieticians, Sanctorius adopted the Galenic position that the digestive power was stronger at night, which was why a larger supper was recommended.[70] This might imply that his experiences with the weighing chair made him change his mind. Sanctorius was thus ready to revise traditional knowledge on the basis of his novel quantitative observations. But only to a certain extent, as will be shown later (Sanctorius 1612b: 76 ff.; 1614: 38v, 40r; 1634: 40r).

In the context of the number and size of meals, mealtimes were important, as one had to make sure that the previous meal was already digested before taking in new food and drink. Perspiration occurred least when the stomach was full, Sanctorius explained. The moment to eat, according to him, was when the body, shortly before ingesting the first food of the day, had returned to the same healthy weight as the previous day. In the *Commentary on Galen*, he recommended 9 to 10 h between lunch and supper and, correspondingly, 14 to 15 h between supper and lunch. It is important to remember in this context that the digestive process was conceived of as proceeding in distinct stages. This means, knowing how long each of them took also disclosed the ideal time to eat. By continuously weighing the body and monitoring its excretions, Sanctorius attempted to gain exactly this knowledge (Sanctorius 1612b: 78; 1614: 41v, 46v–47r; 1634: 42r).

Quality of Food Besides the questions of what time to eat and how much, one wonders, of course: What to eat? According to Sanctorius, food could be nutritive, abundant, raw, vaporous, scarce, fat, dry, liquid, or solid, and most importantly, it might also have the ability to perspire. If not, obstructions, corruptions, lassitude, sadness, and heaviness of the body would loom (Sanctorius 1614: 32r–48r; 1634:

[70] The opinion that the digestive power was stronger during night was connected to the differentiation between digestion and concoction. While digestion was thought to occur during waking, concoction was thought to occur during sleep. See also Sects. 3.2.5, fn. 31 and 3.2.7, fn. 40. For more information on the controversy whether the midday meal or evening meal should be larger, see: Albala 2002: 112 f.

39v–42r). But fortunately, some foodstuffs could enhance the perspirability of others:

> Onions, garlic, mutton, pheasants, but most of all, *succus cyrenaicus* help the perspiration of hardly perspirable foodstuffs (Sanctorius 1614: 48r).[71]

Unfortunately, this worked also the other way around:

> The use of pork and of porcini is bad, both because they do not perspire, and because they do not permit that the other foodstuffs, ingested at the same time, perspire (Sanctorius 1614: 36r).[72]

During Sanctorius's times, mushrooms were commonly thought to be unhealthy, and pork was usually recognized as difficult to digest. It is thus not surprising that Sanctorius categorized them as bad also with regard to their effect on insensible perspiration. When Sanctorius explained in another passage of the *De statica medicina* that melons perspired poorly and therefore repressed perspiration, he also followed the fashion of his time, as Renaissance dieticians never tired of launching into tirades against melons. With regard to onions, garlic, mutton, and pheasants, the picture is, however, different. All of them were usually not considered healthy by the Italian dieticians of the time. But in the *Methodi vitandorum errorum*, Sanctorius hinted at his sources, when he wrote that Galen had counted garlic among warm and dry things that dissipate flatus. Moreover, in the work *De alimentorum facultatibus* (On the Properties of Foodstuffs), Galen wrote that garlic had the power to digest and to open obstructions. Notwithstanding that Sanctorius did not cite this exact passage, he frequently referred to the treatise in his books (e.g., Sanctorius 1603: 169v; 1612a: 196, 513). From this, it can be inferred that Galen's ideas on food and diet probably played a part in Sanctorius's qualification of nutrition according to its ability to perspire (Sanctorius 1603: 137r; 1614: 36r–36v; Galen. 1997a: 658 f.).

In this context, Sanctorius's mention of *succus cyrenaicus* deserves brief consideration. It refers to the resin of silphium, a plant that was an important commodity of the ancient North African city of Cyrene. In fact, it became a legendary spice, praised by many Greek and Roman physicians for its digestive qualities. However, in the first century it disappeared. Why? The reasons are uncertain (Dalby 2000: 17 ff.). What is certain is that Sanctorius did not have the spice at his disposal. Instead of being based on his own experiences with the weighing chair, Sanctorius's praise of silphium thus seems to rather depend on the well-known Greek physician again. Galen wrote in one of his books: "Indeed, *succus cyrenaicus* surpasses all [simple drugs] in heat and in fineness and therefore also dissipates the most through vapor, …." (Galen. 1997c: 90 f.).[73] Hence, it was Galen, who already pointed to the perspirability of silphium. This confirms the suspicion mentioned above that Galen

[71] "Caepae, allium, caro vervecina, phasiani, sed maximè omnium succus cyrenaicus iuvant perspirationem eduliorum aegrè perspirabilium." See: Sanctorius 1614: 48r.

[72] "Usus carnis suillae, & boletorum malus, tum quia haec non perspirant, tum quia non permittunt caetera edulia simul ingesta perspirare." See: ibid.: 36r.

[73] "Succus Cyrenaicus quidem omnes et caliditate et tenuitate exuperat, ac proinde etiam omnium maxime per halitum discutit, …." See: Galen. 1997c: 90 f.

provided the basis not only for the quoted aphorism, but also, on a more general level, for Sanctorius's qualification of foodstuffs with regard to their effect on insensible perspiration.[74] The familiarity of Sanctorius with Galen's respective treatise, *De simplicium medicamentorum temperamentis et facultatibus* (On the Mixtures and Powers of Simple Drugs), is confirmed by the frequent citations that can be found in Sanctorius's publications (e.g., Sanctorius 1612a: 494; 1612b: 397; 1629a: 68; 1629b: 70).

Another interesting aspect in this regard is that Renaissance dieticians considered the nutritive value of food, amongst other things, with regard to the proportion of the food expelled as excrement. The material that passed through had obviously not been assimilated and foods that produced abundant excrement were therefore considered less nutritious. If they were thoroughly processed, they left behind only a small amount of waste. Thus, in a certain way, the quality of food was here too connected to its perspirability. Following this line of argument, Sanctorius recommended food that was little nutritious (*pauci nutrimenti*), as to him it was fundamental that a body perspired sufficiently. As peculiar as this might seem to the modern eye, it was not unusual for contemporary physicians to not always recommend the most nutritious substances. What they feared most was an overburdening of the system and there was no equivalent as yet to the modern concept of minimum daily requirements or even of energy supplied by nutrients. Moreover, the nutritive value was not the most important criterion for a choosing foods (Sanctorius 1614: 32v, 40v, 41r, 42v).

In addition to general recommendations for certain foodstuffs, Sanctorius also took account of the fact that individual bodies reacted differently to nutrition, depending on their complexion. "Honey," he wrote, "is good for cold bodies, because it nourishes them and perspires, whereas it is harmful for warm bodies, as in them it is turned into bile" (Sanctorius 1634: 42r).[75] By the same token, fasting was not for everyone. In the *Commentary on Hippocrates*, Sanctorius reminded the reader that a distinction had to be made with regard to time, age, region, and habits to decide whether a person should, or should not do fasting.[76] In the *De statica medicina*, he emphasized the importance of weighing in order to decide whether fasting is healthy or not. Following the important premise mentioned above, according to which nourishment must be proportionate to perspiration, fasting was only beneficial, if there was still food left in the stomach to digest from the previous day. Being careful to eat the right food with the qualities that matched the individual needs of a body, and to abstain from eating under certain circumstances, was, however, not enough. A too great a variety of food also needed to be avoided, as

[74] Thomas Secker (1693–1768), archbishop of Canterbury from 1758 until his death, critically mentioned Sanctorius's adherence to Galen with regard to *succus cyrenaicus* in his medical doctoral dissertation, see: Secker 1721: 10.

[75] "In frigido corpore mel iuvat, quia nutrit, & perspirat, in calido nocet quia bilescit." See: Sanctorius 1634: 42r.

[76] In a later part of the *Commentary on Hippocrates*, Sanctorius discussed the suitability of bodies to fasting at length in a separate question (*quaestio*), see: Sanctorius 1629a: 293 ff.

Renaissance physicians commonly agreed. Sanctorius, too, warned of three harms that resulted from the variety of food: eating too much, concocting too little, and perspiring too little (Sanctorius 1614: 37v, 41v; 1629a: 102).

There is much more to say about Sanctorius's ideas on nourishment and eating. It is a very important topic in the *Commentary on Hippocrates*, in which he considered nutrition with regard to sick bodies, too (Sanctorius 1629a: e.g., 100–3). In the *De statica medicina*, in contrast, the focus is on prevention and the preservation of health. While food and drink played an important role in Sanctorius's quantitative study of insensible perspiration, this close connection had a less prominent place in his other works. Even though Sanctorius repeatedly pointed to his static observations, there are also passages in which he examined the influence of nourishment on the body detached from considerations of insensible perspiration (e.g., Sanctorius 1629a: 183–6). How this may relate to the importance of food and drink in Sanctorius's quantitative approach to physiology will be elucidated in later chapters. Here, I have limited myself to analyzing the topic in the context of the doctrine of the non-natural things and Sanctorius's revision of it.

3.3.3 Sleep and Wake

The relevance of sleep and wake with regard to the digestive process and to the production of *perspiratio insensibilis* was already mentioned above (Sects. 3.2.7 and 3.3.2, fn. 70). The body concocted during sleep and digested during wake. The digestive power was thought to be stronger at night and Sanctorius repeatedly stated that the body perspired insensibly twice as much while asleep as while awake (Sanctorius 1612b: 40; 1614: 52r). In this context, Sanctorius also referred to two different kinds of *transpiratio insensibilis*—one was generated during sleep, the other during wake. This differentiation was connected to the rest or the movement of the body. In order to gain a better understanding of these ideas, I will next present Sanctorius's physiological understanding of sleep and waking hours, and refer to some characteristics that I consider important with regard to his medical doctrine of static medicine.

The Physiological Concept of Sleep In his descriptions of the physiological processes that occurred during sleep and wake, Sanctorius followed Galen, contrasting his views with those of Aristoteles. All evidence put together, Sanctorius's explanation of sleep can be summarized as follows: sleep arose when the heat, dispersed over the sensory organs (*sensiteria*), withdrew into the inner parts of the body. Due to the activity of the sensory organs during waking hours, this heat was dried up and exhausted and needed to be moistened and restored. When it drew back into the body, the influent heat merged with the innate heat of the internal organs, which was why the overall heat within the body doubled. As a result, the digestive power increased and enabled the body to transmute substances, i.e., food into *chyle* and *chyle* into blood. In short, the doubled heat allowed the body to perform concoction.

In this process, the heart was heated and the brain moistened. The moisture in the brain prevented the animal spirits from flowing to the sensory organs. Moist vapors filled up the brain and the animal spirits were overwhelmed by these vapors. As the animal spirits were the active agent in all the sensory organs, spreading through the nerves and the spine, their retention led not only to their repose, but also to the repose of the five external senses. What is more, the vital spirits, from which the animal spirits arose, rested as well. Thus, sleep was needed in order to perform concoction, to restore heat, and to regenerate the spirits. As soon as this was accomplished, heat returned to the outside of the body and the animal spirits continued to flow again, thereby provoking sensation and voluntary motion, and the body woke up (Sanctorius 1612a: 358 ff., 364; 1612b: 39, 81; 1625: 362, 726; 1629a: 305).[77]

So far, so clear. Yet there was a problem when Sanctorius connected this conception of sleep and wake with insensible perspiration and the observations he made during his weighing procedures. According to his measurements, the insensible perspiration of the body was twice as great in sleep as during waking hours (Sanctorius 1612b: 40; 1614: 48v–49r, 52r; 1625: 68) (Sect. 3.2.7, fn. 40). But how can this be possible given that concoction occurred during sleep, and digestion during waking hours? According to Sanctorius's differentiation, concoction described the transmutation of substance and referred to the first two stages in the digestive process. Digestion, on the contrary, was, according to him, the transmission of nutrition; and it referred to the third and final step in the digestive process, the step during which *perspiratio insensibilis* was excreted. Why then did the body perspire insensibly during sleep at all? Why even twice as much as when awake? The only conclusion that I can draw is that Sanctorius was simply not able to conclusively integrate his novel observations with the weighing chair into the Galenic concept of sleep. The merging of old and new ideas was certainly not always easy and the way in which Sanctorius coped with the problem is telling for an understanding of his works. Hence, a closer look into the *De statica medicina* will reveal more about how Sanctorius connected insensible perspiration with sleep and waking hours.

According to Sanctorius, sleep and perspiration were interdependent. He wrote: "The things which impede sleep, also impede the perspiration of cooked perspirable matter" (Sanctorius 1614: 50r).[78] By the same token, short sleep was produced by the acrimony of retained perspirable matter, and a minor perspiration announced restless sleep and a tiresome night. Ultimately, both, good sleep and healthy insensible perspiration were determined by undisturbed concoction. As was mentioned

[77] In the 2001 edition of the *De statica medicina*, Giuseppe Ongaro erroneously referred to natural spirits in his translation of aphorisms XLVII and XLVIII (in the 1614 edition aphorisms XLVIII and XLIX), which describe the physiological processes during sleep and waking. With the knowledge of Sanctorius's commentaries and his denial of the existence of a natural spirit (see Sect. 3.2.6, fn. 36), I argue that Sanctorius referred here rather to the three faculties (*facultates*), or their respective virtues (*virtutes*) than to spirits. See: Sanctorius and Ongaro 2001: 144 f., Sanctorius 1614: 58r.

[78] "Quae impediunt somnum, impediunt quoque perspirationem cocti perspirabilis." See: Sanctorius 1614: 50r.

above, Sanctorius not only stated that insensible perspiration was more abundant during sleep, but also that it was of a different kind than insensible perspiration that occurred during waking hours (Sect. 3.2.7). This differentiation of *perspiratio insensibilis* seems to correspond to Sanctorius's differentiation between concoction and digestion along the same lines as between the rest or the movement of the body. While the perspirable matter that was produced during sleep was *cooked*, Sanctorius described perspiration that was expelled during waking hours as *crude*. What is more, the cooked perspiration that occurred during sleep seems to have been more beneficial. Contrary to its counterpart, it increased strength (Sanctorius 1614: 5r, 50r–50v, 53r; 1634: 50r). Sanctorius's solution to reconcile his discovery of the high amount of *perspiratio insensibilis*, which was expelled during sleep, with the Galenic differentiation between concoction and digestion was, it seems, the introduction of two different kinds of *perspiratio insensibilis*. A detailed explanation of the weighing procedures will be given below to further elucidate how Sanctorius connected his quantitative findings with Galenic physiology (Sect. 7.5).

Sleeping Times and Duration of Sleep Following the functions of sleep described above, namely the performance of concoction, the restoration of heat, and the regeneration of the spirits, the duration of these processes also determined the healthy length of sleep. This duration, however, was influenced by the individual complexion of the body. And so Sanctorius explained that warm bodies needed short sleep, while cold bodies needed longer sleep. In a warm brain, the moisture, which caused sleep, was quickly dissipated and the flow of animal spirits could not be hindered for long, as moving, spreading out, and diffusing from the center to the outside was characteristic of heat. But in a cold brain, the animal spirits could be hindered longer, as cold things naturally rested and withdrew heat for the sake of concoction (Sanctorius 1612a: 358, 364; 1612b: 79).

In the *Commentary on Avicenna*, Sanctorius explained that, according to Galen, the quantity of sleep varied, depending on which food was consumed beforehand. If lettuce was eaten for dinner, long sleep followed; if spices were eaten, short sleep followed. Hence, suitable sleeping times could vary between 7, 8, or 9 h.[79] This parallels the discussion mentioned above, as to whether the midday meal or evening meal should be larger (Sect. 3.3.2). As the duration of sleep was connected to the duration of concoction, it was only consequential that food also determined the duration of sleep. This instance illustrates well the interconnection between the different non-natural things. Food and drink, just like sleep and waking hours, had a major influence on the physiology of the body, especially on the digestive process, and had to be harmonized with each other in order to preserve health. They could not be treated in isolation. In the *De statica medicina*, Sanctorius wrote: "From food comes sleep, from sleep concoction, and from concoction a good transpiration"

[79] According to Ken Albala, Renaissance dieticians often recommended lettuce to combat sleeplessness, following Galen. See: Albala 2002: 137.

(Sanctorius 1634: 50r).[80] Accordingly, if one went to bed with an empty stomach, the amount of insensible perspiration was three times less than usual (Sanctorius 1614: 52v; 1625: 69).

Just as knowledge of the duration of the distinct stages in the digestive process disclosed the ideal time to eat, it also indicated the ideal sleeping time. Sleep should stop as soon as the first two stages of digestion had been completed. Sanctorius connected these stages with a certain kind of beneficial *perspiratio insensibilis* and it seems that he based his recommendation for a general duration of sleep on the amount of this perspiration excreted. In the *De statica medicina*, he specifically and positively referred to 7 h of sleep, which implies that this is the time by which concoction was completed and a healthy amount of *perspiratio insensibilis* excreted (Sanctorius 1614: 48v–49r, 52r, 59v).

But again, things are not that easy. Sanctorius wrote that it was very beneficial to sleep around 4 h after eating, as the body during this time was less occupied with the first concoction and better able to restore what was lost. Moreover, this favored perspiration. Why did he not recommend sleeping directly after eating, as sleep was the time when the first two stages of concoction took place? In the *Commentary on Avicenna*, Sanctorius explained that sleep should not, per Avicenna, begin directly after supper, because the food should arrive first at the bottom of the stomach in order to be concocted during sleep. This was why Galen recommended a brief walk before going to bed. However, 4 h seems a long time for the food to arrive at the bottom of the stomach. And what is more, Sanctorius implied that the first stage in the digestive process started before sleep began. The solution to this riddle lies in the following citation, taken from the *De statica medicina*: "He who concocts and digests well every day will really have a long life: concoction occurs during sleep and rest; digestion during waking hours and exercise" (Sanctorius 1634: 50v).[81] Hence, it was possible that concoction occurred while awake, as long as the body rested. In turn, digestion could also take place during sleep, if the body moved. However, while Sanctorius pointed to the beneficial effects of yawning and stretching of the limbs immediately *after* sleep for the expulsion of insensible perspiration, he did not say a word about the effects of movement *during* sleep on insensible perspiration.[82] At least, not in this section. The analysis of the next non-natural pair, exercise and rest, may bring more to light. But first, some other aspects of sleep and wake must be mentioned (Sanctorius 1614: 53v–55v; 1625: 69).

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[80] "A cibo somnus, à somno coctio, à coctione utilis transpiratio." See: Sanctorius 1634: 50r.

[81] "Ille verè longaevus, qui quotidie bene concoquit, & digerit: coctio fit somno, & quiete: digestio vigilia & exercitio." See: ibid.: 50v.

[82] Following Sanctorius's differentiation between concoction and digestion it makes total sense that slight movements that occurred directly after sleep promoted the excretion of insensible perspiration. The perspirable matter was concocted and refined during sleep and was then ready to be expelled by the body during the third and final step of the digestive process: digestion, which occurred during waking and exercise. In another passage of the *De statica medicina*, Sanctorius wrote that the hour of the best perspiration was usually in the period of two hours after sleep (Sanctorius 1614: 55r–55v). It remains the question why insensible perspiration was twice as big during sleep than during waking.

Whatever the duration of sleep and its timing with regard to eating, sleep and wake had also to be arranged according to the time of day. Daytime sleep, Sanctorius wrote, was not as beneficial as nighttime sleep. He explained that the animal spirits were luminous (*lucidi*), and therefore were diverted by the sunlight in the daytime, when being drawn back into the inside of the brain during sleep. As a result, daytime sleep occurred with violence, because the animal spirits could be retained in the interior parts of the brain only with violence. By contrast, at nighttime the air was colder and innate heat withdrew easily into the inner parts of the body and was retained without violence there, which was why nighttime sleep was more quiet and more pleasant.[83] With regard to insensible perspiration, a midday sleep could, however, also be useful. In the *De statica medicina*, Sanctorius explained that it served to excrete perspiration that had been retained the day before (Sanctorius 1612a: 80; 1614: 55v–56r; 1625: 68 f.).

With regard to the seasons, Sanctorius was of the opinion that sleep was longer in winter and spring, and shorter in autumn and summer. In this context he suggested that the length of sleep was derived not from the weakness of the spirits, but from their concentration inside of the body. During winter, because of the external cold, the concentration was stronger and sleep therefore longer. Moreover, the external cold made the influent heat, which came from the sensory organs, withdraw more easily inside, into the body. In spring, he wrote, sleep was longer than in summer and autumn, because of the predominance of blood (Sect. 3.3.1). As blood was a sweet humor and without acrimony, sleep was longer.[84] Contrariwise, acrimonious, bilious, and melancholic humors encouraged wakefulness. According to Sanctorius, sleep in winter was more salutary than in summer, not because of the length of sleep, but because the bodies grew warmer before dawn in winter and as a result perspired very much, whereas they were colder in summer and perspired less (Sanctorius 1612b: 82; 1614: 56v; 1629a: 376 f.).[85]

One last remark has to be made about Sanctorius's conception of sleep and wake. In the *De statica medicina*, he wrote that the exhalation of sleeping bodies was so abundant that not only the sick who slept with the healthy, but also the healthy among themselves mutually communicated good and bad dispositions (Sanctorius 1614: 60v). This implies that Sanctorius thought that vapors, most likely insensible perspiration, could be transmitted from body to body and might affect their health and disease. It is, however, difficult to make sense of this statement, as Sanctorius did not pursue the idea any further. Interestingly, he did not connect it with his

[83] Sanctorius's reference to the luminosity of animal spirits fits his suggestion that animal spirits emanated an incorporeal radiation that caused sensation and voluntary motion (see Sect. 3.2.6, fn. 37).

[84] In Galenic humoral theory, the distinction between the humors was also by taste: blood was sweet, yellow bile was bitter, black bile was sour, and phlegm was salty. See: Jouanna 2012: 339, fn. 20.

[85] In this context, see also the discussion of the effects of cold and warm air on the body and on its excretion of insensible perspiration in 3.3.1.

notions of plague, or air. Another case, in which there are more questions than answers.

To sum up, Sanctorius generally followed the Galenic conception of sleep and wake. However, his new focus on *perspiratio insensibilis* required a reworking of the traditional notions of sleep and wake, as was the case for all the other six non-naturals, too. However, what makes his treatment of sleep and wake so interesting is that inconsistencies occur. Seemingly, Sanctorius was not able to coherently integrate his novel finding, the high amount of insensible perspiration which was expelled during sleep, into the traditional medical framework. Therefore, this section provides a valuable insight into the way in which Sanctorius struggled to compromise between innovation and tradition, between new and old ideas. It reveals how he handled this struggle and presented it to his readers and pupils. It is observations like these that contribute to an understanding of how Sanctorius developed and stabilized his static doctrine.

3.3.4 Exercise and Rest

Playing ball, walking, swimming, horseback riding, jumping, and dancing—the list of exercises Sanctorius mentioned in the *De statica medicina* reads like the program of a modern sports center. However, on closer examination, one finds also activities like tossing and turning in bed, frictions, being treated with cupping glasses, and travelling in a boat, palanquin, or carriage, as well as exercises of the mind that can certainly not be counted among current leisure activities, or be included in present-day workout plans. In line with Galen, Sanctorius described exercise as a movement during which a change happened and breathing altered. These aspects distinguished exercises (*exercitia*) from other movements (*motus*). Closely connected to the topic of exercise were periods of relaxation, as the proper alternation between activity and rest was thought to be crucial to a healthy life. Hence, in Galenic medicine the concept of exercise was somewhat broader than our modern notion of exercise as an activity chosen in moments of free time (Sanctorius 1612b: 64; 1614: 61r–67v).

The suitable quantity of exercise for a temperate body was, so Sanctorius, until the body started to tire. Referring to Hippocratic-Galenic teachings, the physician pointed out the importance of a body not continuing to exercise upon reaching this point, as only the first signs of fatigue could be easily and immediately remedied by rest. If a body experienced real fatigue, exercise was unhealthy. Avicenna had suggested, as Sanctorius explained, that exercises should be done until vaporous sweat occurred. If sweat turned fluid, further exercise should be avoided (Sanctorius 1612b: 63 ff.). This relates to the above discussion of the connection between movement and sweat (Sect. 3.2.7). Given Sanctorius's ambiguous attitude toward sweat and his conviction that this excretion only emerged with violence, it is likely that he interpreted Avicenna's vaporous sweat as insensible perspiration. Understood in this way, exercise was healthy as long as insensible perspiration was expelled; and

it became harmful once the body started to sweat. This is also in line with the beneficial effects that Sanctorius connected with exercise.

Beneficial Effects of Exercise Referring to Hippocrates, Galen, and Avicenna as authorities on the matter, Sanctorius described three benefits of exercise. First, it rendered the muscles hard and very robust, and hence less susceptible to fatigue and pain during exercise. Secondly, it disposed the body to resolve excrements via insensible perspiration. And thirdly, it carried nourishment to the parts that needed to be nourished. As movement was the cause of heat, the internal heat was increased during exercise, which led to an augmentation of the attractive and the distributive faculties. Therefore, the digestive process and nutrition were better performed. Moreover, the spirits became finer and faster and therefore readier to act. Due to these physiological processes, bodies became lighter with exercise, as Sanctorius explained in the *De statica medicina*. While, today, losing weight is one of the main motivations for exercising, in Sanctorius's day, it was not necessarily considered beneficial. A median body size was the medical and cultural ideal, so dietetics did not put great emphasis on keeping the body slim. Too much exercise was even seen as positively harmful. According to Sanctorius, violent exercise speeded up the aging process and increased the risk of premature death (Sanctorius 1612b: 64 f.; 1614: 62v–63r, 65r; 1625: 64, 96, 369; 1629a: 385 f.).

Time of Exercise In connection with the functions and beneficial effects of exercise, its timing was determined by a number of conditions. Sanctorius's comments and suggestions on this topic were again based on Galenic and Galenist dietetics. Physical exercise should be done before meals, when the first two stages of digestion were completed. It was most healthy, Sanctorius argued in the *De statica medicina*, if the body returned to its usual weight two times a day, before eating. Moreover, before exercising, the body had to be free of superfluities, most importantly, of crude humors. During exercise, crude humors would be distributed throughout the body and produce adiapneustia, defective perspiration. Immediately after exercise, the body should rest and under no circumstances eat. Food would not restore the body's exhausted virtue, but rather, overwhelm it. Aggravated by the food, the body would also perspire less. Therefore, one should eat only when the heat, produced during exercise, has dissipated (Sanctorius 1612b: 65, 68; 1614: 62r, 66r; 1629b: 144).

Based on these considerations, Sanctorius recommended a moderate lunch and a substantial supper. To make sure that the foodstuffs ingested for lunch were concocted and healthy, they should be easy to digest; also, exercise could be done before supper. Supper, on the contrary, had to be of more copious and solid foodstuffs, as sleep would follow, and a longer time period in which exercise might be done before the next meal. Following his advice on mealtimes, according to which 9 to 10 h must be scheduled between lunch and supper, and 14 to 15 h between supper and lunch (Sect. 3.3.2), Sanctorius wrote that 1 h exercise in the period from 7 to 12 h after eating produced more insensible perspiration than 3 h exercise at any other time (Sanctorius 1612b: 68; 1614: 62r–62v). Considering that Sanctorius

suggested elsewhere that one should sleep around 4 h after eating (Sect. 3.3.3), living according to his schedule turns out to be a complicated task. It was already mentioned that in his treatment of the non-natural pair, sleep and wake, there are inconsistencies which, together with the complex timing of the various non-natural things, highlight a tension between his recommendations and their individual implementation. Sanctorius not only struggled to reconcile his novel quantitative findings with traditional medical theory, but also to accommodate his newly formulated rules to their practical application, and vice versa. This raises the question of the feasibility of the static aphorisms, which will be addressed later, when analyzing the practical and material aspects of Sanctorius's work.

Exercise and Sleep In the previous section on sleep and wake, I pointed to the issue of reconciling the Galenic differentiation between concoction and digestion with Sanctorius's observation that insensible perspiration was twice as great during sleep as during wake (Sect. 3.3.3). Digestion, the third stage in the digestive process and the one that produced insensible perspiration, occurred, according to Sanctorius, during wake and exercise. Did Sanctorius reveal more on the effect on insensible perspiration of movement *during* sleep, in the present section? Does this explain why insensible perspiration and, hence, digestion also took place during sleep? Not quite. In the *De statica medicina*, Sanctorius wrote: "A body perspires much more when resting in bed than when tossing and turning with frequent and repeated agitation" (Sanctorius 1614: 61v–62r).[86] Accordingly, if the body moved at night, insensible perspiration was less and, hence, digestion was neccessarily hindered.[87] Thus, exercise at nighttime had different effects than exercise in the daytime. This, however, fits with the suggestion that exercise should be done only after the first two stages in the digestive process were complete, which is to say, concoction, which occurred during sleep when the body rested. How digestion and, consequently, the excretion of insensible perspiration happened during sleep remains an open question. Be that as it may, Sanctorius, drawing on his quantitative findings, explained that the body perspired less during exercise than during sleep. Around 10 h after supper, provided that the body had rested in bed during this time, insensible perspiration was optimal (Sanctorius 1614: 61r, 63r–63v, 65v).[88]

[86] "Longe magis perspirat corpus in lecto quiescens, quam in lecto frequenti & crebra agitatione circumvolutum." See: Sanctorius 1614: 61v–62r.

[87] One may argue that tossing and turning in bed was rather considered as movement than as exercise and hence did not have the same effects. However, the fact that Sanctorius included the quoted aphorism in the section on exercise and rest suggests that he counted tossing and turning in bed among exercises. Moreover, in an aphorism of the section on sleep and wake, Sanctorius compared the movement of the body in bed to a speedy run, which further implies that he considered movement in bed to be exercise. See: ibid.: 51r.

[88] This corresponds to the characterization of the early morning as the most propitious moment for purging put forward by the medieval rules of health (*regimina sanitatis*). At this particular time, the kidneys and bladder were thought to excrete superfluous material, which had been generated during the second stage of the digestive process. See: Sotres 1998: 311.

Forms of Exercise The variety of exercises to which Sanctorius referred in the *De statica medicina* was already mentioned above. But what was the most beneficial way of exercising? Which sports did Sanctorius recommend? With regard to the different ways of horseback riding, Sanctorius explained that trotting was the healthiest, while gallop was the least healthy. Walking was healthier than being transported in a palanquin or a boat, as it prepared the body better for the necessary perspiration. However, going by boat or by palanquin for a long time was very healthy, because only then did it dispose the body extraordinarily for the necessary perspiration. Going by carriage was the most violent movement of all, because it made the uncooked perspirable matter exhale and harmed the solid body parts, especially the kidneys, so Sanctorius. Discus exercise was good for perspiration and moderate dance without jumping was nearly as commendable as moderate walks, given that it expelled the cooked perspirable matter in moderation. In view of these statements, it seems that Sanctorius considered walking to be the best and healthiest exercise, also with regard to its effect on insensible perspiration, just like the physicians in Ancient Rome and the authors of the medieval rules of health (*regimina sanitatis*), to whom I refer in Sect. 4.1.2, (Sanctorius 1614: 66v–67v).

Exercises of the Mind Besides muscular activity, Sanctorius also wrote of exercising the mind, as was common in contemporary discussions of the topic. In doing so, he anticipated his treatment of the non-natural thing, affections of the mind.[89] The activity of the mind was important with regard to the excretion of insensible perspiration, because it especially evacuated insensible excrements, mainly from the heart and the brain, as Sanctorius explained. This meant, above all, that the smoky vapors, produced during the formation of the vital and animal spirits (Sect. 3.2.6) were excreted by the exercises of the mind. Among them, anger, great joy, fear, and sorrow made the spirits exhale the most. Along this line of thought, too much rest of the mind impeded perspiration more than too much rest of the body. And bodies that rested in bed, but were agitated by an intense emotion usually resolved more and lost more weight than bodies that were agitated by an intense physical activity, but with a calm mind. Here, too, moderation was the rule. Just like any violent exercise of the muscles, any violent activity of the mind made aging faster and dying sooner more likely (Sanctorius 1614: 64r–65r).

From the preceding paragraphs it becomes clear that Sanctorius followed traditional Galenic concepts with regard to exercise and rest. In accord with the non-naturals already considered, the novelty lies, here, too, in his focus on insensible perspiration and body weight. Given the fact that exercise and rest are the fourth non-natural pair scrutinized in this chapter, the complex interrelations between the different non-natural factors come more and more to the fore. Sanctorius's newly formulated rules, which were meant to guarantee a healthy insensible perspiration and, consequently, a healthy body weight and general well-being, must at times

[89] The physiological processes that were connected to the exercises of the mind will be explained below in the section on the affections of the mind, see Sect. 3.3.6.

have been difficult to reconcile with each other, in everyday life, as the proper timing of the different non-natural factors reveals. This is important when it comes (in Sect. 7.5) to consideration of the practical application of the *De statica medicina*, namely the questions of how the weighing procedures were conducted, and of the relation between theory and practice.

3.3.5 Coitus

In contrast to the common list of the six non-naturals (Sect. 3.1), the sixth section of the *De statica medicina* does not examine evacuation and repletion in general, but only with regard to the effects of sexual activity (Fig. 3.1).[90] In the *Commentary on Galen*, Sanctorius gave a possible explanation for this choice by stating that he reduced coitus not to excreted or retained matter, but to movement, that is, to those things that happened. The *Isagoge Johannitii*, which included coitus as a special category in the list of the non-naturals, may also have encouraged his separate treatment of sexual activity (Sect. 3.3.1). What is more, Sanctorius's general shift to the effect of the non-naturals on insensible perspiration and the potentially important influence of coitus on its excretion may likewise have contributed to this decision. It may also be seen as a manifestation of his social environment: sexual activity seems to have been an important aspect of the daily lives of Sanctorius's patients and readers, so it seems hardly surprising that he dealt with it in detail in his rules for a healthy life (Sanctorius 1612b: 90 f.; see also Sanctorius 1603: 166r).

The Role of Females Before turning to Sanctorius's physiological concept of coitus and its relation to *perspiratio insensibilis*, it is important to note that Sanctorius geared the *De statica medicina* to a male audience. Reflecting the tendencies of the dietary literature of the time, he made no mention of female arousal and did not specify women's needs in particular. Only one aphorism of the section on coitus refers to women, explaining that excessive coitus with the most coveted female does not make one feel exhausted. Hence, it is from a male perspective that Sanctorius reconsidered the rules for a healthy lifestyle; and certainly, his audience was predominantly male. In the *Commentary on Avicenna*, Sanctorius revealed a rather misogynist attitude to women, when he stated that female concupiscence was not directed toward sexual pleasure, but was merely a means of gaining tyrannical control over men (Sanctorius 1614: 69r; 1625: 384; Siraisi 1987: 303).

The Physiological Concept of Coitus In Renaissance physiology, generation was closely tied to nutrition. Sperm was produced during the final stage of the digestive process, and it was generated from an excess of blood remaining after the body had been nourished. This unused nutritive material that was equal to almost completely

[90] The topic of coitus was usually subsumed under the non-natural pair of evacuation and repletion. See: Sanctorius 1612b: 91, Sotres 1998: 312, Albala 2002: 143.

assimilated food was directly converted into sperm. This applied to both sexes. According to Galen, both males and females had a form of sperm. In the female body, however, abundant blood that was not converted into sperm was naturally evacuated in the form of monthly menses. During pregnancy, the menstrual blood fed the growing embryo and, after the delivery, it was transformed into milk and conveyed to the breast. Accordingly, sperm, blood, and milk resulted from the same basic substance, and all were the direct product of the food first ingested. Thus, the diet of both sexes directly influenced reproduction (Van't Land 2012: 363–74). When Sanctorius discussed generation, he followed this physiological thinking, which was largely based on ancient beliefs, especially on Aristotle. Unsurprisingly, in matters of dispute between Aristotelian and Galenic theories of generation, Sanctorius followed the latter, as for example with regard to whether females actively contributed to the formation of the fetus, which Aristotle had denied (Sanctorius 1612b: 98; 1625: 656 f.). Without diving into the vast topic of Renaissance embryology, the following passages will focus on Sanctorius's notions with regard to the importance of coitus for maintaining health and, most importantly, for the excretion of insensible perspiration.

Beneficial Effects of Coitus Sanctorius, referring to Galen, explained that coitus was healthy when it was done with sufficient pauses in between. Only superfluous semen should be expelled, in order that the body be relieved and its strength increased. But due to the variety of the individual complexions and the different foodstuffs consumed, it was difficult to generally determine the lengths of the intervals between sexual activities. Warm and moist bodies, for example, regenerated semen more quickly than warm and dry bodies, and people who ate oysters and cooked onions or capons were more quickly prepared for coitus than people who ate lettuce and cabbage. This was why Galen put forward two precepts from which everyone could derive the individual pause needed between one coitus and the next, per Sanctorius. First, if a person was lighter, more agile, and readier to fulfill all duties after coitus and, second, if inhalation was better and easier, one knew that there had been a suitable interval between sexual activities. The reasons for this were that a copious semen, if retained, choked heat and thereby diminished the animal, vital, and natural operations and, especially, slowed down respiration (Sanctorius 1612b: 90 f.).[91]

On the basis of his observations with the weighing chair, Sanctorius argued that a body did not only *feel* lighter and more agile after useful coitus, but that the actual bodyweight also always diminished after sexual activity. Interestingly, this weight loss had to be compensated during subsequent sleep, after which, as Sanctorius wrote in the *De statica medicina*, there should be no change in weight, if coitus was

[91] According to Galenic medicine, operations (*operationes*) were functions of particular organs. They were subdivided into animal, vital, and natural operations and included for example imagination, the five senses, movement, respiration, or digestion. These operations were associated with respective virtues and faculties (Sect. 3.3.3, fn. 77) (Sanctorius 1625: 91, Siraisi 1990: 107 ff.).

proper. However, Sanctorius was somewhat ambiguous on this point, because in another aphorism he explained that generally old people became heavier by a moderate use of coitus, while young people became lighter. Further salutary effects of coitus, which Hippocrates and Galen promised and which Sanctorius seems to have accepted, were that it made a person more daring and less irascible, that it procured sleep, prevented inflammations of the groin, and removed the heaviness of the head. It is remarkable that Sanctorius did not deal with the beneficial effects of coitus with regard to insensible perspiration per se in the *De statica medicina*. Instead, he focused on the dangers of excessive coitus, from which the salutary effects of sexual activity could only be deduced. This may reflect his experience as a physician, which probably taught him that many of his patients "used Venus" excessively (Sanctorius 1612b: 95, 99; 1614: 68v, 69v, 74r).

Harmful Effects of Coitus Right at the beginning of the section on sexual activity in the *De statica medicina*, Sanctorius wrote: "Both too much abstinence from coitus and the excessive use of it impede perspiration; but the excessive use, more so" (Sanctorius 1614: 68r). Hence, as with all non-natural factors, moderation was the key. A healthy body continuously produced an abundance of sperm, which, as soon as it built up an excess, required expulsion by means of sexual activity. Otherwise, the retained sperm would harm the body. Sexual desire signaled the build-up of sperm and was therefore a sign of useful coitus. The higher the libido, the healthier was the frequent use of coitus. However, if there was no excess of sperm, coitus was not required, and sexual activity was immoderate and harmful. Sanctorius explained that the afflictions which resulted from excessive coitus depended indirectly on impeded perspiration and directly, on a harmed digestive process. Immoderate sexual activity resolved spirits and heat, cooled the body, and led to the perspiration of crude matter. Innate heat was diminished, the stomach cooled and, therefore, the digestive power reduced. Consequently, less insensible perspiration was excreted. From this resulted tremor and flatulence. Besides the stomach, excessive coitus damaged mostly the eyes, per Sanctorius. It removed a large amount of spirits from the eyes, which rendered the tunics of the eyes very hard and rough, and the channels less penetrable. As a consequence of diminished perspiration, the fibers that formed the tunics of the eyes became opaquer. Therefore, vision occurred through very small passages, as if through a lattice. Glasses, which united the objects in a single point, were needed so that one might see distinctly through one space only. This explanation of the harmful effects of coitus on vision originated with Sanctorius. However, the fear of a weakening of the eyesight effectuated by an overdrying of the brain through immoderate sexual activity was common at the time (Sanctorius 1603: 123v; 1612b: 91; 1614: 68v, 69v–70v, 71v–72r).[92]

[92] For an account of early modern medical concepts of vision and of the general Galenic framework on which they are based, see: Boudon-Millot 2012, Vanagt 2012. Early modern medical perspectives on eyeglasses are dealt with in Vanagt 2010. For more information on Sanctorius's notion of optics, see Sect. 4.2.3.

On the other hand, abstinence from coitus entailed its own set of harms. Sanctorius alluded here again to Galen and described six effects of retained semen: heaviness of the head, disgust for food, risk of fever, diminished concoction and digestion, numbness, and fear. These afflictions could be traced back to the sympathy or consent that Sanctorius thought to exist between the different body parts (Sect. 3.2.10), as well as to acrimonious vapors, which were raised by the retained semen and perturbed the organs. No purging drugs nor other changing aids could help, as the only cure was coitus. But semen could not only harm with regard to its quantity, but also with regard to its quality. If semen was corrupted, poisonous vapors arose and, transmitted to the organs, corrupted them as well. This might generate very serious affections, such as strokes or catalepsy. Because good semen enhanced strength, its corruption resulted in the opposite, that is, in the worst afflictions, as Sanctorius explained. Healthy concoction and digestion as well as regular sexual activity were thus crucial for a suitable quantity and quality of semen (Sanctorius 1612b: 91, 93; 1625: 649).

According to the various constitutions of individuals, improper coitus could have numerous other harmful effects. It might diminish memory and strength, warm the liver and the kidneys, produce toothache, bad breath, or bloody spittle as well as nephritis or diseases of the bladder. In any complexion, however, excessive coitus ultimately cooled and dried, thereby accelerating the aging process, as the latter was also a matter of cooling and drying (Sanctorius 1612b: 99). In order to evade the harmful effects of sex and to make sure that it was healthy, proper timing was of course important.

Time for Coitus Following the teachings of Hippocrates, Galen, and Avicenna, Sanctorius defined the proper time for coitus as subsequent to sleep. The first and second stages of the digestive process had to be completed, while the third stage should be advanced but not finished. The reasons for this were that semen was made from the food ingested during lunch and supper, which was only concocted during sleep. After sleep, when the semen was concocted, the body was primed for reproduction. In fact, according to Sanctorius, this was also the time when coitus was most suitable for producing offspring, as the semen was not only well-cooked, but also stuck more tenaciously (Sanctorius 1612b: 93 f., 98–101; 1634: 62r).

Hence, in the section on coitus, Sanctorius again adhered to traditional Galenic conceptions, while shifting the focus to body weight and to the excretion of insensible perspiration. Contrary to the common list of the six non-natural things, Sanctorius identified coitus itself as a non-natural factor, which hints at its importance with regard to body weight and insensible perspiration. Moreover, his frequent warnings about excessive sexual activity probably reflect the sexual life of his distinguished Venetian clientele. The male perspective that Sanctorius adopted in this section reveals that he addressed the *De statica medicina* to a male audience and raises the question as to whether he included females in his weighing procedures—a question which will be considered in Sect. 7.5.4.

3.3.6 Affections of the Mind

In medieval and Renaissance medicine, mind and body were inextricably interwoven. There was thought to be a mutual influence: of the body upon the mind, and of the mind upon the body. Physical health and mental health could not be separated. On the one hand, the humors were directly linked with emotional states, character traits, and dispositions of the mind. Hence, the predominance of one humor in the body did not only determine whether some people were, for example, hotter and moister compared to others (Sect. 3.1.2), but also referred to psychological characteristics. According to their individual complexions, people could be described as sanguine, choleric, phlegmatic, or melancholic, with each of these attributes being connected to one of the humors: sanguine to blood, choleric to yellow bile, phlegmatic to phlegm, and melancholic to black bile (Fig. 3.2). On the other hand, changes in emotion altered the humors and digestion, which is why moderation was praised here, too, in order to keep the passions in balance. In fact, sudden emotions were thought to be especially dangerous and might even lead to death. To understand how emotions such as joy or sorrow could produce an alteration in the complexion, or actually pose a threat to life, a look at the associated physiological processes is required.

Physiological Concept of Emotions Sanctorius's treatment of exercises of the mind in the section on exercise and rest in the *De statica medicina* has already highlighted the connection between emotions and movements (Sect. 3.3.4). However, in this context movement does not refer to muscles, bones, or body parts, but to heat and the spirits. Following the common Galenic physiological understanding of emotions, Sanctorius thought that emotions could produce two different movements. Depending on the different mental affections, vital spirit and heat either moved from the heart to the extreme parts, or the other way around, from the exterior parts toward the center of the body. While the first movement was the natural movement of heat and therefore usually quite harmless for healthy people, the second movement was unnatural and rendered the body cool and dry. Excessive emotions suddenly moved the spirits and heat to such a degree that they harmed the body by corrupting or burning the spirits. Similarly, great joy could lead to death, as too much heat was moved to the exterior parts, whereby innate heat was extinguished (Sanctorius 1603: 116r; 1612b: 41 f., 89 f.; 1625: 66 f., 369; Ottosson 1984: 263).

The close relation between emotions and spirits may account for Sanctorius's conviction, mentioned above (Sect. 3.3.4), that exercises of the mind were important with regard to insensible perspiration, as they mainly excreted the smoky vapors produced during the formation of the vital and animal spirits. The fact that emotions were equally closely connected to the innate heat of the body, which determined the digestive power, explains how affections of the mind could disturb the digestive process and how a defective digestive process could produce harmful emotions. In his work *De remediorum inventione*, Sanctorius stated that passions of the mind rendered the stomach weak, sometimes because they scattered the heat flowing to

the stomach, and sometimes because they corrupted the spirit, which together with innate heat, effected concoction (Sanctorius 1629b: 109). This direct causal relation between the digestive process and emotional wellbeing highlights the correlations between affections of the mind and insensible perspiration.

The Division of Emotions In the *De statica medicina*, Sanctorius identified four basic emotions from which all the others could be inferred: anger (*ira*), great joy (*pericharia*), fear (*timor*), and sorrow (*maestitia*). These corresponded to the exercises of the mind that, according to Sanctorius, made the spirits exhale most (Sect. 3.3.4). He organized them into contrasting groups according to their effect on body weight. While anger and great joy rendered bodies lighter, fear and sorrow increased body weight. This was because in fear and sorrow only light matter was perspired, while heavier materials remained in the body. On the contrary, in joy and anger both, light and heavy matter was expelled. Along the same lines, an excess of retained heavy perspirable matter disposed a person to fear and sorrow, whereas an obstruction of lighter perspirable matter, to anger and joy. The *Pantegni*, one of the most influential general medical textbooks in the Middle Ages and the Renaissance, reduced the passions of the mind to six: joy (*gaudium*), distress (*tristitia*), fear (*timor*), anger (*ira*), anxiety (*angustia*), and shame (*verecundia*).[93] Of these, anxiety, joy, fear, and anger were the main four passions discussed by medieval and Renaissance Galenists. They were conceptualized as the "accidents of the soul" or "affections of the mind" and normally considered to be the sixth of the non-natural factors. Thus, Sanctorius's division of emotions was very much in line with traditional medical thought, even though he deviated slightly from the common list of the basic emotions, by referring to sorrow instead of anxiety.[94] However, the classification criterion put forward in traditional accounts of the affections of the mind was different from Sanctorius's: instead of body weight, the movement of the vital spirit was the decisive factor. Joy and anger were associated with the movement of the vital spirit from the heart to the extreme parts, and anxiety and fear, with the movement toward the heart. Sanctorius thus shifted the focus from the movement of the spirits to body weight and to the excretion of insensible perspiration, while still remaining in the traditional Galenic framework. It seems that the different movements of heat and spirit had, according to Sanctorius, a direct bearing on *perspiratio insensibilis* (Sanctorius 1614: 75r–76r).

[93] The *Pantegni* was a Latin rendition of 'Alī ibn al-'Abbās al-Majūsī's (Lat. Haly Abbas, fl. tenth century) Arabic *Kitāb Kāmil aṣ-Ṣinā'a aṭ-Ṭibbiyya*, (The Complete Book of the Medical Art), written by Constantine of Africa (d. 1087). The work was largely based on Galen's writings and, together with Avicenna's *Canon* and the *Isagoge Johannitii*, numbered among the most influential general medical textbooks in the Middle Ages and the Renaissance (Siraisi 1990: 12, 14, 110).

[94] The emotion "anxiety" (*angustia*) was termed differently by different medieval and early modern medical authors and was for example often referred to as "distress" (*tristitia*). Thus, it can be assumed that Sanctorius had the same emotion in mind when using the term "sorrow" (*maestitia*). It has to be noted that modern English translations vary, too (e.g., *tristitia* is sometimes translated as sadness and *angustia* as distress). See: Knuuttila 2004: 215 f., Carrera 2013: 115–26.

Interestingly, Sanctorius related the division of the four basic emotions only in the *De statica medicina* to body weight and insensible perspiration, while he remained completely in the traditional scheme in his other works, including those published after 1614 (e.g., Sanctorius 1612b: 42; 1625: 66 f.). Instead of pursuing his characterization of the basic emotions according to their effect on body weight, he repeatedly explained that he followed Aristotle's twofold division, according to which all the affections of the mind could be reduced to pleasure and pain (Sanctorius 1612b: 89; 1625: 65).[95] This makes it difficult to understand which conception of emotions Sanctorius actually held and to what extent it was influenced by his observations with the weighing chair. The fact that he published in 1634 a second revised edition of the *De statica medicina*, in which he added one aphorism to the section on the affections of the mind, suggests that he still supported the views he expressed in the original work, even though he did not refer to them in his other books.

Healthy and Harmful Emotions In correspondence to their effect on body weight and insensible perspiration, Sanctorius's two groups of emotions can be characterized as healthy (anger and great joy) and unhealthy emotions (fear and sorrow). This is analogous to the traditional classification of emotions according to the two movements of the vital spirits, which considered one movement to be natural (from the heart to the exterior parts) and hence positive, or healthful and the other to be unnatural (from the exterior parts toward the heart) and hence negative, or unhealthful. Accordingly, medieval and early modern medical authors commonly agreed on the harmful effects of fear and sorrow and praised joy as a healthy passion. The opinions with regard to anger were, however, varied. Usually conceived as a deleterious emotion that should be avoided, anger was also sometimes described as beneficial to health (Carrera 2013: 132–43). Yet, Sanctorius's positive view of anger as an emotion which was closely connected to joy, is exceptional. In the *De statica medicina*, he often contrasted anger and joy with fear and sorrow, explaining the healthy and harmful effects of these two groups of emotions. Angry or cheerful people, for example, did not feel fatigue when travelling, because their bodies easily excreted thick perspirable matter, contrary to people who were troubled by fear or sorrow. As the latter only excreted the lighter parts of insensible perspiration and the heavier parts remained in their bodies, they often suffered from obstructions, a hardening of the parts, and hypochondriac affections. While joy facilitated the diastole and the systole of the heart, sorrow and melancholy rendered these processes more difficult. This implies that joy promoted the formation of vital spirits that occurred during diastole as well as the excretion of the residual matter, smoky vapors, which took place throughout systole (Sect. 3.2.6). However, long-lasting joy could also be harmful, as it impeded sleep and took the forces away. In the same vein, any excess

[95] Notwithstanding that Sanctorius adopted Aristotle's division of emotions into pleasure and pain, he differentiated between the medical and the moral philosophical study of the mind. He was of the opinion that philosophers should consider the affections of the mind in order to acquire virtue, while it pertained to the physicians to deal with them in order to gain and to preserve health (Sanctorius 1612b: 89, Sanctorius 1625: 65).

of joy was unhealthy as it did not only evacuate the superfluous, but useful matter, too. The danger of sudden emotions was already mentioned above and so Sanctorius warned in the *De statica medicina* that unexpected joy provoked the exhalation not only of the excretions of the third stage of digestion, but also of vital spirits (Sanctorius 1614: 75v, 79v–80r; 1634: 68v). This shows that emotions, usually characterized as healthy, could have harmful effects, too, depending on the circumstances of their appearance. In fact, the last aphorism in the 1614 edition of the *De statica medicina* reads:

> Those who are sometimes cheerful, sometimes sad, sometimes angry, and sometimes afraid have a healthier perspiration than those who always enjoy one single affection, albeit a healthy one (Sanctorius 1614: 84r).[96]

Hence, a variety of different emotions from both groups was recommended. Anyway, it is hard to imagine that individuals' emotions do not change from time to time. But how can a well-balanced mind be acquired? By what means can imbalanced passions be corrected? How can one keep one's emotions in check?

As with the other non-natural things, it was contraries which effected a cure. Accordingly, anger and hope removed fear, while joy took away sorrow. However, due to the close relationship between emotions and insensible perspiration, fear and sorrow could also be taken away by an evacuation of thick perspirable matter. Contrariwise, anger and great joy were removed by the evacuation of thin perspirable matter. Sanctorius explained more generally that immoderate passions could be diminished or completely taken away by the evacuation of perspirable matter. Inversely, comfort of the mind made the body perspire most freely, as it opened the pores and produced abundant perspiration. Hence, according to Sanctorius, the monitoring and manipulation of insensible perspiration allowed the physician to draw direct conclusions on the emotional state of his patients. It seems then that by controlling insensible perspiration, emotions could be controlled, too. This goes of course hand in hand with the management of the other non-natural factors. Foodstuffs which opened the pores, for example, produced joy, while those which impeded perspiration provoked sorrow. And sleep was hindered by excessive joy which led to a removal of the forces (Sanctorius 1614: 76r, 77r, 78r–79r, 80r–81r, 83v–84r).

3.3.7 The Ars … de statica medicina *and Its Galenic Context*

By concluding my analysis of the final section of the *De statica medicina*, the whole section on Sanctorius's new interpretation of the six non-natural things likewise comes to an end. It has shown how Sanctorius conceptually integrated his novel finding, the high quantity of insensible perspiration, into this standard Galenic

[96] "Nunc hilares, nunc maesti, nunc iracundi, nunc timidi perspirationem magis salutarem habent, quam qui unico, licet bono, semper gaudeant affectu." See: Sanctorius 1614: 84r.

framework. But it has also shown the difficulties into which the historian plunges, when trying to reconstruct and understand the physiological foundations of static medicine. Inconsistencies, unsolved questions, and puzzling features came to the fore. It has become clear that the *De statica medicina* is about much more than a steelyard and quantitative values. It is a manifestation of the way in which contemporary dietetic guidelines coincide with new experiences and observations. In this conglomeration of traditional and innovative ideas it is anything but easy to disentangle the old from the new. And it might be even misleading. The point is this: However abstract and tiresome Sanctorius's intellectual background may seem from a modern perspective, it is inextricably linked to those of his activities which his followers and historiography have labelled innovations. In fact, the study not only of the famous *De statica medicina*, but also of Sanctorius's other books, especially those published after 1614, discloses a much more refined view of Sanctorius and his undertakings than is usually presented in the literature.

Given the central role which Sanctorius assigned to the monitoring of insensible perspiration for the preservation of health in the *De statica medicina*, one expects his general concept of medicine, or at least of dietetics, to be oriented to this physiological phenomenon and its weighing. However, perusal of the other publications reveals that Sanctorius did not always relate the six non-natural things to *perspiratio insensibilis* and its quantification. While these works add important additional information to the *De statica medicina* with regard to the physiological processes that characterized human involvement with the non-naturals, they often mention insensible perspiration, the weighing procedures, and the importance of quantification for physiology only marginally, if at all. Insensible perspiration and its quantitative investigation do not play a major role even in the *Commentary on Avicenna*, in which Sanctorius published all of his instruments, including the weighing chair. Therefore, static medicine cannot readily be identified as the overall framework of Sanctorius's written works. To further illustrate this point, his last publication, *De remediorum inventione*, makes no mention of either the observations or the findings with the weighing chair.

However, Sanctorius's written output is just one side of the coin. Static medicine was not only the product of intellectual activity, but had a practical dimension, too. Sanctorius's use of instruments, his interaction with patients, his observations and their interpretation, in short, the material dimensions of his medical research and practice, are crucial to a full appreciation of his endeavors. Yet, they cannot be isolated from their conceptual background. Starting from the medical context outlined in the preceding paragraphs, the next part of the work will analyze the practical side of Sanctorius's work and elucidate the correlations between the two realms, theoretical and practical. The close connection between the six non-natural things and insensible perspiration suggests that the former of these were more than just a structural element in the *De statica medicina*. In the following chapters, I will consider the role this doctrine has played in the preparation and conduct of Sanctorius's weighing experiments. Maybe it was reading contemporary dietetic handbooks that inspired Sanctorius to do research on insensible perspiration? Maybe the importance of moderation in quantities with regard to the use of the six non-natural things

made him think of using a steelyard to define precisely what that meant in practice? From the perspective of Galenic dietetics, according to which balance and moderation were crucial to maintaining health, the step from the idea of balance to the use of a balance itself seems, at least in retrospect, quite natural.

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