Spinoza's Missing Physiology

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This article concerns the notion of living bodies that Spinoza develops in the Ethics *(published posthumously in 1677). While commentators have emphasized the relevance of Spinoza's works for contemporary physiology, they have neglected to study Spinoza's own views on this topic. My aim is to draw attention to the specific* parti pris *that underlies Spinoza's passages on anatomy. To do so, I first compare Spinoza's claims on human body with the conceptions developed in his immediate historical environment. Then, I propose to draw a parallel between Lakatos's notion of "negative heuristics" and the high level of generalization Spinoza demonstrates in his propositions on the human body. This parallel allows me to show how Spinoza's critical remarks on our knowledge of human body have heuristic value.*

1. Introduction[1]

In his *Handbook of Physiology*, the nineteenth-century physician Johannes Müller cited the third part of the *Ethics* entirely: no one, he held, had ever explained "static connections among passions" better than Spinoza (Müller 1840, p. 543). Earlier, Goethe referred to the famous physiologist Boerhaave as a "master of clinical medicine and the last disciple of Spinoza" (Aron 1965, p. 62). And more than a century later, in his book *Looking for Spinoza*, the neuroscientist Antonio Damasio considered that Spinoza's *Ethics* offered

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1. I use the following abbreviations: CW, for *The Collected Works of Spinoza. Complete Digital Edition*, edited and translated by Edwin Curley. Princeton: Princeton University Press; AT, for Descartes 1964–1974, *Œuvres*, edited by C. Adam and P. Tannery, Paris: Vrin.

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the proper philosophical framework for understanding the neurology of human emotions (Hild 2008, p. 202). The lasting relevance of the *Ethics* to human physiology may seem surprising: Spinoza hardly mentions anything specific on this topic. To be sure, Spinoza includes in the *Ethics* several statements on the specificity of the human body; but these statements are striking for their vagueness and very general nature (Adler 1996, p. 256). Even in the passages where Spinoza mentions the mind-body union, he does not appeal to the anatomical taxonomy of the human body. These features are all the more striking when compared with the anatomical precision with which Descartes and Malebranche dealt with passions, feelings, or imagination. Indeed, at the time when Spinoza was writing the *Ethics*, it was more common to mention in philosophical treatises the anatomy of the human sensory-motor system, than it was to exclude this knowledge.

Some commentators have explained the absence of physiology in Spinoza's texts by his lack of interest in medicine (Rivaud 1924, p. 25; Hild 2008, p. 187). However, Spinoza owned a certain number of medical books and numbered among his friends many physicians (see Meinsma [1896] 2006; and Klever 1990, p. 303). More importantly, there is strong textual evidence of Spinoza's interest in anatomy. As twenty-first century readers, we have projected onto Spinoza our own understanding of the respective limits, specificity, and proper vocabulary of the different disciplines dealing with human and animal bodies (mainly physiology, biology and physics). This is one of the reasons why we have either overlooked Spinoza's texts dealing with anatomy or physiology, or considered that those texts dealt with physics rather than with physiology (for this diagnosis, see Klever 1990, p. 303; Sangiacomo 2016, p 103). The historiographical situation is thus the following: there are several studies on the biological implications of Spinoza's philosophy, or on its relevance for contemporary physiology (Jonas 1965; Duchesneau 1998; Damasio 2003; Atlan 2018), but nearly no study on how Spinoza may have integrated the biological knowledge of his time into his own thought (Andrault 2014; Scribano 2015)—and no study at all on what counts, in Spinoza's view, as physiological knowledge. My aim in this paper is twofold. First, I want to call attention to the specific scientific *parti pris* that underlies Spinoza's passages on anatomical topics. Second, I want to show how a certain kind of medical knowledge that was conceived of in Spinoza's time and within his immediate environment profoundly differed from what we today call "physiology." In order to do so, I offer an account of the highly general nature of Spinoza's remarks on the human bodies through Lakatos's distinction between positive and negative heuristics. This last notion will allow me to show in what sense Spinoza's goal is to preserve and protect the basic

foundations of mechanical physiological explanations, without committing himself to unproven hypotheses explaining particular phenomena.

2. The Historical Context

Several commentators have rightly emphasized that there were many physicians in Spinoza's circle—most notably Meyer, De Volder, Kerckring, Juan de Prado, Bouwmeester, Velthuysen, Steno, Swammerdam (Meinsma 2006, pp. 158–60 and p. 215). To be sure, the category of "physicians" was rather broad in Spinoza's time. On the one hand, to have a medical degree could lead to a wide range of career paths: physicians were everywhere in early modern Europe (Andretta and Mandressi 2017, p. 11; Margócsy 2009, pp. 191–2). On the other hand, medicine at that time was not separated from wider theoretical interests in physics or anthropology. For example, Caspar Bartholin ranked the anatomy of the human body as a part of "anthropology" and as the most excellent part of "physics." (Bartholin 1651, p. 1). There was no clear line between the fundamental knowledge of living bodies (whether plant or animal life) and more practical knowledge devoted to medical treatment. Accordingly, among those who counted as "physicians," one could find medical practitioners; professors of anatomy; anatomists going from place to place performing dissections in their patron's home; naturalists; botanists and entomologists; or even philosophers and mathematicians that had simply taken classes in medicine. Thus, mentioning that Spinoza was surrounded by friends who had received a medical degree, as W. Aron does (1965, p. 67), may hardly be used as a specific indication of Spinoza's acquaintance with medicine—nor as an indication of the kind of medical knowledge with which he was acquainted. It is necessary to add at least three pieces of information in order to specify the kind of biographical relationship that Spinoza had with medicine.

First, the medical books owned by Spinoza reveal that he was a *connoisseur* in matters of anatomy (see Vereniging het Spinozahuis, 1965). Indeed, it is possible to divide the medical books that were catalogued in Spinoza's library into two categories. The first corresponds to popular textbooks: to this category belong Hippocrates' *Opera* (1554), which remained a major source of therapeutic knowledge in the seventeenth century, and three more recent books of anatomy: Riolan's *Anthropographia et osteologia* (1626), Bartholin's *Anatomia reformata* (1651), and the *Syntagma anatomicum* (1647) by Vesling, Thomas Bartholin's teacher. These three books were richly illustrated and gave an overall view of the human body based on first-hand dissections. They corresponded, in the 1650's, to the up to date but consensual basis for all further anatomical examination. Regarding Bartholin's book, for example, Spinoza owned the most famous edition: the third revised edition, which

included comments made by Franciscus dele Boë Sylvius, the famous professor of anatomy, as well as two letters by Johannes Waleus on blood circulation, and an anatomical criticism of the localization of the *common sense* in the pineal gland addressed to Descartes's "sectators" (Bartholin 1651, p. 336). We can add Nicolaus Tulp's works to this first category of books (*Observationes medicae*, the third revised and augmented edition of 1672). Tulp, who had been Mayor of Amsterdam from 1654 on, was a famous local figure of Dutch medicine of that time. Most notably, he was appointed *Praelector Anatomiae* to the Amsterdam Guild of Surgeons in 1628. Once a year, during winter, Tulp publicly dissected one dead body in Leiden's anatomical theater. These public demonstrations were famous enough to be painted by Rembrandt in the *The Anatomy Lesson of Dr. Nicolaes Tulp* (1632). In addition, Tulp supervised the *Pharmacopoea Amstelodamensis* (1636), a highly popular book which was also catalogued in Spinoza's library. This collective work presented recipes of useful remedies and was standard in seventeenth century Holland (Dudok van Heel 1998, p. 229).

The second category of medical books owned by Spinoza corresponds to dissertations or collections of observations written by physicians who had close biographical ties with Spinoza: Theodor Kerckring's *Spicilegium anatomicum* (1670), which was a very popular book, two books by Nicolas Steno, Spinoza's friend and Thomas Bartholin's pupil (the *Observationes anatomicae*, 1662, and *De solido intra solidum naturaliter contento dissertationis prodromus*, 1669), and finally Lambert Velthuysen's *Tractatus duo medico-physici, unus de liene, alter de generatione* (1657).[2] It is an important but neglected fact that Kerckring used for his anatomical observations a microscope "made for [him] by the famous Spinoza, mathematician and physicist":

> What I discovered thanks to [this] remarkable instrument appeared to be even more remarkable: that is, intestines, liver, and other parenchyma of viscera are teeming with an infinity of tiny animalcules; as for knowing if these animalcules corrupt or preserve the parenchyma by their permanent movement, this remains uncertain [...]. (Kerckring 1670, p. 178; my translation)

There is no proof that Spinoza witnessed Kerckring's observations. But we have good reasons to believe that the two discussed the kind of observations that Kerckring intended to make with Spinoza's microscope. Lastly, Spinoza had Descartes's *De homine* in his library, a book which was abundantly discussed by the physicians and anatomists of Spinoza's circle

2. We could add Kerckring's edition of the *Commentarius in currum triumphalem Antimonii Basilii Valentini* on the pharmaceutic use of antimony (1671), but this kind of text is rather a book on alchemy.

of friends (Steno [1661] 1952, 1:163). In this article, I will mainly base my analysis on the contents of the books catalogued in Spinoza's library.

One can read a lot of books which are not in one's own library; and conversely, one may not have read a lot of books which were present in one's own library (Moreau 2009, p. 40). Be this as it may, the medical part of Spinoza's library is neither poor nor heterogenous; on the contrary, it gives a faithful picture of the vitality and importance of the late seventeenth century-Leiden for the medical sciences in general, and anatomy in particular. In addition, it contained anatomical books that were closely connected to each other. For example, Vesling was the tutor of Bartholin, Bartholin was the tutor of Steno, and Bartholin's book cited Riolan. At the very least, the composition of Spinoza's library casts doubts on Hild's claim according to which Spinoza's own medical books "prove his bad health rather than his deep interest in this topic" (Hild 2008, p. 186). True enough, Spinoza felt concerned about his own health, as is testified by his mention of the bloodletting he underwent in order to cure a "tertian fever" (Letter 28 to Bouwmeester, June 1665, CW 1:396). But this therapeutic concern alone fails to explain the presence of Riolan's or Bartholin's comprehensive surveys of human anatomy in his library.

The second indication of Spinoza's interest in medicine is given by Spinoza's correspondence. According to Simon de Vries's letter from Amsterdam (1663), Spinoza would have advised him to attend a medical course (see Aron 1965, p. 65):

> I have entered an anatomy course, and am about half through. When it is finished, I shall begin chemistry, and following your advice, go through the whole Medical Course. (letter 8, CW 1:193)

Spinoza thus considered that going "through the whole medical course," and notably anatomy and chemistry, constituted good training for his young friends. This indication is consistent with Spinoza's own interest in anatomy and dissections. Indeed, according to the anatomist Nicolaus Steno, Spinoza "paid [him] daily visits to see the anatomical investigations of the brain that [he] carried out on several animals in order to discover the place where motion begins and sensation ends" (Totaro 2002, p. 32; Spruit and Totaro 2011, pp. 10, 28).

Steno, born a Lutheran in Denmark, studied medicine first in Copenhagen with Thomas Bartholin, and then in Amsterdam and in Leiden with Sylvius. There, during his studies in this "country of freedom" (Steno 1952, 1:366), Steno was "at the epicenter of a circle of radical philosophers," including Adriaan Koerbagh and Spinoza, a "close friend" of his (Jorink 2018, p. 15; CW 2:452). As we will see, it is likely that Steno was an important source for Spinoza's medical knowledge. After a tour in France in 1665, Steno remained some time in Florence at the Catholic court of the Grand Duke

Ferdinand II, where he converted to Catholicism in 1667 and eventually was ordained a priest in 1675. In September 1677, just a few days before becoming a bishop, Steno sent a letter to the Holy Office. He also sent a manuscript of the *Ethics* that would be put into the *Index* by the Inquisition. Steno's intention in the letter was both to "denounce the damage done by the new philosophy through a certain Spinoza in Holland," and to show his own efforts "in taking appropriate countermeasures" against the dissemination of Spinoza's heresies (Spruit and Totaro 2011, pp. 9, 13). On this occasion, Steno mentioned his earlier acquaintance with Spinoza, as well as Spinoza's interest in the brain dissections that Steno had performed in the early 1660s. He, however, immediately added that God gave him "a chance to humble [Spinoza], first in the anatomy of the brain, showing him that neither [Steno's] hand with the scalpel nor [Spinoza's] mind with its scrutiny could arrive at establishing anything at all" (Spruit and Totaro 2011, p.10). Because of this strong polemical background, one can doubt the truthfulness of Steno's testimony in this letter (on Steno's strategy, see Lærke 2018). However, it seems very likely that Spinoza did indeed attend private dissections of the brain, as was related by Steno. On the one hand, to regularly attend private dissections was then a common practice (Borch [1661] 1983, pp. 63, 67–9), and there is no good reason to think that Spinoza would have avoided witnessing anatomical experiments. On the other hand, at least two passages from Spinoza's own texts testify that his knowledge of the anatomy of the human body was not trivial. I will turn now to these passages.

3. Spinoza and the Circulation of the Blood

As we have mentioned above, references to anatomy are very rare in Spinoza's books. There are, at least, two notable exceptions. The first one is in letter 32 to Henry Oldenburg of November 1665. In this famous letter, Spinoza tries to explain to Oldenburg how he could both affirm that "each part of Nature agrees with its whole and coheres with the others," and acknowledge that it is impossible to know how the parts of nature really cohere with each other and agree with the whole (CW 2:18). Spinoza uses the example of the circulation of the blood to illustrate his claim:

> when the motions of the particles of lymph, chyle, etc., so adapt themselves to one another, in relation to their size and shape, that they completely agree with one another, and they all constitute one fluid together, to that extent only the chyle, lymph, etc., are considered as parts of the blood. But insofar as we conceive the particles of lymph, by reason of their shape and motion, to differ from the particles of chyle, to that extent we consider them as a whole and not as a part. (CW 2:18)

The fiction of a worm moving in the blood, which immediately follows this paragraph, allows us to understand the meaning of the analogy with the circulation of the blood: a worm moving in the blood, being able to distinguish by sight the respective particles of lymph, chyle, and blood, would consider them as completely independent bodies, or as different "wholes." In reality, these particles are just different components of the same common fluid. Moreover, the worm would believe that there were "no causes outside the blood which would communicate new motions to the blood, and no space outside the blood, nor any other bodies to which the particles of blood could transfer their motion" (CW 2:19): the worm would not know that the blood in turn is just a part of a bigger whole, and thus, that the blood may undergo change in motion due to changes within the whole body of the animal (containing the blood) and, beyond that, changes within the environment of the animal. In the exact same manner, we, human beings, imagine that the bodies we perceive as distinct really evolve independently, without adapting themselves to the motions of the others, while in reality they are only parts of an infinite whole, i.e., Nature itself. Exactly like the worm, we wrongly take the particular part of the universe where we live as the whole universe, and we wrongly believe that our sensorial perceptions of the different bodies allow us to grasp the objectives shapes of the material world.

The analogy with a worm in the blood, over which a lot of ink has been spilled, is too complex to be fully examined in this article. I am only interested here in the anatomical knowledge the analogy reveals. As it appears in this letter, Spinoza considers as a well-established fact not only Harvey's description of blood circulation (1628), but also the recent additions that had been made to his discovery, in particular, the description of the lymphatic vessels provided by Pecquet and Bartholin in the early 1650's. It could seem that it was trivial in the 1660's to support the notion of blood circulation, that is, the idea that the same fluid continually circulates in a single direction within a closed system, going from the arteries to the veins (Descartes, *Passions of the Soul* art.7, AT VI, pp. 331–2; trans. 2000, p. 299). But first, a certain number of features of blood circulation remained then to elucidate: for example, how exactly is the blood derived from the chyle? And the chyle derived from food? What is the exact role of the liver in this system? In what proportion is venous blood transported to the heart from the organs through the cava vein, and from the intestines, stomach, and spleen, through the portal vein and the liver? Letter 33 from Oldenburg to Spinoza about the milky aspect of a blood that was taken from a girl that "had a rather large breakfast" shows a shared interest in the question (CW 2:23). Second, there were still disputes about the exact connection between blood, lymph and chyle. In 1661, Bils and Deusing

argued that chyle, lymph, or other white fluids poured entirely into the liver, upon which it was incumbent to make blood. Thus, they argued for a certain disconnection between, on the one hand, the liver and the lymphatic system, and, on the other hand, the heart and the venal system: for them, it was impossible to regard chyle, lymph, etc. as different kinds of blood, as Spinoza and a certain number of physicians then did (Bartholin 1651, p. 532). Steno, who held beliefs similar to those of Spinoza, insisted on the fact that fluids with different colors may correspond to superficial modifications, or transformations, of a common fluid. In his *Observationes anatomicae* (1662) catalogued in Spinoza's library, Steno examines the secretion of saliva, tears, and nasal mucus, their links with the circulatory system, and the mechanical and emotional factors that may indirectly explain certain variations of the flow of tears and saliva. In Steno's view, even if saliva is colorless, it does come from the arterial vessels in which a red blood circulates (1662, p. 30). Later on, in his geological treatise, also catalogued in Spinoza's library, Steno would present the anatomical problem very abstractly, in terms of the exact connection between a "common internal fluid" (which circulates in the veins, arteries, lymphatic vessels, and is distributed to all the parts of the body), and different "proper internal fluids" (which are present all around the capillary vessels, are prepared in peculiar places of the animal body, and join afterwards blood vessels to which they add some solid particles from the peculiar animal parts; Steno 1671, p. 28).[3] I will not dwell on these physiological details here. Let me briefly say that the issue of the dynamic links and the chemical disparities between lymph, chyle, arterial blood, venal blood, and the different fluids secreted by specific glands, was a crucial anatomical and chemical topic when Spinoza was writing his letter to Oldenburg. More importantly, it was then not unusual to express this problem in very general terms that apply also to physical problems, as Spinoza himself did. According to Steno's questioning in the *Observationes anatomicae*, for instance, the fluids circulating in the body communicate with each other according to different "speeds," which themselves depend upon the "size" of the vessels and the thickness of the fluids (i.e., the size of the different "particles" which compose these fluids). Under certain conditions, the *animi motiones* of the individuals indirectly influence the contraction of the vessels, and thus change the "proportion" between different kinds of blood in the area of the heart (Steno 1662, pp. 95–7).[4] Accordingly, the physical notions used by Spinoza in his letter to Oldenburg, e.g., the size and shape of the particles

3. Oldenburg translates "fluidum internum proprium" by "appropriate internal fluid."

4. Part of Steno's problem was to understand how the feelings of the mind may indirectly influence the circulation and proportion of those fluids, given the fact that no direct causality was considered.

of lymph, or the ratio of motion and rest, are to be seen in the context of recent physico-anatomical research on blood circulation and its various interactions within the human body.

In 1665, the circulation of the blood and its different physiological implications were simultaneously a sound foundation for the new medical sciences of the seventeenth century and the subject of active experimentation and scientific disputes. This is exactly what Spinoza's letter to Oldenburg reveals. On the one hand, Spinoza clearly considers as a consensus the idea that venal blood, chyle, and lymph are just parts of the same blood. According to Bartholin's textbook, arterial blood and venal blood do not differ entirely in their form despite their different colors; these fluids agree in the same manner as boiling milk differs from cold milk (Bartholin 1651, p. 532). For Spinoza, as for Steno, all these fluids are parts of the same circulatory system, and this belonging affects their own "ratio of motion and rest." On the other hand, in Spinoza's letter, blood circulation illustrates the difficulty of fully understanding the causal vertical links between the whole and its parts, as well as the horizontal links between the different parts of Nature. As an indication of the fact that the circulatory system remained an open question and still involved unelucidated complexities, Spinoza did not give the exhaustive list of its components and left open the possibility of future discoveries: he mentions "the particles of lymph, chyle, *etc.*" (CW 2:19; my emphasis).

If we exclude the polemical passages where Spinoza criticizes Descartes, the circulation of the blood is the only concrete physiological function that is ever mentioned by Spinoza in specific, i.e., anatomical terms. Spinoza mentions it in the *Political Treatise* as one of the main criteria of the animal life, in comparison with a *human* life that is also defined by reason:

> When we say, then, that the best state is one where men pass their lives harmoniously, I mean that they pass a human life, one defined not merely by the circulation of the blood, and other things common to all animals, but mostly by reason, the true virtue and life of the Mind. (CW 2:530)

In the *Ethics* IV prop. 39 sc., the circulation of the blood appears again as one of the main criteria according to which a body is thought to be alive:

> I understand the Body to die when its parts are so disposed that they acquire a different proportion of motion and rest to one another. For I dare not deny that—even though the circulation of the blood is maintained, as well as the other [signs] on account of which the Body is thought to be alive—the human Body can

> nevertheless be changed into another nature entirely different from its own. (CW 1:569)

But for Spinoza, the criterion provided by blood circulation does not suffice to guarantee that the individual remains the same despite great changes (for example a loss of memory). Spinoza regards blood circulation as one nodal physiological criterion that does not by itself suffice to define a single human life. There is nothing original in that. The originality lies elsewhere: Spinoza's description of blood circulation in letter 32 was far from usual for a philosopher, if only because he did mention the notion of "lymph," and refrained from mentioning "animal spirits." Indeed, if we consult, for example, Malebranche's *Search after Truth* (1674), which is crammed with passages dealing with human physiology, we find no mention of lymph. This is also the case of Hobbes's *Leviathan* (1651), which is full of comparisons between the functioning of the political body and the circulation of the blood, but never mentions the different components of the blood. Actually, mentioning lymph is a manner of speaking of blood circulation as an anatomist, not as a philosopher mostly interested in its psychophysiological or metaphorical implications. More meaningfully, it was quite rare then not to mention animal spirits as a component of the blood. Indeed, anatomists, such as Waleus in Bartholin's books, as well as philosophers, casually speak of animal spirits as a very subtle fluid which was supposed to be responsible for sensory-motor functions (Hobbes 1839-45a, 1:319; Regius 1668, pp. 8–9, 22; Velthuysius 1657, p. 45). According to Descartes, for example, "we know that all these movements of the muscles, as well as the senses, all depend on the nerves, which are, as it were, small filaments or little tubes proceeding from the brain, which, like the brain, contain a certain very subtle air or wind called the animal spirits" (*Passions of the Soul*, art. 7, AT XI, p. 332; trans. Descartes 2000, p. 300). In the *Metaphysical Thoughts*, Spinoza, like Descartes, considered that "imagining is nothing but being aware of the traces found in the brain from the motion of the spirits aroused in the senses by the objects" (CW 1:300). In the *Short Treatise* (1670–1677), part 2, there are at least fifteen occurrences of the word "spirits (*geesten*, see Spinoza 1925, 1:91)." Classically enough, animal spirits were presented by Spinoza as the corporeal vehicle of so-called voluntary motions and passions (such as pain, sadness, or joy). For example, in the chapter 19:

> the soul's power to move the spirits can also be hindered, either because the motion of the spirits is much decreased, or because it is much increased. It is decreased, for example, when we have run a great deal. In doing this, we bring it about that the spirits give so much more motion than usual to the body, and lose so much motion, that they are necessarily much weakened. This can also happen through taking too

> little food. It is increased, for example, when we drink too much wine or other strong drink, thereby becoming merry, or drunk, and destroying the soul's power to govern the body. (CW 1:132)

After that, Spinoza no longer mentioned animal spirits, except in the polemical passages where he commented on Descartes's explanation of voluntary motions. Incidentally, it was roughly during this time period, between 1662 and 1665, that Steno stopped using the word, and noted that the notion of "animal spirits" was rather obscure and pointless (Steno [1665] 2009, pp. 84–5). According to him, "animal spirits" were a kind of black box: "a lot of people call *animal spirits* the subtlest part of the blood, its vapor, and the nervous juice, but these are words expressing nothing" (Steno 1667, p. 63; Miniati 2009, p. 99). More generally, Steno disapproved of the anatomical terminology then in use: most often, anatomical terms implied metaphorical connotations and comparisons which were structurally and functionally misleading.[5] Some influence of Steno on Spinoza's rejection of the "animal spirits" is thus possible. Two other facts may partly explain the disappearance of the notion of "animal spirits" under Spinoza's pen. First, when Spinoza was writing the *Ethics*, he had given up the doctrine of the soul's power that he presented in the *Short Treatise*,[6] and, more generally, had moved away from Cartesian philosophy. Afterwards, in the *Ethics*, he presented the mind and the body of a single individual as two different aspects of the same thing—or, technically speaking, as a single "mode" conceived of through two different aspects, or attributes (i.e., thought and extension). Second, Spinoza's aim in the *Ethics* was by definition ethical; it is not a work of anthropology or natural philosophy (Gabbey 1995, p. 146; Savan 1986, p. 101). Nevertheless, the non-mention of the spirits in letter 32 remains quite noticeable if we put it back into the scientific and philosophical context of that time, even among the detractors of Descartes's psychophysiology.

4. Spinoza and the Anatomy of the Brain

The second passage which indicates that Spinoza had some very specific knowledge of the human anatomy has escaped the attention of most of the commentators.

5. It is particularly true for the pineal gland, see *Discours sur l'anatomie du cerveau* (Steno [1669] 2009, pp. 107–9).

6. Even if it is possible to give *Short Treatise*'s passages a meaning compatible with a non-interactionist conception of the mind-body union arguing that the power of the soul over the body could be indirect, through passions and beliefs, which would be compatible with determinate motions of the spirits.

In the preface to *Ethics V*, Spinoza rejects Descartes's explanation of the mind-body problem. Spinoza first gives metaphysical arguments to counter the notion that the human will could trigger voluntary movements, and, conversely, that through the pineal gland the body could mechanically cause various sensations in the mind: "since there is no common measure between the will and motion, there is also no comparison between the power, or forces, of the Mind and those of the Body" (CW 1:596–7). It is thus impossible to clearly conceive how the mind can give to the body a force, or a degree of motion, so as to produce a voluntary motion. But Spinoza then adds an anatomical criticism of Descartes's explanation in the *Passions of the Soul*, a book which was also catalogued in Spinoza's library:

> To this we may add that this gland is not found to be so placed in the middle of the brain that it can be driven about so easily and in so many ways, and that not all the nerves extend to the cavities of the brain. (CW 1:597)

What has not been emphasized yet, is the fact that this anatomical criticism is anything but trivial. Indeed, when Spinoza was writing the *Ethics*, several anatomical criticisms of Descartes's brain anatomy had been published. The most famous was in Bartholin's *Anatomia reformata*, which criticized the role ascribed to the pineal gland in the *Passions of the Soul* (1651, pp. 336–7). But the criteria that Spinoza mentions in the preface to *Ethics V*—the fact that the gland was not in the middle of the brain and could not be moved so easily—were not evoked in Bartholin's textbook. To my knowledge, the first published book to emphasize those anatomical facts was Steno's *Discours sur l'anatomie du cerveau*, delivered in Paris in 1665 and published in 1669 (Steno 2009, p. 99; Andrault 2018, pp. 91–3). The two anatomical remarks that Steno raised in his *Discours* and Spinoza mentioned in the *Ethics* proved to be an overwhelming objection for Descartes's conception of the mind-body union. Descartes's theory indeed implies that both the various feelings that the mind perceives and the various voluntary motions that the mind initiates depend upon the great mobility of the gland and its central situation in the middle of the four cerebral cavities, on the pathway of the animal spirits (AT XI, p. 363; trans. Descartes 2000, p. 311).

It is likely that Steno, and particularly the experiments on the brain that he performed in front of Spinoza in the early 1660s in Leiden, influenced Spinoza's opinion of Descartes's psychophysiology. But beyond the question of his medical sources, the simple fact that Spinoza put forward an *anatomical* criticism of Descartes is very striking: why did Spinoza mention an empirical element against Descartes's conception of the mind-body

union, given the fact that his metaphysical arguments were strong enough to dismiss it? The intrusion of those technical anatomical data is all the more surprising in a work like the *Ethics*, in which Spinoza remains very general, if not vague, especially in the passages that deal with physical bodies in general, and with the human body in particular. Spinoza's apparent indifference "toward the details of nature" have led some commentators to claim that Spinoza's "philosophy was strikingly disconnected from the sifting and interrogating science that went on around him" (Maull 1986, pp. 6, 3). How are we then to understand the intrusion of anatomy in the preface to *Ethics V*? A first explanatory element would be the very nature of this preface. It is indeed a polemical text, in which Spinoza discusses conceptions supported by other philosophers (Descartes and the Cartesians to be specific). Exactly as in scholia and appendices, Spinoza's writing here does not obey the mathematical manner of reasoning that constitutes the essential part of the *Ethics*. Accordingly, the anatomical remarks that are included in the preface to *Ethics V* could be addressed to those of Descartes's readers who were not convinced enough by Spinoza's metaphysics. To include therein a remark on the true position of the pineal gland in the brain would be tantamount to giving an exoteric and additional deathblow to the Cartesian explanation of the mind-body union. But this would still imply that Spinoza found this anatomical criticism interesting and decisive enough to mention it in the *Ethics*.

5. Spinoza's Medical Sources

Hence, we have the following situation. There is no doubt that Spinoza was a *connoisseur* of anatomy, and that anatomy provided him with questions or topics that presented a philosophical interest—in particular, the issue of the unity of Nature, the mind-body problem, and, more generally, an experimental refutation of Descartes's anthropology.[7] Nevertheless, there are in Spinoza's works very few passages which attest to this interest. More importantly, there are still fewer passages which could allow us to trace back Spinoza's claims on human or animal bodies to medical sources with any certainty.

Most of the commentators that have written on Spinoza and the medical sciences have sought to identify Spinoza's main sources on the topic. But these works come up against three difficulties. First, we have no biographical or textual indications that are detailed enough to unquestionably prove

7. The circulation of the blood as it was described in Bartholin and Steno refutes two important physiological theses developed by Descartes: the fact that there is a fire without light in the heart and the fact that the heart is the source of the animal spirits.

any specific influence on Spinoza. In his work on the "Decisive year 1657," Dunin-Borkowski suggested a connection between Velthuysen's *Tractatus de liene* and Spinoza's so-called "physical interlude," namely Ethics II, prop. 13, schol., axioma and lemma (Dunin-Burkowski 1935, v.2, p. 263). But there is no textual evidence in Spinoza's works supporting the claim that Velthuysen's ideas on the role of the animal spirits in the animal body and in nature as a whole would have been a more direct source of inspiration than, say, Descartes's *Principles of Philosophy*.[8] Indeed, it is particularly difficult to demonstrate that a thesis or a specific term X, which is present under Spinoza's pen and which one can trace back to a medical book Y, is only present in *this* medical book, and not elsewhere. Notions that could first seem very original, or specific to a physician, turn out to be shared by a whole group of natural philosophers, and to be a very common thesis. For this reason, the importance of Steno in Spinoza's construction of his anatomical knowledge—rather underestimated, to date—can only be conjectural.[9] It is a conjecture that is strongly supported by biographical and textual data, but not a certitude that one may oppose to other possible influences, as if they were mutually exclusive. For my purposes in this article, it is more important to use Steno's works as an indication of Spinoza's own positions within a historical and scientific framework which is partly common to both of them. Second, there is no good reason to think that the physiologists which are deemed today the most important of their time from a positivist and teleological perspective were actually considered more innovative or interesting in Spinoza's view.[10] For example, in his article "Die Stellung Spinozas und Hobbes zur Medizin" (1930), Hühnerfeld comments on Willis's works on nerves and brain after having briefly enumerated a list of the important discoveries that were made in Spinoza's time. But there is absolutely no proof that Spinoza knew or read Willis. More generally, there is no indication that Willis's works, which are today regarded as particularly important for the history of neurophysiology, might be of some importance to understand Spinoza's thought. Third, and more importantly, the originality of Spinoza's discourse on bodies lies in its high

8. In addition, Velthuysen's comments on chemistry do not fit with Spinoza's physics or comments on Boyle's experiments in the letters to Oldenburg. See for example *De liene*, 16, in which Velthuysen uses the example of mercury to show that coldness and warmth do not depend on the movements of the parts of the body.

9. Surprisingly enough, Hühnerfeld does not even mention Steno. Two scholars have emphasized the importance of Steno on Spinoza's medical thought: Dunin-Borkowski (1935, v.2, p. 171) and Wim Klever (1990).

10. See Hühnerfeld's positivist comment (1930, p. 125) on the fact that the medical sciences were then too speculative—which would explain why Spinoza did not appeal to the medical sciences in his own works.

degree of generality, and thus its adaptability to different kinds of observations or future developments of physics (Matheron 1991, p. 109).

According to Adler, "the *primary* purpose of the purely physical parts of [the *Ethics*, that is, the lemma that follow *Ethics II* prop. 13,] is to show how knowledge of physics is possible;" for this reason, "Spinoza's account is intentionally general and programmatic" (Adler 1996, pp. 255, 260). Most notably, the notion of the "ratio of motion and rest," which defines each complex body, is not to interpret in any technical (or mathematical) sense, and does not commit Spinoza to a particular physical theory (Gabbey 1995, pp. 169–70; Adler, p. 269).[11] What has been shown regarding Spinoza's physics is also true for what one might call Spinoza's "biology:" to trace Spinoza's philosophy back to a single medical source leads us to overemphasize one possible instantiation of Spinoza's general claims on animate bodies; consequently, this might fail to account for the high degree of generality in which lies their very originality.

I will now develop further this notion of the "high level of generality" applied to Spinoza's claims about human bodies. Then, I will show how this high level of generality, that I will consider as a consequence of the "negative heuristics" of Spinoza's mechanism, corresponds to a certain kind of conception of the articulation between physics and anthropology. Paradoxically, the difficulty in tracing Spinoza's works back to specific medical sources may be partly explained by the project of reforming medical anthropology that was proposed in Spinoza's milieu.

6. Spinoza's Negative Heuristics

In the early 1660s, in the *Metaphysical Thoughts* as well as in the *Short Treatise*, Spinoza remained very general when dealing with animate bodies. From the *Metaphysical Thoughts*, we learn that animate bodies are defined as mere aggregates. Indeed, after having put forward inconsistencies in the scholastic theory according to which three different souls (vegetative,

11. See for example the definition of lemma 3, axiom 2: "When a number of bodies, whether of the same or of different size, are so constrained by other bodies that they lie upon one another, or if they so move, whether with the same degree or different degrees of speed, that they communicate their motions to each other in a certain fixed manner, we shall say that those bodies are united with one another and that they all together compose one body or Individual, which is distinguished from the others by this union of bodies" (CW 1:460). Gabbey's and Adler's analyses conflict with Matheron's and Gueroult's technical readings of the physical digression, and particularly with Gueroult's comparison between Spinoza's physical interlude and Huygens's *Horologium* (Gueroult 1968, p. 552). See also Peterman, 2014, p. 221: "I don't think we should expect to find a fully developed physics anywhere, not least of all because Spinoza himself didn't think he had developed one."

sensitive, and intellective) give life respectively to plants, lower animals and men, he adds:

> We shall not take much trouble to refute these doctrines. We have already proven sufficiently that those three souls they attribute to plants, the lower animals, and men are only fictions, for we have shown that there is nothing in matter but mechanical constructions and operations. (Appendix part II, chap. V, CW 1:325)

The notion that animate bodies are just mechanical constructions that obey the general laws of physics is obvious for Spinoza. Accordingly, in the *Short Treatise*, the human body is defined exactly in the same manner as any other body, that is, by a certain proportion of motion or rest. In addition, what distinguishes the different feelings perceived by a human body is the variation of the proportions of motion and rest in its body. Let us say, for example, that the human body X is defined by a proportion of motion and rest that may vary between 1 and 3 (CW 1:96). When the motion is decreasing, and particularly the motion of the animal spirits around the heart, there may occur a feeling of coldness, sadness, pain, hunger, or weakness, for example after having run a great deal (CW 1:132). Similarly, the sensations caused by different external bodies, or the sensations occurring in two different places of the same human body, are also explained in terms of specific proportions between motion and rest. What an economical view of the human body, in which there is nothing other than a determined and global proportion of motion and rest, along with varieties and variations of such a proportion!

Approaching human physiology in mechanical terms was not unusual at Spinoza's time. On the one hand, this is the very project of what has been called "mechanical philosophy," and which was variously illustrated by Boyle, Hooke, Huygens, and even Leibniz. On the other hand, as we have seen, some physicians dealt with specific physiological functions, such as the production of tears, in general terms, without presupposing any specificity of the fluids that flowed inside human bodies in comparison with other kinds of fluids such as milk: both kinds of fluids were defined by the specific shape, size, and motions of the particles that compose them; and complex phenomena were supposed to be produced by the change in the proportions of these components (Steno 1662, pp. 94–5). It is thus perhaps not as original as one may think at first glance to use, as Spinoza did in his letters, the very same notions to speak of the relationships between butter and buttermilk during the churning of butter and the relationships between different components of blood: in both cases, the cohesion or separation of the parts depend upon the new motions acquired by the components during the process of change (letter 6 to Oldenburg,

CW 1:183). The "individuals" with which the physical lemma of *Ethics II* deals include stones, bones, plants, and organs, as well as the more complex bodies composed of those very organs (Duchesneau 1998, pp. 130–31). Spinoza's aim is precisely both to show that every natural body, animate or inanimate, highly composite or structurally simpler, obeys the same laws, and to insist on the fact that common experience confirms the relevance of mechanical explanations in terms of motion and rest. It may be the case that those kinds of mechanical explanations are not detailed and complete enough, but at least they may be considered "known through themselves" and intelligible (E2p13 sc., lem.3, cor., CW 1:459).

If, however, there is nothing unusual then in considering that mechanical explanations apply to complex physiological phenomena, the manner according to which Spinoza sticks to this level of generality is particularly striking. As I have indicated above, even someone like Hobbes, whom commentators have recently regarded as a possible source of Spinoza's physics, mentioned that sensations and the production of images (or phantasma) imply "certain spirits and membranes, which, proceeding from the *pia mater*, involve the Brain and all the nerves [...]." Thus, if the motions of those spirits and membranes are not continued from the brain to the heart, "there will be no perception of the object" (1839-45b, vol. 1, p. 392; on Hobbes and Spinoza, see for example Shein 2018). In contradistinction to Hobbes, Spinoza carefully avoids specifying the kind of fluids and soft parts of the body which are physically involved in memory and imagination. Generally speaking, memory requires some capacity to retain traces from the encounters with external bodies—a capacity that supposes only that a soft part of a body is modified by hard or fluid parts, according to *Ethics II*, prop. 13, postulate 5. Actually, memory is one of the main physical properties which define the human body. The human body is characterized as being "composed of a great many individuals of different natures," i.e., of fluid, soft, and hard parts, "each of which is highly composite." Consequently, its preservation "requires a great many other bodies, by which it is, as it were, continually regenerated." But in return, first, the human body may be affected by external bodies "in very many ways," and, second, he has a great capacity to memorize the traces of its encounters with other bodies (*Ethics* II, prop. 13, postulates, CW 1:462). In *Ethics II* prop. 17 cor. dem., Spinoza is a bit more specific, and explains how we may sometimes perceive as existent or present bodies which are in reality neither existent nor present:

> While external bodies so determine the fluid parts of the human body that they often thrust against the softer parts, they change (by Post. 5) their surfaces with the result (see A2 after L3) that they

> are reflected from it in another way than they used to be before, and still later, when the fluid parts, by their spontaneous motion, encounter those new surfaces, they are reflected in the same way as when they were driven against those surfaces by the external bodies. Consequently [...] the Mind will again regard the external body as present; this will happen as often as the fluid parts of the human body encounter the same surfaces by their spontaneous motion. (CW 1:464)[12]

This passage is even more abstract than the first texts from 1661–1663, and confirms an evolution between the *Short Treatise* and the *Ethics*. Here, Spinoza does not even term the kind of process, or fluid, that would be specifically at stake in the feelings of pain, cold, or joy, as he did in the *Short Treatise*. We do not know, for example, if the softer part in question in this demonstration of *Ethics* II prop. 17 is the heart or, more likely, the brain, according to the proverbial allusion in the appendix to *Ethics I* (CW 1:445). The abstract mention of the soft and fluid parts in the propositions and demonstrations of the *Ethics* is all the more striking when compared with the polemical passages against Descartes that refer either to the "pineal gland" (*Ethics* V, pref.) or to "the images that are formed at the back of the eye (and, if you like, in the middle of the brain)" according to *Ethics II*, prop. 48, schol. (CW 1:484). In the propositions and demonstrations of the *Ethics*, Spinoza refuses to align himself with Cartesian psychophysiology, and to directly debate with it; he rather focuses on the most general physical conditions of memory and imagination, and chooses not to deal with the physiological manifestations of our affects. Indeed, after having quickly alluded to the stomach to account for the affect of disgust, Spinoza adds: "As for the external affections of the Body which are observed in the affects—such as trembling, paleness, sobbing, laughter, etc. —I have neglected them, because they are related to the Body only, without any relation to the Mind" (*Ethics III*, prop. 59 schol, CW 1:530).

I would like here to insist on the fact that not to refer to any specific organ when sensation, memory, imagination, or passions are at stake is particularly original. And one cannot entirely account for this specificity in invoking Spinoza's criticism of the mind-body interaction. To quote only

12. Basically, such an explanation, which is a hapax in the *Ethics*, does not seem entirely incompatible with the physiological schema of the article 26 of the *Passions of the Soul*, in which Descartes observes that "all the same things that the soul perceives by the mediation of the nerves [directly triggered by external bodies] may also be represented by the fortuitous course of the animal spirits," which in their turn modify the disposition of the brain (AT IXb, p. 348; trans. 2000, p. 306). On this point, see Gueroult 1968, pp. 570–71.

one example, Locke denied the very idea of a mind-body interaction that men would be able to explain, but he still mentioned that the modifications caused by external bodies in the sensorial organs have to reach the "brain" to provoke a true feeling (Locke 1979, p. 143). Spinoza himself emphasizes the independence of his proposition with regard to the exact physical process to which the imagination corresponds:

> We see, therefore, how it can happen (as it often does) that we regard as present things that do not exist. This can happen from other causes also, but it is sufficient for me here to have shown one through which I can explain it as if I had shown it through its true cause; still, I do not believe that I wander far from the true [cause] since all those postulates which I have assumed contain hardly anything that is not established by experience which we cannot doubt, after we have shown that the human Body exists as we are aware of it. (CW 1:464)

Spinoza deals with psychophysical explanation in a seemingly negligent way: the true "cause" of the fact that we regard as present things that do not exist is not important; what matters is just to give an idea of the possible physical processes that would account for this fact. Actually, Spinoza sticks here to two features that define his general attitude toward physics in the *Ethics*: first, to give the indication of the explicability of the mental event in question; second, to stay general enough not to run the risk of being refuted by experiments that would be more detailed than the irrefutable "experience" to which he refers here (on this kind of "experience," see Moreau 1994, pp. 293–9).

At first glance, Spinoza's attitude toward physics, and more generally, his reluctance to make claims concerning existing bodies, could seem explainable simply by the fact that he did not have the opportunity to develop in a satisfying way his own thoughts on the physical aspect of reality. As he himself admitted in a 1676 letter to Tschirnhaus, who had asked a question about the shortcomings of Descartes's physics, and particularly of Descartes's definition of matter as extension, Spinoza had until then "not been able to set out anything concerning [these matters] in an orderly way" (CW 2:487; on the theoretical issue at stake in this letter, see Matheron 1991; Lærke 2014, p. 231). However, this simple explanation is not fully satisfying. First, it fails to account for the evolution in Spinoza's writings between the 1660s and the 1670s. Indeed, Spinoza's first published book, *Descartes's Principles of Philosophy*, showed that Spinoza did dedicate time and energy to the discussion of the details of Descartes's physics. Moreover, as we have seen, the *Short Treatise* included several specifications on the human body, which disappeared from Spinoza's later texts. For example, in the *Short Treatise* Spinoza defined a determinate body by a

certain "proportion of motion and rest" to which he gave a numerical expression. By contrast, in the *Ethics*, he only mentions a "*ratio* of motion and rest," or even a communication of motions according to "the same ratio" (EIIP13, lem. 6 and 7)—i.e., to a certain determined "manner" according to which motion is transferred. In other words, in the *Ethics*, there is no longer any identification of bodies through their numerical proportions, and the new characterization of a determinate body is rather vague (Adler 1996, p. 269). Second, Spinoza was not the only philosopher of that time, who did not develop his own physics even though he was interested in the topic. He was, however, one of the only ones who explicitly chose to restrict himself only to very abstract claims on animate bodies. Malebranche, for example, who conceded that Descartes's localization of the seat of the soul in the pineal gland was probably empirically false, still believed that the soul's principal functions were located somewhere in the brain (Malebranche 1997, p. 89). Accordingly, we still need to understand the conception of the knowledge of bodies that underlies Spinoza's particular attitude toward empirical data in the *Ethics*. Third, as is the case in his letter to Tschirnhaus, Spinoza's voluntary lack of precision on the physical world does not prevent him from making very definitive claims on what is impossible in Descartes's physics and anthropology, on the shortcomings of Boyle's experiments, and on the main mechanical principles governing every physical consideration. Paradoxically enough, Spinoza's epistemology at the time of the *Ethics* is what explains his caution concerning bodies. Most notably, his criticism of an imaginative knowledge of external bodies leads him to "stick to what he knows with certainty" (Lord 2010, p. 38), and to deduce a general framework which could embrace different possible physical theories (Matheron 1991, pp. 107–8). Here, I would like to specify what Spinoza deems certain concerning animate bodies in general, and human bodies in particular. To do so, I will now turn to a parallel between Lakatos's notion of "negative heuristics" and the high level of generality of Spinoza's propositions on the human body. This parallel will help me to show in what sense Spinoza's rare and critical considerations on complex bodies in the *Ethics* clearly indicate what he conceives of as false, as possible, or as confirmed on the topic. In this sense, the notion of "negative heuristics" clarifies the epistemological level at which Spinoza speaks of bodies, a level which differs from the one at which he situates his discourse on God, mind, affects, or state. More significantly for my purposes, Lakatos's notion also indicates a close affinity between Spinoza's views and those of Steno.

According to Lakatos, the growth of science presupposes a certain continuity within a series of scientific theories, and this continuity is defined by the fact that these theories share two kinds of methodological rules: 1/ rules that "tell us what paths to pursue" constitute the positive

heuristics of the research program; 2/ rules that "tell us what paths of research to avoid" constitute the negative heuristics (Lakatos 1978, p. 47). As an example of a research program defined by these two kinds of rules, Lakatos mentions the so-called "Cartesian metaphysics, that is, the mechanistic theory of the universe—according to which the universe is a huge clockwork [...] with push as the only cause of motion," and which "functioned as a powerful heuristic principle" (Lakatos 1978, p. 47). Such a characterization of Cartesian mechanism is general enough to apply to different kinds of historical instantiations of this general heuristics in the second half of the seventeenth century, including versions of it that include a sharp criticism of Descartes's natural philosophy (Lachterman 1977, p. 76). By definition, the negative heuristics of the program "forbids us to direct [*sic*] the *modus tollens* at its 'hard core'," which is considered irrefutable by its proponents (Lakatos 1978, p. 48). Anomalies and observations are not regarded as nullifying for the hard core; they just demand marginal modifications of the auxiliary hypotheses that form the "protective belt" of the theory. In contrast with the positive heuristics, which articulates sets of suggestions on how to modify the refutable protective belt, the negative heuristics that defines its core is not flexible.

Generally speaking, Spinoza is not personally involved in the development of the positive heuristics of the mechanism, while constantly reminding his readers or correspondents of the indubitable principles which form its "hard core." According to letter 13 to Oldenburg on Boyle's experiments, the main principles of mechanical philosophy are too fundamental to be dealt with in the same manner as we deal with some sophisticated hypotheses explaining certain phenomena: no experiment can ever refute or prove them (CW 1:178–9). It is thus possible to consider that Spinoza is mainly interested in the negative heuristics of the new mechanical natural philosophy. The same is true for the science of animate and human bodies. Indeed, as we have seen, there is for Spinoza no doubt that the human body is a mechanical "construction" that one should explain in accordance with mechanical philosophy. In the *Ethics*, Spinoza showed himself very critical of the attitude of the theologians and metaphysicians regarding the structure of the human body:

> when they see the structure of the human body, they are struck by a foolish wonder, and because they do not know the causes of so great an art, they infer that it is constructed, not by mechanical, but by divine, or supernatural art, and constituted in such a way that one part does not injure another. (*Ethics I*, appendix, CW 1:443)

All bodies are modes of extension and imply motion and rest; all their actions can be explained physically, and immanently, without invoking transcendent powers like God or the soul. For these reasons, one should not

interpret the famous passage of *Ethics III*, prop. 2, scholium, as an indication of Spinoza's skepticism concerning the medical sciences:

> For indeed, no one has yet determined what the Body can do, i.e., experience has not yet taught anyone what the Body can do from the laws of nature alone, insofar as nature is only considered to be corporeal, and what the body can do only if it is determined by the Mind [...] [The] Body itself, simply from the laws of its own nature, can do many things which its Mind wonders at. (CW 1:495)

Spinoza's main concern here is to draw attention to the fact that the soul is usually used as a black box to which we refer when we are not able to give a relevant explanation of a physical phenomenon. Even an action like beating someone, i.e., an action that is usually considered as voluntary, and thus transcendentally caused by a decision of the mind, can be explained physically, by the sole structure of the human body:[13]

> The act of beating, insofar as it is considered physically, and insofar as we attend only to the fact that the man raises his arm, closes his fist, and moves his whole arm forcefully up and down, is a virtue, which is conceived from the structure of the human Body. (Ethics III, prop. 59 schol., CW 1:580)

If one wants to consider the affective and ethical aspect of the act of beating, one has to take into account the confused ideas and imaginary associations that give a particular meaning to this act; but in any event, no direct action of the mind on the body will really explain this act.

On the one hand, Spinoza points out the extent of our ignorance regarding the structure of the human body and the range of actions that this structure can perform in interaction with other bodies. Reducing our conjectural ignorance of what the body can do requires further experiments and auxiliary hypotheses, i.e., a positive heuristics which does not interest Spinoza. On the other hand, Spinoza's claim about our ignorance also suggests that the following epistemological rule should govern our explanations: no specific explanation X of a human action Y should imply that the structure of the human body is not the efficient cause of this action. If this rule, which belongs to Spinoza's negative heuristics, does not suggest any particular explanation of Y, it still gives a general framework that is partly defined by methodological proscriptions: it forbids attributing to the soul's

13. This is the reason this article does not address the analysis of the notion of *conatus*, since it does not interfere with Spinoza's conception of the human body here. In addition, this notion of a "striving by which each thing strives to persevere in its being" (CW 1:499) is not present in the medical books which were catalogued in Spinoza's library. On Spinoza's conception of life, see Andrault 2014, pp. 182–204.

or God's powers physical actions that are actually produced by a body of which the structure and its effects are not perfectly known. This rule echoes the methodology then adopted by a certain number of anatomists who were faithful to the general framework of mechanical philosophy while being critical of Descartes's anthropology. Indeed, they were convinced that bodily functions, or "actions," as they called them (Bartholin 1651, pp. 1–2), were strictly dependent on the structure and movements of bodily parts—and this, even in cases where they admitted not knowing the first cause which triggered those actions (Steno 1667, p. 63). Accordingly, they considered that one should not formulate tentative explanations of the functions performed by a body of which one does not know entirely the structure (Bayle 1675, p. 24; Winslow 1732, p. vii). In particular, Steno noted that ascribing a bodily action X to a bodily part Y of which the structure has not been fully described was often justified through claims such as: "God and nature do nothing in vain" (Steno 2009, p. 123). This kind of arbitrary claim introduces an intentional teleology into the explanation of the body's actions that just aims at hiding our lack of knowledge. The research program of these anatomists thus consisted in investigating the most inner parts of the human body, which still escaped the visual inspection of corpses. For this purpose, they developed comparative anatomy; pathological anatomy (Steno 2009, pp. 125–26); "chemical anatomy" (Steno 1662, p. 14); "*anatomia subtilior*," that is, the experimental investigation of the smallest structures [*fabricae*] of the animal body (Duchesneau 1975); as well as embryological anatomy (Swammerdam 1669). Exactly like Spinoza, these anatomists harshly criticized the medical anthropology of their time while seeking to develop the knowledge of the human body's structure and of its different interactions with other bodies (Steno 2009, p. 125).

The notion of the negative heuristics of mechanism appears clearer in Steno's geological treatise, of which Spinoza had two exemplars in his library. Therein, Steno first presents four very general postulates, or "common precepts," on which he bases his explanations for the formation of the "solids naturally contained in other solids," be they fossils or kidney stones, plants, or animals (1669, p. 10; trans. by Oldenburg in Steno 1671, p. 24). Steno identifies those common precepts, which all the different "sects" of philosophers accept, with the "most certain principles of nature" (1671, p. 14). Among them, we find these three propositions: 1. a natural body is an aggregate of insensible particles (i.e., of particles too small to be perceived); 2. "a *Solid* herein differs from a *Fluid*, that in a *Fluid* the insensible particles are in perpetual motion, and part from one another; but in a *Solid* although the insensible Particles be moved sometimes, yet they scarce ever part from one another, as long as that Solid remains a solid and entire"; 3. while "a Solid body is produced, the particles thereof are mov'd from one place

to another" (1671, p. 15). Steno does not claim that matter is reducible to those corpuscular properties. For example, he holds that we do not know "whether [there are] in those particles, besides extension, and hardness, some [other properties] unknown to us" (1671, p. 15). Moreover, he stresses the fact that the known matter cannot provide the first principle of motion and explain the perception of motion (1671, p. 16). Next, Steno presents his hypotheses on the formation of particular solids as if there were no solution of continuity between the rudimentary "most certain principles of nature" that he brings forward first, and the geological or biological explanations that he proposes then. We may have the impression that there is a conceptual and stylistic gap that separates specific physical explanations from the most general principles of nature. And yet, those specific explanations are in accordance with the general principles, in the sense that they do not contradict them, even if they require observations and auxiliary hypotheses that are not *deduced* from those principles. Consequently, Steno's common precepts may be regarded as the rules that govern the negative heuristics of his minimal mechanism.

The minimal physics that Steno proposed in the *De solido intra solidum* partly differs from Spinoza's physical interlude in *Ethics II*. Moreover, in contrast with Steno, who developed geological and anatomical hypotheses, Spinoza stuck to the negative heuristics of mechanism. Nevertheless, Steno's dissertation sheds a new light on how Spinoza presents the general postulates on the human body contained in *Ethics II* as the simple specification of a minimalist physics. Indeed, this shows that other natural philosophers in Spinoza's historical environment tried to include the specific knowledge of complex bodies within a physics that was general enough not to be threatened by the future development of science. Steno was not an isolated case: someone like Johannes Swammerdam, for example, who was Steno's friend, and very likely also a friend of Spinoza's, tried to propose a natural history of insects and cold-blooded animals that would be in accordance with the mechanical postulates which he shared with Steno (Miniati 2009, pp. 97–106; on the relationships with Spinoza, see Freudenthal 1904, vol. 1, p. 186; Jorink 2003, pp. 85–6, 90–91, 100). In both cases, the basic notions and principles that explain the structuration of stones are suited to animals and plants. But in Steno's *De solido* and Spinoza's *Ethics*, the general project of building a new science of complex bodies in accordance with the negative heuristics of mechanism have a striking consequence: their positions bring about a strange occultation of the lexical specificities that indicate the boundaries separating physics from disciplines like geology, biology, or natural history. In my view, this is the reason why Steno's treatise is neglected by Spinoza's commentators. Steno's *De solido* is classified as a geological treatise, which it is, in one sense: it deals with the history of the earth and the formation of fossils. But this kind of

classification, which corresponds to current disciplinary boundaries, leads one to disregard the general epistemological project in which Steno's geological arguments took place.[14] More generally, the recent disciplinary labelling leads us to neglect important historical sources that would be worth investigating in order to better understand Spinoza's works.

7. Conclusion

In his article on "Spinoza's natural science and epistemology," Alan Gabbey argued that the "intellectual traditions and relations between disciplines that Spinoza and his contemporaries know are the proper contexts within which his thought can be understood, and a competent assessment of his originality and subsequent influence be grounded" (1995, p. 144). Motivated by a similar conviction, I have established that Spinoza was a *connoisseur* in matters of anatomy. If this historical fact has often been neglected, it is partly because we judge Spinoza's claims on living bodies in the light of twentieth century physiology and biology. The very notion of "physiology," understood as the science of bodily functions clearly distinguished both from physics and anatomy, did not make sense at the time: first, anatomy then naturally included the study of the functions, or "uses," which now belongs to physiology;[15] and second, anatomy was conceived of as a part of physics. Then, I have proposed to consider Spinoza's claims on the structure of the human body as an illustration of the "negative heuristics" of mechanism. This notion, borrowed from Lakatos, does not challenge the most widely accepted interpretations of Spinoza's natural philosophy that have been developed in the past thirty years (see for example Garber 1994, p. 64). Indeed, there is nothing new in conceiving of Spinoza's natural science as an unorthodox and polemical understanding of the mechanical philosophy that had first been illustrated by Descartes. However, the notion of a negative heuristics enlightens Spinoza's seemingly paradoxical position on the structure of human bodies. On the one hand, in the *Ethics*, there are almost no specific claims about the human body, nor are there any technical terms to refer to its parts. This is particularly astonishing in a work which partly deals with the so-called union of mind and body and the power of the mind over its passions. On the other hand, Spinoza confidently considers that the physical actions that a body can do are

14. Another reason why Steno's *De solido* has been neglected is the fact that this dissertation, written after Steno's conversion, has been seen in a theological context (see Miniati 2009, p. 276). But in these first pages of the *De solido*, the physico-theological orientation of Steno is far less obvious that what Miniati claims (see his own precision p. 27n16).

15. As for physiology, it rather corresponded to a synthetic survey of the functions of a healthy human body: it had a theoretical dimension, while anatomy corresponded to first-hand investigations. See Cunningham 2003.

explicable by its structure alone. In addition, Spinoza does not hesitate to use his knowledge of human anatomy to illustrate his conception of the relationships between the parts and the whole, or to dismiss Descartes's pineal gland. It is thus not possible to qualify Spinoza's position regarding the science of the human body as merely skeptical. Accordingly, the remarks on human bodies that are scattered in Spinoza's works do not so much indicate some mistrust regarding the anatomical knowledge of his time, as they suggest his awareness of the kind of anatomical research that remained to be done. The notion of a negative heuristics exactly shows how different critical remarks on our knowledge of human body, taken together, have heuristic value: they define the hard core of the general principles that cannot be contradicted by the future development of the positive heuristics, i.e., of hypotheses to answer specific problems. I have regarded the negative heuristics endorsed by Spinoza as mechanistic in order to insist on three very general claims that belonged to its "hard core" (Lakatos 1978, p. 48): 1. the ontological and epistemological continuity between simpler bodies (like stones) and more complex ones (like blood, lymph, and animal bodies); 2. the notion that the action of a complex body has to be explained by reference to its structure, understood as the set of static and dynamic relationships between its parts; 3. the notion that the dynamic relationships between the parts of a complex body have to be explained by reference to the "communication" of a local movement which obey the laws of collision. By definition, the negative heuristics can never be refuted by experience, and it is not possible to deduce from it any particular explanation; it rather indicates what cannot count a priori as an explanation for a certain range of phenomena.

Thus presented, the negative heuristics of the mechanistic research program finds a striking illustration in the natural philosophy of a very famous anatomist who was once very close to Spinoza: Nicolaus Steno. It is not important here to know if Steno influenced Spinoza in this matter. As I have explained in this article, it is often more difficult than one would believe at first sight to discover the medical sources of a philosopher. First, the influence between the two may well partly be the other way round. And second, Steno was not the only one in Spinoza's historical environment who wanted to reform anatomy in accordance with clear and intelligible postulates, which turned out to be mechanical postulates. However, Steno's works show that anatomists who were close to Spinoza, and read by him, also criticized the misleading notions and premature explanations which were then conveyed by "anthropology," i.e., the specific science of human body. Like Spinoza, Steno proposed instead a rudimentary physics, defined by the "most certain principles of nature," on which a new anthropological science should be based. It is worth emphasizing one consequence of this epistemological decision in Spinoza's case. One of the reasons eminent physiologists have found in Spinoza

a valuable source of inspiration is paradoxically the fact that Spinoza's *Ethics* does not contain any proposition that a nineteenth or a twentieth century physiologist would a posteriori classify as "physiological," or "biological." Consequently, the basic rules of *Ethics II* and their various instantiations in the parts of the *Ethics* dealing with affects and virtue can be adapted to different versions of physiological or biological sciences. If Spinoza had not stuck to the negative heuristics of mechanism, and had developed, ever so slightly, the positive heuristics, his philosophy could not have been adapted to historically incompatible conceptions of the human body.

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