

Man-Machines and Embodiment: From Cartesian Physiology to Claude Bernard's 'Living Machine'

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Abstract. A common and enduring early modern intuition is that materialists reduce organisms in general and human beings in particular to automata. Wasn't a famous book of the time entitled *L'Homme-Machine*? In fact, the machine is employed as an *analogy*, and there was a *specifically materialist* form of embodiment, in which the body is not reduced to an inanimate machine, but is conceived as an affective, flesh-and-blood entity. We discuss how mechanist and vitalist models of organism exist in a more complementary relation than hitherto imagined, with conceptions of embodiment resulting from experimental physiology. From La Mettrie to Bernard, mechanism, body and embodiment are constantly overlapping, modifying and overdetermining one another; embodiment came to be scientifically addressed under the successive figures of *vie organique* and then *milieu intérieur*, thereby overcoming the often lamented divide between scientific image and living experience.

1. The Problem of Polysemous Embodiment

In what follows we seek to trace and reconstruct, through a series of examples running from the early modern Cartesian context through Enlightenment materialism to mid-nineteenth century medicine, a revised concept of embodiment as emerging out of naturalistic, mechanism-friendly practices in the life sciences and in theoretical efforts relating to such practices. Such an approach runs directly counter to the common understanding in which 'embodiment' (whether it is approached historically or from a contemporary standpoint) is precisely what the scientific study of organic life 'misses'. But what is embodiment? Or more precisely, when a concept of embodiment is invoked in, inter alia, scholarship on Descartes or Spinoza, early modern 'cultures of the body', or the study of embodied cognition (to list some examples¹) what concept is this, if there is any conceptual unity here at all? Broadly speaking,

¹ For example, Amelie Oksenberg Rorty, "Descartes on thinking with the body," *The Cambridge Companion to Descartes*, ed. J. Cottingham, 371-392 (Cambridge: Cambridge University Press, 1992); Lilli Alanen, *Descartes's Concept of Mind* (Cambridge, MA: Harvard University Press, 2003); Iris Marion Young, *On Female*

in the study of cognition, ‘embodied mind’ perspectives reject traditional computational approaches and present our cerebral life as necessarily occurring within a body, understood both as a dynamic system and as something fundamentally *my own* in the sense of Merleau-Ponty’s *corps propre*: I am not ‘in my body’, on this view, as if I were in a merely material container; instead, I sense in a profound way that my body is my own.² The emphasis here usually falls on how an embodied agent inhabits the world, not as one body amongst others (atoms and asteroids and bottles) but as a *subject* in her own environment. In cultural studies, embodiment seems to connote a complex relation between historicity and gender, in which “subjectivity [is] profoundly experienced as interrelated with the physical, and societal changes or structures influenced the ways in which the body was perceived,”³ through scientific discourses but also in many other ways.⁴ Embodiment here is not the facts about our biology but, paradoxically, about our historicity:

There is no clear set of structures, behaviors, events, objects, experiences, words, and moments to which body currently refers. Rather, it seems to me, the term conjures up two sharply different groups of phenomena. Sometimes body, my body, or embodiedness seems to refer to limit or placement, whether biological or social. That is, it refers to natural, physical structures (such as organ systems or chromosomes), to environment or locatedness, boundary or definition, or to role (such as gender, race, class) as constraint. Sometimes-on the other hand-it seems to refer precisely to lack of limits, that is, to desire, potentiality, fertility, or sensuality/sexuality . . . or to person or identity as malleable representation or construct. Thus body can refer to the organs on which a physician operates or to the assumptions about race and gender implicit in a medical textbook, to the particular trajectory of one person's desire or to inheritance patterns and family structures.⁵

Body Experience: 'Throwing Like a Girl' and Other Essays (Oxford: Oxford University Press, 2005); Larry Shapiro, *Embodied Cognition* (London: Routledge, 2011).

² Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. C. Smith (London: Routledge & Kegan Paul, 1962), 104.

³ Ursula Rublack, “Fluxes: The Early Modern Body and the Emotions.” *History Workshop Journal* 53 (2002), 13.

⁴ Aside from the variety of works in ‘history of the body’ that appeared at a bewildering rate during the 1980s and 1990s, in early modern studies one can mention Caroline W. Bynum, “Why All the Fuss about the Body? A Medievalist’s Perspective.” *Critical Inquiry* 22 (1995); T. Reiss, “Denying the Body? Memory and the Dilemmas of History in Descartes.” *Journal of the History of Ideas* 57(4) (1996), G.K. Paster, “Nervous Tension: Networks of Blood and Spirit in the Early Modern Body,” in *The Body in Parts*, eds. D. Hillman and C. Mazzio (London: Routledge, 1997) and in embodied cognitive science, Young, *Throwing Like a Girl*; for interesting and original ways of extending and modifying their programs, combining a sense of historicized embodiment with notions in ‘historical cognitive science’, see John Sutton, “Spongy Brains and Material Memories,” in *Embodiment and Environment in Early Modern England*, eds. M. Floyd-Wilson & G. Sullivan (London: Palgrave, 2010). For a recent attempt to compensate for the total absence of ‘embodiment’ discourse in the history of science (here, early modern life science), see the essays collected in Wolfe and Gal, eds., *The Body as Object and Instrument of Knowledge* (Dordrecht: Springer, 2010).

⁵ Bynum, “Why All the Fuss about the Body?,” 5.

The ‘lived body’ we encounter in contemporary embodiment discourse is the body in pain, or in a state of enjoyment; in a reflexive, indeed intimate relation to itself – quite different, according to embodiment theorists, from the more generic body in space. They maintain that the lived body (which is the only relevant sense of the body for them) exists at least in part “outside of physical space.”⁶ Thus the living body – indeed, any organism – “is an individual in a sense which is not that of modern physics” (*ibid.*, 154). This is often presented in cultural studies as an insight countering ‘Cartesianism’. So, Jonathan Sawday, in his otherwise impressive study of early modern anatomy, *The Body Emblazoned*, refers to the rise of a Cartesian mechanistic world-picture and states that “As a machine, the body became objectified; a focus of intense curiosity, but entirely divorced from the world of the speaking and thinking subject.”⁷ That this is a rather impoverished and historically unfortunate portrayal of early modern mechanism is not germane to the present paper, although it is worth exploring elsewhere.

We are faced already with one general problem: the gap between discourses of embodiment and the complexity of ‘body’ and biological or medical terms as understood from the standpoint of the history and philosophy of the life sciences. That is, cultural discussions of early modern embodiment usually position themselves *counter* to a kind of ‘mainstream science’, which they present as alienated and alienating, as quantitative and reductionist, and of course dehumanizing. The quantitative and reductionist part turns out to be partly true but more complicated; the rest is at best highly debatable, not least given the importance of reflections on ‘organism’ and ‘organismic’ approaches at least since the Leibniz-Stahl debate, and prominently part of physiological discussions in the era of Claude Bernard.⁸ This

⁶ Maurice Merleau-Ponty, *The Structure of Behaviour*, trans. A.L. Fisher (Boston: Beacon Press, 1963), 209.

⁷ Sawday, *The Body Emblazoned: dissection and the human body in Renaissance culture* (London: Routledge, 1995), 29. Thus present-day embodied mind theorists assert quite bluntly that “Life is not physical in the standard materialist sense of purely external structure and function. Life realizes a kind of interiority, the interiority of selfhood and sense-making. We accordingly need an expanded notion of the physical to account for the organism or living being” (Evan Thompson, *Mind in Life* [Cambridge, Mass.: Harvard University Press, 2007], 238). In fact, this “expanded notion of the physical” has always been present; it is rather the picture of “standard materialism” that needs to be revised.

⁸ This problem of doing justice to embodiment without producing a strictly reactive historiography matches up with the problem surrounding the Scientific Revolution and the ‘death of Nature’ (Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* [New York: Harper and Row, 1980]; see John Sutton and Evelyn B. Tribble, “Materialists Are Not Merchants of Vanishing,” *Early Modern Culture* 9 (2011), for an inspiring critique of her view).

complexity can be shown in a variety of cases, ranging from recent reinterpretations of Descartes on life, passions and physiology, the role of early modern automata in modelling vital processes (and thus creating bridges in between the mechanical and the organic), vital materialism understood as a form of materialism specifically concerned with body and vitality, and lastly, vitalist models of the ‘animal economy’ in the mid-eighteenth century and their combined reprisal and rejection in nineteenth-century experimental medicine, from Bichat to Bernard. We shall discuss four cases: Descartes and medicine (section 2), embodied materialism versus the older concept of mechanistic materialism (section 3), and the emergence of organismic yet mechanism-friendly models in nineteenth-century medicine such as Bichat’s physiology, leading up to Claude Bernard’s notion of ‘machine vivante’ (section 4); the status of vitalism, including its scientific pertinence, is addressed in sections 3 and 4.

2. Body and Soul in a Medical Context

Contrary to the standard picture of Descartes the substance dualist, whose understanding of nature is so purely mechanistic that no particular features of ‘life’ or ‘bodies’ subsist in a non-reduced form, scholars including Gaukroger, Sutton, Des Chene and differently Shapiro have pointed to the presence of functional concepts in Cartesian physiology; of body-soul union (in the correspondence with Elizabeth); of a notion of health and consequently normativity generated out of the body-machine concept.⁹ This is not to say that Descartes did not influentially adopt a deflationary approach to embodiment, or that iatromechanism¹⁰ should be confused with, say, Georg-Ernst Stahl’s focus on the holistic properties of organism and the temporal character of disease, as presented for instance in his critique of Leibniz.¹¹ As concerns Cartesian mechanism as apparently a denial or reduction of embodiment, passages

⁹ See for instance Oksenberg Rorty, “Descartes on thinking with the body,” John Sutton, “The Body and the Brain,” in *Descartes’ Natural Philosophy*, eds. S. Gaukroger, J.A. Schuster, & J. Sutton (London: Routledge, 2000), Lisa Shapiro, “The Health of the Body-Machine? Or Seventeenth Century Mechanism and the Concept of Health,” *Perspectives on Science* 11(4) (2003) and, differently, Dennis Des Chene, *Spirits and Clocks: Machine & Organism in Descartes* (Ithaca: Cornell University Press, 2001), e.g. chapter 6 (on *functio* and *usus*).

¹⁰ ‘Iatromechanism’ designates a school of medical and physiological thought that extensively views living bodies as mechanical devices, wholly following the laws of mechanics and likely to be understood, analysed and cured through them.

¹¹ Georg Ernst Stahl, *Negotium otiosum, seu Schiamaxia adversus positiones aliquas fundamentales theoriae verae medicae Viro quodam celeberrimo intentata sed adversis armis conversis* (Halle: Impensis Orphanotrophei, 1720).

like this one from the *Treatise on Man* are numerous (as they are in authors such as Borelli, Pitcairne, Croome and beyond): (QUOTATION IN PUBLISHED VERSION).¹²

Yet we must summarily make two observations that nuance the picture of the Cartesian body-machine as merely a ‘machine made of earth’. The first is internal to Descartes’ system and concerns the extent to which features as diverse as sensation, self-preservation, health, function and perhaps even a ‘life principle’ are – surprisingly – irreducible.¹³ The second is more external and concerns medical mechanism as a whole.

For the ‘body-soul’ problem – arguably the immediate ancestor of the ‘mind-body’ problem, inasmuch as it was concerned with possible relations between corporeal states and mental processes – was also a medical one. With reference to the Cartesian context alone, entire books have been written just on the specifically medical context of Cartesianism.¹⁴ Both during Descartes’ own lifetime and in the following decades, numerous physicians claimed to be carrying out a legitimate Cartesian project, e.g., eliminating final causes and explaining all of nature mechanically, including the human body, while in fact moving ever closer to an integrated view of psychosomatic processes. Thus Henricus Regius, a physician and Professor of Theoretical Medicine at the University of Utrecht, often called the ‘first apostle of Cartesianism’ (e.g. in a review in the *Nouvelles de la république des lettres* in October 1686), asserted that the soul could be a mode of the body, with the body being understood as a machine, and that the human mind, inasmuch as it exists in a body, is organic.¹⁵ Even Marx (borrowing from Renouvier’s history of philosophy) mentioned Regius as a precursor of La Mettrie: “Descartes was still alive when Le Roy applied to the human soul the Cartesian idea of animal structure, and declared that the soul was but a *mode of the body*, and ideas were but

¹² AT XI 131; CSM I, 100. Cf. also the passage in the Sixth Meditation on the ‘health’ of a watch: “A clock constructed with wheels and weights observes all the laws of its nature just as closely when it is badly made and tells the wrong time as when it completely fulfills the wishes of the clockmaker. In the same way, I might consider the body of a man as a kind of machine equipped with and made up of bones, nerves, muscles, veins, blood and skin in such a way that, even if there were no mind in it, it would still perform all the same movements as it now does in those cases where the movement is not under the control of the will or, consequently, of the mind” (AT VI, 84; CSM II: 58); thanks to Christoffer Basse Eriksen for discussion on this).

¹³ See Fred Ablondi, “Automata, Living and Non-Living: Descartes’ Mechanical Biology and His Criteria for Life,” *Biology and Philosophy* 13 (1998) and the discussion in Barnaby Hutchins, “Descartes and the dissolution of life,” *The Southern Journal of Philosophy* (forthcoming).

¹⁴ Most recently, Annie Bitbol-Hespériès, *Le principe de vie chez Descartes* (Paris: Vrin, 1990), Vincent Aucante, *La philosophie médicale de Descartes* (Paris: PUF, 2006), and Gideon Manning, “Out on the Limb: The Place of Medicine in Descartes’ Philosophy,” *Early Science and Medicine* 12 (2007) (a useful review essay).

¹⁵ Henricus Regius, *Fundamenta physices* (Amsterdam: Elsevier, 1646), 248, 246. For more discussion of Regius see the excellent analysis in Delphine Bellis, “Empiricism Without Metaphysics: Regius’ Cartesian Natural Philosophy,” in *Cartesian Empiricisms*, eds. M. Dobré and T. Nyden (Dordrecht: Springer, 2014).

mechanical motions.”¹⁶ Others asserted that Descartes was too timid, and one should be a Cartesian in physiology while eliminating substance dualism, in favour of a parallelism of physical events and mental events (Louis de La Forge¹⁷), or, rather tortuously, tried to argue ‘from’ Descartes towards a materialist account of mind-body interaction, at times seeking to integrate Cartesianism and Epicureanism.¹⁸ Such thinkers tried to collapse their ideas into Descartes’ own, but others – perhaps tellingly, outside of France – were quicker to dispense with any monopoly Descartes might have had over the prestige of mechanism in medicine, like Herman Boerhaave (1668-1738) or Hieronymus Gaub (1705-1780).

Boerhaave’s 1690 doctoral thesis in philosophy at Leiden, where he was later Professor of Medicine, Botany, and Chemistry (he was widely viewed as the most influential lecturer in medicine in Europe, and taught figures including La Mettrie, Gaub and Haller) was entitled *De distinctione mentis a corpora*, and there he argued for a distinction between mind and body. But in his later *Praelectiones academicae* (1739), he denied any medical or physiological pertinence to the distinction between body and soul or mind understood as a form of substance dualism (§ 27). Body and mind are united, communicated, mutually affect one another, and a change occurring in the one produces a change in the other; this view may explain the unfair accusations of Spinozism that were laid against him. Boerhaave admits that he has no way of explaining the interaction between body and mind experimentally;¹⁹ he considers three hypotheses, “physical influx,” occasional causes and divine harmony, and opts for the last (§ 27.7). He adds a remark that was repeated, with or without attribution, many times during this period (similar comments can be found in Galen): physicians should only concern themselves with the body, *even when dealing with mental illness* (or ‘diseases of the soul’), for once the body is working correctly, the mind will return to its proper “officium” (§ 27.8) – the ancient Stoic term for the role we are destined to play, which in this context can be rendered as “function.”²⁰

¹⁶ Marx, *The Holy Family*, VI, 3, d, discussed in Olivier Bloch, “Marx, Renouvier et l’histoire du matérialisme.” *La Pensée* 191 (1977).

¹⁷ Louis de La Forge, *Traité de l’esprit de l’homme, de ses facultés et de ses fonctions, et de son union avec le corps. Suivant les principes de René Descartes* (Paris: Théodore Girard, 1666), ch. XV.

¹⁸ Henri Busson, *La religion des classiques* (Paris: PUF, 1948).

¹⁹ La Mettrie was quick to fill in the descriptive gaps in Boerhaave’s psychophysiology, both in his edition and translation of Boerhaave’s lectures (*Institutions de médecine de M. Hermann Boerhaave*, trans. with commentary by La Mettrie, 2nd ed., vol. 5 out of 8. Paris: Huart & Cie, 1747), and in his own writings.

²⁰ On ‘officium’ or ‘office’ as a functional, teleological or ‘teleomechanical’ concept in early modern medicine, see Wolfe, “Teleomechanism redux? Functional physiology and hybrid models of Life in early modern natural philosophy.”

Boerhaave's student Gaub, who took over his Chair in Leiden, gave a lecture in there in 1747 which La Mettrie claimed to have attended (some months prior to finishing *L'Homme-Machine*), entitled *De regimine mentis*. This text is important for us because there Gaub suggests a clinical perspective on the problem of mind-body interaction (for he is speaking of *mens* rather than *anima*, reflecting a process of naturalization which is underway in this period).²¹ La Mettrie spoke favourably about the ideas he heard, and his enthusiasm²² makes sense, for Gaub had defended the view that for the physician, the metaphysical distinction between mind and body is irrelevant. "Although the healing aspect of medicine properly looks toward the human body only, rather than the whole man, it does refer to a *body closely united to a mind* and, by virtue of *their union*, almost continually acting on its companion as well as being itself affected in turn."²³ Gaub refers to the authority of Descartes, "the most ingenious philosopher of his age," who "yielded to physicians" regarding the priority of medicine in these matters (74)²⁴, and states that due to the variability of temperaments, itself explainable in humoral (and hence medical) terms, the philosopher "cannot dispense with the aid of the physician" where the mind is concerned (86).

So whereas some of the Cartesians, Boerhaave and Gaub thought that the body-soul union (or relation, depending on their convictions) fell under the medical purview, but that it was perhaps best to focus on the body, others were more aggressively materialist in asserting the autonomy of medicine with respect to theology or other disciplines. Thus Boerhaave's advice to physicians ('only concern yourself with the body') becomes, in the Montpellier physician Ménéret de Chambaud's entry "Mort" in the *Encyclopédie*, more radical:

The separation of the soul from the body, a mystery which may be even more incomprehensible than its union, is a theological dogma certified by religion, and consequently is uncontestable. But it is in no way in agreement with the

²¹ John P. Wright, "Substance vs. Function Dualism in Eighteenth-Century Medicine," in *Psyche and Soma. Physicians and Metaphysicians on the Mind-Body Problem from Antiquity to the Enlightenment*, eds. J.P. Wright & P. Potter (Oxford: Clarendon Press, 2000), 249. Gaub, like Haller, did not appreciate La Mettrie's materialist appropriation of his ideas, and in 1763 included a short essay against La Mettrie in his new edition of *De regimine mentis*, calling him "a little Frenchman" who produced a "repulsive offspring . . . his mechanical man" (in L.J. Rather, *Mind and Body in Eighteenth-Century Medicine. A Study Based on J. Gaub's De regimine mentis* (Berkeley: University of California Press, 1965), 115).

²² More on which in our penultimate section.

²³ Gaub, *De regimine mentis* (1747), in Rather, *Mind and Body in Eighteenth-Century Medicine*, 70, emphasis ours.

²⁴ Gaub has in mind the passage from Part VI of Descartes' *Discours de la méthode* where Descartes notes the interpenetration of mind and the organs of the body, so that medicine is the best way to render people wiser than they have hitherto been (AT VI, 62).

lights of reason, nor is it based on any medical observation; hence we will not mention it in this purely medical article, in which we will restrict ourselves to describing the changes of the body, which, as they alone fall under the senses, can be grasped by the physicians, those sensual artists, *sensuales artifices*.²⁵

Here the medicalisation is administered in such strong doses that the concept of soul falls out altogether.

But these attempts to articulate and justify a specifically medical approach to body-soul relations (which will gradually be termed ‘body-*mind*’ relations by the later eighteenth century) can also accept substance dualism, albeit idiosyncratically. William Cullen, in physiological lectures given at the Royal College of Physicians of Edinburgh in the mid-1760s, reflected on substance dualism, not in order to reject it, but to give it a peculiarly medical cast. For Cullen, we can know the mechanism(s) governing our bodies, not that which governs our minds. Yet, like Boerhaave, he also thinks that our mental states are inseparable from “some conditions in the body.”²⁶ But – perhaps on ideological grounds – Cullen immediately appealed to the good reputation of Boerhaave and Haller, who were never “suspected of Irreligion” (*ibid.*). However, he also recognises that the mind-body problem remains problematic for physicians as well; but the specifically medical version of the problem as he states it sounds much like an *embodied* materialist statement from Diderot or La Mettrie, as we shall discuss below: it reduces “the problem of the action of the mind upon the body” to the problem: “how one State of the body or of one part can affect another part of it” (*ibid.*). Such reduction is a reduction *to states of the body, in accordance with explanations of bodily processes*; it is not a reduction to some ‘fundamental physics’ or to the properties of matter as a whole.

Similar (although not in medical-historical terms) to Cullen’s way of defending substance dualism while insisting on a *specifically medical* variant, the Paris physician Antoine Le Camus, in his *Médecine de l’esprit* (1753), put forth the program that medicine should know

²⁵ Ménuret de Chambaud, “Mort,” *Encyclopédie ou Dictionnaire raisonné des arts et des métiers*, eds. D. Diderot & J. D’Alembert (Paris: Briasson, 1765), X, 718b.

²⁶ Cullen, notes added to “Lectures on the Institutes of Medicine,” cit. in Wright, “Substance vs. Function Dualism in Eighteenth-Century Medicine,” 244.

both minds and bodies, so that it can perfect the mind by acting on the body. Le Camus notes that most people would not deny medicine's expertise when it comes to the body, but they would be reluctant to grant it authority over the mind, and he wants to remedy this situation: "to remedy to the vices of the mind is nothing other than to remedy the vices of the body."²⁷ Although phrased in terms of Cartesian dualism, Le Camus' conception of medicine and of therapeutics is a different creature, for it belongs to the conceptual scheme of the "animal economy" – a more integrated, organisational approach²⁸, as we discuss below. Though his title suggests that Le Camus is a sort of Cartesian (since the Cartesian thesis is that passions are effects of the mind-body union on the mind), he has a more expansive conception of medicine. Similarly, Le Camus gestures initially in a Cartesian direction, saying he knows the soul is rational and immortal, but he immediately adds that it is also true that the soul is "aided in its operations" by "genuinely mechanical causes."²⁹ Le Camus's program for medicine holds that it is the science which has equal knowledge of mind and body, and hence can treat their "abstract combinations" and their "relations" (*commerce*). While he still refers to these as two substances in his terminology, in practice he gives an integrated account of "virtues" and "passions" as being as much part of the body as of the soul.³⁰

3. Mechanistic Materialism or Materialist Embodiment? Vitalist Intimations

The medical outlook here allows for a particular kind of materialism, in which embodiment is not reducible to more general claims about how what is real is (a) body. Contrast this more integrated sense of 'the body' with Hobbes' "That which is not body is no part of the universe," "there is no motion save of corporeal substance"³¹ or the assertion that Nature in its entirety is a "weave of bodies" (*tissure de corps*), in an intriguing, then-anonymous work of

²⁷ Antoine Le Camus, *Médecine de l'esprit, où l'on traite des dispositions et des causes physiques qui sont des conséquences de l'union de l'âme avec le corps, influant sur les opérations de l'esprit; et des moyens de maîtriser ses opérations dans un bon état ou de les corriger quand elles sont viciées* (Paris: Ganeau, 1753), I, 7; "God only excites ideas in our souls relative to the dispositions in our bodies" (*ibid.*, ch. III, section 2, 49).

²⁸ Huneman, "'Animal Economy': Anthropology and the Rise of Psychiatry from the *Encyclopédie* to the Alienists," in *The Anthropology of the Enlightenment*, eds. Larry Wolff & Marco Cipolloni (Stanford: Stanford University Press, 2007), 266.

²⁹ Le Camus, *Médecine de l'esprit*, I, xviii.

³⁰ Le Camus, *Médecine de l'esprit*, I, 111f.; II, 239.

³¹ Hobbes, *Leviathan*, IV, § xlvi, ed. E. Curley with selected Latin variants (Indianapolis: Hackett, 1994), 459; Hobbes, *Thomas White's "De Mundo" Examined* (approx. 1642-1643), trans. H.W. Jones (London: Bradford University Press, 1976), ch. 37, § 4, 447.

medical materialism known as the *Parity of Life and Death* (1714) by the eighteenth-century physician and materialist Abraham Gaultier.³² Diderot gives a more explicitly reductionist cast to the claim that ‘all is body’, when, in a major unpublished work which occupied him during the last two decades of his life, the *Elements of Physiology*, he explains that “the action of the soul on the body is the action of one part of the body on another, and the action of the body on the soul is again that of one part of the body on another” and, in his marginal commentary on Franz Hemsterhuis’ 1772 *Lettre sur l’homme*, “wherever I read *soul* I replace it with *man* or *animal*.”³³ Similarly, La Mettrie in his first philosophical work, the *Natural History of the Soul* (1745, later revised under the title *Treatise on the Soul*), declares that “he who wishes to know the properties of the soul must first search for those which manifest themselves clearly in the body,” and a few years later, in *Man a Machine*: “But since all the faculties of the soul depend to such a degree on the brain and the whole body’s own organization that they visibly are nothing but this organization itself — here is a *machine bien éclairée!* (really, a sophisticated machine; CW).”³⁴

That the historian of philosophy concerned with mind-body relations, mechanism and the status of the soul in a context of ‘naturalization’ ignores the medical context at her peril, is one lesson emerging from the above. The same applies to the specific case of materialism, with an additional ‘moral’ regarding its well-known assimilation to the position known as ‘mechanistic materialism’. For one often hears that proper materialism – that of Hobbes, d’Holbach and also, what will become ‘physicalism’ in the twentieth century – reduces all causes to physical causes, and all matter to a kind of mechanistically (and by extension mathematically) specifiable matter. This view was prominently expressed by a thinker not so frequently cited in scholarly contexts, Friedrich Engels, in a statement as rewarding of study as it is rife with mistakes:

The materialism of the past century was predominantly mechanistic, because at that time . . . only the science of mechanics . . . had reached any sort of completion. . . . For the materialists of the 18th century, man was a machine.

³² Abraham Gaultier, *Parité de la vie et de la mort. La Réponse du médecin Gaultier* (1714), ed. O. Bloch (Paris: Universitas / Oxford: Voltaire Foundation, 1993), 167; he is actually discussing Spinoza’s views.

³³ Diderot, *Éléments de physiologie* (a work which on every page seeks to explore connections between ‘physiological’ ideas of living bodies and philosophical materialism), in Diderot, DPV XVII, 334-335; Diderot, in François Hemsterhuis, *Lettre sur l’homme et ses rapports* (1772), avec le commentaire inédit de Diderot, ed. G. May (New Haven: Yale University Press / Paris: PUF, 1964), 277.

³⁴ *Traité de l’âme*, I, in La Mettrie, *Œuvres philosophiques*, ed. F. Markovits (Paris: Fayard-“Corpus”, 1987), I, 125; *L’Homme-Machine*, in *ibid.*, I, 73.

This exclusive application of the standards of mechanics to processes of a chemical and organic nature – in which the laws of mechanics are also valid, but are pushed into the background by other, higher laws – constitutes the specific (and at that time, inevitable) limitation of classical French materialism.³⁵

There are two major mistakes here.

One is the belief that chemistry emerged suddenly in the nineteenth century. On the contrary, matter theory, materialism and ‘philosophies of nature’ in the eighteenth century, from Stahl to Rouelle and Venel, including individuals attending Rouelle’s lectures at the Jardin du Roi, like Diderot who was an active participant for three years in the 1750s, were chemically obsessed.³⁶ Diderot’s metaphysics of a universally sensing matter, i.e., his enhanced materialism in which sensitivity (*sensibilité*, typically translated ‘sensitivity’) is an irreducible property of matter, is laden with chemical concepts and vocabulary, in a usage (not unique to him) of the image of the chemical laboratory or the distillation still as a way to describe the body: “The animal is the laboratory in which sensitivity shifts from being inert to being active.”³⁷

The other mistake is to take the man-machine model so literally, while it is really, primarily, an organic model, that is, an organism-centred model.³⁸ Even when La Mettrie uses the celebrated mechanistic image of the watch or clock as an analogy for the brain’s capacity to think, in the opening paragraphs of *L’Homme-Machine*, when he states that the question, ‘can matter think?’ is tantamount to asking ‘can matter tell time?’, he is not literally saying that brains are like clocks, but rather, putting forth a functional analogy between different arrangements of matter and their correspondingly different functional properties.³⁹ Again, La Mettrie is not asserting that the processes and properties of the specific material organization

³⁵ Engels, *Feuerbach und der Ausgang der klassischen deutschen Philosophie* (1888), in Marx & Engels, *Werke*, vol. 21 (Berlin: Dietz Verlag, 1982), 278; Marx & Engels, *Basic Writings on Politics and Philosophy*, ed. L.S. Feuer (New York: Doubleday / Anchor Books, 1959), 211.

³⁶ On chemistry in this context see François Pépin, *La Philosophie expérimentale de Diderot et la chimie* (Paris: Garnier, 2012). Diderot criticized physics for its abstraction and insisted that “it is from chemistry that it learns or will learn the real causes” of natural phenomena (Diderot, DPV IX, 209). His lecture notes were first published in 1887, and are now available in the standard edition of his works: *Cours de chimie de Mr Rouelle* (1756), in Diderot, DPV IX. Note that this criticism of physics is more or less identical with his criticism of mathematics in the name of a kind of irreducible ... embodiment: “of all the physical sciences to which one has attempted to apply geometry, it appears that there are none in which it penetrates less than in Medicine” (Diderot, “Mécanicien,” 221). A variety of kindred spirits such as Buffon, Maupertuis, La Mettrie and Bonnet (who rejected materialism as a metaphysics) concurred in *denying* that the body is something that could be *mathematized*.

³⁷ Diderot “Lettre à Duclos,” October 10 1765, *Corr.*, vol. 5, 141.

³⁸ Ann Thomson, “Mechanistic Materialism versus Vitalistic Materialism,” in *Mécanisme et vitalisme*, ed. M. Saad, special issue of *La Lettre de la Maison française d’Oxford* 14 (2001).

³⁹ Timo Kaitaro, “‘Man is an admirable machine’ – a dangerous idea?” In M. Saad, ed., *Mécanisme et vitalisme*, special issue of *La lettre de la Maison française d’Oxford* 14 (2001).

of the brain are *the same* as the processes and properties of the specific material organization of a clock.

But also, Engels can be rebutted by showing that materialism had a more constitutive relation to the emerging life sciences and their ontology (as in the case of Diderot's 'Spinozism' mentioned below) as well as to vitalism.⁴⁰ Thinkers such as La Mettrie and Diderot articulated their form(s) of materialism, not just in direct dialogue with the emerging and evolving life sciences, particularly disciplines such as medicine, physiology and natural history (for Diderot: "there are no works I read with more pleasure than medical works"⁴¹), but more strongly, in such a way that the ontological implications of these sciences have a direct impact on the core philosophical commitments. This relation between core materialist commitments and new life science developments (here, generation/development rather than medicine) is explicit in a particularly fascinating if brief text, Diderot's article 'Spinostiste' in the *Encyclopédie*.⁴² What is striking in this short article is that so-called 'modern Spinozists' are presented as agreeing with the basic tenets of a metaphysics of substance and modes, *and in addition* as defenders of the biological theory of epigenesis, according to which the embryo is formed by successive addition of layers of material substance, without addition of any purely 'informational' entity as in preformationism.

The relation to vitalism deserves more analysis than can be provided here, not least because in this case, it is not one but two major misconceptions that are still common, including in major survey works like the *Oxford Companion to the History of Modern Science*: that materialism reduces everything to matter and motion, while vitalism has as its basic principle an immaterial vital force or principle. The present essay builds on work we have done earlier on the eighteenth-century Montpellier vitalists, and nineteenth-century physiology and medicine (from Bichat onwards), respectively.

Since our 'Leitfaden' in this essay is the non-oppositional relation between machine models and embodiment, and thus between mechanistic and organismic explanations (if the latter are understood structurally rather than 'foundationally', i.e. as attempts to model organizational complexity rather than as a strong distinction between a foundational principle of order, unity or individuality and the aforementioned complexity), we will simply indicate for now that the

⁴⁰ Wolfe and Terada, "Animal Economy"; Thomson, "Mechanistic Materialism versus Vitalistic Materialism."

⁴¹ *Éléments*, in Diderot, DPV XVII, 510.

⁴² *Enc.* XV, 474. It is not signed by him but strongly resembles passages in his other works and is included in most editions of his complete works. For full discussion of this text see Charles T. Wolfe, "Epigenesis as Spinozism in Diderot's biological project," in *The Life Sciences in Early Modern Philosophy*, eds. O. Nachtomy and J.E.H. Smith (Oxford: Oxford University Press, 2014).

case of vitalism, at least in some of its Enlightenment forms, can be shown to be much the same. That is, just as the reductionist potential of materialist explanations did not mean a denial of embodiment but rather a response to the (simultaneously ontological and explanatory) challenge of its existence, similarly, the vitalist insistence on the specific organizational complexity of living systems is not an insistence on ontological ‘otherness’ with respect to mechanical models. Ménuret de Chambaud, one of the more intriguing of the physicians associated with the Montpellier School of Medicine, who are commonly referred to today as ‘Montpellier vitalists’, not least since they were the first to use the term and apply it to themselves, speaks of the ‘human machine’, playing on classic mechanistic language while adding on higher-level, chemical properties:

What is man? Or to avoid any misunderstanding . . . what is the human machine? It appears at first sight to be a harmonious composite of various springs, each of which is impelled by its own motion but (which) all concur in the general motion; a general property especially restricted to organic composites, known as irritability and sensibility spreads through all springs, animates them, vivifies them and excites their motions. But, modified in each organ, it infinitely varies their actions and motions: it leads the various springs to tighten against one another, to resist, to press, act and mutually influence one another. This reciprocal commixture sustains motions, no action without reaction. From this continuous antagonism of actions, life and health result.⁴³

There is a kind of equilibrium here – for if we no longer have an autonomous, immaterial soul controlling the motions of a mechanically defined body, a more unified, more immanent picture of vital activity is needed. Ménuret observed this quite sharply, in his ambitious and programmatic article for the *Encyclopédie* on the “animal economy”:

This idea that the soul is the efficient cause of phenomena because it is the origin (*principe*) of vital motions is not an undeniable truth. It is true that if our body was a brute, inorganic machine, it would necessarily have to be directed by some other agent, maintaining and powering its motions. And I do not think the errors of the mechanists stem from anything else than the fact that they do not hold animals to be living, organized composites.⁴⁴

⁴³ Ménuret de Chambaud, “Spasme,” *Enc.* XV, 435b.

⁴⁴ Ménuret de Chambaud, “Economie Animale (Méd.),” *Enc.* XI, 364b.

The human machine or organic machine is thus not literally the same as another ‘brute’ machine; but the difference lies neither in a ‘soul’ nor in a ‘vital principle’. Rather, it is one of organizational complexity.⁴⁵ These models of biological ‘organization’, including the ‘animal economy’, which in many respects is a direct predecessor of the organism concept, as when its practitioners oppose it to merely mechanical explanations of the living body (Wolfe and Terada, “Animal Economy”), open up a conceptual space which sometimes resembles a kind of ‘expanded mechanism’, sometimes a heuristic vitalism which would remain compatible with mechanistic accounts of specific lower-level organs and functions (in Bordeu and Ménuret de Chambaud notably⁴⁶), in the sense that it would seek to understand higher-level functions – from digestion and fevers to sleep and perhaps Life itself – while not losing sight of lower-level entities and processes enabling the higher functions.

What then of nineteenth-century medicine in the wake of vitalism and newer, more sophisticated mechanistic models?

4. From Bichat to Bernard (Embodiment in Physiology after 1800: The ‘French Connection’)

Late eighteenth-century physiologists inherited from the medicine of the animal economy – whether that of Montpellier vitalists, or Scottish and English physiologists like the school of Munro and Cullen⁴⁷ – a concern with specifying the proper vital properties likely to support the functioning of the ‘machine’ – sensibility, contractility, irritability, elasticity. Some carried on experiments on frogs to capture the role of electricity within the nervous system (so-called Galvanism). Haller’s milestone textbook, the *Principles of Physiology*, was very influential and his experiments to isolate the properties of sensitivity and irritability⁴⁸ triggered a trend towards experiments in physiology – even though the scope and use of

⁴⁵ We leave open here the possible comparison with Leibnizian ‘machines of nature’, which are also defined by a specific organizational complexity, as discussed in the chapter by Ohad Nachtomy in the present volume, “Leibniz’s view of Living Beings: Embodied or Nested Individuals.”

⁴⁶ See E. Williams’ helpful comment particularly regarding Bordeu: “Mechanists had long attributed glandular action to the compression of glandular bodies by surrounding muscle and bone, but by 1750 it was widely recognized that this approach did nothing to explain why particular glands secreted particular fluids. Indeed it was in regard to this problem that vitalists first made inroads against mechanists, denying the explanatory power of such a model for glandular action and substituting for it a view based on the ‘internal sensations’ alluded to earlier, specifically the ‘taste’ or ‘desire’ of the gland that determined which components of blood it drew to itself and acted upon in furtherance of its specific function” (“Sciences of appetite in the Enlightenment, 1750-1800,” *Stud in Hist. and Phil. of Biological and Biomedical Sciences* 43(2) (2012), 398).

⁴⁷ John P. Wright, “Metaphysics and Physiology. Mind, Body, and the Animal Economy in Eighteenth-Century Scotland,” in Michael A. Stewart (ed.), *Studies in the Philosophy of the Scottish Enlightenment* (Oxford: Clarendon, 1990).

⁴⁸ Albrecht von Haller, *A Dissertation on the Sensible and Irritable Parts of Animals* (London, J. Nourse: 1755; reprint, Baltimore, 1936).

experimentation and especially vivisection were also critically discussed at the time and opposed to the value of observation, as Ménéuret did in his “Observation” entry in the *Encyclopédie*.⁴⁹ At the same time, medicine initiated its turn towards clinical medicine, with the idea that disease is a (possibly local) alteration of a functional organism rather than a “species” which would be instantiated by the diseased body. Bichat’s work, spanning medicine and physiology, was elaborated around 1800 at the crossroads of those trends. As has been extensively studied, he instituted foundations for anatomo-clinical medicine by showing that diseases should ultimately be traced back to the altered tissues,⁵⁰ the basic building-bricks of an organism, while his Anatomy (*Anatomie générale*, 1798; *Anatomie descriptive*, 1802) inventoried the 21 various types of tissue in detail.⁵¹ His physiology undertook, in the wake of Haller, a systematic experimental investigation of the functioning and death of the organism’s main organs. We take this physiology as a major locus for elaborating an embodiment concept in the life sciences, along the lines described below.

i. The general argument. Making embodiment into an object of experimental science

Bichat’s physiology put forth three types of principles: a definition of life as the set of functions that resist death;⁵² a specification of tissues in terms of their elementary properties of sensitivity and contractility in his anatomical works; and a division between what he called the two lives, i.e. the organic life and the animal life.⁵³ The first life – universal among living things – is described as a “relation between the organism and itself,” and the second – proper to animals – as its relationship to the external environment. Interestingly, it is a new way of conceiving of the traditional distinction between “vital functions” and “animal functions” – here, in terms of distinct logical kinds of relationship, namely reflexive or correlational. It is here that the notion of embodiment seems to find its way into physiology: organisms include a

⁴⁹ On experimentation in physiology in the earlier vitalist context see Charles T. Wolfe, “Vitalism and the resistance to experimentation on life in the eighteenth century,” *Journal of the History of Biology* 46 (2013) and for Bichat and the nineteenth-century context, Philippe Huneman, *Bichat. La vie et la mort* (Paris: PUF, 1998).

⁵⁰ Michel Foucault, *Naissance de la clinique* (Paris: PUF, 1963); Toby Gelfand, *Professionalizing Modern Medicine. Paris Surgeons and Medical Science and Institutions in the 18th Century* (Westport, Connecticut and London: Greenwood Press, 1980).

⁵¹ James E. Lesch, *Science and Medicine in France: The Emergence of Experimental Physiology, 1790–1855* (Cambridge, Mass.: Harvard University Press, 1984). For Auguste Comte, this was one major foundation of biology as a science (*Cours de philosophie positive* [Paris: Hermann, 1982], 41^{ème} leçon, p. 752).

⁵² Bichat, *Recherches*, 1.

⁵³ Bichat, *Recherches*, Book I, chapter 2.

sort of inner space through which they can be related to themselves.⁵⁴ This basic duplication or reflexivity supports the very idea of functionality and functions in Bichat's physiology.

In other words: what ontologically characterizes the animal are those two "lives" and their relations. Within each *life*, one finds 'functions' in the sense of 'major biological functions' – respiration, digestion, motion, perception. And then, each of these functions is achieved through the 'functions of several organs' – the eyes see, the stomach decomposes nutriments, etc. Those are the functions in a second sense, 'local functions', functions that the physiologist first tries to identify ("what's the function of this organ?") and then, analyze ("through which mechanism is this function achieved?", and more precisely for Bichat, "which specific combination of tissues, endowed with their specific properties, is required for this function to be carried on?").⁵⁵ Functions, in both senses, are the elementary units required to analyze and understand the existence of lives and their essential relations. Thus, the bipartition of lives defines the territory of *functional analysis* for physiology, which is classically indeed oriented towards functions, while anatomy is oriented towards structures and can therefore rely on mere observations.

'Embodiment', here, refers first of all to organic life as – in phenomenological terms – what differentiates any living body (including plants) from mere bodies – a space of reflexivity so to speak; and second, the articulation between organic and animal life, which makes it possible for the animal to be an embodied agent behaving in the world. Before examining the move from Bichat's inaugural experimental physiology to Claude Bernard's ambiguous position regarding embodiment and vitalism, it is worth mentioning that the latter's most famous idea, that of the *milieu intérieur* or "internal environment," could be seen as an additional extension of Bichat's idea of *vie organique*. The *milieu intérieur*, as is well known, is the set of liquids (mostly) in which each organ of the organism lies, and which mediates the communications between organs, and, above all, between each organ and the external

⁵⁴ This conceptual distinction between organic and animal life was highly praised by nineteenth-century post-Kantian philosophers. Hegel appreciated it greatly in his lectures on the philosophy of nature and turned it into a dialectical opposition between merely organic life and a life in which the animal "lives outside of its body" (in Bichat's own terms). (Georg Wilhelm Friedrich Hegel, *Enzyklopädie der philosophischen Wissenschaften*, hrsg. von Eva Moldenhauer, Karl Markus Michel (Frankfurt am Main: Suhrkamp, 1970). II: Naturphilosophie, 3: Organische Physik, C. Der tierische Organismus, § 355). His opponent Schopenhauer saw it as a massive proof, through empirical science, of his own distinction between representation and will: the organic life is the will, the animal life is representation, and Bichat's thesis according to which passions originate from the epigastrium, namely the center of organic life (hence the life related to itself and not to any object), confirms the philosopher's thesis about the originality of the will (Schopenhauer, *World as Will and Representation*, Suppl. X).

⁵⁵ Bichat, *Recherches* I, 46.

environment.⁵⁶ The conceptual divide between an external and an internal “milieu” allows Bernard to account for the fact that organisms are not directly determined by changes in their milieu – e.g. their temperature does not covary with external temperature; their glucose rate is not immediately affected by glucose intake from the external environment etc. – *without giving up on general determinism, that is, the idea that in a given set of conditions, the same effect will always happen.* The exact mechanism (in Bernardian terms, *le déterminisme*) that governs animal functioning and behavior is not a strict relation between organism and the external milieu, but a double relationship, between organs and their *milieu intérieur*, and then between this *milieu intérieur* and the external environment. To this extent, the state variables that describe the trajectories of each organ are not directly affected by the modification of environmental variables, that is, the *milieu intérieur* somehow buffers them against external extreme and rapid changes likely to be met by the organism.

Claude Bernard’s *milieu intérieur* can then easily be understood as an operationalizable way to understand what Bichat called the “lives” of the animal: it is the *medium* of the relation between the animal and itself, which Bichat termed “*vie organique*.” In this sense, the “*milieu intérieur*” can be seen as a figure of animal embodiment, inherited from Bichat’s physiological bipartitioning of lives, which can be analyzed regarding its composition and potential alteration as a specified mix of liquids, and thus addressed by the tools of chemistry (toxicological analysis, etc.), which is the way through which Bernard intends to make experimental physiology more rigorously scientific, and therefore overcome vitalism.⁵⁷

ii. *Embodiment in experimental physiology, from Bichat to Bernard – or how determinism and vitalism come into play*

It is impossible to account for this conceptual history without highlighting the fact that Bichat’s concepts in anatomy – e.g. tissue (*Anatomie générale*) - and physiology (*Recherches physiologiques*) – the two “lives” – were systematically related, and both were embedded in a specific physiological experimental device for producing knowledge. Bichat was clearly a vitalist, in the sense that he acknowledged a principled opposition between living and brute matter, and insisted on the fact that living matter could not display the same regularity and

⁵⁶ Claude Bernard, *Introduction à l’étude de la médecine expérimentale* (Paris: J.B. Baillière & Fils, 1865), 115; *Principes de médecine expérimentale* (Paris: J.B. Baillière & Fils, 1882), 25.

⁵⁷ See Mirko Drazen Grmek, *Raisonnement expérimental et recherches toxicologiques chez Claude Bernard* (Genève: Droz, 1973).

generality that characterizes brute matter.⁵⁸ Epistemologically, this means that whereas physicists unveil laws of nature, under the form of what philosophers would now call a set of general counterfactual-supporting statements, physiologists can neither access robust counterfactuals such as: “if organism A were heated it would do such and such,” nor claim general statements such as “swans like to eat eels.” The former impossibility Bichat terms the *plasticity* of the living: answers to stimulation are variable,⁵⁹ the latter is the “*idiosyncrasy*” of the living.⁶⁰ This conceptual opposition is neatly stated in physiology under the form of a famous metaphysical opposition: “*la vie c’est l’ensemble des fonctions qui résistent à la mort*” that cannot but remind us of Stahl’s *Theoria medica vera*, in which chemical forces conspire towards the death of living animated bodies. However, elsewhere Bichat curiously acknowledges that this quite classical formulation of the singularity of life is somehow contingent and hinges upon the historical sequence of the invention of scientific theories: had humans invented physiology and not physics first, he said, instead of talking of forces and weight when we try to understand the living they would talk in terms of pulses, sympathies, secretions, etc., when they would describe motions of bodies, flowing of rivers, etc.⁶¹

The second part of *Recherches physiologiques sur la vie et la mort*, “Recherches sur la mort,” is crucial in the articulation between physiology and anatomy because it somehow legitimizes the scientificity of physiology, even though one should acknowledge the strong vitalism to which Bichat was committed, as indicated by his ideas about plasticity and idiosyncrasy. We will not enter into the details of this epistemological structure.⁶² Suffice to say that in this work Bichat investigates the way each of the three major organs (in the physiological tradition he inherits), namely brain, lung and heart, conditions the death of the two others: how does the death of the brain cause the death of the lungs? Is it direct or happening through the death of the heart? etc. Each question is answered by the construction of a sophisticated device that neutralizes one organ in an organism slowly enough to make manifest all the downstream effects. To this extent, what these physiological researches about death show are the sets of necessities required to sustain life in a healthy organism. Even though life is plastic and idiosyncratic, so that no gathering of observations would let us know anything about life in

⁵⁸ Bichat, *Anatomie générale*, 37.

⁵⁹ Bichat, *Recherches physiologiques sur la vie et la mort* (Paris: Béchét, 1800), 42.

⁶⁰ *Recherches*, 44.

⁶¹ *Recherches*, 67. This interesting remark about the contingency of some of the most deeply entrenched ingredients of our conceptual scheme is recalled here in order to indicate that the conceptual and metaphysical opposition between the brute and the living should not be taken as a proof of the epistemic inferiority of physiology as compared to physics. It is an anticipated rebuttal of any physics envy, so to speak.

⁶² For more details see Huneman, *Bichat. La vie et la mort*.

general and its manifestations – we can still, through these experimental devices, understand which set of necessary conditionings yields in general all the various manifestations of physiological functioning and therefore life.

Especially, one important object for Bichat in this framework of study is constituted by the relationship between the two *vies* – since the brain is the major organ for the *vie animale* and the heart is the crucial organ for the *vie organique*. Therefore, the physiological apparatus that explores the sets of necessary conditionings proper to sustain life – conditionings which involve primarily the heart and the brain - is capable of showing us how the two lives relate to one another.

We earlier hypothesized that Bichat grasped embodiment as *vie organique*, conceptualized it in the complex structure of knowledge that articulates *vie organique* and *vie animale*, and then related both of them into a rich anatomical structure implementing them and decomposable at the level of tissues rather than organs. If this hypothesis is correct, we also understand now that a new path taken by the history of embodiment in the nineteenth century goes through the novel structure of physiology that Bichat elaborated, which centred around the figure of the dying animal, whose death is monitored and grasped by complex experimental apparatuses.

As indicated, the next step in this sketch of a history of ‘clinical embodiment’ was taken by Claude Bernard. But before that, however, it is important to consider the work of Bichat’s major disciple, who was the teacher of Claude Bernard (a *préparateur* for his lectures from 1841 on): François Magendie, himself a famous physician and physiologist at the College de France (1831-1855), even though the fame of his disciple finally eclipsed his own. Magendie indeed pursued Bichat’s project of establishing experimental physiology as a science, as it is clear from reading his *Précis élémentaire de physiologie* (1816-17). However, in contemporary terms one could say that deflationism and minimalism were crucial in his approach, in medicine as well as in physiology.

Magendie was a supporter of what is called “expectant medicine”, which means the preference for not intervening on a diseased patient, and letting nature naturally bring recovery. This attitude stems from two ideas, one which concerns philosophy of nature and consists in an Aristotelian or Hippocratic confidence in the healing power of nature itself, the other, an epistemic skepticism regarding all human ways of intervening in the complex

working of pathological conditions. Here the old slogan “*primum non nocere*” is pushed to its limits: since any intervention is potentially harmful, and we subscribe to a principle of not being harmful, it’s better not to intervene at all.

In physiology too, Magendie was somehow deflationist –he was precisely deflating Bichat’s vitalism, in a very interesting way. For Magendie, the idea that unknown forces lead organisms and organismic tissues to behave in an unpredictable, plastic and idiosyncratic way is absurd: since these forces are unknown, we cannot even ascribe these properties to them. There is a *roman* of the vital properties which basically is “the philosophers’ anthropomorphism applied to molecules.”⁶³ It is therefore more rational to say that we don’t know anything about the substance of what behaves in physiological and biological ways, and be content with describing these behaviors as well as all the regularities we can observe, then relate them to chemical and physical regularities involved in them, that our physiological devices can make manifest. Science is about detecting regular correlations rather than unraveling hidden natures: paradigmatically, the glory of Newton does not consist in having “discovered attraction,” but in having “established that it acts as a direct function of the mass, and inverse of the squared distance.”⁶⁴

Figure 1. Magendie – classification of bodies – distinction between “corps bruts” and “corps vivants”. (see published version)

Magendie therefore gives up Bichat’s commitment to a metaphysical opposition between the living and the non-living; according to him, this statement would go far beyond what our observations and experiments allow us to claim. Nothing authorizes us to make any principled differences between the metaphysical forces that support physiological properties and behaviors, and the physical forces that explain the natural phenomena investigated by physicists. Actually, the apparent irregularities, variations and unpredictability that we see in the case of physiology and pathology could perfectly be ascribed to a lack of understanding, observation and information on our part, with no need to attribute these properties to the natural forces themselves. We can only hope that progress in our observations and

⁶³ Magendie, *Précis élémentaire de physiologie* (1816), 2nd revised edition (Paris: Méquignon-Marvis, 1825), 30.

⁶⁴ Magendie, *Précis*, 15.

experiments will ultimately bridge the gap between the degree of completeness of our knowledge in physics, and the current state of physiology.

Magendie's skepticism as such is not especially telling for the history of embodiment. In this regard, one could even argue that whereas Bichat's vitalism allowed him to conceptualize the two lives and make "embodiment" into a concept which can be encompassed in the project of an experimental physiology, Magendie's denial of vitalism, epistemological skepticism, and almost phenomenalist philosophy of scientific method⁶⁵ is just extraneous to the history of the avatars of embodiment. However, this skepticism plays an important logical role in our story, because it provides the grounds on which Claude Bernard will elaborate some of its most crucial concepts, including the elements of a theory of *milieu intérieur*, in various general publications, from the *Introduction à l'étude de la médecine expérimentale* (1855) to the *Leçons sur les phénomènes de la vie communs aux végétaux et aux animaux*, the published version of his lectures at the Collège de France in 1873.

Magendie was not exactly a pure behaviorist or phenomenalist. He admits some "forces" that are involved in living phenomena, and that are manifested each time a biological phenomenon occurs, since he acknowledges that there may be an unknown force acting within living bodies (see Fig 1). However, he refuses, against what he sees as vitalism, to ascribe to them some distinct properties (such as plasticity etc.) that would make them proper to the living realm, i.e., treating them as ontological entities that instantiate a specific and independent ontological realm. Instead, he conceives of these forces as pure unknown references or designations that we make in specific contexts of scientific descriptions. We just label "vital force," he says, "an unknown cause of the phenomenon of life." We have to recognize these forces, because they are supporting the constant connections between phenomena that we can identify through experiments and observations, and because we need them to turn the mere establishment of connections into useful relationships of causality.

Actually, even though he applies Bichat's ideal of experimental physiology, Magendie's metaphysical views are not so far from Barthez's vitalism, in which a vital "principle" was understood as a sort of unknown, and physiology is an effort to grasp the systematic manifestations of this principle through organized machines. Therefore, Magendie could be

⁶⁵ "All phenomena of life can be traced back to nutrition and vital action ultimately; but the hidden motions constituting those two phenomena being out of scope of our senses, it's not to them that we should pay attention: we limit ourselves to studying their results, that is in the physical properties of the organs, and search for the content with the physical properties of the organs, and search for the way the ones and the others concur to the general life" (*Précis*, 37).

seen as a vitalist *in the sense of those embodied vitalist thinkers*, or “materialist vitalists” discussed in section 3, rather than in the sense of Bichat, whose vitalism is more exclusive vis-à-vis ordinary materialism. Yet, one needs just one more step to definitively get rid of these vital forces and the meager commitments to vitalism that could therefore be found in Magendie’s writings, notwithstanding his own wording.

Claude Bernard’s idea of “determinism” – as it is explicated carefully in his two books on the methodology of experimental physiology or medicine⁶⁶ – takes this step. Since what physiology establishes is in many cases a regular succession of physiological events, such as for example, the secretion of sugar when the liver is left alone, or the neutralization of the parasympathetic nervous system when curare touches it, it is unnecessary to stipulate an unknown force which, so to say, makes this connection. What exists is this mere connection, whose existence has to be attested and demonstrated through careful and methodical investigation. Physiology aims at unraveling all these connections. These are what we now call the *mechanisms* implementing some specific functions: for instance, the mechanism of the gluconeogenic function of the liver, that allows animals to produce their own glucose and therefore not rely on consuming plants to gather one of the crucial constituents they need (glucose). Experimental physiology thereby does two things: identifying functions – e.g. the gluconeogenic function etc. – and finding the mechanisms that implement such functions.

A Bernardian function is actually a more fine-grained instantiation of the sets of necessary conditioning that Bichat intended to explicate through his researches *sur la mort*. A mechanism implementing a function is often established through the same method Bichat systematically elaborated: disturbing or killing some of the tissue putatively involved in the realization of the function, identifying the subsequent effects of the intervention, and finally summing up this information about the effects of the controlled disturbances and reconstituting the mechanism.⁶⁷

Bernard calls “a determinism” the “mechanism” that the research unravels. This “determinism” should not be confused with another meaning of determinism, which is nevertheless bound to it – namely, the metaphysical principle of determinism, stating that any effect produced in a given set of circumstances, will reoccur once the same set of circumstance is reactivated. This principle, obviously not falsifiable – since any putative

⁶⁶ See Jean Gayon, “Déterminisme génétique, déterminisme bernardien, déterminisme laplacien,” in *Le hasard au cœur de la cellule. Probabilités, déterminisme, génétique*, ed. J.-J. Kupiec (Paris: Editions Syllepse, 2009), on Bernardian and Laplacian determinism.

⁶⁷ Grmek, *Raisonnement toxicologique*.

falsification could in fact be traced back to a fine-grained undetected break-up of the identity of conditions – is necessary for science to be possible, and especially, for any experimental physiology⁶⁸ – the science which was modeled by Bichat’s devices of animal experimentation.

According to this viewpoint, no vital forces of any kind are therefore necessary to account for the regular and necessary connections established by experimental physiology. “Vital phenomena are not manifestations of a free and independent principle. One cannot grasp this inner living principle, isolate it and act on it. On the contrary one sees vital acts having constantly as conditions some external physico-chemical circumstances, perfectly determined and capable of hindering or allowing their appearance.”⁶⁹ Bernard’s determinism succeeds in getting rid of Magendie’s deflated vitalism. Interestingly, the arguably metaphysical principle of general determinism – and its connection to the idea of “*le déterminisme de*,” as a target of experimental research – permits the elimination of this other metaphysical idea – the “unknown forces” or the vital forces – that a whole tradition of physiologists postulated, from Bordeu to Magendie, through Barthez or Bichat. Moreover Bernard does not hesitate to explicitly reject Bichat’s famous dualistic and conflict-centered definition of life: “Science, one must say, has debunked this definition, according to which there would be two kinds of properties within living bodies: physical properties, and vital properties, constantly fighting, and tending to predominate the ones over the others.”⁷⁰

Such is the logic governing the construction of the concept of “*milieu intérieur*.” Organisms *seem* to be plastic and idiosyncratic, as Bichat initially recalled; however, no vital forces govern them. There are just sets of determinisms to be investigated. What is therefore the reason for the seemingly unconnectedness between environmental events such as cold, increase in temperature, etc., and the organismic behavior – an unconnectedness that seems to challenge the idea of a general and predictable (nomothetic) connectedness between all events and things in physical nature? This “unconnectedness” would, in our terms, relate to the acknowledgement of this “embodiment” which is the focus of our story. And it can be accounted for in terms of a specific kind of determinism, which would explain the apparent disconnection by mediating the relation between the organs of the organisms and the external

⁶⁸ Bernard, *Introduction*.

⁶⁹ Claude Bernard, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, tome II (Paris: Germer Baillière, 1879).

⁷⁰ Bernard, *Leçons sur les phénomènes communs*.

environment. What Claude Bernard achieves here is a way of allowing for a scientific conceptualization of embodiment.

To put it bluntly, the “*milieu intérieur*” is a privileged *object* for Bernardian physiology – but it is also a *tool*, because any modification of the organism that can be controlled and measured, in order to understand an organism’s proper patterns of causality, should either initially modify some parameters of this milieu, or influence its composition. More generally, experimental physiology uses the tools of toxicology in order to show how the tiny alterations of some liquids constituting the *milieu intérieur* entail major disturbances of some organs – or how perturbations of these organs (e.g. the curare neutralizing neurotransmission in the parasympathetic nervous system) are diffracted through various layers of the *milieu intérieur*.

Embodiment therefore appears as epistemologically crucial in the deterministic science of living things. This would be the last twist given to the idea of embodiment, once it took the path of experimental physiology, under the mode of a *vie organique* as understood by Bichat.

5. Conclusion

Common perceptions of early modern mechanism, of Enlightenment materialism, and of the genesis of nineteenth-century experimental medicine (and biochemistry) all share a tacit, sometimes explicit supposition that these must rule out the richness, the experiential texture, the significance of ‘embodiment’. Thus Ian Hacking recently spoke in rather mournful tones of our current “Cartesian bodies”: no longer machines governed by immaterial souls, but nevertheless fully mechanical assemblages of replaceable parts, whether prostheses or artificially grown biological parts.⁷¹ Similarly, Terry Eagleton warned that the body of embodiment discourse was quite remote from biology – “the plastic, remouldable, socially constructed body, not the piece of matter that sickens and dies.”⁷² But if Descartes already warned (thus defusing one giant phenomenological objection against him in advance) that we

⁷¹ Hacking, “The Cartesian Body.” Notice that an entire mini-generation of prominent Descartes scholars has rejected this reading, emphasizing instead an ‘embodied Descartes’, as we noted in Section 2. But that doesn’t affect the prevalence of our common concept of the ‘Cartesian body’, often associated with a ‘scientific’ image of the body.

⁷² “Postmodernism is obsessed by the body and terrified of biology. The body is a wildly popular topic in US cultural studies – but this is the plastic, remouldable, socially constructed body, not the piece of matter that sickens and dies. The creature who emerges from postmodern thought is centreless, hedonistic, self-inventing, ceaselessly adaptive. He sounds more like a Los Angeles media executive than an Indonesian fisherman” (Terry Eagleton, *After Theory* (London: Allen Lane, 2003), 186).

should not conceive of the mind in the body like a sailor (or pilot) in a ship⁷³, and if from some moments in Cartesian physiology, La Mettrie and eighteenth-century vitalist medicine onto Claude Bernard, we are faced with different rearrangements of the conceptual landscape in which mechanism, body and the concept we here term ‘embodiment’ are constantly overlapping, modifying and overdetermining one another, the status of embodiment in relation to life science requires some fresh consideration.

Where certain discussions of embodiment tend to emphasize its cultural embeddedness or its presence in literary texts of the period at the expense of so-called scientific works, we would instead point to the series of ‘negotiations’ or displacements in which, from early modern automata to scientific physiology in the nineteenth century, and in theoretical constellations we could term ‘vitalism’ but also ‘vital materialism’, the idea of “organism as individuality” (as Bernard put it), of the body-machine as necessarily *my own*, given that it is an affective, desiring, hedonistic entity,⁷⁴ come to the fore.

Among these negotiations, we insisted on the last one, that culminated with Claude Bernard’s idea of physiology – wherein the *milieu intérieur* appeared not only as a crucial concept, but also as an organising principle. Now, assuming that embodiment of the living is at least partly about the way living beings can relate to themselves in a way which mediates their relation to their environment and ultimately specifies their specific patterns of behavior, the construction of the concept of *milieu intérieur*, together with its embedding within a specific experimental set of practices inaugurated by Bichat’s *Recherches physiologiques*, is a crucial moment in the history of embodiment: it becomes the correlate of an operational scientific practice. Bernard inherits some of the strictures Bichat imposed onto physiological knowledge: pervasiveness of an apparatus that displays, through the making of regular sequences of dying (and here, Bernard replaces Bichat’s mechanical death with mostly chemical ways of killing organisms or organs, via toxic substances), the essential organic relationships of causality or conditioning.

⁷³ It is not sufficient for [the rational soul] to be lodged in the human body like a helmsman in his ship . . . but that it must be more closely joined and united with the body in order to . . . constitute a real human being” (AT VI 59; CSM I 141), cf. Geir Kirkebøen, “Descartes’ Embodied Psychology: Descartes or Damasio’s Error?,” *Journal of the History of the Neurosciences* 10:2 (2001), 181.

⁷⁴ “To be a machine, to feel, to think, to know how to distinguish good from evil, as well as blue from yellow, in a word, to be born with an intelligence and a sure moral instinct, and to be but an animal, is thus no more contradictory, than to be an ape or a parrot and to know how to give oneself pleasure” (La Mettrie, *L’Homme-Machine*, in *Œuvres philosophiques*, I, 192).

Now, whereas Bichat understood embodiment under the mode of a specific *life* and tied it to a vitalism that accepts contingent and unpredictable changes of regime – which oppose any nomothetic understanding and possibly scientificity – Claude Bernard invests the Bichatian structures of physiological knowledge into a “milieu intérieur,” which is less directly laden with the idea of “life” and the notion of vitalism, and which allows for determinism and scientific manipulation.⁷⁵ In concluding the last section, we pinpointed a logical link between giving up the notion of vital forces – even the deflationary forces postulated by Magendie –, elaborating the idea of determinism and the many determinisms as objects of experimental knowledge in physiology, and finally, elaborating the notion of “milieu intérieur” as a set of determinisms that mediate between organs (on which physiology either intervenes, or notices the effects of interventions) and physical and chemical variables describing the environment. This logic supported the constitution of perhaps the last figure of “embodiment,” taken in the context of the story of its progressive acculturation within a physiology that progressively turned into “experimental physiology” during the nineteenth century.

From Cartesian mechanism and automata (a case not discussed here) as engagements with the organizational complexities of living being, through a kind of historico-scientific dialectic of materialism and vitalism in philosophy, medicine and physiology in the eighteenth and nineteenth centuries, we arrived at Bichat, Magendie, and Claude Bernard. Rather than a linear progression from ‘blind mechanism’ to the complexities of embodiment, with the discovery of the *milieu intérieur*, we are faced instead with a perpetual elaboration of mechanisms or organizational wholes in which a ‘vitalistic’ component is never entirely eliminated, nor entirely acknowledged. As Bernard puts it, “The final component of the phenomenon is physical, but the arrangement is vital.”⁷⁶ Or, in La Mettrie’s terms, “That the mind possesses such a corporeal nature need not be feared as a blow to our self-esteem.”⁷⁷

⁷⁵ Bernard spoke of “le vrai vitalisme de B(ichat)” in his *Carnet de notes* – an expression he crossed out. The letter “B” referred to Bichat (G. Canguilhem, ‘Claude Bernard et Bichat’, in *Études d’Histoire et de Philosophie des sciences* (Paris: Vrin, 1968), 157). This is not an essay on the dialectics of the figure of vitalism in 19th-century medicine and philosophy but it is worth noting that a series of these figures engaged both in new articulations of experimental, laboratory-driven life science and in reflections on the nature of Life, shift and negotiate positions in an uneasy ballet with the notion of ‘vitalism’.

⁷⁶ Bernard, *Leçons sur les phénomènes communs*, 524.

⁷⁷ La Mettrie, *Institutions de médecine de M. Hermann Boerhaave*, 111.

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