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Machines of Nature and Corporeal Substances in Leibniz

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Editors

Machines of Nature and Corporeal Substances in Leibniz

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Foreword

A few years ago, a younger colleague reported to me that he had submitted an article on Leibniz and the life sciences to a respected journal in the history of philosophy. It was rejected. The explanation given was that since at root, Leibniz recognizes only monads and their perceptions and appetitions, Leibniz could not have been genuinely interested in anything like biology. Studies like the ones in this volume should cause us to reevaluate such a priori judgments about the history of philosophy.

Our understanding of Leibniz's thought has come a long way in the last few years. The prodigious work of the editors of the Akademie edition have made available hundreds of new texts, in addition to making available better and more reliable editions of older texts. There is still a great deal to be done before we have a complete edition of Leibniz's papers, but even so, it is safe to say that the scholar working today has a variety of texts that no contemporary of Leibniz's had access to and that were unavailable to almost everyone interested in Leibniz's thought throughout the eighteenth, nineteenth, and most of the twentieth centuries. Furthermore, recent scholars have come to appreciate more and more the interconnections between the history of philosophy and the history of science. Standard figures from the history of philosophy such as Leibniz were as much involved in the scientific life of their age as they were in the philosophical. Indeed, for Leibniz and his contemporaries, there was no real boundary between the two. To focus exclusively on Leibniz's philosophical writings, understood in the way in which our contemporaries in departments of philosophy understand that term is to have only a very partial and distorted picture of his thought.

Much of the work that has been done in the history of philosophy in relation to the history of science has concentrated on philosophical conceptions of the physical world, and the ways in which natural philosophy is linked with questions and doctrines that later thinkers would recognize as philosophical. But recent scholars have moved into an interesting new domain, that of life. The scholars who have contributed essays to this volume are very much a part of that new trend.[1] The aspect of Leibniz's thought that they focus on concerns living things and

[1] Some excellent examples of this new approach can be found in Duchesneau (1998) and the essays collected in Smith (2006).

Leibniz's relation to the science that would come to be called biology in later years. Traditional approaches to Leibniz's thought have hidden the extent to which life and living things are central to Leibniz's thought. Monads are certainly important to understanding Leibniz's view of the world, at least in his later years. But if you focus on the idealistic metaphysics suggested by a narrow reading of certain later texts, such as the *Monadology*, then you miss a great deal of Leibniz's rich view of the physical world, a view teaming with life, soul, and animated corporeal substances.

To appreciate Leibniz's views, though, we must understand their historical context. They are, in a way, extensions of views found earlier in the seventeenth century, most prominently in Descartes and Hobbes, while at the same time they constitute a profound critique of those same views.

Descartes and Hobbes were certainly not the first to think of living things as complex bodies whose behavior can be explained entirely in terms of the size, shape and motion of their material parts; views like those can, in one way or another, be traced back to the ancient Epicureans and Stoics, if not farther still. Nor were they the only ones among their contemporaries to do so. But in the seventeenth century, it was Descartes and Hobbes, perhaps, who gave these doctrines their most striking and influential articulation.

Descartes' *Traité de l'homme* was probably written sometime between 1630 and 1633, when he withdrew it and the companion *Traité de lumière* from publication upon hearing of the condemnation of Galileo. But it wasn't published until 1662 in Latin translation, and 1664 in the original French. The book begins, apparently *in medias res*:

> These men will be composed, as we are, of a soul and a body. First I must describe the body on its own; then the soul, again on its own; and finally I must show how these two natures would have to be joined and united in order to constitute men who resemble us. (CSM I.99, AT XI. 119–120)

But in the text as it has come down to us, Descartes is concerned exclusively with the body of "these men" whom he posits:

> I suppose the body to be nothing but a statue or machine made of earth, which God forms with the explicit intention of making it as much as possible like us. Thus God not only gives it externally the colours and shapes of all the parts of our bodies, but also places inside it all the parts required to make it walk, eat, breathe, and indeed to imitate all those of our functions which can be imagined to proceed from matter and to depend solely on the disposition of our organs. We see clocks, artificial fountains, mills, and other such machines which, although only man-made, have the power to move of their own accord in many different ways. But I am supposing this machine to be made by the hands of God, and so I think you may reasonably think it capable of a greater variety of movements than I could possibly imagine in it, and of exhibiting more artistry than I could possibly ascribe to it. (CSM I 99, AT XI 120)

And so Descartes proceeds to set out, in some detail, the wheels and springs that can account for the behavior of this man in entirely mechanical terms, as if the body

were one of those clocks, fountains, or mills which can do apparently remarkable things all on their own, but to which no one would think to attribute a soul.

What Descartes is opposing here is the standard view of life, human life in particular, that was taught to every school boy. Basic to Aristotelian natural philosophy was the explanation of the characteristic behavior of bodies in terms of substantial forms. Because of the form fire has, it tends to be hot and rise; because of the form that earth has, it tends to be cold and to fall. In living things, forms are called souls, and these souls are the principles of life. Now, these souls were of three sorts: vegetative, sensitive, and rational. The vegetative soul explained such things as nutrition, growth, and reproduction, the sensitive soul such things as sensation and locomotion, and the rational soul, reason. Descartes, of course, recognized a rational soul in humans, the principle of thought. But that was the *only* function that he attributed to the soul. The man of the *Traité de l'homme* was just a "statue or machine made of earth," a material thing whose physical organization explains all of the vital functions that had previously been explained in terms of the vegetative and sensitive souls.[2]

There is an even more radical story in Hobbes. Beginning with the *Elements of Law* in 1640 (first published in 1650), but continuing in the *De cive* (1642), the *Leviathan* (1651), the *De corpore* (1655) and the *De homine* (1658), Hobbes developed a conception of the world which excluded form and soul altogether, even for thought. In particular, all living things, including humans, were explained entirely in terms of their material composition, the complexity of their parts and their relations to one another. And this applies to thought and volition as well. At the root of Hobbes' political theory is a view of thought, grounded in motion, transmitted to the brain by the sensory organs, and transmitted from the brain to the heart, and from the heart to the muscles either to seek what gives us pleasure or to flee what gives us pain.[3]

There are many features of both Descartes' and Hobbes' view that troubled contemporaries. For Hobbes, there was the problem of the immortality of the soul: if the mind is just matter organized in a particular way, then there is nothing that survives the death of the body. As Hobbes was certainly aware, this view was not necessarily inconsistent with revealed religion; one could, and some did hold that all Christian orthodoxy requires is the ultimate resurrection of the body, though others were not convinced. But there is another disturbing feature of these views. For Descartes there is a clear boundary between humans and the animal world: even though animal bodies and human bodies may share their mechanical structures, humans have souls that animal bodies don't have. For Hobbes, though, the difference between animal bodies and humans can only be a matter of complexity: we are more complicated than animal bodies, and for that reason, our bodies are capable of various

[2]For some recent studies of Descartes' biology and medicine, see Des Chene (2001) and Aucante (2006).

[3]Although many commentators note aspects of Hobbes' materialistic views on life in passing on their way to his political philosophy, it is strange that there is no extended and systematic discussion of his thought on life, so far as I know.

tricks (reason, for example) that (most) other animal bodies aren't. But for both Descartes and Hobbes, outside of complexity there seems to be no real boundary between the living and the non-living. Living bodies are certainly capable of much more than the machines that we build can do. But they are very much the same kinds of things. The new view of life that thinkers like Descartes and Hobbes introduced would seem to undermine the very category of life itself.

And it is in this context that we can appreciate Leibniz's view. As with Descartes and Hobbes, Leibniz believes that everything in the material world is explicable in terms of size, shape and motion, including life. In this way, living things are natural machines, *machines de la nature*. But even so, they are not like artificial machines, the kinds of machines that we can build. Artificial machines are made up of finite components, and are of finite complexity, as they would have to be if they are such that we could build them. But natural machines are not: they are infinitely complex, individuals nested in other individuals. All of these individuals which compose a living thing are themselves living things, which are, in turn, composed of an infinity of other living things, bugs in bugs to infinity. In this way, Leibniz is able to preserve the idea that everything is mechanical, including life, but that living things are fundamentally different from non-living machines. There is another difference between the living and the non-living for Leibniz. An important part of Leibniz's idiosyncratic version of the mechanical world view was the reintroduction of substantial forms into physics. For a variety of reasons, Leibniz believed that forms were needed: forms were to be the ground of active force, and that which makes an individual substance a genuine individual. Furthermore, Leibniz conceived of these forms as souls, the souls of corporeal substances that are the ultimate constituents of bodies in the world. These souls aren't joined to just any bodies, though, but only to the organized bodies that constitute natural machines. And together with them, they constitute living things. In this way, for Leibniz, biology can be said to ground the physical world. Leibniz agrees with Descartes and Hobbes that everything in the world, including living things, can be explained in terms of size, shape, and motion: but life in the form of these ensouled natural machines is at the root of everything. At some stage in Leibniz's philosophical development, monads come to underlie the whole structure in some way. But, it seems, this view of life and its centrality is something that runs through much of Leibniz's view of the physical world.[4] The living thing is not just *in* the world, but in a basic way, *constitutive of* the world: it is the metaphysical ground of the world. For Leibniz, the living body goes from being the outlier, the exception to be explained, to being at the center of his conception.

But the devil is in the details. This fascinating collection of essays is concerned with understanding the infinite depth of Leibniz's conception.

Princeton University Daniel Garber

[4]The view of Leibniz I assume here is, admittedly, somewhat controversial, particularly in regard to the place of the monadological metaphysics in his thought. For a fuller development and defense, see Garber (2009).

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Chapter 1
Introduction

Justin E.H. Smith and Ohad Nachtomy

This volume stems from a colloquium held at the Sorbonne, in Paris, in February, 2008, which brought together a number of the world's leading scholars of the natural philosophy of G. W. Leibniz. The theme of the colloquium was the very controversial question of the role and meaning of the concepts of corporeal substance and natural machine in Leibniz's metaphysics. As scholars have come to terms with the fact that the wide range of Leibniz's written works simply does not permit us to continue in the traditional view of him as an orthodox idealist, a tremendous new interpretative problem has emerged in the scholarship as to how to understand the entities that cannot be accommodated within Leibniz's idealist ontology, and foremost among these are corporeal substances, natural machines, and organism. The papers in this volume contribute important new interpretative approaches to one or both of these concepts.

Regarding the last of the three concepts just mentioned, it would only be a slight overstatement to describe Leibniz as the thinker who invented the concept of organism, though scholars continue to disagree as to whether this is the same thing for Leibniz as the concept at work in our own count-noun, "organism", does not describe a general condition of a certain class of bodies, but rather picks out individual organisms.[1] At the turn of the eighteenth century, it was Leibniz who appropriated the term "organism", from its classical sense, in which it designated any organized unity, and applied it exclusively to living beings. As is well known in retrospect, the concept of "organism" has come to play a prominent role in the life sciences. Thus, Leibniz's view of living beings is important not only for our understanding of how living beings were conceptualized in the seventeenth and eighteenth centuries, but also for our understanding of one of the most influential concepts in the yet-to-be-born life sciences.

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[1] See Smith (2011), for an extended defense of the view that for Leibniz "organism" is understood as an abstract noun, which cannot easily be rendered in the plural.

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But Leibniz's notion of organism is strongly related to and indeed grows from his conception of living things as, variously, natural machines or corporeal substances. The papers in this volume focus on these concepts and their internal relations in Leibniz's thought and development, in order to shed light on the unique and essential contribution of this original thinker to the history and philosophy of the science of life and being, which, according to Leibniz, turn out to be one and the same thing.

The growing interest in Leibniz as a life-scientific thinker was made possible by an earlier wave of scholarship that familiarized us with the role of body, force, and corporeal substance in Leibniz's philosophy. Ever since the publication in 1985 of Dan Garber's influential article, "Leibniz and the Foundations of Physics: The Middle Years," there has been growing interest among English-language scholars in "the other Leibniz", the Leibniz whose basic ontology is not exhausted by simple substances imbued with perception and appetite, but instead takes seriously the existence of fully real composite or corporeal substances. As Garber insightfully put it in his article, for the Leibniz of the "middle period" (roughly speaking, 1676–1690), biology constitutes the true foundational science, and physics is only fully comprehensible in terms of biology, rather than the other way round, as is generally held today. In the French-language literature, this other Leibniz was also discovered – if not for the first time since Leibniz's death in 1716 – and exhaustively analyzed by André Robinet in his massive *Architectonique disjonctive* of 1986. The "realist" Leibniz has subsequently been defended and brought into vivid focus by a number of very skilled commentators.

But in what sense exactly was Leibniz's conception of corporeal substance 'biological', to use Garber's term? And isn't biology fundamentally at odds with the mechanical philosophy to which Leibniz remainder, at least formally, committed? One of the respects in which Leibniz's mechanism differs from that of Descartes is that the German philosopher sought to draw a distinction between artificial machines, which are merely mechanical, and natural machines, which are also organic, which is to say that they remain machines in their least parts. While Leibniz's distinction is very subtle, it serves him to support the distinction between living and non-living beings. Likewise, it serves his own program to characterize living beings not as inert mechanisms but as animate active creatures. Indeed, according to Leibniz, all true beings in the world are living beings. These beings are unique individual agents, endowed with inherent force and activity.

One of the most intriguing features of the account of organic body that Leibniz offers as his emendation of mechanism – the one on which this volume will focus – is that he conceives of them as nested one within another, *ad infinitum*. For Leibniz, living individuals are organized in hierarchical structures, so that one individual is always nested within infinitely many others. Furthermore, this nested structure to infinity is what distinguishes living beings from non-living ones. In recent work, we have called this feature "nested individuality", and have argued that it typifies Leibniz's mature view of organic beings.

Versions of Leibniz's notion of nested individuality appear in his earlier writings, but are at their most developed in his later writings, especially following the *New System of Nature* (1695), in which the notion of a natural machine is introduced. In

his later writings, the concept of a "natural machine" is identified with the newly invented concept of "organism." Leibniz's contemporaries (such as Malpighi and Leeuwenhoek) described the world of minute animals (*animalcula*) revealed to them under the lens of the newly invented microscope with terms such as "emboîtement" and "enveloppement". Leibniz, however, uses these terms not only descriptively but in a metaphysical sense as well. In particular, he uses the infinitely nested structure as a distinct mark of living beings. In fact, according to him, this is the sole difference between a natural machine, which is created by God, and an artificial machine, produced by humans. As François Duchesneau has persuasively argued, Malpighian subtle anatomy played a crucial role in Leibniz's theory of natural machines. This theory is a sort of "micromechanism", according to which mechanical bodies are themselves made up out of further *machinulae* or little machines. Leibniz's employment of the notion of nestedness should be situated within the context of the micro-mechanist conception of machines within machines. Likewise, his metaphysical use of this notion should be understood not only in the context of animal generation but also with regard to the attempt to account for the integration and unification of infinitely many machines within machines into a complete and unique living being.

The papers in this volume take on the problems of corporeal substance, organism, and life from different perspectives and with different methodological approaches, yet all share the conviction that these problems are crucial for understanding Leibniz's philosophical project as a whole.

In the opening essay on "Leibniz vs. Stahl on the Way Machines of Nature Operate," Duchesneau argues that the theory of living beings as machines of nature and the conception of composite substances endowed with conjoined souls, entelechies, or monads, as well as that of organic bodies, were solidified over the course of the transformations of Leibniz's thought that issued in the *New System of Nature*. On this basis, the monadological versions of a system of nature centered upon the integrated organization ad infinitum of living beings were gradually articulated. But over the course of this evolution, Leibniz was preoccupied with the task of determining just what a physics of organic bodies, or a physiology of vital processes, could consist in. Duchesneau argues that in this way Leibniz aimed to spell out a science that would be, as much as possible, in agreement with the epistemological exigencies of the complex metaphysical model that he had elaborated. On the one hand, Leibniz offers a critical evaluation of the methodological options that divide the allegiances of the doctors and naturalists who are his contemporaries; what is more, he determines the profile of the analyses and explications that are to be promoted, and he sketches some research orientations that he would like to see undertaken. For Duchesneau, this double preoccupation translates into the scientific exchanges and correspondences that accompany the construction of the theory of organic bodies as constituents of machines of nature. Leibniz rejects any form of analysis that would consist in postulating the causal intervention of specific agents of organogenesis – plastic natures, elementary psychisms, intelligent physical agents – in the formation and the functioning of phenomenal vital beings. At the same time, Leibniz lays out the exigencies that must be respected in any sort of explanation that has in view the

sufficient reason of physiological phenomena. He thus sketches out the principal elements of a "mechanist" doctrine that adequately take account of the organismic characteristics through which living beings – the only true substances in the physical order – are manifested. This modified mechanism to which he adheres is influenced by the invention of dynamics, but Leibniz tends to refurbish the particular forms in view of his openness to the research orientations prevalent among the physiologists and naturalists. In this connection, Duchesneau focuses on the particular case of the propositions concerning the science of the living that stem from his reaction to the work of Georg Ernst Stahl.

In the next essay, "Leibniz's Animals: Where Teleology Meets Mechanism," Glenn Hartz claims that Leibniz's theory of corporeal substance helps resolve the problem of the incompatibility of extension (the realm of mechanism) and thought (that of teleology). He maintains that this resolution makes that theory unattractive to defenders of the "idealist" account of Leibniz's metaphysics, since according to them mechanism (body) grows out of what's teleological (the monads) and no deep incompatibility can arise. Hartz goes on to take Leibniz's account of intentional action as a test case, in order to determine whether the "all explained mechanistically" doctrine is always upheld, or whether the guidance of the dominant substance is sometimes needed to explain what is going on in the organic body under its command.

In "Monads and Machines," Pauline Phemister raises a number of queries and problems concerning the distinction between living and non-living machines. Leibniz contends that the presence of the dominating monad "in" the mass that comprises the organic body gives rise to the animal or corporeal substance that exists as a living, unified entity. From pre-formed seeds, the organic body of this corporeal substance comes into existence as a living machine that is also a machine in the least of its parts and whose organizational structure and internal complexity sustains and preserves it as a biological entity. However, if, granting pre-formation, physiological functions are explicable solely by appeal to the mechanism of the body, what need is there for the dominating monad? Conversely, how can Leibniz rule out pre-formation in bodies we normally presume to be inanimate and as lacking dominating monads? Examination of common defining characteristics of living machines – self-motion, self-repair, nutrition, reproduction and inner complexity – brings into focus some of the difficulties and limitations attached to the use of such empirical data to distinguish living from non-living machines. Leibniz insists that natural machines have something substantial – soul or form – that makes them one and the same thing in the least of their parts. Leibniz's curious formulation of the distinction is that, while both are said to be machines, a natural machine, unlike an artificial one, "remains machine to the least of its parts, and what is more, it always remains the same machine" (GP 4 482). This characterization constitutes the main difference between two different types of machine. Furthermore, this characterization applies both to the internal structure of a natural machine (all its parts are machines) and to its development (it remains the same machine through its various states). After a brief presentation of the context, Nachtomy considers the suggestion that the distinction depends on the difference between finite and infinite number of

organs or parts. He rejects this suggestion, arguing that the distinction turns on the infinite structure of a natural machine.

In his contribution on "Leibniz on Artificial and Natural Machines, or, What it Means to 'Remain a Machine to the Least of Its Parts'" Ohad Nachtomy notes that Leibniz's distinction between an artificial and a natural machine coincides with his distinction between living and non-living things. Leibniz describes living beings as nested one within the other ad infinitum and, according to him, the nested structure ad infinitum is the main difference between a natural machine, which is God's creation, and an artificial machine, which is made by humans. Leibniz's distinction between the natural and the artificial also coincides with his distinction between truly active beings or substances and mere aggregates, which he deems well-founded phenomena. Thus the distinction not only divides living and non-living things, but also beings and non-beings. Thus it is clear, Nachtomy argues, that the distinction between artificial and natural machines has considerable consequences for Leibniz's metaphysics. Leibniz insists that natural machines have something substantial – soul or form – that makes them one and the same thing in the least of their parts. Leibniz's curious formulation of the distinction is that, while both are said to be machines, a natural machine, unlike an artificial one, "remains machine to the least of its parts, and what is more, it always remains the same machine" (GP 4 482). This characterization constitutes the main difference between two different types of machine. Furthermore, this characterization applies both to the internal structure of a natural machine (all its parts are machines) and to its development (it remains the same machine through its various states). After a brief presentation of the context, Nachtomy considers the suggestion that the distinction depends on the difference between finite and infinite number of organs or parts. He rejects this suggestion, arguing that the distinction turns on the infinite structure of a natural machine.

In "The Organic vs. the Living in the Light of Leibniz's Aristotelianisms", Enirco Pasini argues that the development of Leibniz's metaphysics during the 1670s and 1680s shows that its core focus is not a theory of substance, but a theory of essence and existence. The theory of substance is a theoretical middle ground that connects pure metaphysics to the epistemic level of natural science, on the one hand through dynamics, and on the other hand through a theory of the composition of substances. The latter in turn is two-sided, with a permanent component, namely, pre-established harmony, and a variety of solutions to the problem of what will be called by Leibniz "composite substance" – as well more generally, as solutions to the "form-matter" problem that is traditional in the theory of substance and that represents a recurring strain of Aristotelianism, with different phases and versions, in Leibniz's thought. For Pasini, the relation between the dominating monad and the bodily machine, as an organic aggregate which is not in itself "living", is of particular importance in Leibniz's multi-level monadological universe. Aristotelian conceptual tools are instrumentally used by Leibniz to provide a theory that can describe its metaphysical structure, but at the core of this theory we can find a peculiarly Leibnizian identification of the true living and the "*vere unum*".

In "The Machine Analogy in Medicine: A Comparative Approach to Leibniz and His Contemporaries," Raphaële Andrault notes that Leibniz's designation of

organic bodies by the term "machine" may be traced back to his partial adoption of the corpuscular philosophy. This explanation, however, has for her the disadvantage of leaving unaccounted for the notable differences between the various uses of this analogy, whether in Leibniz's philosophy itself or, more broadly, within the medical sciences of the seventeenth and eighteenth centuries. Stahl and Leibniz, for example, both make use of the comparison between the human body and the clock, but it leads both of these authors to exactly opposite epistemological consequences. For this reason, Andrault finds it worthwhile to compare Leibniz's use of the analogy with the use to which it is put in the medical texts that were known or read by Leibniz. She bases her comparison principally on the works of Steno and Malpighi, while further seeking to explain the polemic between Leibniz and Stahl on the basis of other, lesser known texts of Leibniz, including those of the 1670s an 1680s, as well as the letter to Michelotti of 1715. From here, Andrault attempts to determine methodological implications of the machine analogy in the late seventeenth and early eighteenth centuries: deployed to defend different kinds of connections between organic functions and their subordinate structures, the machine analogy receives all of its meaning from the heuristic priority that is assigned to, or withheld from, anatomical research as a component of the medical discipline. In this context, the machine analogy becomes a tool for moderating the opposition between fortuitous and intentional facts and, in the same time, for demonstrating the limits of the explanations collected loosely under the banner of the "Epicureanism".

In "Sennert and Leibniz on Animate Atoms" Andreas Blank takes up Richard Arthur's recent argument that there are interesting points of consilience between the theories of corporeal substance in the writings of the Wittenberg physician and philosopher Daniel Sennert (1572–1637) and those of Leibniz. For example, both Sennert and the early Leibniz accepted the Lutheran doctrine of traduction of souls; both Sennert and Leibniz (early and late) held that soul-like entities individuate corporeal substances; both Sennert and the early Leibniz held that in mixture a continuum arises; and both Sennert and the later Leibniz held that corporeal substances involve a hierarchy of dominant and subordinate forms. While Blank agrees with the overall framework of Arthur's interpretation, he argues that there are also some real points of divergence between Sennert and Leibniz. First, Sennert allows for two cases of genuine mixture: one in which the forms of the constituents remain unchanged, and one in which the forms and qualities of the constituents remain with modifications. By contrast, within the vortex theory developed by the early Leibniz, cases of mixture in which forms remain unchanged do not involve the emergence of a material continuum, while cases of mixture in which a material continuum emerges involve the destruction of the previous forms of the constituents. Second, Sennert's "animate atoms" are conceived of as natural minima, i.e., as minimal bodies capable of sustaining a particular substantial form. This is why Sennert has a robust conception of the death of the soul-like entity animating a corporeal substance: if the body of the corporeal substance becomes too small to sustain the soul, the soul dies. Blank spells out the ways in which this view contrasts strongly with Leibniz's later transformation theory

of biological generation, according to which every living being or "atom of substance" always has existed and will always exist, albeit on a much more reduced scale.

The doctrine of natural machines, of organisms, and of composite substances, Antonio Nunziante tells us in his contribution, "Continuity or Discontinuity? Some Remarks on Leibniz's Concepts of 'substantia vivens' and 'Organism'," assumes a marked consistency in Leibniz throughout his mature years. There is thus no doubt, Nunziante thinks, that for a full explanation of the conceptual content of Leibniz's reflections on the nature of living substances we must turn to the "classic" places where it took form: to the letters to De Volder and Lady Masham of the early 1700s, to the *Nouveaux Essais* of 1704, to the *Animadversiones* against Stahl of 1709–1710, and, naturally, to the *Principes de la Nature et de la Grace* and to the *Monadologie*. Nunziante asks: What are the elements of specific difference that emerge in this vast doctrinal corpus regarding those elements of the theory of living beings that had already appeared with some frequency in the texts of the early 1680s? In other words, what connection is there between the proto-theory of living beings of the 1680s and that of the mature years? To approach the problem in reverse fashion: what elements of discontinuity suddenly break into Leibniz's reflections from the second half of the 1690s, in contrast with the immediately preceding phases of his thought? Certainly, there are the monads. But Nunziante wishes to know whether it is possible to find certain finer-grained changes. After a decade of intense theoretical debate on the nature of corporeal substances, on organisms, on machines of nature, Nunziante wishes to sketch a historical picture that accounts in a coherent manner for the development of Leibniz's thought.

In "'The Organism, or the Machine of Nature': Some Remarks on the Status of Organism in the Substantial Composition," Jeanne Roland begins with an examination of the role of the machine of nature within the composite of the corporeal substance. The crucial question for her is to determine whether this machine can really be conceived separately from the soul with which it is to be united. The categorical difference between machines of nature and artificial machines clarifies this problem. A machine of nature is ordered by a dominant monad, from which it cannot be separated lest it be confused with a pure aggregate. It is thus problematic to define the machine of nature as a simple "part" of the complete corporeal substance. Roland maintains that we can determine the meaning of the term "organism" through the convergence of four exigencies. First, as the "order essential to matter, produced and arranged by divine wisdom", the organism satisfies the need for a connection between all of the substances in the universe, which in turn applies another exigency, namely, that there could not be souls entirely separated from bodies. Thus "organism" could not strictly speaking be a synonym of "organic body" or "machine of nature", but must designate more broadly the metaphysical principle of the connection of any given soul to a body. Secondly, insofar as it is an "artifice", it satisfies the need for a composition of matter that accounts for the formation of living beings. It is here that the meaning of "organism" connects up with that of "machine of nature", and more broadly with the "mechanism" that determines the operations of organic bodies. Organism, Roland says, is the name of the origin of natural forms,

which no human artifice could reproduce. It grounds the mechanical intelligibility of natural phenomena, without ever being reducible to mere mechanism. Thirdly, it is the condition of expressivity of the living individual. The singularity of the organization of the body makes the monad's point of view into something real. Fourth and finally, it is the corporeal sign of the soul. In this latter sense, the term is employed more correctly as an adjective than as a substantive. Roland's analysis clarifies the question concerning the substantial composite. It shows how the exigencies that lie within the concept of organism are able to break free from a composition of the corporeal substance by way of the parts and the whole, and to substitute for this a mode of composition by way of folds or envelopings, which is what the artifices of matter are in the final analysis.

In "Action, Perception, and Organization," Anne-Lise Rey argues that the novelty of Leibniz's introduction of his science of dynamics lies in the fact that he conceives of the action of a body as a motive action that is also, at bottom, an action directed toward itself. In pursuit of the animal hidden in the machine, the explanatory frame that the dynamics puts in place to account for action, in such a way that the action within the body as well as the relation between bodies and simple substances are simultaneously comprehended, can serve, Rey believes, as a foundation for thinking about the status of organic bodies and their relationship to the notion of substantiality.

From the outset, action may be grasped as perception, that is, as the expression of order. In order to understand this expression of order as organization, Rey asserts that we must gain hold of a means of distinguishing corporeal substances from mere heavy bodies: this is, namely, the animal, which unifies bodies and in so doing distinguishes them from those endowed with mass alone. In this manner, it is possible to think of action as organization, if we allow an understanding of organisation as the expression of the connection of the organs among themselves, at a higher level of complexity, or indeed of subtlety. It is not just a matter of expressing the order of the world, but also of the transformations that are at work in the body in the form of folds, and unfoldings, of the organs. Thus the complexity of the transformations is correlated with "perceivability", that is to say with the capacity of perception.

Nevertheless, at first sight it appears to be the living being, understood in an ordinary sense, that puts up resistance to the scheme of intelligibility of heavy bodies in terms of the dynamics of action. The entirety of Leibniz's interest in this question, Rey thinks, is rooted in the fact that the formula, "everything is full of life," can be restated without any loss of meaning by the formula, "everything is full of perception." It is, she holds, perhaps not so much the living being as such that is singular, but the manner in which Leibniz, while conceiving the living being in strictly mechanist terms, nonetheless invites us to understand the body from the dual point of view of both its mass and its structure, or indeed of its corporeality and of its organisation, or, finally, of its secondary matter and its entelechy. Thus, as in an investigation on the phenomenal level – in which, in expressing the derivative forces one also invokes their relation to the primitive forces and so arrives at the substantial level – two levels of intelligibility are laid out for us along with the path that permits us to move from one level to the other: as in such an investigation, Rey

proposes that, by venturing into what Leibniz describes as applied physics, which includes chemistry and anatomy, we could be led to the particular form of substantiality employed in the concept of corporeal substance. Rey hypothesizes that, in fact, what it is that determines the specificity of each domain of knowledge is not so much the object that Leibniz has in view, as it is the explanatory modality that he employs. It is in this connection that she inquires into the way in which the intelligibility of organic bodies is conceived by Leibniz. If, as Michel Fichant has shown, the degree of substantiality of organic bodies corresponds to an intermediate level between the monad and the aggregate lacking unity which articulates the organic bodies – that is to say, which assures the progression from one body to the next – then as Rey sees it, the task is to determine the nature of the substantiality that is involved in the body. In other words, the task is to understand the reality of the body. Rey's hypothesis is thus that action can be used as a guide for the intelligibility of the organization at work in machines of nature, precisely to the extent that it proposes a connection between the corporeal dimension of the body and its substantial dimension.

Finally, in "Perceiving Machines" Evelyn Vargas focuses on the epistemological problems involved in Leibniz's successive definitions of perception in the context of the development of a theory of the actions and the passions of created substances. Although his first characterization of perceptual experience involves "cogitation" or thought that is related to an object as its requisite his newly developed science of dynamics makes it possible to introduce a teleological approach to perception by which sentience can be extended to animals or even living machines more generally. Insofar as perception can be regarded as an organic function it can be treated within the dynamical framework of the exercise of forces. Moreover, perception is an end-directed process because perceptual experience is a representational relation in which a certain action of the animal is formed in response to a certain representation of an object. Despite the advantages of this innovating view of perceptual representation without thought that Leibniz describes in his medical texts the scope of such an account beyond the limits of empirical disciplines related to medical practice can be put into question once pre-established harmony enters the picture. If the causal vocabulary ordinarily used in our statements concerning the objects of perception is properly understood, the epistemic connection between sensory experience and external objects has to be reconsidered. However, Vargas argues, Leibniz's teleological conception of sentience can provide a univocal description of both human and animal perception while preserving its informative role.

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Chapter 2
Leibniz Versus Stahl on the Way Machines of Nature Operate

François Duchesneau

The theory of living "machines of nature" and the notion of complex substances jointly endowed with souls, entelechies or monads, and with organic bodies, resulted from the transformations of Leibniz's philosophy which came to fruition in the *Système nouveau de la nature et de la communication des substances* (1695), and in writings of the same period. These were the bases on which versions of a system of nature centred on the integrated organization of the living to infinity were progressively worked out. But, in the course of that evolution which led among others to the theory of monads, Leibniz set his mind to the task of defining or delimiting what a physics of organic bodies, or even a physiology of vital processes, could consist in. He aimed at characterizing a science that could conform as much as possible to the epistemological requirements of the complex metaphysical model he had developed. His approach combined two more or less convergent trends. On the one hand, Leibniz undertook to critically assess the methodological options which divided physicians and naturalists of that era. On the other hand, he drew the profile of analyses and explanations which ought to be promoted, and he sketched research orientations which he wished would be achieved in the scientific milieus he was related to. These twin objectives were faithfully represented in the exchanges and scientific correspondences which accompanied his framing up a theory of living beings *qua* machines of nature. The texts which flowed from those exchanges allow us to identify two axes along which concepts illustrating a scientific approach to vital phenomena might be regrouped in Leibnizian fashion. For one, Leibniz rejected any form of analysis that involved postulating causal interventions by special agents responsible for morphogenesis and the formation and operations of phenomenal living beings, such as plastic natures, spirits of nature, intelligent physical agents; as a counterpart, he reaffirmed requirements to be fulfilled in all explanations aiming at the sufficient reason of physiological phenomena. On the other hand, in a more positively oriented strategy, he would draw guidelines for a "mechanist" doctrine that could adequately account for the organic features which the living, the only

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true substances of the physical order, display. The reinstated or revised "biological" mechanism he adhered to followed from his invention of the dynamics, but it took on some specific forms and features because of Leibniz's openness to research orientations prevailing among contemporary physiologists and naturalists. I shall now consider a single case from among many: that of the arguments about the life science which Leibniz's critical reaction to Georg Ernst Stahl's doctrine entailed.

1 Mechanism Versus Stahl's Heterogeneous Organism

On a few occasions already, I have undertaken to analyze the writings of the Leibniz-Stahl controversy.[1] Arising from the publication of *Theoria medica vera* (1708) by Stahl and from the critical remarks Leibniz decided to object to the already famous professor of medicine at the University of Halle, the controversy fostered a double series of objections and replies, and finally resulted in a synthetic publication after Leibniz's death: *Negotium otiosum, seu Skiamachia* (1720).[2] I have systematically expounded Stahl's doctrine, which I believed marked the birth of physiology as an autonomous discipline. I have also analyzed his views on the radical distinction of organism and mechanism.[3] For now, I shall draw your attention to the contrasting views of Stahl and Leibniz on the way a science of the living should be constituted, and to their opposite conceptions of organic body. In his *Animadversiones circa assertiones aliquas Theoriæ Medicæ veræ Clar. Stahlii* and in his *Exceptiones* to Stahl's *Enodationes*, Leibniz resumes the essentials of his theory of monads and complex substances. In consideration of his own conception of pre-established harmony and of the corresponding psychological and physical series, he objects to the direct interaction of soul and body in the physical order, which Stahl supported. His conception implies that no reciprocal mixing can occur between states of the soul – perceptions and appetitions – and modifications of the organic body: for him, the latter modifications comprise the various motions affecting organs and the replacement of the constituent particles of preformed structures, and these structures in turn are subject to unfolding (*evolutio*) and folding-up (*involution*).

From the viewpoint I adopt, a first interesting aspect concerns the relation between mechanism and finality according to Stahl. Manifestly, for the author of *Theoria medica vera*, the physical universe obeys mechanical determinations, but these, notably present in the chemistry of mixed bodies and in the reactions they display, ultimately depend on a divine ordering of phenomena; but God's design in this system of Nature escapes us. The phenomena of inorganic matter seem to Stahl to represent a chance distribution, due to mere contingency in the interaction

[1] F. Duchesneau (1982, 1998, 1995, 2000).

[2] G.E. Stahl (1720).

[3] F. Duchesneau (1976); F. Duchesneau, *La Physiologie des Lumières*, 1–30; F. Duchesneau, *Les Modèles du vivant de Descartes à Leibniz*, 287–311. On the theory of Stahl, cf. also F. P. de Ceglia 2000; J. Geyer-Kordesch 2000.

of particles and the combinations formed out of these, even if the issuing combinations are replicated with some constancy. True finality resides in the direction and order that the soul imposes on the course of organic processes in the unstable aggregate of mixes which constitutes the organic body. The soul creates a zone of specific teleology within the organism, which runs otherwise the risk that its functions be disrupted and its structures dissolved. It is by the active power of the soul achieving its own objectives that what appears to be a kind of precarious chemical machine forms an integrative whole and seems to combine multiple actions in pursuance of goals of preservation and reproduction. But, according to the laws ruling over physical and chemical phenomena, such a machine would represent a highly improbable natural accomplishment, and its persistence in duration is a fact that would lack a mechanist sufficient reason. What defines a Stahlian organism by contrast with any mechanism is an intrinsic finality in its formation, organization and functioning. Such a goal-directedness is only to be attributed to a soul-like principle which combines chemical mixes so as to maintain intact the unstable organic aggregate: such a soul-like principle would also determine the actions required for the combined structures to operate in an integrated and harmonious way.

To Leibniz's eyes, there seems to be evident family resemblance between that explanation of the organism as an entity actualized by a "telos" heterogeneous to the mechanical order, and a metaphysical doctrine of "plastic natures", or soul-like agents, which frame up, organize and regulate living beings in a physical order that can neither account for their production nor for their functioning.

Leibniz's 7th *Animadversio* concerns a proposition on which he and Stahl might possibly agree[4]: the fine description of a clock would allow us to understand the reasons for its functioning in terms of the ends and means displayed. But the meaning of this proposition differs for each of the two authors. Stahl conceives that an intelligent mind, which sets to itself the objective of measuring the course of time with a machine, can combine its organs, determine how they will operate and provide the whole structure with appropriate impulses. This finality which appears extrinsic to the clock, but without which the clock would only be an amorphous heap of pieces, symbolizes the relationship of a soul with a body whose structural and functional harmony is only achieved by the soul's intervention in the physical order. Leibniz endorses the same metaphor, but gives it a diametrically opposite meaning. As exact as possible a material description of the clock would reveal a mechanical composition devised to enable it to accomplish by its own means the end or ends for which it has been conceived. In a way, once the machine has been structured, finality has become an integral feature of its material composition and of the motions which it executes following a regulation implied in the very organization of its parts. Indeed a living being is such a machine, but infinitely more refined and more subtle than a clock because it has been engineered in its least parts down to infinity. The extrinsic finality which operated in its original formation has become intrinsic and fully

[4]Leibniz, *Animadversiones*, §7, Dutens II-2, 137: "Ex descriptione exquisita horologii comprehensionem rationum, cur & quomodo agat, sequi putem."

integrated in its structures and on-going operations. Hence the formula: "and it may be said [...] that organic bodies of nature are divine machines."[5] They embody what we could term a "natural finality."

But, according to Leibniz, natural teleology is not solely restricted to the living organisms we perceive; it is also implied in the tiniest elements of the physical order: any mass, be it ever so small, contains organic bodies or machines of nature. Attributing certain effects to chance is a consequence of our ignoring the true order of connecting causes. The organic bodies, at whichever level of integration, have their proper ends by virtue of their structures and the operations deriving from these. This is not the case though with mere aggregates of bodies: these may display some finality, but by virtue of a kind of extrinsic organization, depending on the serial connection of effects produced on them by external agents. This surface or epiphenomenal teleological order, if you authorize this phrase, nevertheless reflects the inner determinations of underlying organic bodies or machines of nature. There would thus be a hierarchical encasement of phenomenal teleological relations, and we would be incited to acknowledge a natural foundation for those relations in the inner organization of true living beings. As for this inner organization, it appears self-sufficient by virtue of a functional integration of parts that deploys itself to infinity.

> We concede that there is great difference between machines and aggregates and masses, for machines have their ends and effects by the power of their structure; but the ends and effects of aggregates arise from series of concurring things, and thus from the encounters of various machines, which though they follow from divine destination, display more or less coordination; so the end and original task of the silkworm is to produce silk, but for it to generate another silkworm there must be copulation between a male and a female, and so the combination of an animal with something external to it, but nevertheless this combination displays more coordination [...] than that which makes silk into human clothes [...]. At the same time, not even a very intimate operation like silk production would happen without the addition of external conditions, like the heat of the sun, the nutritive consumption of mulberry leaves, and other conditions of the same kind.[6]

Stahl's argument that mechanical explanations are insufficient to account for the preservation of the living's integrated and functional system, implies a deep criticism of the means employed by the Moderns for reaching to mechanisms of the vital order. On the contrary, Leibniz will restore an epistemic and methodological

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[5] *Animadversiones*, §2, Dutens II-2, 136: "[...] dicique possit (ut jam notavi) corpora naturæ organica machinas divinas esse."

[6] *Animadversiones*, Responsiones, ad §1, Dutens II-2, 144: "Interim concedimus, magnum esse discrimen inter machinas & aggregata massasque, quod machinæ fines & effectus habent vi suæ structuræ, at aggregatorum fines & effectus oriuntur ex serie rerum concurrentium, atque adeo ex diversarun machinarum occursu, qui etsi etiam sequatur divinam destinationem, plus tamen minusque manifestæ coordinationis habet; ita bombycis finis opusque initium est, ut sericum producat sed ut alium bombycem gignat, opus est congressu maris & fœminæ, atque adeo combinatione unius animalis cum alia re externa; sed hæc tamen combinatio plus habet coordinationis manifestæ [...] quam ea, quæ facit, ut sericum transeat in vestem hominis [...]. Interim nec opus maxime intimum, velut serici productio, obtineretur, nisi externa accederent, velut calor solis, nutritio ex foliis mori, aliaque id genus."

equation between organism and mechanism, even if living organisms, especially those of animals, are divine mechanisms, implying an arrangement of means and ends that would have to unfold to infinity for our discovering their full and entire sufficient reason. In animals, teleology prevails through relations linking structures with functions. And these relations may be specified according to the distinct principles or laws of self-preservation, development and reproduction. The scientists' task is to reveal those principles and laws: this task consists therefore in investigating and analyzing structure-function correlation. To this purpose, scientists shall combine the comparison of phenomena with models matching the criteria of a *mathesis physica* in order to account for natural processes with the highest probability.

In challenging that logic of research and explanation, Stahl drew support from a dramatic paradox afflicting medical knowledge at that time. The life sciences had remarkably progressed in the investigation of organic structures and processes, notably due to the development of micro-anatomy (*anatomia subtilis*) and the formulation of mechanist models for circulation, nerve-sensitivity, muscular motion, secretion, nutrition, and respiration. The promoters of a modern investigation of animal economy, such as William Harvey, Giovanni Alfonso Borelli, Niels Stensen, or Marcello Malpighi, had many followers. Henceforth, many were attempting to describe and explain the micro-processes and complex arrangements of the least organic parts. And research was expanding, not only through the investigation of the microscopic strata of vital organization, but also through comparative analyses involving highly diversified sets of Nature's productions. The principle justifying this bi-directional extension was a presumed analogy in variations between modes of organization: this analogy would unfold to infinity under the aegis of a presumably self-sufficient order of fundamental physical laws. Indeed, this program was far from being perfectly unified. It was in fact quite diversified, not only because of various kinds of mechanist conjectures, but also and mostly because of divergent interpretations about the role of chemistry in physiological analysis: determining what might be scientifically retained from the chemical explanation of functions was at stake, especially since these functions were being conceived as processes of assimilating inorganic particles to the living organism and of correlatively disassociating organic compounds from the latter. Indeed, the physiologists who were partisans of a *mathesis physica* tended to develop a sceptical position towards theories inspired by Jan Baptista Van Helmont and his disciples; but they viewed themselves as pursuing in the footsteps of Robert Boyle who aimed at grounding the analysis of chemical reactions and combinations on a corpuscular and mechanist hypothesis about the fundamental corpuscular interactions in the order of Nature. For instance, iatromechanists such as Malpighi, Lorenzo Bellini, Archibald Pitcairn and Johannes Bohn – just to mention some physiologists Leibniz admired and referred to – would endorse part of the iatrochemical theory of Franz de le Boë (Sylvius), while aiming at transposing concepts of vital chemistry into a framework of geometrical and mechanical models.

This huge effort at analytically understanding vital phenomena by means of subtle anatomy, comparative anatomy and the framing-up mechanist or mechanical-chemical models of organic processes implied various modes of adhesion to the natural philosophy of the Moderns, but generally, contemporary physicians were still left confronted with a radical deficit in therapeutic applications, and this deficit was bitterly resented by the new savants of the vital order.[7] Practical medicine was a weak discipline in the Scientific Revolution. Hence the persistence of formulas from Galen's medicine among the dispensators of academic training who were prone to denounce, like Giovanni Gerolamo Sbaraglia in his polemics against Malpighi, the impotence, uselessness, and even futility of all applications of a *mathesis physica* to a traditional medicine solely devoted to observations and treatments of pathological deviances in humoral mixes.[8] Hence also, in another area of medicine, apparently more progressive, a radical empiricist trend symbolized by a direct linkage with Hippocratic tradition and by the paradigmatic essays of Thomas Sydenham bearing on epidemic as well as chronic diseases. Sydenham's *Observationes medicæ circa historiam & curationem morborum acutorum* (1676) proclaimed from their outset empiricist and sceptical theses shared by John Locke.[9] They set for medicine a program of abandoning search for structural and functional causes of normal as well as pathological processes; they favoured instead the sole investigation of epiphenomenal correlations, that is, presumed specific correlations of symptoms. On these correlations indications of treatment would be patterned as closely as possible, for they supposedly represented the very means Nature deploys in her regular, but fallible, course for the self-preservation of the living. Wedged between the dogmas of Galenic tradition and the insufficiencies of Sydenhamian scepticism, and criticized and attacked for its presumed lack of proper models for efficient practice, was the new mechanist science of the living to yield ground to a new doctrine like Stahl's, conjoining medical empiricism with psychomorphic explanatory conjectures?

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[7]Many observations to that effect may be found in the writings of Malpighi's disciples. Very telling is for instance this anecdote reported by Antonio Vallisneri according to his biographer, G.A. di Porcia 1986: "Era solito in nostro Antonio di raccontare, che la prima volta quando vide il Malpighi, era accompagnato dal proprio padre, e che ritrovarono a letto aggravato da certi suoi incomodi quell'insigne medico, e filosofo. Nel progresso de' scambievoli ragionamenti il padre, confortando Malpighi, affermò, che presto e' sarebbesi riavuto; imperciocché, essendo gran medico, conoscer dovea i rimedi opportuni al suo male. Il Malpighi speditamente, e con aria decisiva rispose: *Non abbiamo rimedi*. Una risposta cotanto strana, e inespettata sorprese egualmente il padre, e "l Vallisneri. Ma Antonio diceva, che mai meglio penetrato non avea la verità di quelle tronche parole, se non quando giunto agli anni maturi e scoperta la debolezza della medicina pratica insieme cogli inganni de" visionari, o misteriosi scrittori, s'avide della mancanza di que' rimedi specifichi, che tanto si ricercano, e necessari sono per la rette cura de' mali" (quoted by D. Generali 2007, 134, n. 395).

[8]In his *De recentiorum medicorum studio dissertatio epistolaris ad amicum* (1685), Sbaraglia had attacked Malpighi on the basis of the uselessness of rational medicine based on anatomy and mathematical explanatory models. Malpighi's *Risposta* was published in his *Opera posthuma* (1697). Leibniz was familiar with that work. For a modern edition, cf. M. Malpighi 1967.

[9]Cf. F. Duchesneau 1973.

Leibniz's critical remarks illustrate a number of arguments about applying mechanism to the study of organic processes. Thus Leibniz focuses on Stahl's distinction between mixed bodies, that is, plain homogenous and stable chemical compounds without an immanent integrative principle and without intrinsic functionality, and the disparate and heterogeneous aggregates which constitute living beings in their chronic instability and tendency to corruption and dissolution.[10] According to Stahl, inorganic mixes would also be indifferent to the various forms of synthesis that might yield aggregates, while living organisms would correspond to specific models of aggregation. Complex architectures, those of the living, would contrast with mere combinations of modest import, those of inorganic bodies. The relation in duration for mixes would be homogenous to the interactions involved, while aggregates would have relations to duration dissociated from that of their material components. Thus their duration would be unconnected with and even antithetic to that of their chemical ingredients. We ought in this instance to trace back a cause of durability that differs from the strict proportion of the materials involved. On the constitutive mixes, the causal action of fire, warmth, air, water and humidity would be major, but vital duration would depend on a principle surpassing those material and instrumental relations. This principle would entail a mode of action, simple, formal and incorporeal, totally different from that of physical agents like the mixes. In addition, this principle would act by restoring or regenerating individuals subject to corruption according to the specific type they belong to, a kind of operation that would not occur with mixes. Finally, if art can destroy the integrity of the living, it could not inversely operate in a mechanical way to restore it, while this reciprocity in mechanical operations could happen in mixes *qua* inorganic bodies, since actions and reactions could be balanced in that case. All this argumentation would drive us to the point of acknowledging that the real principle behind the constitution, preservation and functioning of living bodies is a specific agent, heterogeneous to mechanism, beyond reach by any physical or chemical analysis, but controlling and ruling over the interaction of particles, restraining or suspending chemical reactions which affect the unstable aggregate a living body reduces to.[11]

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[10] Cf. in particular *De diversitate mixti & vivi corporis*, §10, in: G.E. Stahl 1737, 70–73.

[11] For a survey of Stahl's arguments concerning the irreducibility of living aggregates to chemical mixes, cf. F. Duchesneau, *La Physiologie des Lumières*, 17–18: "C'est ainsi que Stahl établit la différence typologique des corps en tant que mixtes et en tant que vivants: (1) les corps mixtes sont contraires à toute espèce d'agrégation et opposent une résistance lorsqu'il s'agit de produire cette agrégation, car ils ne sont mixtes que dans leur unité, et pris comme molécules individuelles, ils tendent à l'isolement fonctionnel. Par contre, il est de l'essence des corps vivants d'exister comme agrégats. (2) Il n'y a pas d'aptitude particulière des corps mixtes à constituer soit des agrégats homogènes, soit des agrégats hétérogènes. Nécessairement les corps vivants opèrent comme agrégats hétérogènes. (3) La plupart des corps mixtes résistent à une prompte dissolution; tous les corps vivants requièrent, pour satisfaire aux conditions de la vitalité, une composition de mixtion faite de matières hétérogènes et peu cohérentes, par conséquent sujette à corruption rapide. (4) Tous les corps mixtes sont par eux-mêmes indifférents à tout mode certain et déterminé d'agrégation; tout corps vivant, suivant ses caractéristiques spécifiques, nécessite la détermination a priori, donc structurale, d'une disposition fonctionnelle propre à en assurer la persistance dans l'existence. (5)

Leibniz denies such a radical restriction imposed on the dominion of mechanical efficient causes in the vital sphere: he deems it unjustified and contrary to the principle of sufficient reason. For sure, the integrative unity of a living entity depends on a soul. Life as a distinctive property of certain types of corporeal entities – machines of nature in contrast to mere corporeal aggregates – arises solely from perception and appetition.[12] The essential activity of monads thus underlies the order of organic phenomena, that is, the sequence of physical states which the functioning of a living being boils down to. In sum, Leibniz considers that Stahl renders the animal soul material by making it into a sort of active component of the body which preserves it from an ever impending decomposition caused by its heterogeneous and unstable state. Because of this materializing of the soul through its instrumental or organic role, he even sees in *Theoria medica vera* a doctrine analogous to Hobbes' who tended to explain sensation and the mental operations arising from sensation by the reaction of some subtle particles to the motions produced by sense impressions.[13] Leibniz's favourite strategy consists in attributing the full set of specific vital motions, identified with nutrition, structural restoration and reproduction, to a force of vegetation (*vis vegetandi*) operating "by the very structure of the machine,"

La durée des corps mixtes dépend de leurs propriétés purement géométriques et physiques; ce n'est pas le cas pour les corps vivants, dont l'existence est précaire et brève. (6) Les corps mixtes ont une raison naturelle de leur durée; ce qui caractérise les corps vivants, c'est un rapport de forces antagonistes et compensatrices dans la détermination de leur durée propre [. . .]. Le rapport de forces antagonistes par rapport aux énergies de dissolution semble donc résulter de la cause déterminant l'agencement structural et fonctionnel de l'agrégat. (7) La conservation des mixtes dépend d'une condition proportionnelle des matières qui les constituent; dans le même cas, le corps vivant semble se dispenser de cette condition de rapport matériel et même lui faire échec comme inappropriée à sa conservation. (8) Pour le mixte, point de corruptibilité équivalente à celle des vivants. (9) Mais alors le vivant se trouve défini négativement par rapport au mixte; et telle définition qui le concerne, consiste en rapports d'analogie négative faisant ressortir l'autonomie et la régulation interne, voire intrinsèque, par contraste aux principes de proportion matérielle qui valent pour les mixtes. (10) Non seulement le principe, mais l'opération même de la conservation vitale s'accomplit suivant un mode différent de celui de la conservation des mixtes, car elle résulte d'un acte simple, formel et incorporel, hétérogène aux mixtes purement corporels: ce qui doit signifier le mode harmonique et intégré des processus de conservation vitale. (11) Les phénomènes vitaux renvoient en effet à un principe permanent et immanent, régulateur des processus de l'agrégation. (12) De plus, ce principe détermine le renouvellement constant des processus agrégatifs, par une direction spéciale de reconstitution des mixtes intégrés dans l'agrégat. Il s'agit d'une loi de reproduction étrangère aux processus stabilisés propres aux corps mixtes."

[12] *Animadversiones*, §8, Dutens II-2, 137: "Optime passim urget Cl. Autor immensum discrimen inter viva & alia mixta. Vitam ego colloquare solebam in perceptione & adpetitu. Autor celeberrimus magis constituit in ipsa corporis tuendi se potestate contra interitus proclivitatem, cum alioqui vivorum corpora sint maxime fluxa, ut vita salis instar futura sit, quod quidem per jocum de anima porci dicebat."

[13] Cf. in particular *Animadversiones*, §29, Dutens II-2, 142–143, and *Responsiones*, ad §29, Dutens II-2, 159–161.

from which vital motions follow.[14] The relationship of the soul to these motions reduces to a "conspiracy" (*conspiratio*), that is a regulated correspondence, but with this particular feature: the dynamic dispositions of the soul express in an integrative and unified way the sequential order of physiological processes which unfold to infinity. Vegetative life as such is compared to a flame that feeds, spreads, diffuses into multiple motions and sets itself back in its proper identity. Beyond the metaphor, Leibniz seems to support the idea that analysis should focus on series of physical and chemical operations that can be adequately combined and integrated to correspond to ends of vital organization.

2 Resorting to Physical-Chemical Models

This programmatic assertion implies that micro-anatomy shall be vindicated against Stahl's scepticism. Understanding the figure, situation and interrelationship of microscopic structures is presumed to provide an account of the formative and structural conditions for animal organization (*œconomia animalis*).[15] And it is reasonable to expect that this knowledge will foster several practical implications for medicine and surgery. But, above all, scientific analysis of "organic mechanism" (*mécanisme organique*) – if I may borrow this term from Louis Bourguet whose *Lettres philosophiques*[16] were directly inspired by Leibniz's views – involves awareness of the micro-structural features that underlie the very processes the living organism engages in for its own preservation and development as well as for replication of its species type.

Significantly, Stahl's criticisms were addressed in particular to chemistry, which he judged incompetent for determining the essence and organization of the living beyond the level of some of their contingent components. In contrast, Leibniz places chemistry at the core of his interpretation of machines of nature considered with regard to normal as well as pathological processes. As he wrote to Johann Andreas Stisser in 1700:

> I would indeed believe that for those ailments that affect the fluid parts of our body, including even the most malign ones, help could come from our having made sufficient progress in the chemical science. Therefore I would not doubt that anything efficacious that occurred to medicine [apart from empirical remedies which we owe to chance and not to art] should be attributed to parallel advancements in chemistry.[17]

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[14] *Animadversiones,* §9, Dutens II-2, 138: "Ego hæc ad vegetandi vim referebam, qua corpus vivum sese perficit, nutrit, reparat, propagat, quod ex ipsa structura machinæ consequi puto; etsi anima ubique conspirante."

[15] *Animadversiones*, Introduction, Dutens II-2, 135.

[16] Cf. L. Bourguet 1729.

[17] Cf. Letter to Johann Andreas Stisser of 15 May 1700, Dutens II-2, 130: "Ego certe libens crediderim, his malis, quæ in fluidis corporis nostri partibus hærent, ne malignissimis quidem exceptis,

In so doing, he aligns himself with a style of synthetic iatromechanism, which integrates chemists' analyses, while for other currents of iatromechanism manifestly prevailing investigations in subtle anatomy might have screened off the importance and relevance of combining chemical with structural analyses. It should be recalled, for instance, that Leibniz left important reading notes from *Praxeos medicæ idea nova* (1671) by Franz de Le Boë and from *Collegium practicum doctrinale* by Michael Ettmüller,[18] but foremost he joined with Thomas Willis, Malpighi, Johann I Bernoulli, Pitcairn and Antonio Vallisneri in wishing that investigations of physiological processes integrate mechanist transcriptions of chemical hypotheses. From that perspective, Leibniz makes a general assessment of the supposed difficulty of grounding an explanation of vital phenomena on chemistry. This assessment consists in noting the considerable difference that characterizes chemical reactions involving acids, alkalis and oils, depending on whether they take place in inorganic aggregates, or in organic bodies, and even on whether they occur in animals or in plants. However, while taking into account the specific chemical transformations that animal and vegetal fluids undergo, the task remains of tracing back inductively from among this diversity of effects the common relations ordering phenomena in both cases. In conformity to the theoretical option Boyle had illustrated, notably in *Skeptical Chymist* (1661), these reactions and their outcomes are appropriately presumed to depend on interacting imperceptible corpuscular aggregates; and chemical transformations are presumed to correspond to physical processes which, instead of resulting from the structure of organic bodies per se, result from their component masses – this boils down to making the causal source of chemical processes reside in the sub-microscopic structures of these bodies and in the forces they deploy. Essentially this is what Leibniz asserts in his 12th *Animadversio*:

> There is, so to say, a chemistry proper to animals, and the mutations that take place in the humors of animals are no less relevant to chemistry than those occurring in the liquors of plants: furthermore all bodies are relevant to chemistry, when, with regard to their physical operations which consist in insensible processes, they are considered not as mere structures, but as masses.[19]

In Leibniz's *Exceptiones*, chemistry is presented as an essentially empirical discipline: it is principally concerned with similar, that is inorganic bodies, and it yields "general aphorisms" describing the reactions that take place in and amongst such bodies, but the possibility is left open of extending these aphorisms to vital

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succurri posse, si satis in chemica scientia profecissemus. Itaque quicquid Medicinæ in his efficaci accedet [si empirica remedia seponamus, quæ casui non arti debentur] non dubitem parallelis Chemiæ incrementis tribuenda fore." This letter is a follow-up on the publication of J.A. Stisser 1700.

[18] Cf. the following manuscripts in the Leibniz-Archiv LH III, IV, 7.a & 7.b, and also 6.b.

[19] Cf. *Animadversiones*, §12, Dutens II-2, 139: "[. . .] est tamen animalibus quædam propria, ut sic dicam, Chymia, & ad Chymiam non minus pertinent mutationes, quæ in humoribus animalium, quam quæ in liquoribus vegetabilium fiunt: imo corpora omnia ad Chymiam pertinent, quando secundum operationes physicas, insensibili processu constantes, non ut structuræ, sed ut massæ tractantur."

processes themselves. By differential assessment, the part of chemical transformations taking place solely in living organisms could be detected. The emphasis is mainly put in this instance on the eruptive and explosive processes that the insensible parts of organic bodies would yield; emphasis is also put on such combinations of processes from the various realms of Nature as may assist us in understanding the metamorphoses affecting organic humours.

Concerning vital mechanics or, if you prefer, the *sui generis* operations of machines of nature, the general and specific chemistry of living beings should be taken into account. It becomes clear that the modalities of this mechanics exceed plain structural integration and form the object of a special physics (*physica specialis*). This special physics focuses on the dynamic processes by which organs are transformed, but above all, on the chemical changes of those organic fluids with which anatomical structures interact, thus causing reciprocal transformations. Hence the famous and often replicated formula: "One can say that our body is not only a hydraulic and pneumatic, but also a fire-operated machine."[20] This formula is further clarified by the statement that the impetus animating that machine springs from a summation of small explosions like those of gunpowder.[21] It is only by this hypothesis that one can analytically explain the commotions that strong affections (*pathemata*) of the soul seem to directly occasion in the organic functioning. That type of phenomena provided Stahl with one of his principal arguments in support of the irreducibility of organic processes to mere effects of proximate mechanical causes. The physiological effects of strong affections or passions of the soul would be without proportion with the dispositions of organs and with organic motions that would be produced in accordance to geometrical requisites. For Leibniz, that presumed heterogeneity between affections of the soul and organic dispositions would result from not considering the reality and effectiveness of such motions as affect the tiniest corporeal parts. Indeed these motions express effects of impetuses at the submicroscopic level whose convergence and summation get translated as conscious appetites for the organic body's dominant monad. It is nevertheless worth noting that the organic body is essentially moved by the internal dynamics of its component masses. As underlined by Leibniz in the 15th *Exceptio*: "The affections of the soul (*animi pathemata*) have a favourable or detrimental effect, because they are accurately represented in a spirituous matter, that is, a matter producing impetus."[22] At the same time however, Leibniz relates the action of the principle of impetus, like a flame attracting air or a pump sucking water, to a mechanical cause which acts by impulse and is conversely characterized according to its organic effects. Attributing those effects to some mysterious force of attraction, without foundation in physical

[20] *Animadversiones*, §13, Dutens II-2, 139: "Et dici potest, corpus nostrum non tantum machinam hydraulico-pneumaticam, sed & pyriam esse."

[21] Cf. *Animadversiones*, Responsiones, ad §13, Dutens II-2, 149: "Corpus animale esse machinam hydraulico-pneumatico-pyriam, & impetus in eo oriri ab explosionibus, quæ sint pyriis similes [. . .]."

[22] *Animadversiones*, Responsiones, ad §15, Dutens II-2, 150: "Hinc etiam animi pathemata corpori prosunt aut nocent, quia in materia spirituosa seu impetum faciente, accurate repræsentantur."

order, would indeed form a hypothesis to be excluded. For, in any case, the description of effects would not allow the researcher to appeal to models of causation that contradict mechanist intelligibility, even if the latter stays concealed at the background of particular phenomenal properties, identified as such, like properties of fibre motility.

So, in the 28th *Animadversio*, Leibniz objects to the attribution of modalities of organic motion to the soul, rather than to specific dispositions of the body. If management of the actions of vital organs may be said to be under the soul's control, it can only so happen within the limits of pre-established harmony. It should not be admitted that the soul could exert its power directly over the body, unless specific dynamic dispositions in the organic structures and, even more deeply, in the least corporeal masses determined physiological actions from which accomplishment of vital functions would result.

Historians of philosophy most notably retained from Leibniz's 21st *Animadversio* and the corresponding *Exceptio* the argument developed at length that soul would be granted boundless or infinite power, if it were presumed to determine physiological motions independently from any determination by organic structures and their components, as well as from any determination by the precise potential of force comprised in organic devices.

> Since actions of the body are available, why should we resort to influxes of incorporeal entities, and in effect to something supernatural, that it is impossible to explain from the natures involved? In addition, that cause would accomplish too much. For, as I already mentioned, the power of the soul would not be constrained by any limits.[23]

For Leibniz, in the analysis of voluntary motion, these anatomic and physiological determinations constitute the efficient cause of the act that is accomplished, even if the soul's more or less conscious appetitions intervene in accounting for the monad's unified sequence of inner states that is reflected in the animal's behaviour. If this were not the case, what would prevent us from jumping to whatever height we wished by the effect of a purely arbitrary act of will? However, Leibniz's thesis implies as a corollary an interpretation of organic motility: namely, organic determinations which obey the general principles of vital mechanics admit of strict analogues in terms of small perceptions and minute subordinate appetitions in the soul. This is because an entelechy is indeed required to provide a subject of inherence and principle of integrative unity to warrant the operations of a machine of nature unfolding its wheelworks to infinity.

An agent of impetus (*impetum faciens*), characterized as a physical-chemical principle capable of producing precise dynamic adjustments in a machine which itself manifests properties of constant self-adjustment, is essential in this instance: as Leibniz argues, "it is most certain that the explosions, fermentations, and other

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[23]Cf. in particular *Animadversiones*, §31, Dutens II-2, 143: "Cum ergo actiones corporum præsto sint, cur ad incorporalium influxus confugiamus; imo revera ad supernaturale aliquid, seu quod ex rerum naturis explicari impossibile est. Adde, quod nimis efficeret hæc causa. Nam ut jam monuimus, potentia animæ nullis limitibus coerceretur."

internal motions, vary in degrees on account of fluids and solids, but also of agents of impetus. Even in some coarser mechanism [than the organic body's], we encounter springs from which the fluid flows unevenly and periodically."[24] The hypothesis of intensive variations and minute adjustments in vital motions due to specific physical-chemical agents exerting their action in organs makes it even possible to dismiss one of Stahl's major arguments about the effect of custom, a presumably psychological determinant of physiological operations. Leibniz surmises that organic mechanisms can account for the development of habits in the fulfilment of functions, whether or not these imply conscious correlates.[25] The argument of the 30th *Animadversio* may be recalled in this instance. Motion is in the body as in its substrate: motion is therefore a property modifying the aggregate rather than the monad. Hence, whatever may be characterized as a motion phenomenon should be explained from the relevant source of motion in organic dispositions; this applies even to motions which seem to result from a principle of animation *stricto sensu*.

This is why Leibniz is prone to refer to phenomena that bear the closest analogy with states of life, while outstretching the sphere of actions of living beings as such. The example he refers to is the heart excised from the animal and continuing to throb for a while by virtue of a properly corporeal disposition. The latter can be attributed to an agent of impetus exerting its action even outside the living being. This allows us by analogy to suppose that the equivalent agent in the living being belongs with the class of vital or animal spirits; and these spirits can be reduced to subtle fluids whose component particles exert appropriate physical-chemical actions in the organs containing them.

> I am indeed surprised, writes Leibniz, that [Stahl] denies vital and animal spirits, that is to say, a fluid, imperceptible to the senses, circulating rapidly in the body. For that there be no other agent of impetus in the body but the soul, this is what the reason of things does not support. Furthermore, it is known that agents of impetus even exist in things exempt of life and it has been often observed that the heart excised from an animal continues to throb.[26]

Unless we admit "transmutations of souls" according to Leibniz's expression in *Exceptiones*, and notably transmutations by division,[27] we shall acknowledge that the excised heart is not a living being, but a mere corporeal aggregate, for any body

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[24] *Animadversiones*, §28, Dutens II-2, 142: "Certum utique est, explosiones, fermentationes aliosque motus intestinos, gradu variari: pro fluidorum & vasorum, tum etiam pro impetum facientium, ratione. Etiam in crassiore mechanismo fontes habemus inæqualiter & per intervalla fluentes."

[25] *Animadversiones*, §28, Dutens II-2, 142: "Consuetudo, quæ hic allegatur, non minus corpus quam animam ad agendum aptat."

[26] *Animadversiones*, §31, Dutens II-2, 143: "Quod autem spiritus vitales animalesque, id est, fluidum insensibile, celeriter in corpore discurrens, negat Vir Cl., miror. Nam ut nihil aliud sit in corpore impetum faciens, quam anima, ratio rerum non fert. Præterea impetum facientia etiam in rebus vitae expertibus esse constat, & sæpe cor animali evulsum pulsare notum est."

[27] Cf. *Animadversiones*, Responsiones, ad §31, Dutens II-2, 161: "Speciatim autem adduxi instantiam de motu cordis ex corpore avulsi, ubi jam anima animalis non actuatur, nisi quis eam quoque pro parte evulsam putet, atque adeo revera in corpus transmutet."

deprived of perception and appetition cannot be qualified as living.[28] Similarly, vegetation, nutrition and reproductive replication proceed from the structures and motions of the machine. Indeed, this machine, under normal conditions, appears to be animated, but the physiological processes it displays flow from physical-chemical dispositions of the aggregated corporeal parts. Nothing prevents considering that one segment of the machine, while losing its connection with the unitary and integrative functional disposition of the living organism, can keep acting for a while as a less perfect machine, and above all as a machine undergoing dissolution, but still capable of fulfilling operations which imply strictly corporeal agents of impetus. In these conditions, the organic functioning of the living organism appears liable to physical-chemical analyses of a similar kind,[29] even if we attribute to the dominant monad and its subordinate monads the formal causation of the organism as a system of perceptive and appetitive operations: such a formal cause serves as a caution for the integrative unity of the machine of nature in its phenomenal unfolding to infinity.

At the centre of the physiological model Leibniz opposes to Stahl stands the connection of impetus agents with powers exerted by the micro-constituents of vital fluids as these interact with corresponding micro-structures in organic solids. Hence some elements pertaining to what we may designate as vital chemistry. This is the case with the remarks on the action of the volatile salts of urine (= ammonium carbonate) which act as anti-coagulants of blood in vitro. This reaction which occurs outside the organism did not seem to Stahl the least enlightening for interpreting physiological processes, nor even *a fortiori* the least useful for any therapeutic approach. In his 24th *Animadversio*,[30] Leibniz praises this type of experiment and presumes that we may be dealing in this case, though at a very different degree of intensity, depending on infinitely lesser quantities, with an analytic instrument for understanding functions and establishing treatment, provided it be possible to identify the other chemical agents capable of intervening jointly with those salts in function fulfilment. In the same spirit, Stahl denied the relevance of altering medicaments, and even the fact that there might be any of that kind; instead, in cases of disorders of organic functions, he linked possible interventions to the sole evacuation of morbid matters, either by normal processes of the living organism, or by external interventions (bloodletting; purgation, etc.). In his 25th *Animadversio*,[31] Leibniz evokes against him the febrifugal action of Peruvian bark (*Cinchona*), as well as the effects achieved by opium or arsenic-based drugs. More generally, he

[28] Cf. on this argument *Animadversiones*, Responsiones, ad §8, Dutens II-2, 146: "Si corpus perceptione & adpetitu careret, credo non magis vivum appellari mereretur, quam flamma ad se nutriendam laborans."

[29] Cf. *Animadversiones*, Responsiones, ad §9, Dutens II-2, 146: "Vegetationem, nutritionem, propagationem oriri ex structura & motu machinæ; *Responsio* pro nuda positione habet sine probatione. Sed contrarium potius ipsa probare debebat. Quicquid enim in corpore & a corpore fit, id mechanice, seu per magnitudinem, figuram & motum fieri præsumitur, nisi contrarium probetur, id est, nisi ostendatur, id esse supra materiæ naturam."

[30] *Animadversiones*, §24, Dutens II-2, 141.

[31] *Animadversiones*, §25, Dutens II-2, 141–142.

underlines that everything in the normal functioning of organisms is a matter of physical-chemical alteration, and consequently, that the same principle applies to the means for restoring bodies injured by illness to their proper functional dynamics. Even evacuant drugs, Stahl's favourite, produce their effects only by altering vital processes. And these forms of alteration can be analyzed according to models framed to represent the interactions of organic fluids and solids and their modification by substances introduced in the organism for experimental or therapeutic ends. The crucial notion of alteration makes for the design of multiple analyses of the dynamic relations occurring between the various masses, solid and fluid, constituting organs, on one hand, and chemical compounds from mineral, vegetal or animal origin, on the other, which can enlighten the processes taking place in these organs through the modifications they produce.

More generally, it is chemistry that can unveil the inner mechanisms that determine and regulate functional operations in organic bodies. Such mechanisms endow these bodies with a capacity for action and regulation that represents at the level of phenomena the integrative order of the living as complex substances. Leibniz views the chemistry of his time as essentially empirical, focused on the phenomena pertaining to similar or quasi-similar bodies, that is, bodies the parts of which are homogenous or almost so and can be related to the inorganic masses entering into the composition of organic bodies. But this science can undergo three significant evolutions, which may help account for properly vital phenomena. Chemistry may correlate its most general statements which apply both to inorganic and organic processes, with the results from micro-anatomy concerning the combinations of parts out of which organisms are formed: this first option involves enlarging the sphere of experience-based knowledge. But, as another option, the data gathered and integrated from micro-anatomic and chemical analyses, can be given theoretical shape, conformably to a *mathesis physica*, by resorting to one form or another of mechanist theoretical framework: by this means, the sphere of causal explanation will be enlarged. Along the same line, by assessing the differential aspect of vital chemical reactions compared to the chemical reactions involved in inorganic compounds or mixes, we may analogically conceive of the subjacent organization of agents of impetus responsible for vital functions. Hence physics is expected to undergo adjustments so that it may adequately apply to machines of nature.

> Now, because physical arguments are supported by mathesis and mechanics and because physical experiments are supported by microscopy and chemistry, there is hope that physics will grow and having finally abandoned the toys of childhood will advance towards adulthood.[32]

Thus, Leibniz conceives that it is possible to set up a *physica specialis* that will unveil the insensible operations of observable parts of organic bodies in their relations with vital functions. Presently, these operations are only hinted at inductively

[32] *Animadversiones*, Responsiones, ad §11, Dutens II-2, 148: "Nunc vero ex quo ratiocinia physica, per mathesin vel Mechanicam, & experimenta per microscopia & Chymiam adjuvantur, spes est, Physicam paulatim crescere, & tandem crepundiis relictis ad adolescentiam proficere posse."

from observations which fall short of reaching their inner mechanisms. Such is the case for the fibrils of nerves and membranes.

> For we reach the insensible operations of sensible parts more by observations than reasoning; so is it with those of nerves and membranes considered in accordance to vital functions; and we often err about the transition from a healthy to a morbid state, or about the recovery from an illness, that is to say about the causes and remedies of illnesses, but this should come less as a surprise to us since special physics is still almost entirely at cradle-stage.[33]

Structural-functional relations in cases of this kind shall be mediated by reasons prolonging relations based on more directly accessible observations. These reasons will be essentially borrowed from a mechanist chemistry involved with organic micro-processes. This is the way we shall interpret the formula defining the animal body as a *machina hydraulico-pneumatico-pyria*. In this sense, the organism appears as a combination of dynamic micro-processes for which agents of impetus should be identified: this might be done by means of the chemical reactions that correspond to their specific functional properties.[34] Leibniz notes in particular the major role of circulatory networks, which in his time implied the blood vessels, but also the nervous and lymphatic systems, in the intense, rapid and effective transformation of particles of food mixes for the sake of the various specialized organic functions. "From the most intense change and circulation [of these particles] across the various vessels it is manifest that there follows their dissipation, involution and secretion."[35] These modified particles would be subject to evacuation (*dissipatio*), incorporation (*involutio*) and secretion (*secretio*) – a technical terminology aimed at representing the various modalities of organic assimilation and decomposition.

3 Conclusion

Leibniz opposed Stahl's conception of the organism because it went astray from his own concept of a machine of nature. According to Stahl, the soul would impose its efficient direction on physiological processes of the unstable and eminently corruptible aggregate that forms the living body. Leibniz defended contrariwise the functional autonomy of machines of nature as they had been engineered by God.

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[33] *Animadversiones*, Responsiones, ad §11, Dutens II-2, 148: "Magis enim observationibus, quam rationibus assequimur, operationes partium sensibilium insensibiles; v.g. nervorum & membranarum ad usus vitales, & sæpe hæremus circa transitum a statu sano ad morbosum, aut circa reditum a morbo ad sanitatem, id est, circa causas & remedia morborum. Sed hæc minus mirari debemus, quia Physica specialis omnis fere hactenus in cunis jacet."

[34] *Animadversiones*, ad §13, Dutens II-2, 149: "Corpus animale esse machinam hydraulico-pneumatico-pyriam, & impetus in eo oriri ab explosionibus, quæ sint pyriis similes, vix quisquam amplius dubitat."

[35] *Animadversiones*, ad §14, Dutens II-2, 149: "Ex vehementissima subactione & circumactione per varia vasa, manifestum est, dissipationem, involutionem, secretionem sequi."

Their finalized operations would be due to structural-functional arrangements that unfold into hierarchically integrated processes to infinity. But Stahl also questioned the analytic means modern physiology applied to the explanation of vital phenomena. He especially denounced the inadequacy of micro-anatomical investigations, but also the presumed failure of chemical models in accounting for vital processes. On the contrary, Leibniz conceived that vital motions flow from the structures and micro-structures of the living as natural machines. We could therefore view them as dependent on a *vis vegetandi* residing in the correlation of chemical reactions that take place within corporeal masses. And so analogy would apply between the combinations involved in inorganic mixes and the processes proper to a chemistry of the living. It would be possible to institute comparative analyses so as to reveal those processes while providing for their analytic transposition according to a *mathesis physica*. The representation of vital mechanisms would thus undergo some transformation in order to account for the presumed dynamics of organ change and vital fluid alteration in the interrelationship of organic systems. From the critique of Stahl's principles, it could be inferred that machines of nature required the development of a special physics that associated micro-anatomical investigations with explanatory models based on the processes of vital chemistry. Hence a confirmation that the animal body, a *machina hydraulico-pneumatico-pyria*, had to be analyzed by combining specific chemical as well as mechanical models, subject to empirical confirmation.

From physiology thus reformed according to a combination of empirical inferences and mechanical-chemical models a scientific pathology would flow, in strict continuity with the science of normal processes. The objective is in fact that of founding a *medicina rationalis*, a formula which Friedrich Hoffmann precisely favoured in the practical sphere. Hoffmann was Stahl's mechanist opponent at the University of Halle and also one of Leibniz's correspondents. Studying Hoffmann's physiology, I found in particular that he introduced physiological agents of impetus to account for vital processes, in the form of inherent organic forces (*vires insitæ*) in the micro-structures of the various anatomical systems.[36] A parallel and contemporary move will be that of Giorgio Baglivi who, in his *De fibra motrice et morbosa* (1700), prior to Haller, focuses on the live properties of elementary fibres to construe his physiological theory.[37] For various reasons, these disciplinary scientific developments as well as others fit in the overall picture of what a Leibnizian science of organisms would look like. In any case, the methodological pattern Leibniz expounded against Stahl corresponded to his own general views on the requirements that would condition the emergence of a science of the living. To this methodological pattern he also referred when he went assessing the empirical and theoretical endeavours of his contemporaries in physiology, natural history and medicine – a challenging topic in its own right.

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[36] Cf. F. Duchesneau, *La Physiologie des Lumières*, 32–64.

[37] Cf. G. Baglivi 1710.

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Chapter 3
Leibniz's Animals: Where Teleology Meets Mechanism

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1 Macroteleology Versus Microteleology

There are two main kinds of questions that can be raised about the relation between teleology – or explaining events in terms of goals and purposes – and mechanism in Leibniz's metaphysics. *Macroteleology* inquires into the relationship between events in the world of mechanism and the purposes and goals God had in mind as he selected this, the best possible world. Macroteleological issues are obviously far removed from the everyday world of goal-driven behavior. Inquiry into them is completely uninformative for that world: *every* physical event, however untoward, has a macroteleological explanation.

Microteleology, by contrast, aims at relating a delimited set of mechanical events to a set of goals and purposes of finite beings. In Leibniz's mature terminology, this typically involves relating events going on in an animal's organic body to the "appetitions" of its soul or dominant substance.

Macroteleology won't concern me much here, though it is well to remember that it is always there in the background, including all microteleology in its larger, all-encompassing scope. It is sometimes said that Leibniz wasn't concerned enough with microteleology, but, given the complete concept doctrine, it's hardly surprising. As every substance – including every animal – is running a script which fits into God's larger script for the best world, macroteleology covers the territory.

But of course what theorists have wanted from Leibniz is something more fine-grained, some way of singling out behavior which needs a teleological explanation in addition to its (according to Leibniz) always-available mechanical explanation. And then he must show how the teleological account is complementary to, rather than in competition with, the mechanical one. Only this will fulfill his claim to have harmonized the "realms" of teleology and mechanism.[1]

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[1] For example, DM 22; G 4:391/L 409–10; Mon 79.

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I argue that Leibniz did, in the end, show us in a general way how to handle microteleological issues. He remains clear throughout that he'll not be caught using teleology to explain specific events, and many of his other theoretical commitments discourage him from going any distance down this road. But it is there in certain texts from the later mature period. Enough is there to absolve him of Jonathan Bennett's charge: "It seems to me that Leibniz simply did not think hard about the essentially explanatory nature of teleological concepts."[2] In these later texts, the teleologically-driven dominant substance or monad is able to explain the events going on in an animal's body – though never in such a way as to replace or make obsolete the mechanical explanation of those very events. It is the richest harmony Leibniz offers.

2 Teleology and Mechanism in the Big Picture

As with so many topics, when it comes to teleology and its impact on the physical world, Leibniz's multiple metaphysical theories push him this way and that. He ends up in many different positions, and isn't nearly as worried about making them all fit together as we often are.

This study will emphasize that those who insist on an *exclusive* metaphysic pay a huge price in understanding. So much of what Leibniz says all through the mature period makes no sense on a single perspective like "Idealism" or "Parallelism." Once again it is clear that Leibniz is best allowed to maintain theory-pluralism, or adherence to multiple metaphysical accounts.[3] This gives him a stunning lineup of options which other theorists might well envy. The exclusive interpretations are constantly dogged by texts in which Leibniz asks questions quite different from those they expect him to ask, and answers those questions in unexpected ways. As we'll see.

3 Five Theories: Idealism, Parallelism, Hylomorphism, Panpsychism, and Animal

3.1 Idealism

Here "mechanism" is the realm of quasi-causes among phenomena, like Berkeley's laws of nature representing the "rules" God follows as he dispenses sequences of appearances into finite minds. Since, on this reading of Leibniz, bodily phenomena of aggregates (as aspects of the broadly perceptual states) follow from the appetitions specified in a monad's complete concept, teleological matters are part and parcel of the deep metaphysics from which emanates what is here called "mechanism." Any notion that the two are in competition and need to be reconciled

[2] Bennett 2005, 146.

[3] See Hartz 2007.

seems misguided and to manifest a striking misunderstanding of the mature system. Idealism would thus solve by fiat the problem Leibniz sought to address, making his efforts along these lines – and much else that he says – unintelligible. In addition, Leibniz's later claim that a dominant monad unifies and grants direction to its "organic body" becomes nonsense on Idealist principles. For on this view, as organic bodies are aggregates, and all aggregates are phenomena, the doctrine will be that a mind-independent monad unites itself with a mind-dependent appearance – one of its own or one in another mind. Which is either impossible or a gross abuse of terms.

In the *Monadology*, Leibniz mentions the case of his "present writing." This will serve as our central example of an event which seems to require a teleological explanation even if a mechanistic one is also available. The passage:

> There is an infinity of shapes and motions, present and past, which play a part in the efficient cause of my present writing; and there is an infinity of tiny inclinations and dispositions of my soul, present and past, which play a part in its final cause. (*Mon.* §36)

This is put in terms of "Parallelism," to be covered next, but for now I want to inflict on it an Idealist reading. It says the monad which is Leibniz pursues its goals – following out its "inclinations and dispositions." At the same time in the realm of sense-data in finite minds, there is an appearance of a man dipping a pen and jotting down "*La Monade*. . ." on a piece of paper. It is in that realm of appearances that the "infinity of shapes and motions" is somehow to be housed. According to Idealism, the appearances always proceed from the teleologically-driven monad as it realizes its complete concept: the shapes and motions follow as aspects of the perceptual states from the monad's "inclinations and dispositions." Here teleology and mechanism are not separate and never could be. Idealism makes nonsense of Leibniz's question of how they are to be reconciled.

3.2 Parallelism

This is the "pre-established harmony" of mind and body, most familiar from the *New System* (14–15) and reiterated through the mature period. It is the preferred metaphysic in the passage noted above from *Monadology* §36. It, or something very similar, appears as early as 1690 when Leibniz writes Arnauld about "indivisible substances" which "have something corresponding to souls":

> Each of these substances contains in its nature the law by which the series of its operations continues, and all that has happened and will happen to it. . .. The union of soul and body. . . consists only of that perfect mutual harmony deliberately set up by the order of the first creation, by virtue of which every substance according to its own laws, acts in harmony with what the others require. (LA 135–6)

When applied to Leibniz's writing of the *Monadology*, the Parallelist story is as follows: Leibniz's soul follows its "inclinations and dispositions" having to do with his plans and purposes and designs on how best to start the work. At the same time (but without any causal interaction with the soul's goings-on) Leibniz's body

follows the laws of nature and the "shapes and motions" determining that his hand should write "La *Monade*. . ." rather than some other words. The "harmony" consists in these events going on in completely separate, explanatorily isolated realms and yet mirroring and staying in sync with each other.

But Parallelism seems explanatorily lame. It guarantees *God* raw materials to "find" teleological explanations corresponding to physical events. But it does nothing for us – who are, after all, the ones who need microteleological information. As in Spinoza, Parallelism merely guarantees that "somewhere in the realm of mind" such information lurks. It doesn't tell us where to begin looking. And things are even worse: it makes the prospect of finding it hopeless because *every* physical event – no matter how rudimentary and far removed from intentions and goals – will have, in this sense, a teleological explanation. In a word, the microteleology entailed by Parallelism is completely uninformative: *what explains everything explains nothing*.

3.3 Hylomorphism

In Aristotle and many scholastics, the substantial form provides robust teleological involvement in an animal's physical goings-on – where those goings-on are typically tied to the presence of some sort of matter. Leibniz sides with the modern mechanists in supposing teleology is out of place when it is brought in to explain specific physical events (Except very rarely, as in the general account of Snell's Law). Thus, at least during the early and middle mature periods, Leibniz allows that the substantial form grants unity and reality to an animal, but he does not want to use it to explain any of its particular actions. To reinforce the point, he declares that every event has a purely mechanistic explanation.[4] Still, he leaves the door open by saying every event *can* be explained mechanically; he does not say it must.

Hylomorphism's take on Leibniz's writing would be this: Leibniz's soul or substantial form unifies and grants reality and substancehood to what is otherwise a mere parcel of matter. The form makes it a human hand, not a puddle. But the soul's role in explaining the fact that it is a hand typically goes no further – e.g., to explaining why this hand is writing "La *Monade*. . ." rather than something else or nothing at all. Leibniz often says final causes are out of place in explaining particular phenomena, and so he would shy away from what we're here calling microteleology.

We have only a programmatic and vague connection between that form and what the body does – nothing that would single out writing (as opposed, say, to digesting or secreting) as particularly tied to the substantial form's direction. The "harmony" here, I suppose, consists of the fact that what's teleological is never (naturally) divorced from the mechanical, and so the two "realms" are always inseparable (As in Idealism, one wonders what the problem of their reconciliation – at least within hylomorphic substances – might be.).

[4]For example, DM 18; GM 3:536–7/AG 167.

3.4 Panpsychism

Beginning in the Arnauld correspondence and continuing on in about half the mature texts on aggregates, Leibniz (often in texts of the same provenance as Idealist and Parallelist ones) contradicts the Idealist "aggregates are phenomena" story. Panpsychism has it that aggregates are not after all mere mind-dependent phenomena. They are said to be or to contain or to be composed of substances – true unities, animals, or "monads."

That makes them decidedly mind-*in*dependent. No interpretation can construe such a body as mind-dependent if it's literally made up of mind-independent substances or monads. In Panpsychism the old "substantial form" is transformed into a monad or substance used as a "building block" of mechanical aggregates – including the organic bodies of animals. What's inherently teleological is implicated in the very *structure* of the mechanical world.

As in Parallelism, Panpsychism makes teleology ubiquitous. But the difference is huge. For now the teleological bit is not merely found in mirroring states sealed off from the physical world by an explanatorily airtight barrier. Instead, it is *in* bodies. Note how foreign this is to Spinoza, who would *never* allow what's mental to migrate into and compose what's extended: the two have "nothing in common."

In Leibniz's Panpsychism, by contrast, mind and body *do* have something in common – something different from mere synchronicity and mirroring. Here at last something genuinely mind-like and teleological is beneath bodies. When those bodies have the appropriate, "machines within machines" structure, they are perfectly set up to be directed by a single teleologically-actuated master mind. The body-upshot of the little servant-substances manifests in its behavior at least something of the goals of the master.

Panpsychism's take on aggregates is the first step towards Leibniz's later doctrine of animals. It allows the teleologically-driven soul to have an interesting, intimate, informative, and nuanced relationship to its body. Indeed, we can wait to give Panpsychism's version of the "Leibniz writes the *Monadology"* case under Animal, as it is incorporated into the Animal account.

3.5 Animal

This is the confluence of the older Hylomorphic theme and the newer Panpsychist one in the later metaphysic. The substantial form of the earlier, quasi-Aristotelian system is replaced by or simply identified with a "dominant monad". The "matter" of the former scheme now becomes, on Panpsychism, "secondary matter" or the "organic body" composed of "subordinate monads" or "subordinate substances" (Note: lesser animals might themselves be the subordinate substances in the aggregate or organic body under the command of a dominant substance; hence the "substances" will not always be monads). A harmony is declared between the teleologically-driven (but comparatively blind and unguided) subordinate monads

and the dominant teleologically-actuated monad which gives that body direction as it obeys its master's "orders".

This connection between the early/middle mature period and the later one is the most profound continuity in Leibniz's mature thought – especially as Animal incorporates the huge raft of texts advocating Panpsychism! While Idealists do their best to see Leibniz as starting in the *Discourse on Metaphysics* with protomonads and ending with monads, the real story is that he has hylomorphic substances in DM, LA, and elsewhere in the early/middle mature period, and later modifies the story to give monads a *compositional* (not merely a perceiving) role both in the form's role and matter's role.

Nevertheless, the other theories don't disappear from the late-mature corpus. The *Monadology* alone contains passages endorsing Idealism (§7, 51), Parallelism (§36), Panpsychism (§2, 8), and Animal (§61 ff). Here is a nice Animals text from that work:

> Each living body has a dominant entelechy, which in the animal is the soul; but the limbs of this living body are full of other living beings, plants, animals, each of which also has its entelechy, or its dominant soul. (*Mon*. §70)

The "dominant substance/entelechy/monad" terminology occurs quite often. However, the only text I've found in which "subordinate monads" are explicitly mentioned is in a striking and detailed passage in the De Volder exchange:

> When I say that even if it is corporeal, a substance contains an infinity of machines, I think it must be added at the same time that it forms one machine composed of these machines and that it is actuated, besides, by one entelechy, without which it would contain no principle of true unity.
>
> If you think of mass as an aggregate containing many substances, you can still conceive of a single pre-eminent substance or primary entelechy in it. For the rest, I arrange in the monad or the simple substance, complete with an entelechy, only one primitive passive force which is related to the whole mass of the organic body. The other subordinate monads placed in the organs do not make up a part of it, though they are immediately required by it, and they combine with the primary monad to make the organic corporeal substance, or the animal or plant. I therefore distinguish: (1) the primitive entelechy or soul; (2) primary matter or primitive passive power; (3) the complete monad formed by these two; (4) mass or secondary matter, or the organic machine in which innumerable subordinate monads concur; and (5) the animal or corporeal substance which the dominating monad makes into one machine. (20 June 1703, to De Volder, G 2, 250, 252/L 529–30)

This passage is clear that the dominance/subordination relationship is much more serious than the ideal mirroring allowed by Idealism or Parallelism. It transfers the responsibility for unity owned by the substantial form in the older Hylomorphic system to the dominant monad. That dominant monad actuates and unifies under its command a colony of subordinate monads in the aggregate of secondary matter which is its organic body. Another text from 1711 helps clarify this:

> Now *body* is either corporeal substance, or a mass composed of corporeal substances. I call *corporeal substance* what consists in a simple substance or monad (i.e. a soul or something analogous to a soul) and an organic body united with it. But *mass* is an aggregate

> of corporeal substances, as cheese sometimes consists of a concourse of worms. . .. [A]ny mass contains innumerable monads, for although any one organic body in nature has its corresponding monad, it nevertheless contains in its parts other monads endowed in the same way with organic bodies subservient to the primary one. (12 August 1711, to Bierling, G 7, 501–2/R 226/Rutherford 1995, 172)

So because, under the influence of Panpsychism, the body has been transformed from inchoate "matter" to a collection of monads, what's teleological in the dominant monad can influence what's teleological in the ultimate components of what's mechanical. *Explanatory unity is at last achieved*. Far from being unattentive to the "essentially explanatory nature of teleological concepts," Leibniz tailors the late-mature metaphysic of animals to exploit it. This is a "harmony" well worth the name: not a general, across-the-board mirroring, but a direct relationship between two sets of items which are both genuinely teleological.

So now: Leibniz writes "La *Monade*. . ." in the *Monadology* because his dominant monad sends out commands to the ultimate constituents of his brain, nerves, muscles, sinews and so on – in a word, to the organic body "subservient" to it. The event of writing could be explained wholly mechanistically, but that explanation would merely trace the lawful connections between earlier states of Leibniz's body and later ones, making no mention of thoughts and plans. At this point it would all be "push," horizontal, efficient causation between the "shapes and motions" of various bodies and organs given the laws of nature.

Animal guarantees us that another explanation is available to a mind acute enough to penetrate to the level of ultimate constituents. Such a mind would note that the monads underlying the muscles, nerves, and so on are responding to the commands of Leibniz's soul or dominant monad as he pursues his goals of opening the "principles of philosophy" with the claim that a monad is a simple substance. At this level, the event of these very French words being written on paper would be tied to specific goals Leibniz had of conveying the main ideas of his philosophy to a wider public and explaining some of the *Theodicy*'s doctrines more succinctly. In other words, at last more fine-grained, microteleological explanations are possible because of the tight connection between dominant and subordinate substances.

But what exactly is the influence of the dominant monad over the subordinate substances like? Need it be more than the ideal relationship (protecting world-apart and windowlessness and Leibniz's dislike for transeunt causation) favored by Idealism and Parallelism? Not for our purposes in delineating this harmony. The account above (if we left out "unity" and took the "master/servant" and "dominant/subordinate" relationship metaphorically) could stand with that minimal relationship. But looking at the larger corpus, I don't think it's enough. For again and again – and again! – Leibniz declares these dominant-subordinate composites *true unities*. And if all the relations are merely ideal, that claim becomes laughable. Again, I think we must extend to Leibniz the luxury of advancing multiple theories, in some of which the substances will be really causally interacting, while in others they will be forbidden such liaisons.

4 Comparison with an Exclusive Idealist Interpretation

The explanatory riches of theory-pluralism become apparent when one looks at the sorts of answers to microteleological questions available to exclusivists. I will concentrate here on Jonathan Bennett, an exclusive Idealist who has recently written about this issue.

In "Leibniz's Two Realms"[5] he asks how Leibniz can recognize genuine teleology in the world yet regard what goes on in it as wholly mechanistically explicable. Bennett says Leibniz "does not often remind us" that he is concerned only with mere ideal "quasi-causation" between bodies, "but that is always his view".[6] Also, Bennett claims that we are seldom reminded that "bodies are phenomenal rather than basically real", but that is "always" Leibniz's mature view. So at the outset he makes it clear he will not accept anything which transgresses against the broadly Idealist platform of world-apart monads ideally related to each other and perceiving bodily appearances. The realm of mechanism will be – must always be – the realm of quasi-causes between phenomena.

Bennett considers and rejects as inadequate Leibniz's various attempts to explain the harmony between the two realms. He says that Leibniz fails to explain the "workings" of teleology if his main story centers around the "internally felt wanting or intending" which intuitively lies behind teleological patterns of behavior.[7] Yes, if that story about what goes on internally is divorced from the story about what's going on in an animal's limbs, it "contributes nothing to its *workings*".[8] But Animal does precisely what Bennett wants. It takes the "internal story" and has it direct the animal's working out of the plans conceived in the mind.

Bennett considers the Animal account briefly, and rejects it because it involves the wrong kind of causation:

> One might think... Leibniz can say that what makes it legitimate to explain the animal's movements in terms of a mouse-catching goal is the existence at the same time of a toward-mouse-catching appetition in its dominant monad. It is not clear how that would work. For the pattern to have explanatory force... is for it to be more than merely coincidental; and it is not clear how *that* is headed off by the existence of a certain mental event each time the pattern is instantiate. It might be different if the appetition functioned as the cause of the behaviour.... But Leibniz will not say that, for it involves transeunt causation, which he firmly and deeply denies....[9]

Of course *Leibniz* would and does say the dominant monad is the cause of the behavior of its body. It is *Bennett* who will not. He closes himself off from Leibniz's best offer because he holds tight to the Idealist picture of mere quasi-causation and ideal relations between monads.

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[5] Bennett 2005.

[6] Ibid., 135.

[7] Ibid., 146.

[8] Ibid.

[9] Ibid., 147.

Bennett's Idealism can make no sense of Leibniz's claim that the organic body contains "subordinate monads." It can understand neither "contains" nor "subordinate." In Idealism, all bodies are appearances in minds which can contain at most other sub-appearances, and the very prospect of "subordinate monads" is preposterous because of "world-apart." There can be no question of one monad being at the beck and call of another, despite the fact that Leibniz clearly means to set up that sort of relationship between servant and master substances. Elsewhere Bennett says that the dominant monad fulfills a "logical rather than an executive role"[10] defined in terms of distinctness of perceptions. But Leibniz's notion of subordination entails real causal influence flowing between the dominant and dominated monads. Leibniz assigns it an executive role. Bennett replaces it with a logical one citing in support the "firm and deep" opposite opinion held by Leibniz himself. Which Leibniz do we believe?

I say both, restricting the scope of "their" claims. When wearing his Idealist or Parallelist hat, he maintains the independence of substances in the way Bennett prefers. When developing other theories, he does not. The texts will not change. They force us to change from exclusivists to more generous interpreters. By holding tight to Idealism and rejecting all others, Bennett needlessly impoverishes himself and his readers.

5 Conclusion

In this study we have discovered much more than the fact that Leibniz has a theory tailor-made to handle microteleological issues. We've discovered that the only way to see that is to open our minds to the full range of theoretical options he managed somehow to weave into his works despite the fact that the theories often don't jibe with one another. His notion of a system was more like a group of claims which he found interesting and helpful for various reasons. One could think of it this way. In response to a wide range of metaphysical issues, he simultaneously has the resources of Plato or Berkeley (Idealism), Spinoza (Parallelism), Hylomorphism, Panpsychism, and his own unique version of Animal – a version which exploits the strengths of Hylomorphism and Panpsychism in a stunning synthesis.

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[10] Bennett 2001, 302.

Chapter 4
Monads and Machines

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In the well-known passage from Leibniz's letter to Burchard De Volder of 20 June 1703, Leibniz sets out five conceptually distinct elements within the corporeal substance: (i) the primitive entelechy or soul; (ii) primary matter or primitive passive power; (iii) the complete monad (primitive entelechy and primary matter); (iv) mass or secondary matter, the organic machine, for which subordinate monads come together (concur); and finally, (v) the animal or corporeal substance (the dominating monad and the organic machine, which exists as the conjunction of (i) through (iv) and which is made "one" by the presence of the dominating monad (iii)). The presence of the dominating monad is described in terms of the dominating monad being "in" the mass and by this inclusion, the dominating and subordinate monads together comprise a living, unified animal or corporeal substance.[1] The relation of the dominating monad (iii) to the "mass or secondary matter" (the organic machine

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[1] "Distinguo ergo (1) Entelechiam primitivam seu Animam, (2) Materiam nempe primam seu potentiam passivam primitivam, (3) Monada his duabas completam, (4) Massam seu materiam secundam, sive Machinam organicam, ad quam innumerae concurrunt Monades subordinatae, (5) Animal seu substantiam corpoream, quam Unam facit Monas dominans in Machinam" (GP II. 252).

"I therefore distinguish: (1) the primitive entelechy or soul; (2) matter, namely primary matter or primitive passive power; (3) the monad completed by these two things; (4) the mass or secondary matter, or organic machine for which innumerable subordinate monads come together; and (5) the animal, or corporeal substance, which the monad dominating in the machine makes one" (Lodge, http://users.ox.ac.uk/~mans1095/25_Lz_2007pdf.pdf).

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specified in (iv)) for which the subordinate monads that "come together" is particularly problematic and has implications for the substantiality attributed to (v). How are we to understand the relation of the dominating monad "in" the machine to (a) the subordinate monads that come together for the mass and to (b) the corporeal substance or animal made one by its presence in the animal's organic body? How can the unified, indivisible substance, the corporeal substance (v), include the divisible aggregate mass that is its organic body without destroying its own indivisible unity? It is, however, a more empirical and practical issue that concerns us here, namely, the reliability and usefulness of empirical evidence in determining whether any particular body is a living, organic machine (iv) or a mere aggregate, inanimate object. What criteria can we use to identify a particular mass of matter as the organic body of an indivisible corporeal substance? Can we ever be certain that a particular body is living and has a dominating monad in its mass? Finding definitive characteristics of the living that set boundaries that accord with common practice is no easy task. A few preliminary remarks are in order as background to the ensuing discussion.

1 Preliminaries

First, it needs to be noted that when Leibniz declares to De Volder that an organic machine (as an extended physical mass, or secondary matter) is that "in which innumerable subordinate monads come together", we ought not to infer from this that the organic machine (secondary matter, mass) is nothing more than an aggregate of subordinate monads. The organic machine involves aggregations of monads, but the relation is not a simple equivalence. Leibniz states only that the subordinate monads "come together *for*", or "come together *to*" (concurrent *ad*) the machine. He has not claimed that the organic machine is equivalent to the subordinate monads that have come together for the sake of it. Indeed, there is some evidence that Leibniz actually conceives all masses or pieces of secondary matter, including organic machines, as aggregates of corporeal substances. In a draft letter to Burnet, he writes:

> In bodies, I distinguish corporeal substance from matter, and I distinguish primary from secondary matter. Secondary matter is an aggregate or composite of several corporeal substances, as a flock is composed of several animals. (Draft letter to Thomas Burnett, 1699: AG 289, GP III. 260)

This characterisation of secondary matter cannot be dismissed on the ground that it only occurs in a draft for similar claims are made in letters that Leibniz deemed complete and which were sent to their recipients. In a letter to Wilhelm Bierling, Leibniz explains that he understands "body" as either a "corporeal substance or a mass made up from corporeal substances", adding that the secondary matter is "an aggregate of corporeal substances, just as cheese sometimes occurs with the coming together of worms" (to Bierling, 12 August 1711, GP VII. 501–2).[2]

[2]See also to J. Bernoulli, 13/23 January 1699: GM III.656, AG 170; Remarks on the Objections of Mr Foucher: GP IV. 492, AG 147; Monadology, §70: GP VI. 619, AG 222.

Each corporeal substance is a living substance, comprising a soul together with an organic body. This organic body, as with any piece of secondary matter, is an aggregate of smaller corporeal substances. All corporeal substances have organic bodies that are aggregates of smaller corporeal substances whose own organic bodies are in turn aggregates of even smaller corporeal substances, and so on to infinity. Each organic body is an aggregate of infinitely many little animals or other living entities analogous to animals.

> But each animal and each plant is also a corporeal substance, having in itself a principle of unity which makes it truly a substance and not an aggregate. And this principle of unity is that which one calls soul, or it is something analogous to soul. But, besides the principle of unity, corporeal substance has its mass or its secondary matter, which is, again, an aggregate of other smaller corporeal substances – and that goes to infinity. (Draft letter to Thomas Burnett, 1699: AG 289, GP III. 260)

The second point concerns the mechanical, extended parts of organic bodies. As secondary matter, organic bodies are extended.[3] By Leibniz's account, this means that the essence of the body has been diffused and repeated so as to produce a plurality of co-existing beings arranged continuously and indeed embedded within each other so that there are no gaps between them. The whole extended, secondary matter organic machine is thereby made up of extended parts that are the organic bodies belonging to the subordinate monads that have come together for the sake of the whole machine. These co-existing, extended parts function as mechanical "cogs and wheels", so to speak, that produce the movement of the body as whole. They move and resist each other in accordance with physical laws of efficient causation. The immediate physical causes of these motions and resistances lie in the bodies' derivative forces. Mechanical or physical explanation need refer only to the active and passive derivative forces in bodies to explain and predict collisions and interactions among bodies. However, at a higher, metaphysical level, these derivative forces themselves are understood as grounded in monadic active and passive primitive forces, namely, those that comprise the monad described in the third distinction made in the letter to De Volder cited at the beginning. Leibniz had already made the point in a letter to Johann Bernoulli:

> You also rightly believe that all bodies in the world arise from the mixture of inherent forces; I do not doubt that these forces are coeval with matter itself, since I think that matter *per se* cannot persist without forces. However, I think that primitive entelechies, that is, lives, are different from dead forces. Dead forces perhaps always arise from living forces. . . (to Bernoulli, 18 November 1698, AG 169, GM III. 552)

The primitive forces are laws that govern the sequences of perceptions and appetitions in the dominating monad and the motions and resistances of its body. These primal, metaphysical forces set and maintain these sequences as they unfold in time. The primitive force is, as it were, both the information on the tape and the source

[3] *Specimen Dynamicum*, Part II (GM VI. 247, L 445, AG 130). For details, see Phemister (2005), chap. 4.

that powers the machine on which it is played.[4] Each primitive force unfolds both as a series of consecutive states (perceptions and appetitions) of the mind, soul or entelechy, and as a parallel series of consecutive physical states (derivative forces, manifested as motion and resistance) of its organic body.

Hence, everything that happens in any body, whether organic or inorganic, as it exists through time can be explained by recourse to the theory of efficient causes and their derivative forces. But the existence and nature of this edifice of efficient causes is itself explicable only through the monadic primitive forces that underpin them and ultimately by recourse to the benevolence, omnipotence and omniscience of God who created the best possible world. Mere mechanical interactions among bodies do not suffice to produce the organic machines that operate by mechanical causes. God must first create the primitive active forces. In so doing, God creates pre-formed seeds whose natures unfold according to the laws of their series, which are so co-ordinated one with another that each unfolding organic body interacts with others harmoniously and in ways that permit the mechanical production of new organisms. Or, more precisely, since nothing entirely new arises in the course of the history of the world, the unfolding of the natures of these seeds ensures the emergence of previously hidden organisms.

This brings us to the third point to be noted: preformation. Leibniz's commitment to the doctrine of pre-formed seeds is evident in his *Theodicy* of 1710. Referring his readers to his previously published article, *Considerations on Vital Principles and Plastic Natures, by the author of the system of pre-estabished harmony*,[5] he contrasts his hypothesis of pre-established harmony with the doctrines of plastic natures and vital principles proposed by Ralph Cudworth and Henry More. Against his neo-Platonist predecessors, he asserts that, so long as divine creation of pre-formed seeds is admitted, the formation of organic bodies is explicable solely by resource to purely mechanical actions among bodies themselves. Pre-established harmony obviates the need to introduce immaterial plastic natures or vital principles as causal agents within matter itself.[6]

> [I]n reality mechanism is sufficient to produce the organic bodies of animals, without any need of other plastic natures, provided there be added thereto the pre-formation already completely organic in the seeds of the bodies whence they spring, right back to the primary seeds. This could only proceed from the Author of things, infinitely powerful and infinitely wise, who, creating all in the beginning in due order, had pre-established there all order and artifice that was to be. There is no chaos in the inward nature of things, and there is organism everywhere in a matter whose disposition proceeds from God. (*Theodicy,* preface, H 64, GP VI. 40)

The same point is repeated in the Correspondence with Clarke. In the act of creation, God pre-formed everything in such a way that, post creation, the organic bodies of plants, animals and other corporeal substances arise simply through

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[4] Ohad Nachtomy suggests these two functions – as law and as force – are kept separate, at least conceptually. I agree. See review of Phemister (2007), 259–60.

[5] Published in the *Histoire des Ouvrages des Savants* in 1705 (GP VI. 539–546).

[6] For more detailed discussion on this point, see Justin E.H. Smith and Pauline Phemister (2007).

the natural mechanical operations of one body on another. With the pre-formed seeds in place, no more is required than that bodies act in accordance with mechanical laws:

> 115. As for the motions of the celestial bodies, and even the formation of plants and animals; there is nothing in them that looks like a miracle, except their beginning. *The organism of animals is a mechanism which supposes a divine preformation: what follows from it, is purely natural, and wholly mechanical.* (Fifth letter to Clarke: Alex, 93, GP VII. 417–418, my emphasis)

Once pre-formed seeds are granted, exactly the same mechanical processes operate in the production of animate, organic bodies as operate in the production of inanimate bodies:

> 116. Whatever is performed in the body of man, and of every animal, is no less mechanical, than what is performed in a watch. The difference is only such, as ought to be between a machine of divine invention, and the workmanship of such a limited artist as man is. (Fifth letter to Clarke: Alex, 93, GP VII. 418)

"Machines of divine invention", however, unlike artificial machines, are infinitely complex. This brings us to our fourth point. The living machine is a machine in each and every of its parts, to infinity.

> I define *an organism*, or natural machine, as a machine of which each part is a machine, and consequently as one such that the complexity of its construction continues to infinity, no part being so small that this does not apply, whereas by contrast, the parts of our artificial machines are not themselves machines. (to Lady Masham, 30 June 1704, WF 214, GP III. 356)

As secondary matter, every machine, whether living or artificial, is divided to infinity. Indeed, every physical object, as extended secondary matter, comprises an infinite number of parts. However even though every piece of matter is divided to infinity, and may be considered as divided into infinite parts, not all these parts count as parts of the matter insofar as that piece of matter is a "machine of human invention". For instance, even though the matter from which the clock is made is divided to infinity, not all of the divisions within the matter of the clock are parts of the clock. What count as the parts of a clock are those, and only those, parts that are specified in its design, such as the springs, cogs, and toothed wheels that make up the mechanism, as well as the pendulum, weights, dial, casing or hood. The parts of the brass, steel and other materials from which these components are made do not qualify as parts of the clock itself. Artificial machines have those and only those parts that are specified in their blueprints or detailed plans.

That artificial machines have a finite number of parts while living machines have an infinite number of parts does not yet comprise a complete account of the distinction between them. Living and non-living machines differ not only in terms of the finite versus infinite number of their parts, but also in terms of the nature of the parts themselves. Parts may be either organic or inorganic. The parts of living, organic machines are themselves organic machines, but the parts of artificial machines are

not themselves organic machines.[7] So it is that we find Leibniz in the *New System* emphasising that "Nature's machines have a truly infinite number of organic parts (*organes*)... A natural machine is still a machine even in its smallest parts" (*New System*: WF 16).[8] Leibniz adopts the same position in the *Monadology*:

> Thus each organised body of a living being is a kind of divine machine or natural automaton, which infinitely surpasses all artificial automata. For a machine constructed by man's art is not a machine in each of its parts. For example, the tooth of a brass wheel has parts or fragments which, for us, are no longer artificial things, and no longer have any marks to indicate the machine for whose use the wheel was intended. But natural machines, that is, living bodies, are still machines in their least parts, to infinity. That is the difference between nature and art, that is, between divine art and our art. (*Monadology*, §64: AG 221, GP VI. 618)

Leibniz might justly be charged with vacuity or circularity were he to define an organic body simply as a body whose parts are themselves organic bodies. A further condition must be met if a body is to be a living machine. This constitutes our final point of note: in the living machine, there must be one monad that dominates the rest. Leibniz is insistent on this issue. The soul, that is, the active aspect of the complete monad identified in (iii) in the letter of 20 June 1703 to De Volder, always accompanies an organic body:

> ... organic bodies are never without souls, and... souls are never separated from organic bodies. (*Considerations on Vital Principles and Plastic Natures*: GP VI. 545, L 590)

In contrast, inanimate natural and artificial objects lack substantial forms (equivalent to the "primitive entelechies" in the aforesaid letter to De Volder):

> I say 'No' to anyone who takes the term [substantial form] in the sense of those who imagine that there is a substantial form in a piece of stone or in any other inorganic body. For vital principles belong only to organic bodies. (Ibid., L 586, GP VI. 539)

Although the parts of a stone or a piece of flint, for instance, are organic bodies,[9] the flint itself has no unifying monad that dominates the whole. A stone lacks that pre-formed seed whose evolution or unfolding would have given rise to an organic body whose component substances act under the direction of a dominating monad

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[7] This satisfies Leibniz's condition that parts are always homogeneous with the wholes they compose.

[8] "les Machines de la nature ont un nombre d'organes veritablement infini,... Une machine naturelle demeure encor machine dans ses moindres parties... (*Système Nouveau*: GP IV. 482 post publication revision). Leibniz here adds that the machine also remains the *same* machine through its myriad transformations by which it is packed up in different ways; sometimes extended, sometimes contracted and as it were concentrated, when we think that it is destroyed" (ibid., GP IV. 482, WF 16). It is this sense of machine that is in use in the letter to Masham (30 June 1704: GP III. 356) when he denies that the parts of artificial machines are themselves machines (quoted above).

[9] See letter to Bernoulli, 18 November 1698 (AG 168, GM III. 551–3). Strictly speaking, in keeping with the homogeneity principle of parts and wholes, the organic bodies of the corporeal substances that are aggregated as the piece of flint should not be called "parts" at all and perhaps too the piece of flint itself should not be called a "whole".

and in accordance with that monad's law or essence.[10] Consequently, the motions and resistances of its parts do not correspond to, nor function in pursuit of, goals or ends found in the appetitions and desires of a dominating monad's soul.

2 Distinguishing Living and Non-Living Machines

We are now in a position to assess the theoretical and empirical applicability of the criteria by which Leibniz seeks to distinguish living and non-living, organic and inorganic, machines. We have seen that, for Leibniz, bodies are aggregates of corporeal substances all of whose changes are subject to, and explicable in terms of, mechanical laws. We have seen also that organic bodies are living machines that are machines in each of their parts to infinity and always have a dominating monad. This dominating monad has been present since the Creation in the pre-formed seed from which, as it unfolds, the corporeal substance's mature organic body emerges and whose motion, in turn, mirrors or corresponds to the perceptions and appetitions had by the dominating monad's soul.

God has created an infinite number of these pre-formed seeds. However, everything that happens subsequently among bodies is brought about fully in accordance with the laws of mechanics, and a mechanical explanation suffices to explain the production of organic bodies. The human body, or the body of any other animal, is just a mechanism that operates according to the same laws as those that we see at play in the functioning of a watch,[11] although it is unlike a watch in being a living machine with its own dominating monad. Post-preformation, Leibniz grants the human body and the man-made clock the same status in the natural sequence of things. Indeed, he often describes the pre-established harmony between souls and bodies as a correspondence akin to that between "two clocks perfectly regulated to the same time" (*Considerations on Vital Principles and Plastic Natures*, GP VI. 541, L 587).[12]

But this raises two unsettling questions, the one the converse of the other:

1 How can we be sure that there is a dominant monad in the things that we consider as living animals? Might they not be automata?

2 How can we be sure that there is no dominant monad in the machines that we consider as inanimate? Might the series of efficient causes that leads to their construction be a process that permits a pre-formed organism to emerge? How do we know that the ship, clocks and stones are not animated by dominant monads?

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[10] On the differences between the role of the dominating monad "in" the machine and the subordinate monads that "come together for" the machine, see note 29.

[11] See Leibniz's fifth letter to Clarke, § 116 (Alex, 63, GP VII. 418), quoted above.

[12] See also postscript to a letter to Basnage de Beauval, 3/13 January 1696, GP IV. 498–9, WF 62–3; "Explanation of the Difficulties which M. Bayle has found in the New System of the Union of the Soul and the Body", GP IV. 520–522, WF 82–3.

We address each of these questions in turn.

(1) For the sake of argument, let us grant Leibniz the doctrine of the divine creation of pre-formed seeds. Let us also assume that one of these seeds is destined to become, by development or augmentation, a larger animal, such as a human being. Let us also take it as given that God created certain other seeds that are pre-formed in such a way that are destined, for at least one period of varying length during their life spans, to be the corporeal substances that comprise this human being's organic body.

Having been preformed to unfold in the way that they do, these other seeds would come together for the sake of the human organic body, even if the seed that was to develop into the human being itself had never been created. In other words, God might have created only the subordinate monads that concur in the organic machine, without also creating the dominating monad that makes the whole into a living corporeal substance. Unless we can be certain that God has not done this, we are faced with the possibility that, despite appearances, what looks like a living animal might in fact be nothing but an automaton. Something that looks as if it is a living animal might only be a mere inanimate aggregate body, without any dominating monad.

It is certainly not beyond God's power to produce a machine that only appears to be alive. Indeed, in his *Theodicy*, Leibniz admits this is not even beyond the limits of human ingenuity. "[E]ven men," he writes, "often produce through automata something like the movements that come from reason" (*Theodicy*, H 65, GP VI. 41).[13] The remark occurs in the context of an objection to the doctrine of pre-established harmony from Pierre Bayle. In the entry for "Rorarius" in his *Historical and Critical Dictionary*,[14] Bayle ridicules as absurd the idea that God could just pre-dispose things in advance in such a way that, for instance, the mass that makes up a ship should, purely by mechanical means and without being guided by the sailors, make its way safely into port. Yet this is effectively what is proposed by the doctrine of pre-established harmony. In advocating harmony or correspondence over interaction, Leibniz commits himself to the view that all things move independently of each other. Even though the captain and the sailors appear to steer the ship, the

[13] See also Leibniz's letter to Masham, beginning of May 1704 (GP III. 342, WF 207) and a very early intimation of this idea in Leibniz's "How the soul acts in the body, c.1677-early 1678? (A VI. iv, 1367) where he raises the prospect of books being written and read by soul-less "human machines", although he there quickly concedes that it would be impossible that "minds might be removed without violating the laws of mechanics": "... and so if (though it is impossible) minds were removed and the laws of nature remained, the same would happen as if minds existed, and also as if books were being written and read by human machines which understand nothing. But we must realise that this is impossible, that minds might be removed without violating the laws of mechanics." ["Itaque si per impossibile tollerentur Mentes, et manerent leges naturae, eadem fierent ac si essent mentes, et libri etiam scriberentur legerenturque a machinis humanis nihil intelligentibus. Verum sciendum est hoc esse impossibile, ut tollantur mentes salvis legibus Mechanicis." (tr. by Strickland)].

[14] Bayle, *Historical and Critical Dictionary*, note L, WF 87–8.

corporeal substances that comprise the ship itself would move in exactly the same way even in the absence of the crew.

In this respect, the presence of the dominating monad in the organic machine is as extraneous as the presence of the crew on the ship. Both the ship and the organic body would behave in exactly the same way even if the crew and the dominating monad were absent. The harmony between each dominating monad and its organic body guarantees a one–one correspondence between the perceptions and appetitions had by the soul with the motions that occur in its body. But since God has ensured the construction and behaviour of the bodies of living animals and human beings by mechanical means, a body's movements would seem to be quite independent of any teleological direction from the dominating monad's soul.

However, if apparently living beings might be mere automata, what justification can Leibniz provide for his belief that they are in fact animated and are not automata? Descartes had raised the issue in his second meditation, declaring that it is only by a judgment of the mind that we conclude that the hats and coats that he sees from his window are not automata, but are in fact men.[15] Like Leibniz, Descartes regards the human body as a kind of machine:

> 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 movement is not under the control of the will or, consequently, of the mind. (*Meditations on first philosophy*, meditation six: CSM II.58, AT VII.84)

However, although Descartes holds that a soul-less human body is capable of performing basic physiological functions – for instance, when there is dryness in the throat "the nerves and other parts will dispose the body to take a drink" (ibid.) – he does not believe that a soul-less body would display any signs that might be interpreted as voluntary activity. Without the presence of the soul, such movements as were under the control of its will would cease. Leibniz does not endorse this division of labour. For him, with only pre-established harmony regulating the relations of minds to bodies, even human voluntary acts come to be realised in the body through purely natural, mechanical interactions among bodies. Moreover, whereas Descartes regards non-human animals as mere automata, Leibniz considers all animals, fish, plants and micro-organisms as living corporeal substances. Being incapable of free voluntary action does not preclude their being alive and having feelings and sensations that correspond to the mechanistic motions of their bodies.

Against Descartes, Leibniz insisted that moving bodies must be imbued throughout with entelechies. Motion in a body signals the presence of derivative active forces in its parts. As earlier remarked, these derivative forces are modifications of monadic primitive active forces. A body's derivative active force, therefore serves to

[15] AT VII.32. Descartes does not here disclose how we arrive at such a judgment, but presumably the mind judges that human bodies are alive on the ground that they appear to act voluntarily.

indicate the monadic primitive active forces that have come together for (*concurrent ad*) that moving body.[16] Consequently, all moving bodies have parts that are living organic bodies, or which are made up of living organic bodies, because the primitive active forces of the monads that dominate these organic bodies are the metaphysical sources of their motion.

Nonetheless, while this provides a reason why at least some of the parts of bodies are organic and are dominated by the (subordinate) entelechies that come together for the living machine, it does not provide a reason why there has to be a monad dominating over the whole machine itself. Perhaps the body as a whole is no more than an inanimate aggregate of corporeal substances, each with its own dominating monad or entelechy moving the part that is its own body. Such an aggregate body would still move, but only because its parts move and not because there is any overall dominating monad.

One argument Leibniz does offer in defence of a plurality of living machines with dominating monads takes the form of an argument from analogy grounded in an appeal to the uniformity of nature. Writing to Damaris Masham, Leibniz suggests that what we know from our own (inner) experience of ourselves as embodied living beings can be extended by analogy to all other beings in all parts of the world. We know from our own experience of ourselves that we are beings that both act and perceive, but "nature would show little consistency if this particle of matter which makes up the human body were the only thing endowed with something which would make it infinitely different from everything else" (To Masham, early May 1704, GP III. 339, WF 204). Assuming that "things are everywhere and always just as they are in us now" (ibid. GP III. 340, WF 205), Leibniz infers in his next letter that bodies with structural complexity that matches that of our own bodies are similarly endowed with perceiving souls or dominating monads and are therefore living machines (to Masham, 30 June 1704, WF 214).

(2) The converse of our two questions is the more serious and intractable. Why do we think that machines of human construction, such as clocks, as well as mere natural aggregates, such as mountains and rocks, do not possess dominating monads and are therefore not living beings? Why would God deny some kind of vital life force to seemingly inanimate things? After all, by the principle of perfection, God has created as many substantial forms and as much variety as possible:

> It has long seemed ridiculous to me to suppose that the nature of things has been so poor and stingy that it provided souls only to such a trifling mass of bodies on our globe, like human bodies, when it could have given them to all, without interfering with its other ends. (to Bernoulli, 18 November 1698: AG 168, GM III. 551)

Surely, if it were possible to create entelechies dominating in seemingly artificial machines and naturally occurring inanimate objects and to do this while maintaining order among substances, God would have done so. If God has not endowed even

[16] Similar remarks hold for bodies' resistance and inertia as indicative of derivative passive forces and ultimately of monadic primitive passive forces.

artificial objects with entelechies, it can only be because to have done so would offend against that other pillar of perfection – order – and introduce chaos into the natural operation of things.[17]

Let us grant, for the sake of argument, that Leibniz's metaphysics does not entail an inevitable decline to an all-pervasive vitalism in which even seemingly inanimate aggregates are living organisms. Still, however, the question remains as to how finite humans of limited intelligence and understanding, and reliant in large part on evidence provided by confused sensory perception, can distinguish animate from inanimate beings. From an empirical perspective, the problem is acute. As noted earlier, Leibniz himself admits in the *Theodicy* that humans are able to create machines that appear as if they are rational (and thereby in possession of distinctly perceiving dominating souls). Of course, humans cannot produce a living organic machine from scratch. But this is because they cannot create entelechies: they cannot produce life. Once all living things have been created and pre-formed by God, what is to prevent the pre-formed mechanical laws from giving rise not only to living animals and plants, but also to *animate* clocks and rocks? Animals and plants, complete with their organised living machines or organic bodies, emerge from the pre-existing organic bodies that are everywhere in the mass of matter[18] and they emerge through the ordinary operation of mechanical interactions among bodies themselves:

> since animals are never formed naturally from an inorganic mass, the mechanism, though incapable of producing their infinitely varied organs anew, can at least draw them out of pre-existing organic bodies by a process of development and transformation. (*Considerations on Vital Principles and Plastic Natures*, GP VI. 544, L 589)

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[17] Against this, it might be argued that Leibniz's God cannot do anything other than endow all aggregates, even those we consider artificial and inanimate, with dominating monads. Having distinguished monads or entelechies according to their respective laws or essences, that is, by their primitive active forces, it follows that no two monads can possess the same degree of active force. Consequently, in any aggregate, animate or inanimate, there will always be one monad that has more active force than any of the others, whose perceptions will be more distinct and its appetitions more effective than those of the others in the aggregate. By Leibniz's criteria, it will effectively be dominant over them (Monadology, §62: GP VI. 617, AG 221).

To avoid this charge, Leibniz might appeal to his account of the way in which the dominating monad perceives or expresses the rest of the world only indirectly, through the filter of its own body (Leibniz to Arnauld, 30 April 1687: GP II. 113, M 145). This does not happen in the case of the monad that has the most distinct perceptions among those in an inanimate aggregate. This monad will have perceptions that are more distinct than those of the others in the aggregate, but the others do not act as the physical means by which an external world is sensed or felt. The substances comprising the clock do not constitute an organic body through which a pre-eminent monad perceives (confusedly or insensibly) the world outside.

It is worth notice also that the most distinctly perceiving monad in the clock-aggregate still perceives the rest of the world, just as do all monads, and it does so through its own organic body. However, this organic body is not the aggregate of corporeal substances that comprise the clock itself, but clearly, if it were, the sum total of monads in the universe would not be increased. The only difference would be that the most distinctly perceiving monad in the clock would perceive the world through a different, and larger, organic body (the clock) instead of the one it currently does.

[18] *Monadology*, §§ 66–69: GP VI.618–9, AG 222.

Why should not the same be said of clocks and other artificial mechanisms? The mechanism of a clock arises from mechanical interactions as much as does the machine of a dog. Might this not be taken as evidence that points towards the clock being an organic body, with its own dominating monad, emerging "out of pre-existing organic bodies by a process of development and transformation"?

The proposal is not implausible. In both cases, the body is constructed through mechanical means. The construction of the watch by the watchmaker's body is as much the result of mechanical activity as is the formation of a human foetus. The only difference assumed is that in the latter case, God has pre-formed a living seed which develops into a full-grown living animal through mechanism, albeit with the "help of external things", as Leibniz explains in the example of the butterfly:

> God pre-formed things in such sort that new organisms are only a mechanical consequence of a preceding organic constitution. Even so do butterflies come out of silkworms, an instance where M. Swammerdam has shown that there is nothing but development. And I would have added that nothing is better qualified than the pre-formation of plants and of animals to confirm my System of Pre-established Harmony between the soul and the body. For in this the body is prompted by its original constitution to carry out *with the help of external things* all that it does in accordance with the will of the soul.(*Theodicy*, GP VI. 41–42, H 65–66, my emphasis)

The mechanical clock is similarly produced "with the help of external things", the most obvious being the mechanical movements of the clockmaker's body as his hands arrange the cogs and wheels of the watch's mechanism. The difference Leibniz conceives between the butterfly and the artificial mechanism lies in the body of the former being "prompted by its original constitution" to unfold from the silkworm into the body of a butterfly that acts in accordance with the desires or appetitions of the butterfly's entelechy. The body of the clock is supposed to have neither such a pre-formed "original constitution" nor a dominating entelechy and on this ground is not regarded as a living thing.

However, what reason do we have for believing the clock has no "original constitution" from which it develops into a visible clock? Can we know with certainty that a clock or, for that matter, a stone has no living seed from which it has developed into a "living" clock or an animated stone? How can we be sure that the role of the clock-maker is not simply to provide the help from an external thing needed for a clock-entelechy to emerge from its organic pre-formed seed into a concrete clock? How, in effect, can Leibniz justify the common-sense classification upon which we all, by and large, agree of things as living or not-living?

Typically, Leibniz appeals to traditional Aristotelian criteria of living biological entities – self-motion, self-preservation, nutrition or self-sustenance, and reproduction – as indicative of the presence of an anima, entelechy or soul in the natural living machine.[19] But as Leibniz himself acknowledged in the *Protogaea*,[20] the criteria are

[19] See Antonio Nunziante (2004), 205–6.

[20] "Nature, in fact, is nothing but a greater art, and we cannot always clearly distinguish the artificial from the natural"[neque enim aliud est *natura*, quàm *ars* quaedam *magna*: nec semper toto genere

inadequate, the boundaries between the living and the non-living, indistinct.[21] Just how inadequate, we explore below.

2.1 Self-Motion

Animals and plants appear to initiate movement in their own organic bodies and they seem to do so without undue influence from external sources. The plant turns towards the sun; the dog runs after the stick. Although the sun and stick are required, neither the dog nor the plant appears to be pushed in that direction by the external body. Instead, each seems to act spontaneously and for this reason, each is thought to possess a dominating entelechy or soul as the metaphysical, though not physical, source of the body's motion. But, as remarked earlier, Leibniz's pre-established harmony dictates that the body would move in exactly the same way as it does even if its dominating soul or entelechy had never been created. An animal's body moves by the combined derivative forces of its parts in the same manner as a ship moves through the water on account of the physical derivative active forces of its moving mechanical parts. Irrespective whether the body is living or not, its motion is effected through the motion of its parts and grounded ultimately in the body's derivative active force. This is true of all bodies whatsoever. All are in motion. Even glaciers and the plates that make up the earth's lithosphere are moving imperceptibly and gradually and would not move at all were their component parts immobile. All thereby display the presence of derivative active force.

"Derivative" active force is so called on account of its being understood as a modification of monadic "primitive" force, the force that comprises the soul or entelechy of a dominating monad. Derivative active force, as a modification of primitive active force, signals the presence of a dominating monad in the mass. But whereas in the organic bodies of plant, animals, human beings and other living machines, the derivative force is attributed to the whole body and a dominating monad governing the whole postulated, in the case of inanimate bodies, the force is regarded only as the conjunction of the forces of the parts and accordingly, dominating monads are postulated only for the smaller organic bodies that form the parts of the whole.

Unfortunately, this response merely begs the question as to which bodies have their own dominating monads and are living and which have dominating monads only in their parts and are therefore inanimate aggregates. It leaves unresolved why we are prepared to account for the motion of the inanimate ship in terms of the motion of its parts and refuse to acknowledge a monad dominating the ship as a

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a nativis factitia distinguuntur] (*Protogaea*, §9: Dutens II-2, 209). Quoted from Paolo Rossi (1984), 61. See also C. Wilson (1994), 248.

[21] Our criteria for demarcating species of living things are also inadequate. "[G]eneration or pedigree" gives us only a "provisional proof" of species membership (*New Essays*, RB 315) and "our determinations of physical species are provisional, and are adapted to what we know." (*New Essays*, RB 317).

whole. Yet, despite the availability of a similarly purely mechanical explanation of the motion of a fish in terms of the motion of the parts of its body, we insist upon regarding the fish as a living thing in itself and suppose that it has a monad dominating in its body.[22]

One reason to ascribe dominating primitive forces to living machines lies in the complexity, integrity and unity of organic bodies and most importantly, in the way that each living body appears not only to move by itself, but also to maintain and preserve itself, in its capacity for self-repair and its ability to replenish itself by digestion, taking in nutrients and excreting poisons. Together these functions fulfil the needs of the body as a whole and suggest the presence of an over-arching teleological principle that ensures that the internal structure and operation of the parts act together in pursuit of the continuing existence of the whole.

2.2 Self-Preservation and Nutrition

Early writings recently brought to light by Justin Smith testify to Leibniz's fascination with human and animal physiology and with the ability of organic bodies to act as true "[m]achines of perpetual motion" as they refuel themselves with food (The Human Body is a Sort of Machine, *Leibniz Review*, 17 (2007), 153). The organic body is

> able now to be nourished, whereby worn-down parts and forces are renewed, now to be itself moved towards the nutriments that are to be obtained and towards other means of sustaining its functions, as well as [away from] impediments that are to be avoided; now, finally, that it be warned by internal and external things, and that it be prompted towards the fitting motion (The Human Body is a Sort of Machine, *Leibniz Review*, 17 (2007), 155)

Do these functions serve us well in differentiating between living and non-living bodies? Certainly, natural masses, like rocks and mountains and artificial machines, such as clocks and carriages, do not display the same physiological processes as humans and other larger mammals, but they do exhibit at least a rudimentary form of self-preservation insofar as they persist as distinct, re-cognisable objects through longer or shorter periods of time. In the face of the perpetual flux to which all bodies are subject and which makes them like rivers with parts that "enter into them

[22] All motion is relative. It consists in the relative change of spatial relations among bodies. When these relations change, motion is attributed to one body rather than another on the basis of explanatory simplicity. When the spatial relations between a ship or a fish and the shoreline change, the simplest explanation attributes motion and force to the ship or to the fish rather than to the shoreline. However, because it is an inanimate mass, the simplest explanation of the ship's motion requires only the postulation of primitive active forces in the component corporeal substances. It does not require the postulation of a monad primitive force governing the ship as a whole. Why, then, does the simplest explanation of the movement of a fish, as a living machine, require us to postulate a dominating monad governing the fish as a whole? What is it about the movement of the fish, as opposed to movement of the ship, that encourages us to attribute a dominating monad to the one but not to the other?

and depart from them continually" (*Monadology*, §71: GP VI.619, AG 222), all physical objects maintain a degree of integrity, relative regularity of structure and coherence of parts over time. For some, this perseverance is stabilised over vast periods of time: mountains and rocks, for example, maintain distinctive shapes and geological composition far longer than does the body of a midge. And might not the exchange or substitution of parts that all physical objects constantly undergo be regarded as a type of nutrition and excretion, not wholly unlike that which is found in living machines? Even the seemingly inanimate rock and the mechanical clock are subject to constant incorporation of new substances and expulsion of others. Why should not these also be looked upon as physiological processes as much as the more sophisticated processes of ingestion of nutrients and excretion of poisons evidenced in animals and plants?[23]

To all intents and purposes the differences between these two groups indicate more a difference in degree than of kind, yet the presence of a dominating monad in the living being suggests a radical type-discontinuity separating the living from the non-living. Leibniz himself would presumably not have regarded this as problematic. He admits gaps among forms. There are possible species that do not exist in this world (*New Essays*, III. vi, RB 307) and species in this world that are very similar to one another typically do not exist in close spatial or temporal proximity.

> In nature everything happens by degrees, and nothing by jumps; and this rule about change is one part of my law of continuity. But the beauty of nature, which insists upon perceptions which stand out from one another, asks for the appearance of jumps and for musical cadences (so to speak) amongst phenomena, and takes pleasure in mingling species. Thus, although in some other world there may be species intermediate between man and beast (depending upon what senses these words are taken in), and although in all likelihood there are rational animals, somewhere, which surpass us, nature has seen fit to keep these at a distance from us so that there will be no challenge to our superiority on our own globe. (NE IV. xvi, RB 472)

Although this discussion is restricted to continuity of species of living things,[24] the general principle is applicable to distinctions between animate and inanimate things. Discontinuity between living and non-living things might obtain in this world even though intermediate species are possible in other worlds.

This does not address the central issue, however, for if we consider all possible species across all worlds together, distinguishing the animate from the inanimate still appears to involve a radical discontinuity between the two types of things. The discontinuity invoked in this case is similar to that which Leibniz considers, and rejects as impossible, in respect of the theory of transmigration of souls. Souls, he reasons, cannot pass from one body to another because were they to do so, discontinuity would be introduced into the natural order as the soul would be disembodied during the time it takes for it to pass from the one body to the other. Similarly,

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[23] On the now obsolete sense of "physiology" as synonymous with "physiks or the science of natural bodies" (J. Harris, *Lexicon Technicum*, 2nd edition (1708)), geological formation and animal digestive systems would both count as physiological processes.

[24] This aspect is taken up for discussion by C. Wilson (1994).

ensouled animate bodies are presumably radically discontinuous with non-ensouled, inanimate bodies. This being so, we might expect that the perceptible differences between these two types of bodies would display more radical differences than in fact they do.

For Leibniz, the self-maintaining, nutritive, and reproductive capacities of living machines are achieved by means of an infinite variety of organs in the body,[25] that function together for the good of the whole. The organic body as a whole thereby displays a degree of complexity that artificial machines and natural inanimate objects lack. More than this, in keeping with the pre-established harmony between souls and bodies, Leibniz believes that the organs themselves are appropriate to the perceptions had by the entelechies and souls: "each being which is living or endowed with perception, will always remain so, and will always retain appropriate organs" (to Sophie Charlotte, 8 May 1704, WF 221, GP III. 344).[26] Even higher spirits are supposed by Leibniz to "be accompanied by organic bodies of an appropriate kind, of a subtlety and force proportionate to the understanding and power of these sublime minds" (to Sophie Charlotte, 4 May 1704, GP III. 344, WF 221). He includes the same thought in the *New Essays* when he writes:

> since I hold that every created intelligence has an organic body, whose level of perfection corresponds to that of the intelligence or mind which occupies the body by virtue of the pre-established harmony, I hold that a very useful way to get some conception of the perfection of Spirits above ourselves is to think of perfections of bodily organs which surpass our own. (NE III.vi, RB 307)

As François Duchesneau notes in his paper in this volume,[27] the inner organization of the organic body "appears self-sufficient by virtue of a functional integration of parts that deploys itself to infinity". The structure of the organic body is intimately related to its functions and the motions of the parts in that structure are expressed, though a "regulated correspondence", by the soul's perceptions and appetitions. The complex structure of various parts, each performing their own particular roles within the more complex whole, suggests that the body is a living machine and that there is "in"[28] it a perceiving, appetitive entelechy, soul or mind, the "complex" perceptions and appetitions mirror the complexity of the body's organic structure. In this way,

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[25] See Leibniz's letter to Lady Masham, 30 June 1704, WF 214, quoted above, 8.

[26] See also, "The reason why children do not form the thoughts of grown men is that the parallel between their thoughts and external phenomena is proportional to their bodies. This is a consequence of the harmony" (to Isaac Jacquelot, 9 February 1704, WF 176, GP III. 465).

[27] "Leibniz vs. Stahl on the Way Machines of Nature Operate".

[28] Leibniz considers the dominating monad is "in" the organic machine, and it is presumably "in" the machine in the same way as the subordinate monads that "come together" for the machine are "in" their own subordinate organic bodies. But we should not assume that the dominating monad plays the same role in the organic machine as do the subordinate monads when the latter "come together" for the organic machine. Rather, Leibniz claims that when the subordinate monads come together with the dominant monad, they do so, not for the organic machine, but rather for the corporeal substance: "Indeed, the remaining subordinate monads placed in the organs do not make up a part of the organic body, although they are immediately required for it, and they come together with the primary monad for the organic corporeal substance, that is, the animal or plant" (to De Volder, 20 June 1703: tr. by Lodge, http://users.ox.ac.uk/~mans1095/25_Lz_2007pdf.pdf).

structural complexity and variety, related to functionality, may provide a fairly reliable test for the presence of a dominating monad in the machine and thereby act as a reliable indicator that a body is a living machine.

Gradual gradations of complexity make imprecise the boundaries between the living and the non-living. Moreover, it is possible that some bodies we assume are inanimate nonetheless possess an inner complexity in their smallest parts that are hidden from us. However, complexity, as in Leibniz's example of Harlequin (*New Essays*, RB 329) whose costumes are arranged "one on top of the other", suggests that living machines have parts within parts "all the way down", not just at the bottom. On this model, parts combine to make larger parts which in turn function as parts of larger parts and ultimately as parts of organic wholes. In contrast, even though the rock has infinitely many organic parts that we do not see, the likelihood that the rock itself is an organic machine is lessened by the fact that these organic parts are not combined into parts that are parts of greater parts and so on upwards to organic parts that are visible to us.

Nevertheless, while the appearance of complex internal mechanisms supportive of nutritive, reproductive and self-repairing functions in a body gives reason to suppose the body organic and in possession of a dominating monad whose perceptions and appetitions mirror the body's complexity, the apparent absence of complex functional structures in other bodies is not reason to suppose these bodies inanimate and lacking any dominating monad. The complex structure of the bodies we take to be living suggests a corresponding complexity of the perceptions, manifested in our own case in the rationality, clearness and distinctness of our perceptions, had by the dominating monad. In contrast, the comparative simplicity in the mechanical structures of other bodies might still support self-preserving functions – as for instance, in the coherence and resistance to separation of the parts of a diamond – that are matched by corresponding obscure and confused perceptions in a monad dominating it. The lack of complexity in seemingly inanimate bodies may indicate only confusion in the perceptions had by their dominating monads rather than a complete absence of any dominating monad altogether. I am not suggesting that this is actually the case. I am suggesting only that the possibility has not been conclusively ruled out.

2.3 Reproduction

The reproductive capacities evident in various species of animals and plants provide, in Leibniz's opinion, the most reliable means of distinguishing living from non-living machines. He regards the study of biological reproduction as the best guide to the natural order of things. Our knowledge in this area is very limited, but if we had

> the acuity of some of the higher Spirits, and knew things well enough, perhaps we would find for each species a fixed set of attributes which were common to all the individuals of that species and which a single living organism always retained no matter what changes or metamorphoses it might go through. (*New Essays*, RB 309–310)

The postulated fixed sets of attributes are presumably encoded in the pre-formed seeds from which the individual members of the species develop. For Leibniz, those pre-formed seeds destined, for instance, to become fully actualised humans, exist in miniature from the beginning of time. He seems uncertain whether they are located always in members of the same species, though by the time of the *Theodicy*, he is perhaps tending towards the view that the seeds of humans alive today can be traced through members of the human race right back to Adam.[29] If provable, this would give greater credence to the reliability of reproductive processes, not only as signs of living bodies, but also of living bodies belonging to particular species. But whether or not the pre-formed seeds are always contained in same species ancestors, it is clear that Leibniz thinks it very likely that particular individual substances belong to the same species throughout their lives. The seeds that will become fully actualised humans are presumably small humans or human seeds right from their creation at the beginning of things and become fully-grown humans only, as he indeed says, through augmentation. Each is "prompted by its original constitution" to unfold in the way that it does.[30]

This last point highlights another feature at play in distinguishing living machines from inanimate bodies: the apparent internal spontaneity that pertains to the actions of living creatures. Duchesneau has already noted that, for Leibniz, living machines are subject mainly to internal influences, in contrast to non-living machines subject primarily to external influences.[31] The emergence of the living machine is already contained in its preformed nature and requires only augmentation or additions, achieved by mechanical means, in order to unfold as the visible organic body of a corporeal substance. So, in response to Stahl, Leibniz explains:

> Meanwhile we grant that there is a big difference between machines and aggregates and masses, because machines have ends and effects by the power of their structure, whereas the ends and effects of aggregates arise from a series of concurring things, and even from the coming together of different machines, which, even if it follows divine destiny, has more or less obvious co-ordination. Thus the end and labour of the silkworm is the beginning of its production of silk, but in order for it to give birth to another silkworm there needs to be congress between a male and a female, and indeed a joining of one animal with another external thing. But this joining still has more obvious harmonious co-ordination. . . than does that [machine] that turns silk into human clothing. . .. At the same time, a very detailed operation, like the production of silk, would not obtain without the addition of external things like the sun's heat, nutrition from the leaves of the mulberry tree, and the like. (*Animadversiones*, reponsiones ad §1: Dutens II-2, 144)[32]

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[29] "It is thus my belief that those souls which one day shall be human souls, like those of other species, have been in the seed, and in the progenitors as far back as Adam, and have consequently existed since the beginning of things, always in a kind of organic body" (*Theodicy*, Part 1, §91, H 172, GP VI. 152). The passage does not prove conclusively that human seeds are always in human bodies because the reference to Adam may be a mere rhetorical allusion to the beginning of the world.

[30] *Theodicy*, GP VI. 42, H 66. Quoted in full above.

[31] Duchesneau, op. cit.

[32] "Interim concedimus, magnum esse discrimen inter machinas et aggregata massasque, quod machinae fines et effectus habent vi suae structurae, at aggregatorum fines et effectus oriuntur ex

Here, Leibniz contrasts the silkworm as a living machine that produces silk with the artificial machine which weaves the silk into cloth, while admitting that even the silkworm can perform its task only under appropriate external circumstances. However, as Locke acknowledged, it is no easy matter to distinguish what counts as internal and what counts as external in respect of bodies' qualities, with consequent difficulties for the identification of bodies as single, discrete things:

> We are wont to consider the Substances we meet with, each of them, as an entire thing by it self, having all its Qualities in it self, and independent of other Things; overlooking for the most part, the Operations of those invisible Fluids they are encompassed with; and upon whose Motions and operations depend the greatest part of those qualities which are taken notice of in them, and are made by us the inherent marks of Distinction, whereby we know and denominate them. (*Essay concerning Human Understanding*, IV vi. 11, N 585)

Gold, he supposes, would lose its distinctive colour and weight if separated from surrounding bodies. Animals lose sensation, life and motion when deprived of air and other "extrinsecal Causes and Qualities of other Bodies" (ibid., N 586). We do not include these external causes in our complex ideas of animals, but clearly, Locke thinks they ought to play a part in our identification of individual bodies and the classification of species. "We are", he says,

> quite out of the way, when we think, that Things contain within themselves the Qualities, that appear to us in them: And we in vain search for that Constitution within the Body of a Fly, or an Elephant, upon which depend those Qualities and Powers we observe in them. For which, perhaps, to understand them aright, we ought to look, not only beyond this our Earth and Atmosphere, but even beyond the Sun, or remotest Star our Eyes have yet discovered. (*Essay*, IV vi. 11, N 587)

Oddly, Leibniz simply agrees with Locke on this point (NE VI. vi 11, RB 405), though his stated agreement is belied by his employing the inner-outer distinction without question in his following gloss in which he admits that even if we knew the structures of bodies, we would still lack a great deal of knowledge due to our ignorance of "the inner nature of other bodies which touch or penetrate them" (ibid.). Of course, we commonly do distinguish individual bodies from their environments. And we do so on the basis of those parts that retain their relations to others while changing en masse their relations to those taken as surrounding them. The relations among the parts of an individual body remain the same while the body moves and changes its relations to other bodies external to it. In this way, Leibniz's appeal to the inner natures of bodies can pass without trouble: so long as we can identify a single body distinct from others, we can also distinguish spatially what is inside the boundary and what outside.

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serie rerum concurrentium, atque adeo ex diversarun machinarum occursu, qui etsi etiam sequatur divinam destinationem, plus tamen minusque manifestae coordinationis habet; ita bombycis finis opusque initium est, ut sericum producat; sed ut alium bombycem gignat, opus est congressu maris et foeminae, atque adeo combinatione unius animalis cum alia re externa; sed haec tamen combinatio plus habet coordinationis manifestae [. . .] quam ea, quae facit, ut sericum transeat in vestem hominis [. . .]. Interim nec opus maxime intimum, velut serici productio, obtineretur, nisi externa accederent, velut calor solis, nutritio ex foliis mori, aliaque id genus" (Dutens II-2, 144).

Locke's point, however, concerns causes and powers or qualities of objects. His claim relates to the reliance of the inner base of a substance's qualities on the powers of external bodies that act upon it. Precisely which mechanical interactions should we count as internal to the machine and which as merely external requisites?[33] What Locke's remarks highlight is the woeful lack of empirical evidence that would justify our ordinary, everyday distinctions between qualities that arise on account of what is internal to a body and what arise from external causes.[34]

In his silkworm example, Leibniz grants the dependence of the silkworm's operations and inner structure on external things. But he insists that the reliance of living machines on external things is more harmonious than the reliance of mere aggregate inanimate bodies on external things. The main reason motivating this claim centres on biological reproduction. The conception of the silkworm, and the start of its life as a "silk-producing machine", requires the coming together of external male and female members of the same species, each of which possesses the same essential characteristics as the creatures their "congress" produces.[35] In contrast, inanimate aggregates typically depend on external things from different species: "the ends and effects of aggregates arise from a series of concurring things, and even from the coming together of different machines, which, even if it follows divine destiny, has a more or less obvious co-ordination".

In the background to this method of distinguishing living from non-living bodies is the doctrine of the pre-formed seeds, passing through the generations within species until such time as the seed is destined to develop into a mature organism. There is some plausibility in the claim that the unfolding of a pre-formed seed occurs through the reproductive processes among members of the same species. The same cannot be said of artificially constructed machines. The silk-loom and the clock arise directly through human intervention and design. Neither displays any evident sign of the unfolding of pre-formed silk-loom or clock organisms. So too, in inanimate natural masses, like rocks, the formation of new rocks occurs only by mechanical division instigated through contact or collision with other external things, which may be, but are not invariably, other rocks. The fact that looms, clocks and rocks do not grow provides further reason to reject the notion that their formation arises through the unfolding of pre-formed seeds in which resides a dominating monad.[36]

All the same, human ignorance of all possible means of reproduction leaves open the possibility that God created pre-formed clock-organisms that emerge only when clock-makers learn to design and construct such machines. Why restrict life and

[33] Ultimately, Leibniz's pre-established harmony dictates that all changes to bodies are initiated internally. However, Leibniz's distinction between matter in a body that is its own and matter that is extraneous may be relevant here. See Leibniz's fifth letter to Clarke, 18 August 1716, § 35: Alex 66, GP VII. 397.

[34] Locke's remarks also suggest a degree of artificiality in the inner-outer distinctions we employ.

[35] The evident circularity should not go unnoticed when Leibniz declares that "In organic bodies we ordinarily take generation or pedigree as a provisional indication of sameness of species" (*New Essays*, III. vi, RB 325).

[36] Crystals provide a puzzling case in this regard.

sensation to those that reproduce only within species? Contemporary developments in synthetic biology and artificial intelligence are set to confound further our traditional views on the boundaries between living and the non-living mechanisms. New species may soon be developed through synthetic biology whose members have existed in miniature since creation, but become fully actual only under today's more favourable external conditions. Researchers in artificial intelligence aim to construct a robot-making robot whose parts, to all intents and purposes, will function as reproductive organs. Research at the interface of AI and biology aims to combine organic matter within artificial computers. Such developments look set to make the boundaries between the living and the non-living even more difficult to determine.

3 Conclusion

In conclusion, of the various criteria supposedly specific to organic living machines, self-motion is the least helpful. Biological functions, including reproduction, together with factors such as structural complexity and causal internality, fare rather better, but are by no means conclusive. This is perhaps a not altogether unexpected result given that in all cases a radically discontinuous distinction between the living and the non-living is being sought using empirical evidence of a world in which the law of continuity holds sway and in which all bodies are subject to the same physical laws. We ought not to be surprised that:

> Anyone who diligently compares the products of nature, wrested from the womb of the Earth, with the products of the laboratories (thus we call chemists' workshops) will accomplish an important task, in our opinion: for then the striking resemblances between the products of nature and those of art will shine before our eyes. (*Protogaea*, §9: Rossi (1984), 61; Dutens II-2, 209)[37]

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[37] Operae pretium autem facturum arbitror, qui naturae effecta ex subterraneis eruta diligentiùs conseret cum foetibus laboratoriorum, (sic enim Chemicorum officinas vocamus,) quando mira persaepe in natis et factis similitudo apparet' (Dutens II-2, 209).

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Chapter 5
Leibniz on Artificial and Natural Machines: Or What It Means to Remain a Machine to the Least of Its Parts

Ohad Nachtomy

1 Some Background and Motivation

The topic of the present paper is Leibniz's distinction between nature and art, which he spells out in terms of his distinction between natural and artificial machines. Leibniz holds that a natural machine, unlike an artificial one, remains a machine in the least of its parts, and my main objective here is to attempt to cast some light on what Leibniz means by this phrase.

Before attending to Leibniz's curious distinction, I would like to present a broader perspective on this question. In the first and second sections, I will do so by looking at the way in which some other thinkers, both before Leibniz (mainly Descartes) and also after Leibniz, have distinguished between nature and art (or as became customary, between organism and clockwork). This will help us understand Leibniz's motivation for drawing the distinction and also hint at some of its possible repercussions in present day discussions of this question. As an aside then, this broad perspective will also show that the question is in fact still very pertinent today. In the third section I will present Leibniz's distinction between natural and artificial machines. In the fourth section I will question the coherence of Leibniz's distinction. In the fifth section I will offer a structural reading of Leibniz's notion of a natural machine and in the sixth section I will offer a functional reading of this notion. In conclusion, I will suggest that both readings (structural and functional) are compatible and that both illuminate Leibniz's definition of a natural machine as a machine that remains a machine in the least of its parts.

1.1 Erwin Schrödinger's What Is Life

The final section of Erwin Schrödinger's remarkable and influential study, *What is Life*, entitled "The Relation between Clockwork and Organism" reads:

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> Clockworks are capable of functioning 'dynamically', because they are built of solids, which are kept in shape by London-Heitler forces, strong enough to elude the disorderly tendency of heat motion at ordinary temperature.
>
> Now, I think, few words more are needed to disclose the point of resemblance between a clockwork and an organism. It is simply and solely that the latter also hinges upon a solid – the aperiodic crystal forming the hereditary substance, largely withdrawn from the disorder of heat motion. [Schrödinger is contrasting here the inner structure of the chromosome with physical systems.] But please do not accuse me of calling the chromosome fibers just the 'cogs of the organic machine' – at least not without reference to the profound theories on which the simile is based.
>
> For, indeed, it needs still less rhetoric to recall the fundamental difference between the two and to justify the epithets novel and unprecedented in the biological case.
>
> The most striking features are: first, the curious distribution of the cogs in a many celled organism, for which I may refer to the somewhat poetical description on page 79; and secondly, the fact that the single cog is not of coarse human make, but is the finest masterpiece ever achieved along the lines of the Lord's quantum mechanics.[1]

As we shall see below, these two features are strongly reminiscent of Leibniz's approach to the distinction between natural and artificial machines.

In his "poetic" description (on page 79), Schrödinger suggests that the chromosomes may "resemble stations of local governments dispersed through the body, communicating with each other with great ease, thanks to the code that is common to all of them". However, Schrödinger remarks,

> . . . it needs no poetic imagination but only clear and sober scientific reflection to recognize that we are here obviously faced with events whose regular and lawful unfolding is guided by a 'mechanism' entirely different from the 'probability mechanism' of physics. For it is simply a fact of observation that the guiding principle in every cell is embodied in a single atomic association existing only in one copy (or sometimes two) – and a fact observation that it results in producing events which are a paragon of orderliness. Whether we find it astonishing or whether we find it quite plausible that a small but highly organized group of atoms be capable of acting in this manner, the situation is unprecedented, it is unknown anywhere else except in living matter.[2]

Schrödinger is keen to point out that we need not appeal to any mysterious vital forces in order to account for the difference in the order and regulation observed in clocks and the order observed in organisms. In his terms, the difference is clear-cut: in the one, entropy (or degree of order) is statistical and hence decreases; in the other, entropy is dynamical and hence order is maintained and preserved. In spite of this difference of category, there is nothing inexplicable in scientific terms about this difference.

Let us recall that Schrodinger's insightful observations precede the discovery of the structure of genetic material (DNA) in 1953 by almost a decade – his book was first published in 1944. The discovery of how information is coded in the chromosomes through the sequential order of base pairs would give much support to Schrödinger's characterization of living organisms as possessing a unique way of

[1] Schrödinger [1944] 2007: 85.
[2] Ibid., 79.

preserving order in each of their cells. Notice that order is preserved in two distinct contexts: in regulating the development of an organism and in passing its characteristics to future generations, thus preserving a dynamical (biological) order in local systems (namely, living beings) within a physical universe whose ultimate order is decreasing (in a statistical sense).

Indeed, since the rise of molecular genetics in the 1950s, it has become common to use the very presence of DNA in cells as the mark of living things. The chemical nature of the genetic information and program of development has inspired some (notably, François Jacob in the early 1970s) to claim a resolution of the old tensions between teleological and mechanical considerations in living things.[3]

Likewise, the image of an a-periodic crystal suggested by Schrödinger as characterizing the living material hidden in the chromosomes has inspired the development of many computer programs and fractal-like structures as models of living systems. Some of these projects do not only pretend to represent life artificially but also, according to some (e.g., Langton[4]), actually to constitute living systems as self generating "creatures" in an attempt to respond to Fontenelle's old (but still pertinent) challenge:

> Do you say the Beasts are Machines just as Watches are? Put a Male Dog Machine and a Bitch Machine side by side, and eventually a third little Machine will be the result, whereas two Watches will lie side by side all their lives without ever producing a third Watch?[5]

This challenge was taken up by Van-Neumann and his colleagues in the 1950s. Since then many self-producing computer simulations have been produced, some of which have the remarkable fractal structure that, as we shall see, plays an important role in Leibniz's distinction between nature and art.

Before we turn to Leibniz, however, let us consider another immensely influential formulation of the distinction between nature and art (or as it came to be phrased, the distinction between an organism and a watch).

1.2 Kant's Third Critique

In his *Critique of the Power of Judgment* (*CPJ*), Kant articulates the distinction between an organism and a watch as follows:

> In a watch one part is the instrument for the motion of another, but one wheel is not the efficient cause for the production of the other: one part is certainly present for the sake of the other but not because of it. Hence the producing cause of the watch and its form is not contained in the nature (of this matter), but outside of it, in a being that can act in accordance with an idea of a whole that is possible through its causality. Thus one wheel in the watch does not produce the other, and even less does one watch produce another, using for that purpose other matter (organizing it); hence it also cannot by itself replace parts that have been taken from it, or make good defects in its original construction by the addition of the other parts, or somehow repair itself when it has fallen into disorder: all of which,

[3] See Jacob 1970.

[4] See for example, Langton 1984.

[5] Cited from Fox-Keller 2002.

> by contrast, we can expect from organized nature. – An organized being is thus not a mere machine, for that has only **motive** power, while the organized being possesses it itself a **formative** power, and indeed one that it communicates to the matter, which does not have it (it organizes the latter); thus it has a self-propagating formative power, which cannot be explained through the capacity for movement alone (that is, mechanism). (*CPJ*, A 5: 374; Kant 2001, 246)

In the paragraph just preceding this one Kant writes:

> In such a product of nature each part is conceived as if it exists only **through** all the others, thus as if existing **for the sake of the others** and **on account** of the whole, i.e., as an instrument (organ), which is, however, not sufficient (for it could also be an instrument of art, and thus represented as possible at all only as an end); rather, it must be thought of as an organ that **produces** the other parts (consequently, each produces the others reciprocally), which cannot be the case in any instrument of art, but only of nature, which provides all the matter for instruments (even those of art): only then and on that account can such a product, as an **organized** and **self-organized** being, be called a **natural end**. (*CPJ*, A 5: 373–74; Ibid., 245)

This leads to Kant's definition of an organized product of nature in the following section: "An organized product of nature is that in which everything is an end and reciprocally a means as well. Nothing in it is in vain, purposeless, or to be ascribed to a blind mechanism of nature" (*CPJ*, A 5: 376; Ibid., 247–248).

It is well known that Kant's notion of the organism played a decisive role in the formation of biology as a distinct domain of scientific knowledge. However, it wasn't Kant who invented the notion of the organism. If anyone is to be credited with its invention, Leibniz is probably more worthy.[6] At the turn of the eighteenth century, Leibniz appropriated the terms "organism" and more frequently *organique* and/or *organicum* to characterize living beings.[7] In this respect, Leibniz's view of living beings is important not only for our understanding of the debate concerning the conceptualization of living beings in the seventeenth and eighteenth centuries but also for understanding one of the most influential concepts in the yet-to-be-born biological sciences.

Two central features of Leibniz's characterization of living things, which we today designate as organisms, stand out: the first is the conjunction of both mechanistic and teleological (or functional) aspects in their scientific description and conceptualization, which is evident and explicit in Kant's definition of an organism. The second, and most conspicuous in Schrödinger's description of an organism, is the dispersion of the inner structure in each organic cell, which obeys an order different from that of the inanimate world. In what follows, I will substantiate this

[6] See Duchesneau 1998.

[7] As Justin Smith and Enrico Pasini have stressed, one has to be careful not to conflate Leibniz's usage with the contemporary usage of organism, as designating an individual. While the term "mechanism" was used to qualify the mechanic, or machine-like, the term "organism" would be used to qualify the organic(um). On the other hand, Leibniz's notion of a natural machine, on which I focus here, does designate an individual living being. In this sense, the notion of a "natural machine" might even be more important for the later notion of an organism in the sense of a living unit.

claim by showing how these two characterizations play a central role in Leibniz's notion of a natural machine.

While the notion of an "organism" has come to dominate biological discourse, the earlier (and more distinct) concept Leibniz was using to designate living beings in his late writings is that of a natural machine. In his later writings, Leibniz describes living beings as machines nested one within the other *ad infinitum*. As we shall see, according to him, the nested structure *ad infinitum* is the main difference between a natural machine, which is God's creation, and an artificial machine, which is made by humans.

2 Descartes and the Analogy Between Natural and Artificial Machines

While the distinction between artificial and natural machines has considerable consequences for Leibniz's metaphysics, it turns, as we shall see, on a very subtle nuance. The first (rather obvious) point to notice is that Leibniz describes both natural and artificial things as machines, that is, in mechanistic terms. This is very significant considering the Cartesian program to describe the natural world in purely mechanistic terms. Particularly relevant is Descartes' program to describe animals (as well as the human body) as subtle and complex machines that lack internal power, let alone spontaneity and vitality.[8] By contrast, Leibniz's agenda may be seen as an attempt to revive the Aristotelian distinction between animate and inanimate things in "an intelligible way" and resist the Cartesian reduction of natural machines to artificial ones.[9] It is with this aim in mind that Leibniz draws the distinction between artificial and natural machines in the *New System of Nature* of 1695 – a work in which he suggests reconciling the ancient and the modern philosophies of nature (basically by accepting mechanical description at the level of physics and Aristotelian description at the level of metaphysics). Thus, while Leibniz accepts a mechanical description of bodies, he strongly resists the Cartesian attempt to describe natural machines in terms of artificial ones. As he writes,

[8]In fact, in his *Principles of Philosophy* part 4, article 203, Descartes seems to assimilate the artificial and the natural. For him, artificial machines serve as models to explain the natural ones. Natural machines are like artificial ones, except much more complicated. He wants to establish that they are of the same kind. He uses the notion of divinely created machines to show that the subtle parts of machines are extremely complex and invisible to us. While both Descartes and Leibniz argue that machines are extremely subtle, Descartes uses this point to argue for his view that, in the final analysis, animals are nothing but subtle machines. By contrast, Leibniz uses this point to argue that there is a categorical difference between them. See also *Les passions de l'ame,* first part, articles 5 and 6 where he writes e.g., that the body has in it "the corporeal source of movement" (art. 6).

[9]See for example, Leibniz's controversy with Stahl (Carvallo 2004). where Leibniz criticizes the Moderns for pretending that "*nihil aliud sit natura corporum quam Mechanismus*" (there is nothing in the nature of bodies but mechanism).

> I am the most readily disposed person to do justice to the moderns, yet I find that they have carried reform too far, among other things, by confusing natural things with artificial things, because they have lacked sufficiently grand ideas of the majesty of nature. (AG 141–42)

To better understand what Leibniz is resisting here, let us briefly review the reform suggested by Descartes. This will help us see why Leibniz thinks that it was carried too far.

Descartes' agenda in his projection of a new science was clear and ambitious. He sought no less than a full mechanization of the natural world. More precisely, he sought a mechanization of our view of the natural world described in terms of extended matter in motion. In effect, Descartes sought to replace any reference to incorporeal agencies, such as powers, faculties, or forms in the explanation of nature with the quantitative and measurable features of extended matter in motion. In this way, the natural world – or at least the part belonging to *res extensa* – would be described in purely geometrical/quantitative terms.

One of the most difficult tasks facing this project was to provide an account of the phenomenon of life and especially of some features of living things such as nutrition, growth, and generation, which were traditionally explained by reference to a vegetative and sensitive soul. Descartes supposed that nature always acts in accordance with the laws of mechanics. Thus he attempted to show that vital force is reducible to heat in the heart, understood as matter in motion. Likewise, he argued that any movement in the bodies of animals can be explained by attending to the mere disposition of their organs.

As Descartes writes in the preface to his *Description of the Human Body*:

> Il lest vrais qu'on peut avoir de la difficulté à croire que la seule disposition des organes soit suffisante pour produire en nous tous les mouvements qui ne se déterminent point par notre pensée; c'est pourquoi je tacherai ici de le prouver, et d'expliquer tellement toute la machine de notre corps, que nous n'aurons pas plus sujet de penser que c'est notre âme qui excite en lui les mouvements que nous n'expérimentons point être conduits par notre volonté, que nous en avons de juger qu'il y a une âme dans une horloge, qui fait qu'elle montre les heures.[10] (AT XI, 226)

As Gary Hatfield notes, "Descartes' aim was to mechanize virtually all of the functions that had traditionally been assigned to the vegetative and sensitive souls," and, "[t]o a large extent, Descartes physiology may be seen as a straightforward translation of selected portions of previous physiology into the mechanistic idiom".[11]

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[10] "It is true that we may find it hard to believe that the mere disposition of the bodily organs is sufficient to produce in us all the movements which are in no way determined by our thought. So I will now try to prove the point, and to give such a full account of the entire bodily machine that we will have no more reason to think that it is our soul which produces in it the movements which we know by experience are not controlled by our will than we have reason to think that there is a soul in a clock which makes it tell the time." (CSM I, 315)

[11] Hatfield 1992: 341–343.

Descartes' attempt to mechanize all of the functions that had traditionally been assigned to the vegetative and sensitive souls comes out clearly in the conclusion to his *Treatise on Man*:

> . . . ces fonctions suivent toutes naturellement, en cette Machine, de la seule disposition de ses organes, ne plus ne moins que font les mouvements d'un horloge, ou autre automate, de celle de ses contrepoids et de ses roues; en sort qu'il ne faut point à leur occasion concevoir en elle aucune autre âme végétative, ni sensitive, ni aucun autre principe de mouvement et de vie, que son sang et ses esprits, agités par la chaleur du feu qui brûle continuellement dans son cœur, et qui n'est point d'autre que tous le feux qui sont dans les corps inanimés. (See also AT XI 202; AT VI, 45–46)[12]

While Descartes aim was very clear and even somewhat simplistic – namely, to show that all living phenomena can be explained mechanistically – his argumentative strategy was rather subtle and sophisticated. Descartes' strategy – and one might say, his powerful rhetorical device – was first to conceive of all natural animals (as well as the human body) as *machines*. Once the body of an animal has been referred to as a machine, Descartes traded on the comparison between a machine manufactured by humans and a machine created by God. Roughly stated then, Descartes' strategy was to model natural machines on artificial ones. More precisely, he argued that the differences between the workings of a complex artificial machine, such as a clock or a fountain, and those of animal bodies are only apparent and turn on their degree of subtlety alone. Descartes attempted to show that in essence complex machines and animal bodies are of the same kind, and that the only differences between them reduce to degrees of complexity and the subtlety of their parts. Thus, just as we don't need to invoke an occult agency in a clock that shows the hour, so there is no need to invoke such agency in our body other than the dispositions of its organs and parts. This is all the more true in animals that have sensitive functions alone. Both functionality and the movement of animals can be ascribed to their internal workings, just as are the workings of complex machines.

As Descartes clearly states in the *Principles of Philosophy*, part 4, article 203:

> [Je] ne reconnais aucune différence entre les machines que font les artisans et les divers corps que la nature seule compose, sinon que les effets des machines ne dépendent que de l'agencement de certains tuyaux, ou ressorts, ou autres instruments, qui, devant avoir quelque proportion avec les mains de ceux qui les font, sont toujours si grands que leurs figures et mouvements se peuvent voir, au lieu que les tuyaux ou ressorts qui causent les effets des corps naturels sont ordinairement trop petits pour être aperçus de nos sens. Et il est certain que toutes les règles des Mécaniques appartiennent à la physique, en sorte que toutes les choses qui sont artificielles, sont avec cela naturelles. Car, par exemple, lors

[12] ". . .these functions follow from the mere arrangement of the machine's organs every bit as naturally as the movements of a clock or other automaton follow from the arrangement of its counter-weights and wheels. In order to explain these functions, then, it is not necessary to conceive of this machine as having any vegetative or sensitive soul or other principle of movement and life, apart from its blood and its spirits, which are agitated by the heat of the fire burning continuously in its heart – a fire which has the same nature as all the fires that occur in inanimate bodies." (CSM I, 108)

> qu'une montre marque les heures par le moyen des roues dont elle est faite, cela ne lui est pas moins naturel qu'il est à un arbre de produire des fruits. (AT IX, 321–322)[13]

It is mainly to this powerful and influential attempt to reduce natural machines to artificial ones that Leibniz responds. It is worth stressing that Leibniz does not object to Descartes seeing both artificial and natural machines as subtle machines. Rather, he attempts to draw a distinction between them as two distinct *types* of machines.

3 Leibniz's Distinction Between Natural and Artificial Machines

In the *System Nouveau* Leibniz insists that natural machines have something substantial – *Soul or Form* – that makes them one and the same thing in the *least of their parts*. Leibniz's formulation of the distinction is that, while both are said to be machines, a natural machine, unlike an artificial one, "remains machine to the least of its parts, and what is more, it always remains the same machine" (GP IV, 482). Note that this characterization constitutes the main difference between two *types* of machines. Furthermore, this characterization applies both to the internal structure of a natural machine, so that all its parts are machines, and to its development, so that it remains the same machine through its various states.

Leibniz's view concerning the unity and identity of a natural machine, in contrast to an artificial one, is confirmed in the sequel to the passage cited above:

> In addition, by means of the soul or form there is a true unity corresponding to what is called *the self* in us. Such a unity could not occur in the machines made by a craftsman or in a simple mass of matter, however organized it may be; such a mass can only be considered as an army or a herd, or a pond full of fish, or like a watch composed of springs and wheels. (AG 142)[14]

Leibniz draws here a sharp distinction: an artificial machine is understood on the model of things that lack true unity, namely aggregates. By contrast, a natural machine is understood on the model of things that have true unity, namely substances. Even if it involves infinitely many states and infinitely many machines, a

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[13] "I do not recognize any difference between artefacts and natural bodies, except that the operations of the artefacts are for the most part performed by mechanisms which are large enough to be easily perceivable by the senses – as indeed must be the case if they are to be capable of being manufactured by human beings. The effects produced in nature, by contrast, almost always depend on structures which are so minute that they completely elude our senses. Moreover, mechanics is a division or special case of physics, and all the explanations belonging the former also belong to the latter so it is no less natural for a clock constructed with this or that set of wheels to tell the time than it is for a tree which grew from this or that seed to produce the appropriate fruit." (CSM I, 288)

[14] "De plus, par le moyen de l'âme ou forme, il y a une véritable unité qui répond à ce qu'on appelle moi en nous; ce qui ne saurait avoir lieu ni dans les machines de l'art, ni dans la simple masse de la matière, quelque organisée qu'elle puisse être, qu'on ne peut considérer que comme une armée ou un troupeau, ou comme un étang plein de poissons, ou comme une montre composée de ressorts et de roues." (GP IV, 482)

natural machine has (or is) a true unity. By 1695 Leibniz is well equipped with this fundamental distinction between substances and aggregates, which he develops and defends in the second part of his correspondence with Arnauld (1686–1687).[15] While a substance has a true unity, an aggregate, which is a collection of substances, does not. The unity of an aggregate is not a natural one in the sense that it requires a mental act, i.e., the very aggregation of its constituents into a single group (such as sheep into a herd, stones into a pile, soldiers into an army, birds into a flock). Such a union is the result of a mental act of unification, namely that of perceiving a plurality of things together (sheep, fish, stones, soldiers) or as one group.[16] I have to stress that these are just analogies and examples to illustrate something that cannot be visualized, namely the difference between a true and natural unity and an artificial one.

In any event, Leibniz is very clear that artificial machines fall on the aggregate side of the divide while natural machines fall on the substance side of the divide. Yet it is not at all clear how Leibniz can account for and justify this division, given that the sole difference between them is that a natural machine remains a machine to the least of its parts. This is the main question I take up here.

Before addressing this question more directly, let me briefly return to Leibniz's motivation for drawing the distinction and to some of the roles it plays in his metaphysics. On this score it is impossible to do better than to appeal to Michel Fichant's admirable article, "Leibniz et les machines de la nature" (to which this article owes a great deal). As Fichant has stressed:

> Le concept [machine de la nature] est [. . .] introduit [en 1695 dans le *Système Nouveau*] comme un moyen de limiter les prétentions d'un mécanisme intégral, qui 'en confondant les choses naturelles avec les artificielles', a réduit les phénomènes de la nature à des effets de machines analogues, au seul degré près, aux machines de l'artifice humain. . .(Fichant 2003:1–2).[17]

According to Leibniz, the difference between "the least productions and mechanisms of divine wisdom and the greatest works of human art" is not one of degree but one of kind. Likewise, to limit the claims of the all-encompassing Cartesian mechanistic program in this context means not only to draw a line between divine and human production but also between living and non-living things. As it turns

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[15] "La substance demande une véritable unité [. . .] Tout être par agrégation suppose des êtres doués d'une véritable unité, parce qu'il ne tient sa réalité que de celle de ceux dont il est composé, de sorte qu'il n'en aura point du tout, si chaque être dont il est composé est encor un être par agrégation [. . .] S'il y a des agrégés de substances, il faut bien qu'il y ait aussi des véritables substances dont tous les agrégés soient faits. [. . .] Il n'y a point de multitude sans des véritables unités. Pour trancher court, je tiens pour un axiome cette proposition identique qui n'est diversifiée que par l'accent, *que ce qui n'est pas véritablement* un *être, n'est pas non plus véritablement un* être." (*Lettres de Leibniz à Arnauld d'aprés un manuscrit inédit*, ed. Geneviève Lewis (Paris, Presses Universitaires de France: 1952), 68–69; see also GP II, 164–165)

[16] For Leibniz's notion of aggregate and its peculiar sense of unity see Nachtomy 2007. Chapter 9.

[17] Fichant 2003. Leibniz et les machines de la nature. *Studia leibnitiana* 35: 1–28. See also *Monadology* § 74: "a kind of divine machine which infinitely surpasses all artificial automats."

out, for Leibniz, this also means drawing a line between active and non-active things and, likewise, between truly existing things (which he typically identifies with substances) and well founded phenomena (which he typically identifies with aggregates). At the same time, Leibniz's characterization of both divine creation and human production in terms of machines is meant to meet his conviction that things can be described both mechanically, by appealing to efficient causes, and teleologically, by appealing to final causes.

Unlike what we might tend to associate with the word today, according to Leibniz and some of his contemporaries, a machine is understood not only in terms of efficient causes but also in terms of final ones.[18] For Leibniz, a machine is also understood as an instrument, that is, in terms of the function and the end it serves – a point to which I will return.

In addition, as Fichant has argued, "in the *Système Nouveau,* Leibniz is concerned. . . with a structural and ontological characterization of natural machines in an attempt to give bodies the reality of a substance".[19] According to Fichant, this strategy is the basis for a realistic interpretation of substance that extends well into the *Monadological* period, which is regarded by many as idealistic.

We can now better appreciate the significance of the distinction for Leibniz. Clearly, a lot hangs on this distinction. Not only does it serve to distinguish between divine creation and human production but also between animate and inanimate things, as well as to reconstruct a (new/old) non-Cartesian model of the living world in which the Aristotelian notions of entelechy, form, and *telos* play a central role.

4 Does Leibniz's Distinction Make Sense?

However, the question arises whether we can make sense of Leibniz's distinction. Let us turn to examine whether Leibniz has the resources to maintain the high expectations he has for it. In other words, we need to examine whether the distinction can indeed differentiate between divine creations and human artifacts; true unities and aggregates; living beings and inanimate things; and we need to examine whether the resulting concept of a natural machine is a coherent one. The most striking difficulty concerning the notion of a natural machine is this. As Fichant observes, the central characteristics of a natural machine are (1) that its composition extends to infinity

[18] "In each machine, one has to take into consideration at once its functions or its end and the mode of operation or the means by which the author of the machine sought its end." "In omni Machina spectandae sunt tum functiones ejus, sive finis, tum modus operandi, sive quibus mediis autor machinae suum finem sit consecutus " (Pasini 1996: 212). The best way to define a machine is by its final cause, in a way that each of its parts would appear [in the explication of its parts] to be coordinated by its designated [destinatum] usage. "Machina autem omnis a finali causa optime definitur, ut in explicatione partium deinde appareat, quomodo ad usum destinatum singulae coordinentur " (Ibid., 217–218; English translations are my own but see the forthcoming translation of these texts by Justin Smith).

[19] Fichant 2003: 7.

and (2) that it is a true unity.[20] Yet it is precisely the conjunction of these two traits that is difficult to grasp. In other words, it is difficult to grasp how Leibniz considers infinitely many machines within machines as one substantial thing.

It is clear that, according to Leibniz, a natural machine is supposed to have a substantial unity that an artificial machine lacks. In the herd analogy, a natural machine is like a sheep; an artificial machine is like a herd. We know that, for Leibniz, the single sheep exemplifies a natural and substantial unity, which the herd, the army, the clock lacks. But the picture is more complicated, and in two respects. On the one hand, an artificial machine, too, has substance-like, sheep-like constituents or composants. It is, in brief, an aggregate of *substances*. On the other hand, each sheep or a natural unity itself consists of other sheep-like, substance-like, creatures.[21]

The challenge then, is to distinguish between an artificial machine and a natural machine, both seemingly consisting of infinitely many natural machines. Clearly, Leibniz's distinction must be very nuanced in order to perform this task.

In a number of texts, Leibniz offers the following mark in order to distinguish between these two kinds of machines: while a natural machine is infinite, an artificial machine is finite. In the *Système Nouveau* Leibniz states clearly that "the machines of nature have a truly infinite number of organs, and are so well supplied and so resistant to all accidents that it is impossible to destroy them" (GP IV, 482; AG 142). And in the following passage Leibniz is saying that a natural machine "is made up of an infinity of entangled organs": "Moreover, a natural machine has the great advantage over an artificial machine, that, displaying the mark of an infinite creator, it is made up of an infinity of entangled organs."[22]

These passages suggest that, according to Leibniz, the distinctive feature of a natural machine is that it has infinitely many organs. Yet this cannot be all there is to his distinction. In fact, praising the subtlety of natural machines is not far from what Descartes says (with the important qualification that Leibniz is committed to *infinite* subtlety whereas Descartes would qualify it as *indefinite*). Taken at face value though, Leibniz's point that a natural machine "is made up of an infinity of entangled organs" cannot account for the difference between artificial and natural machines. The reason is that, as we have observed, an artificial machine would involve infinitely many organs as well. If an artificial machine consists of infinitely

[20] "Cette différence se marque à deux traits: l'infinité de composition, garante d'indestructibilité, et l'unité véritable, fondement de substantialité." (Fichant 2003: 2)

[21] "Dans les corps je distingue la substance corporelle de la matiere, et je distingue la matiere premiere de la seconde. La matiere seconde est un aggregé ou composé de plusieurs substances corporelles, comme un trouppeau est composé de plusieurs animaux. Mais chaque animal et chaque plante aussi est une substance corporelle, ayant en soy le principe de l'unité, qui fait que c'est veritablement une substance et non pas un aggregé. Et ce principe d'unité est ce qu'on appelle Ame ou bien quelque chose, qui a de l'analogie avec l'ame. Mais outre le principe de l'unité la substance corporelle a sa masse ou sa matiere seconde, qui est encor un aggregé d'autres substances corporelles plus petites, et cela va à l'infini." (Draft letter to Thomas Burnett, 1699: AG 289, GP III 260) See also the Replies to Stahl (Carvallo 2004: 102–103).

[22] *On Body and Force*, *Against the Cartesians*, AG 253.

many natural machines, it would also have infinitely many organs and in this sense would be indistinguishable from a natural one.

At the same time, it is clear in these passages that Leibniz sees the composition to infinity as what guarantees the unity and indestructibility of a natural machine. Yet the mere infinity of organs cannot account for this alleged unity and indestructibility. There are two reasons for this: First, a mere infinity of organs does not provide unity but, if anything, multiplicity and infinite divisibility. As Leibniz writes, "an infinity of things is not one whole" (A 6.3 503). Second, as far as we know, Leibniz cannot accept without qualification an infinity of organs as making up one whole because he rejects the notion of an infinite number as a contradictory notion.[23] Thus, if Leibniz's distinction is supposed to turn on the infinite versus finite *number* of organs, it does not seem to be a happy solution for him. Instead, it would seem to render his notion of a natural machine not only as one that lacks unity, but as altogether contradictory.

It might prove more promising to attend carefully to Leibniz's repeated claim regarding the infinite number of organs in a natural machine. Thus, I will try to clarify what Leibniz means by "organ" in this context. My conjecture – to be developed below – is that this might be a different way of expressing the view that a natural machine remains a machine to the least of its parts in the sense that each organ serves a certain function. Likewise, I will attend to the point that Leibniz actually talks about "entangled organs" and suggest that what extends to infinity is not so much the *number* of organs or parts but rather the *structure* of the whole machine, as including more machines within machines to infinity. I will also examine what Leibniz means by "infinite" in this context. Thus I will now propose two ways to read Leibniz's point that a machine remains a machine in the least of its parts – one structural and one functional – in order to clarify the sense in which he employs the notion of infinity in this context.

5 A Structural Reading of What It Means "To Remain a Machine to the Least of Its Parts"

Let me begin with the structural suggestion. This idea comes out clearly in passages such as the following:

> . . . the machines of nature being machines to the least of their parts are indestructible, due to the envelopment of a small machine in a larger one, to infinity. (GP VI 543)[24]

In the following passage, from a 1704 letter to Lady Masham, Leibniz says that, in a natural machine, the composition goes to infinity, or, more precisely, that the subtlety of its artifice extends to infinity:

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[23] For more details on this issue, see Brown 2000; Arthur 2001; and Nachtomy 2005.

[24] "[Le] corps est organique quand il forme une manière d'automate ou de machine de la nature, qui est machine non seulement dans le tout, mais encore dans les plus petites parties qui se peuvent faire remarquer." (PNG §3 GF 224) See also *Monadology* § 67–70.

> I define an organism or a natural machine, as a machine each of whose parts is a machine, and consequently the subtlety of its artifice extends to infinity. . . (GP III 356)

According to the reading I suggest, what extends to infinity is not the *number* of organs or machines but rather the very *structure* of a natural machine which involves machines within machines. Elsewhere I called this the nested structure of natural machines.[25] My suggestion is that the structure of a natural machine develops *ad infinitum*, while that of an artificial machine does not. It is in this sense, I suggest, that an artificial machine does not remain a machine to the least of its parts. While the number of machines within this structure is clearly not finite, we cannot also say that it involves an infinite number of machines (which would be a contradiction), but that the machine's structure extends to infinity. Before exemplifying this point, let me first consider an objection.

One might object that this only means that we need to count structures instead of organs and, if so, the contradiction would arise only with an infinite number of structures. Let me clarify that, while the structure of a natural machine might include many sub-structures, the point is that there is one structure corresponding to the whole machine – and that structure might involve many nested machines as its constitutive elements.

Leibniz's picture of nestedness to infinity is not a simple containment or inclusion of one thing inside another. This can be seen in a passage in the *Nouveaux Essais* where Leibniz evokes the image of the Harlequin – an image that might be misleading indeed. Notice, however, that Leibniz is *denying* that it provides a good model for the richness of natural subtlety.

> c'est. . .comme Arlequin qu'on voulait dépouiller sur le théâtre, mais on n'en put venir à bout, parce qu'il avait je ne sais combien d'habits les uns sur les autres: quoique ces réplications des corps organiques à l'infini, qui sont dans un animal, ne soient pas si semblables ni si appliqués les unes aux autres, comme des habits, l'artifice de la nature étant d'une tout autre subtilité. (NE II, ch. VII, §42; G V, 309)[26]

Leibniz does not clarify here what he has in mind when he says that "[the artifice] of nature is of an entirely different subtlety" from that of human production. I have suggested above that the difference between human-made machines and natural/divine ones is related to a difference in the kind of infinity involved in the two cases. While an artificial machine might also have an infinity of parts, a natural machine has an internal structure that extends to infinity. More importantly still (and I will try to illustrate this below) a natural machine, while infinite in structure, is essentially one, and therefore, must have a notion of infinity that would be compatible with true unity.

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[25] See Nachtomy 2007: Chapter 10.

[26] "it is as if someone tried to strip Harlequin on the stage but could never finish the task because he had on so many costumes, one on top of the other; though the infinity of replications of its organic body which an animal contains are not as alike as suits of clothes, and nor are they arranged one on top of another, since nature's artifice is of an entirely different order of subtlety." (Bennett and Remnant 1996).

Let me now try to illustrate this difference. Let us think of a natural machine as having a fractal-like structure, that is, a structure defined by a simple rule of generation, whose continuous application produces an infinite structure, such that each of its parts has a similar structure to the whole. While the analogy with a fractal structure sounds anachronistic, let us attend to what Leibniz writes to Des Boss in 1706:

> When I say that there is no part of matter that does not contain monads, I illustrate this with the example of the human body or that of some other animal, any of whose solid and fluid parts contain in themselves in turn other animals and plants. And this, I think, must be said again of any part of these living things, and so on to infinity. . .

To a possible objection that this view seems to imply an infinitesimally small being, Leibniz responds[27]:

> I shall use an analogy. Imagine a circle; in it draw three other circles which are the same size and as large as possible, and in any new circle and in the space between circles again draw the three largest circles of the same size which are possible. Imagine proceeding to infinity in this way: it does not follow that there is an infinitely small circle, or that there is a center having its own circle, in which (contrary to the hypothesis) no other is inscribed.[28]

It is easy enough to illustrate the geometrical analogy Leibniz draws here. As it turns out, Leibniz's example corresponds to the contemporary definition of a fractal. It is produced by a simple generation rule and each of its parts is homomorphic to the whole. Notice that, in such a fractal structure, the situation is just as Leibniz is fond of saying, namely "C'est tout comme ici, partout et toujours". In these words, Leibniz states somewhat poetically one of the central principles of his philosophy (see especially the letter to Sophie Charlotte of May 8th, 1704, G III 343–348).[29]

A qualification is in order here. Leibniz clearly overstates his case when he says that "C'est tout comme ici, partout et toujours". While each of the internal structures in a fractal is the same as the whole with respect to the structure, it is also different. If we take Leibniz's principle of considering the whole method of production of a given thing we see that there are differences between these structures, such as their place within the whole structure.

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[27] I should note that the commentators I have seen using and developing this analogy are not attending to the fact that the geometrical analogy, which they call the schema of emboitment, does not come right after the passage cited. In between there is a complex discussion not only about matter but about machines, entelechies and their complex relations. In fact, it is not obvious which passage Leibniz does attempt to exemplify with the analogy. What he says immediately before "I shall use an analogy" is this: "Yet you see that it should not be concluded from this that an infinitely small portion of matter (such as does not exist) must be assigned to any entelechy, although we routinely jump to such conclusions."

[28] To Des Bosses 11–17 March, 1706; G 305–306; Look 2007.

[29] For more details on the way in which Leibniz uses this principle, see Phemister 2004.

Let me now try to use Leibniz's analogy for my current purpose. In this analogy, an artificial machine would be a collection of fractals. A natural machine would be a single fractal that includes infinitely many sub-fractals as its intrinsic constituents.[30] Note that, in this illustration, a natural machine would remain a machine to the least of its constituents, while, at the same time, the whole machine would remain one single machine. An artificial machine, however, does not preserve this structure to infinity; nor is it, for this very reason, truly one being – not at any given moment and not over time, even if it is composed of such machines. On this model, it seems, we can maintain Leibniz's point that the distinction between artificial machines and natural ones coincides with the distinction between a true unit – that is, a substance – and, a collection of them – that is, an aggregate.

In addition, we know that Leibniz defines an individual substance in terms of its individual law of generation – "the law of the series", as he often calls it. Drawing on the fractal analogy as exemplifying how such a law of generation can produce a structure that develops to infinity, we can suggest that a natural machine can be defined as including an infinity of machines and as having a nested structure to infinity, in the sense that its law of production can be seen as including sub-programs as essential constituents (but not parts) of it.

An artificial machine, however, is not constituted in this way. Rather, it is seen as a collection of such individuals, not as a single one that makes up one whole. If this is correct, the distinction between artificial and natural machines turns, strictly speaking, on the question of unity, or, more precisely, it turns on the appropriate conjunction of infinity and unity. In fact, the very composition to infinity of a natural machine suggests that it is individuated by a single law or a single program of action. On this reading, a natural machine turns out to be one *thing* while an artificial machine, being an aggregate, turns out to be a compositional product, or a collection of many things. Thus we can see why Leibniz regards natural machines as substances and artificial machines as aggregates.

Let us now examine how this reading fits with the distinction between divine creation and human production. We certainly know that, according to Leibniz, God creates complete individual substances alone – the rest supervenes on their existence. Furthermore, we know that such substances are individuated by their complete concepts, which are conceived in God's mind before their creation. In a recent book,[31] I suggested that such a concept should be defined not as a set of predicates but through the law that generates a unique structure of predicates in God's mind. The main reason for defining the concept of an individual in this way is that such a genetic definition (via a generative rule) can capture the infinite character of

[30] The idea of using a fractal analogy to exemplify the distinction between a composed substance and an aggregate has been proposed (though in a very loose and imprecise way) in an article by Chazerans 1991.

[31] Nachtomy 2007.

a Leibnizian individual in a consistent way. Otherwise, if we define it simply as a set or a collection of infinite predicates, it would fall into contradiction and would not be seen as a whole, as an infinite number does. The definition of a complete concept in terms of its law of production aims at capturing Leibniz's characterization of an individual substance as having an infinite structure and as informing its development upon creation.

If these observations are adequate, it would clarify Leibniz's identification of a natural machine (but not an artificial one) with the divinely created individual substances. Such an infinite structure, which expresses the infinite nature of the Creator, cannot be produced by humans. Rather, it can only be brought about by an act of creation, that is, a super natural event constituting the natural world by realizing a variety of natural machines. As natural machines cannot be produced, they cannot be destroyed. Thus we see that the indestructibility of a natural machine goes hand in hand with (and in fact is just the other side of) the fact that they cannot be produced but can only be (supernaturally) created or annihilated by God.[32] Leibniz makes it very clear that the indestructibility of natural machines derives from their composition to infinity. As he explains to Des Boss:

> whoever reflects on the doctrine of the conservation of animals, must also consider, as I have shown, that there are infinite organs in the body of an animal, some enfolded in others; and from this it follows that an animated machine, and in general a machine of nature, is absolutely not destructible. (To Des Bosses, 11 March 1706 (Look and Rutherford 2007: 37))

Considering the context in which this passage appears[33] shows that Leibniz connects here the lawfulness of natural machines (created by God), their nested structure, and their natural indestructibility. Leibniz is just as clear about this point in his "Consideration on the Principles of Life":

> Ce qui nous découvre encore des merveilles de l'artifice divin, ou l'on n'avait jamais pensé: c'est que les machines de la nature étant machines jusque dans leurs moindres parties, sont

[32] "Quand aux Mouvemens des corps celestes, et plus encore quant à la formation des plantes et des animaux, il n'y a rien qui tienne du miracle, excepté le commencement des ces choses. L'organisme des animaux est un mechanisme qui suppose une préformation divine: ce qui en suit, est purement naturel, et tout à fait mechanique." (GP VII. 417–418)

[33] "As to my claim that the soul and the animal do not perish, I shall again explain it with an analogy. Imagine an animal as a drop of oil and the soul as some point in the drop. If the drop is now divided into parts, the point will exist in one of the new drops, since any part in turn is transformed into a spherical drop. In the same way, the animal will survive in that part in which the soul remains and which best agrees with the soul itself. And just as the nature of the liquid in any fluid aims at sphericity, so the nature of the matter constructed by the wisest author always aims at order or organization. From this it follows that neither souls nor animals can be destroyed, although they can be diminished and concealed, so that their life does not appear to us. And there is no doubt that in generation, as also in corruption, nature obeys certain laws, for nothing of divine workmanship is lacking in order. Moreover, whoever reflects on the doctrine of the conservation of animals, must also consider, as I have shown, that there are infinite organs in the body of an animal, some enfolded in others; and from this it follows that an animated machine, and in general a machine of nature, is [not] absolutely destructible." (Look and Rutherford 2007: 35–7)

> indestructibles, a cause de l'enveloppement d'une petite machine dans une plus grande à l'infini. (G VI 539–546)[34]

My suggestion is that natural machines are indivisible units in the sense that they are defined and informed by a single rule of generation, compatible with their having an infinitely complex structure such as an infinite series or a fractal-like structure.

I argued above that the infinite structure of a natural machine provides evidence for its being a divine, and law governed creation. These strands come together in the following passage from the PNG:

> Et ce corps (de la Monade Centrale) est organique, quand il forme une manière d'Automate ou de Machine de la Nature, qui est Machine non seulement dans le tout, mais encore dans le plus petites parties qui se peuvent faire remarquer. . . Et les perceptions dans la Monade naissent les unes des autres par les lois des Appétits, ou des *causes finales du bien et du mal*, qui consistent dans les perceptions remarquable, réglées ou déréglées. (PNG 3, GF 224; see also 110)

This passage is remarkable in clarifying under what conditions a body is considered organic and for tying together the nested structure of such a natural machine with its internal law of action (perceptions). Even more important, this passage points to the connection between the internal law of action and the final causality involved in the internal perceptions of a natural machine, to which I now turn.

6 A Functional Reading of What It Means "To Remain a Machine to the Least of Its Parts"

Let us now examine another sense in which the subtle distinction between natural and artificial machines may be understood, namely by emphasizing a functional reading of the notion of machine (and of machines within machines). This sense of machine is related to the traditional notion of organ as an instrument. Leibniz is very explicit about the functional role of machines in texts from the 1680s. As he writes: "In each machine, one has to take into consideration at once its functions or its end and the mode of operation or the means by which the author of the machine sought its end."[35] Leibniz is even more explicit in the following passage: "The best way to define a machine is by its final cause, in a way that each of its parts would appear [in the explication of its parts] to be coordinated with the other by its designated [*destinatum*] usage."[36]

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[34] See also this passage: ". . . la matière arrangée par une sagesse divine doit être essentiellement organisée partout, et qu'ainsi il y a machine dans les parties de la machine naturelle a l'infini, et tant d'enveloppe et des corps organiques enveloppés les uns dans les autres, qu'on ne saurait jamais produire un corps organique tout a fait nouveau" (GF 99; G VI 539–46).

[35] "In omni Machina spectandae sunt tum functiones ejus, sive finis, tum modus operandi, sive quibus mediis autor machinae suum finem sit consecutus." (Pasini 1996).

[36] "Machina autem omnis a finali causa optime definitur, ut in explicatione partium deinde appareat, quomodo ad usum destinatum singulae coordinentur." (Ibid., 217–18)

It is worth reflecting on the similarity between Leibniz's formation here and Kant's formulation cited above. Leibniz's functional reading of his notion of a natural machine comes out quite clearly in the following passage from the *Monadologie* §64 where he writes:

> [. . .] une Machine, faite par l'art de l'homme, n'est pas Machine dans chacune de ses parties, par exemple le dent d'une roue de leton a des parties ou fragmens, qui ne nous sont plus quelque chose d'artificiel et n'ont plus rien qui marque de la Machine par rapport à l'usage où la roue étoit destinée. Mais les Machines de la Nature, c'est à dire les corps vivans, sont encor des machines dans leurs moindres parties jusqu'à l'infini. C'est ce qui fait la différence entre la Nature et l'Art, c'est à dire entre l'art Divin et le Notre. (G IV, 618)[37]

Here it seems that, "to remain a machine to the least of its parts" means that a machine involves serving a certain end or function. An artificial machine is invested with the human purposes and the usage humans make of it. Yet, at a certain level of its internal structure these purposes come to an end. The machine as a whole has a purpose but not each of its constituents, or, more precisely, not each of its constituents to infinity. The cogwheel, for example, has a function within the machine, and in this sense it, too, is a machine; the dents on the wheel have a function as well, but this functional structure does not continue to the fragments of the dents, which cannot therefore be seen as machines. At this point, the functional chain terminates, which is why this is seen as an artificial machine rather than as a natural one.

By contrast, a natural machine expresses God's purposes and designs and, in this respect, it is of a different category: in a natural machine the functional and machine-like structure go to infinity while in the artificial machine they come to an end.

Evidently, according to Leibniz, there is nothing created by God that does not fulfill a certain function. More precisely, everything is created *thanks to* its function or end in the world, which is a very familiar Leibnizian theme. Note that, in this functional sense of nestedness to infinity, the functional chain, or the chain of final causes need not at all be seen as a physical or even structural emboîtement of machines within machines. What is crucial is only that, at every level, each part or constituent serves a function with respect to the other constituents and with respect to the main (dominating) *telos* of the whole. Such a model of functional relations may well be illustrated by circular rather than linear infinity. And once again one is reminded here of Kant's formulation that in a natural product each organ is both means and end.

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[37] "Thus every organic body of a living being is a kind of divine machine or natural automaton, which infinitely surpasses any artificial automaton, because a man-made machine is not a machine in every one of its parts. For example, the tooth of a brass cog-wheel has parts or fragments which to us are no longer anything artificial, and which no longer have anything which relates them to the use for which the cog was intended, and thereby marks them out as parts of a machine. But nature's machines – living bodies, that is – are machines even in their smallest parts, right down to infinity. That is what makes the difference between nature and art, that is, between the divine art and our own." Franks and Woolhouse 1998: 277.

As we have seen, this system of functional relations does not apply to human production in the same way. Even if the cog is made up of other things, and ultimately these things are going to be living things, they are not functionally related as organs are related to the whole organism. In a living animal the constituents are seen as inseparable and as inseparably individuated from the whole structure and *telos* of the animal (which is defined or given by their law of production). In this respect, my liver is not like a cogwheel in my bike, whether or not the technology for their replacement exists. According to this reading of Leibniz, what distinguishes between the natural and the artificial is precisely that the functional chain or, if you will, the teleological chain is never ending – any natural thing, however small or insignificant, serves a certain function in a well defined and well ordered system of ends. Not so in an artificial machine, whose series of functions comes to an end.

In this vein, Leibniz draws a distinction between the ends of machines, which are proper and interior to them, and the ends of aggregates, which are the result of the relations between different machines. This distinction is made very explicitly in the controversy with Stahl between particular final causes that Leibniz ascribes to natural machines and general final causes that he ascribes to the concurrence between them:

> Interim concedimus magnum esse discrimen inter machinas et aggregata massasque, quod machinae fines et effectus habent vi suae structurae, at aggregatorum fines et effectus oriuntur ex serie rerum concurrentium atque adeo ex diversarum machinarum occursu, qui etsi etiam sequatur divinam destinationem, plus tamen minusque manifestae coordinationis habet.[38]

7 Conclusion

I have presented two ways to read Leibniz's characterization of a natural machine as remaining a machine to the least of its parts – one structural, suggested by the fractal analogy, and one functional, suggested by examples such as *Monadologie* §64. In conclusion, let me briefly touch on the question of their relations.

In particular, the question arises whether the functional and structural readings are compatible or whether they exclude one another. Are these readings complementary, so that the one is contributing to the other or are they independent from one another?

Let me briefly state my suggestion: the internal law of the structure of a natural machine expresses the unique *telos* of this machine, as well as the machines nested in it. Thus, through the generative law, the structural and functional aspects of a

[38] "We have recognized a great difference between machines and aggregates or masses, because machines have their effects and ends by the force of their proper structure, while the effects and ends of aggregates originate from a series of concurrent things and diverse machines. . ."(Carvallo 2004: 102–103; my translation)

natural machine are compatible. Hence both structural and functional considerations are essential to Leibniz's notion of natural machine.

And let me close with a question for further research: Given the way I have suggested to read Leibniz's distinction, the following question arises: Does the same kind of infinity apply to both natural and artificial machines? And, if not, what kind of infinity applies to natural machines and what kind to artificial machines?

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Chapter 6
The Organic Versus the Living in the Light of Leibniz's Aristotelianisms

Enrico Pasini

1 Back from the Dead

It is plain that there is a consistent thread of Aristotelianism in Leibniz's thought. Wavering between *ens* and *unum*, as Pico della Mirandola already had before him, Leibniz wants to maintain both. But according to him, as it seems, a true *ens* has to be a substance, and he unquestionably gives to the concept of substance no Cartesian treatment. Thus, his enthusiasm for Platonic philosophy notwithstanding, he endorses explicitly and publicly various devices of the Aristotelian tradition, often going so far as to allege that he has revived by himself substantial forms: and precisely this connection between substance and form heralds, in general terms, a return to Aristotelianism.

All the same, it must be said that Leibniz can well be Aristotelian in a quite peculiar way, but this is not the pinnacle of his philosophical originality. Moreover, the emphasis that is usually placed on the theory of substance can also be misleading, as far as the interpretation of Leibniz's metaphysics is concerned. The first point I would like to stress here is that both theoretically and developmentally this metaphysics can be better understood by not regarding it as a doctrine of substance: the fundamental concept of Leibniz's metaphysics, the decisive one in its development between the end of the 1670s and the beginning of the 1680s, is that of *essence*.

2 The Essentials of Essence

The relation between the essence and its modes of existence is the starting point for Leibniz's invention of an original metaphysics of his own. The chief moment of epiphany might be located at the point when, and in the theoretical setting where, he came across his *theorema praeclarum* (A VI 3, 582), as he calls it in the *Definitio Dei seu entis a se*, written on Hanoverian

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paper between the end of 1676 and the beginning of 1677. It is a "fastigium doctrinae modalis," a pinnacle and masterpiece of modal doctrine, by virtue of which "transitur mirabili ratione, a potentia ad actum": if the necessary being is possible, it follows that it actually exists (A VI 3, 583). This is a constant tenet that concerns not only God, but a more general, recondite connection between essence and existence: "Hoc est fastigium doctrinae modalis," he repeats in 1688, "et transitum facit ab essentiis ad existentias, a veritatibus hypotheticis ad absolutas, ab ideis ad mundum" (A VI 4, 1619).[1] Not only is God's nature connected to existence, but so is any creature's nature or essence, or possibility,[2] as well as that of any possible being.

There is nevertheless an important difference between the divine essence and the essence of creatures, a difference that is rooted in a peculiar property of the essence itself. This feature is the object of a genuine discovery, or at least of an original move, that Leibniz made in the field of metaphysics. There is a modal relation, as we have seen, between essence and existence, and it varies according to different kinds of beings. God is that being whose existence necessarily follows once his essence is posited. Finite things, both created and not, don't convey such a necessary association between their essence and their existence, but, albeit differently, they manifest a connection, namely, that their essence, by itself, demands existence. This very exigency of existence is a general property of essences, according to Leibniz.

The discovery of the pretense of the essence to existence, as a feature of the essence itself, is exactly the starting point of Leibniz's original fashioning in the field of metaphysics. Such a metaphysics of the essence implies, by the way, neither qualitative degrees of reality that might be associated to essences of different kinds, nor degrees of being, nor different degrees of eminence in being. Leibniz himself never seems to put forward gradations of being, nor equivocity, not even analogy: being is univocal, since no real distinction between essence and being can be admitted, nor any being of the essence as distinct from the being of the real existing thing (or the merely possible thing) that has this essence.[3]

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[1] "Haec propositio: *Si possibile est Ens necessarium, sequitur quod existat* est fastigium doctrinae modalis", Leibniz again writes in 1689–1690, "et primum facit transitum a posse ad esse, seu ab essentiis rerum ad existentias" (A VI 4, 1636). On Leibniz's argument(s) for God's existence, innumerable pages have been written. I'll mention here only a recent contribution by Brandon Look, "Some Remarks on the Ontological Arguments of Leibniz and Gödel," in *Einheit in der Vielheit*, Akten des VIII. Internationalen Leibniz-Kongreß (Hannover, Leibniz-Gesellschaft, 2006).

[2] The identification of essence and possibility is constant in Leibniz: ". . . possibilitates sive essentias rerum" (A VI 4, 2317), "ipsa possibilitate vel essentia" (GP 7, 303), "essences ou possibilités" (*Mon*. § 44); see also A VI 6, 293.

[3] This can be, of course, as Aristotelian as anything might be. In his reflections on the question of essence, Leibniz could at times be considered to be repeating the arguments used by Henry of Ghent in his controversy with Giles of Rome concerning the real distinction between essence and existence – a distinction that was maintained at least by Giles and, according to Giles and certain commentators, by Thomas himself. However, as far as the question of the real or modal distinction of essence and existence is concerned, Leibniz's theory of essence is quite strongly influenced by Suarez.

Summing up, what I am tentatively suggesting here is that the development of Leibniz's metaphysics during the late 1670s and 1680s, up to the beginning of the 1690s, shows that its core focus is not a theory of substance, but, in the last instance, a theory of essence and existence. The theory of substance, as seen from this angle, provides a sort of theoretical middle ground that connects pure metaphysics to the epistemic level of natural science. This comes about, on the one hand through dynamics, and, on the other hand, through a theory of the composition of substances. The focus here shall be on the latter, since it is more strictly related to our theme.

3 An Ambiguous Aristotelianism

The first scheme – the substantial form theory – that Leibniz tries out during the years 1683–1685 until the end of the 1690s, in order to give a metaphysical description of things as they exist in the world, is truly Aristotelian in inspiration. Leibniz often states that he is eager to revive substantial forms; at times, for instance, when he is writing to other German scholars such as Placcius (D V, 55), he expresses this thought as if he were excusing himself for it, but in fact he is quite proud. Roughly speaking, the substantial form is the form of a corporeal substance, or, in seemingly equivalent terms, of a body (although the latter is not attached to the substantial principle like the matter to the form in a *synolon*). There is indeed a fair amount of ambiguity in such expressions: the substantial form is, at the same time, a form that (together with a "matter" of some sort) makes a substance, and a form that *is* a substance. The substantial form, in every corporeal substance, is in fact a substance in itself, an individual substance that has a complete concept, and every other property of an individual in itself. In Leibniz's texts, the denomination of corporeal substance itself involves some equivocation. The corporeal substance can at times be considered as a substance that is a body, mostly a living one; but principally it is a substance that "has" a body: when Leibniz states that every substance is a corporeal substance, he means that every individual substance *must* have a body.[4] When, alternately, Leibniz muses on corporeal substances with a meaning that makes clear that they are ordinary beasts – animals that one can meet such as dogs or a flock of sheep – he doesn't convey exactly the same concept as in the other cases: he alludes instead to the corporeal substance as a living body that is (apparently as such) provided with substantial reality.[5]

An artless kind of Aristotelianism is indeed involved in the development of this theory. We can pinpoint it for instance in a passage of *De mundo praesenti* (A

[4] A clear statement of this point can be found in R. M. Adams 1994, 269; an ampler and thorough discussion of every possible position in Leibnizian historiography concerning this whole matter is found in Glenn Hartz 2007.

[5] The metaphysics of the monad, likewise, keeps this ambiguity in its specific language: the monad is the substance, but is also, as the dominating monad, the principle of unity; and yet that of which it is the principle of unity is not univocally substance.

VI 4, 1507–1508), composed not long before the *Discours de métaphysique*. The corporeal substance, Leibniz writes there, has both parts and species, and – just as if the Aristotelian language were the only one that would make it possible to articulate a discourse on substances – the "parts" of the substance are matter and form ("partes sunt materia et forma"). The matter is the principle of passion, the primitive force of resistance, which is popularly called the mass ("moles") and that possesses antitypy, i.e. the resistance that gives rise to the impenetrability of bodies. The substantial form, the form that is the substance and that also – and in this text the ambiguity is apparent – makes or constitutes the substance, "est principium actionis," or the primitive force of action. Leibniz adds that in every substantial form there is some cognition, i.e. the expression or representation of external entities in an individual thing ("hoc est expressio seu repraesentatio externorum in re quadam individua"), which implies that the substantial form *is* the very individual that expresses everything in the external universe.

That's more or less standard Leibniz. But what deserves to be considered with attention is the really naive way he is using concepts like "matter" and "form" as Aristotelian "parts" of the substance. Admittedly, it is not simple to clearly tell apart matter and form, when there is a body which, in strict metaphysical rigor, does not exist genuinely, and that perhaps is made up only of appearances arising from an organized mass formed by infinite substances, each in its turn a corporeal substance. Such "matter", ready to be formed by the corresponding substantial form, should have no autonomy, since surely Leibniz does not share the old Albertist view of the *eductio formarum e materia*, the production of forms by virtue of matter itself; nevertheless, in matter there are forms and those forms, as such, are parts of that matter. Leibniz at this time is already aware of the problem of the composition both of the matter and of the form of corporeal substances, as this problem is lurking in his texts already in 1687, for example in the correspondence with Arnauld. Consider the following passage from a draft:

> [S]i on prend pour matiere de la substance corporelle non pas la masse sans formes, mais une matiere seconde, qui est la multitude des substances dont la masse est celle du corps en entier, on peut dire que ces substances sont des parties de cette matiere, comme celle qui entrent dans nostre corps, en font la partie, car comme nostre corps est la matiere, et l'ame est la forme de nostre substance, il en est de même des autres substances corporelles" (GP 2, 119).[6]

In the draft of a letter to Burnet of Kemney of 1700, Leibniz will be discussing the same question, namely his theory of the substance, as realized, so to speak,

[6]"But if we take for the matter of the corporeal substance, not the mass without forms, but a secondary matter, which is the multitude of substances the mass of which is that of the body as a whole, we can say that those substances are parts of that matter, in the way that those which make up our body form parts of it. For just as our body is the matter and our soul is the form of our substance, so it is with other corporeal substances" (Leibniz 1998, 132, slightly modified). The passage won't be included in the letter and shows different layers of corrections, but even without the later ones it would serve our purpose. Note that Leibniz is not yet in sure possession of the concepts of "result" and "resulting," but the argument will impose itself on such a reasoning.

comprising in itself a form and a matter. He remarks: "quoyque je croye que tant la gravité que le ressort ne sont dans la matière[7] que par la structure du système et se peuvent expliquer mécaniquement", that is, by the elastic properties of parts, due to their conspiring movements, which is Leibniz's preferred explanation, "neantmoins il en resulte deux choses de la maniere dont je le conçois: l'une que le système de l'univers est formé et entretenu par des raisons métaphysiques de l'ordre, l'autre que chaque substance corporelle n'agit que par sa propre force et n'en reçoit jamais d'ailleurs" (GP 3, 260)[8]. That the corporeal substance doesn't receive anything from the outside implies once more that it is a substance in itself, not a substance in the wider meaning of a corporeal being composed by other substances, but the true individual, completely autonomous: and thus we are faced with the monad in the fullest sense. Leibniz adds that he discriminates in the body between the corporeal substance and the matter, and between secondary and primary matter. Accordingly, the corporeal substance about which he is writing is the substance that gives form to the matter of its body: indeed here he doesn't put forward a distinction between form and matter in the corporeal substance. In fact he tries, as he very often does, to have it both ways: so he adds that the corporeal substance has its principle of unity but it also has its mass, or its secondary matter, which is an aggregate of smaller corporeal substances, and so on to infinity.[9] It is a notorious and tremendous problem – let us say again – among the many problems with which Leibniz struggles. It must also be observed that this version of his treatment of substance theory is not naive – things don't "just work", as had been the case in the *De mundo praesenti* – but conceptual murkiness has not dissolved.

On the one hand, the problem Leibniz faces seems to be due to a difficulty in properly conceiving matter and its reality, as far as really existing, living material beings are concerned. On the other hand, there also is the problem of a double role of the form in the constitution of corporeal substances: we have a substantial form, the global form, entelechy, or active principle of the corporeal substance, in other words its soul; yet there ought to be some role also for each one of the particular forms that take part subordinately in its body, as they are living components of its living parts, and *actively* contribute to its existence.

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[7] As far as it is passive, Keplerian matter, endowed only with inertia and antitypy.

[8] "And even though I believe that both gravity and elasticity are in matter only because of the structure of the system and can be explained mechanically, nevertheless, as I understand it, two things follow: (i) that the system of the universe is formed and maintained by metaphysical reasons of order; and (ii) that each corporeal substance acts only by its own force and never receives any of it from elsewhere." (Leibniz 1989, 289, slightly modified)

[9] "Dans les corps je distingue la substance corporelle de la matiere, et je distingue la matiere premiere de la seconde. La matiere seconde est un aggregé ou composé de plusieurs substances corporelles, comme un trouppeau est composé de plusieurs animaux. Mais chaque animal et chaque plante aussi est une substance corporelle, ayant en soi le principe de l'unité, qui fait que c'est veritablement une substance et non pas un aggregé. Et ce principe d'unité est ce qu'on appelle Ame ou bien quelque chose, qui a de l'analogie avec l'ame. Mais outre le principe de l'unité la substance corporelle a sa masse ou sa matiere seconde, qui est encor un aggregé d'autres substances corporelles plus petites, et cela va à l'infini" (GP 3, 260).

4 Ubi Manet?

There is a dictum of Plutarch's, that in its modern Latin version is occasionally quoted in the emblematic tradition as follows: "Manet in se monas".[10] What is *one* does not ramble out of doors: the monad remains at home, and a monad's home is its self. Our problem is therefore *de monade in se manente*, inasmuch as the monad remains in itself, when considered in relation to its own body, because it possesses a representation of that body.[11]

This problem, differently stated, concerns the position of the monad in relation to the corporeal substance. Consider the famous letter to De Volder of 1703. It is a text of seeming clarity, to the point that it is even used to explain Leibniz to students, but in fact it remains impenetrable in many spots, and it is a very deceiving text, for many reasons. I quote the core passage:

> Distinguo ergo (1) entelechiam primitivam seu animam (2) Materiam nempe primam seu potentiam passivam primitivam (3) monadem his duabus completam (4) massam seu materiam secundam sive machinam organicam ad quam innumerae concurrunt monades subordinatae (5) Animal seu substantiam corpoream quam unam facit monas dominans in machina" (GP 2, 252).[12]

Note that the corporeal substance is not meant here as the substance that gives unity to the animal, nor to the body. On the contrary, the animal is a corporeal substance because it is a substance composed of form and body, in conformity with the complicated structure illustrated in the four preceding items. This animal, or corporeal substance, is made "one" by the monad that dominates in the machine. *Dominans in machina* is a phrase that, generally speaking, doesn't seem very appropriate in Latin, if not for conveying the location of the domain. That the monad exerts its activity of domination on the machine, *in machinam*, in the sense of the translation, couldn't be formulated in that way in Latin: either classical, since "dominans" is not part of the vocabulary admitted by classical sources, or modern, since in more recent times a preposition exists to qualify the object of the domination, namely, "super". So it sounds awkward to say *dominans in machina*, although *dominans machinam*, or *dominans super machinam* could be said. Consequently, this can only mean that the monad is situated "in" the machine and dominates it in the

[10] In association with Hermes, as appearing in Achille Bocchi (1555, 138), it has been studied by E. Wind 1968, 12 and Fig. 23; see also B. C. Bowen (1985, 222–29), who points to Plutarch, *De garrulitate*, 507A, as the source: as the one remains uncommunicated, states Plutarch there, so does a story with a single knower.

[11] And to the respective clarity of this representation is due its dominating role, while its "activity" in guiding it is equivalent to an increase in perfection, that is, in the same clarity.

[12] "Therefore I distinguish: (1) the primitive entelechy or soul; (2) the matter, namely, the primary matter or primitive passive power; (3) the monad made up of these two things (4) the mass or secondary matter, or the organic machine in which innumerable subordinate monads concur; and (5) the animal, that is, the corporeal substance, which the dominating monad in the machine makes one" (Leibniz 1989, 177).

role of central unity, as they say, or of the phantom inside the machine. This is an initial and palpable problem.

Now comes a second problem. The monad, as we have seen, is constituted from primary matter and soul, and then there is also the mass, i.e. the secondary matter. Is this secondary matter that of the dominating monad, or is it, so to speak, the "collective" secondary matter of the countless monads that participate in this mass? It surely ought to be the latter: it is difficult to think of a corporeal substance as reduced to the secondary matter of its soul.[13] This is, by the way, another reason why this passage doesn't seem, in the end, exceedingly perspicuous. So the secondary matter of the corporeal substance, that is to say the matter *tout court* of the corporeal substance, is constituted by the organized passivity of the other substances. Indeed, the generic, primary passivity of all the substances that enter and exit the main corporeal substance and its fluxes of exchange with the outside world, cannot by itself play that role; but their secondary matter seems to have an organization of its own, that is to say, an organization that might arise bottom-up from its constituents, at least as much as it can be governed by the dominating complete monad that plays the leading role in it.

Still another puzzle presents itself when Leibniz considers, on the one hand, the monad as a "complete substance" (completed, that is, by its two components – by the coexistence of a primary passive and a primary active principles) and on the other hand that the corporeal substance is completed by the coexistence in it of a soul and an organic body. On this Leibniz explains himself in various ways, but it is sure anyway – at least when he explains himself metaphysically – that no really complete individual substance could exist unescorted by an organic body. The existence itself of a primary matter, of the primary creaturely passivity – God alone is pure actuality – requires a matter that effectively provides the mutual connection of immaterial monads. In the correspondence with Des Bosses, it is clear that there is no subsistence, no continuity of the entelechy (the very reason of the continuity of the individual, that is, the entelechy that remembers itself), without the subsistance of the machine: "materia instar fluminis mutatur, manente Entelechia, dum machina subsistit" (GP 2, 306). Leibniz writes to Bernoulli in 1698: "What do I mean by incomplete? The passive principle without the active, or the active without the passive. The monad would not be complete without both principles together. Nevertheless the complete monad, or the individual substance, is not the soul alone, but the animal endowed with an organic body as well."[14] There is of course, from a Leibnizian point of view, a direct correspondence between its being complete in

[13] Besides, the monad has no secondary matter in the sense that it is a material soul – Hobbes doesn't take part in this discussion. The secondary matter, moreover, is mainly the matter of the other monads, since the soul's own secondary matter is simply the reflection, so to speak, or expression, of the body in the soul's passivity.

[14] "Quaeris 2. quid mihi hic sit incompletum? Respondeo: passivum sine activo, et activum sine passivo (. . .). 4. Monadem completam seu substantiam singularem voco non tam animam, quam ipsum animal aut analogum, anima vel forma et corpore organico praeditum" (GM 3, 541–42).

itself by possessing both activity and passivity, and its being complete in associating itself with a body.

It is easy to understand now that, although the *substantia simplicis completa* is the monad and it might be considered complete when, in general, it is completed by the primitive principles active and passive, the monad must also have, in correspondence with the second-level, a correlate in a "body", which is the organic machine, or mass. Can this monad exert an influence on, or *in*, the mass? Difficult to say – Leibniz was conscious of this, as we read in a letter to De Volder written some time before the one we have just quoted:

> Cum dico animam vel entelechiam nihil posse in corpus, tunc per corpus intelligo non substantiam corpoream cujus est entelechia quae substantia una est, sed aggregatum aliarum substantiarum corporearum organa nostra constituentium, nam una substantia in aliam adeoque et in aggregatum aliarum influere non potest (GP 2, 205).[15]

This remains valid also in a situation where the organic body is mutable. As Leibniz writes in a letter to Bierling of 1711: "omnis Monas creata est corpore aliquo organico praedita, secundum quod percipit, appetitque; etsi per nativitates mortesque varie volvatur, involvatur, transformetur, et in perpetuo fluxu consistat" (GP 7, 502).[16] This perpetual flux is indeed a machine,[17] similar to the ship of Theseus much lionized in philosophy: just as planks are replaced but the ship is always the same, the machine changes its components and nevertheless it is always there; should it dissolve, the soul would depart and the visible organic individual would "die". In this machine there is a monad as its entelechy or soul, the *monas dominans in machina*, enduring through time within this flux as the principle of its unity. But in another sense, although one that is not so easy to envisage, the machine is in the monad, since the monad directly perceives this machine as the machine whose soul it is – the body of which it is the soul. So this machine in its entirety is in the monad in a representative or representational manner, although the monad in turn is in the machine, in a manner that is not simply the reverse of that representation. The soul is in the *substantia corporea* as the principle of its unity, but not as a part of it. From the opposite point of view, it can be said that the machine

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[15] "When I say that the soul or entelechy cannot act upon the body, by body I do not mean the corporeal substance of which it is the entelechy, that is one substance, but the aggregate of the other corporeal substances that make up our organs. In fact a substance cannot influence another one, nor, consequently, an aggregate of others".

[16] "Every created monad is endowed with some organic body, in accordance with which it perceives and has appetitions, although [this body] is variously conveyed, developed, transformed, through birthings and dyings, and consists of a perennial flux".

[17] This should raise other difficulties, concerning the relation between matter and form, but, one might suggest, in Leibnizian terms the problem is indeed weakened, since the relation of matter and form is contaminated, so to say, by a concept that is absolutely not Aristotelian, i.e., that of the *infinite*. His metaphysics of essence entails that there is an infinity of essences, i.e. of individual beings, and in fact it is so, according to him, in created reality. Leibniz can thus afford to take some liberties, much better than keeping faithful to Aristotelian orthodoxy.

is in the monad, because it is in harmony with the latter's primary and secondary passive.[18]

5 That Ole Devil

We are finding ourselves ultimately confronted with a sort of *Aristotelianisme boiteux*: as a devil of Lesage, a double-faced instrument. From a certain point of view, Leibniz's Aristotelianism is nothing but a toolbox that, among other uses, allows him to shape the metaphysical setting within which it will be possible to locate his beloved neo-Galenist finalism (at least, such is his intention). But, although useful, perhaps even indispensable, it also generates its own problems.

Nevertheless, in yet another phase of his Aristotelianizing (approximately between 1708–1709 and 1712–1713), Leibniz goes back to developing the matter-and-form aspects of substance theory, and, all that happened notwithstanding, he does it in a quite systematic way. Central to this phase is a newfangled development of an already existing conceptual couple, that of *substantia* and *substantiatum*. For example, the corporeal mass is not substance, but *substantiatum*.[19] This concept could, in Leibniz's plan, explain the coherence of phenomena. "Phenomenon" means appearance, appearance entails perceptions, and perceptions, finally, are states of substances. Phenomena exist, lastly, as nothing but states of substances, but there are anyway degrees of phenomenal reality: many years before, the *De modo distinguendi phaenomena realia ab imaginariis*, well-known to Leibniz scholars, considered this problem from the point of view of epistemology. The *metaphysical* qualification of real phenomena is now that of being *substantiata*.

This is enough to establish the importance of this concept for Leibniz's metaphysical "real-idealism". Moreover, in this period, Leibniz theorizes on the same basis the emergence of matter and form of the corporeal substance as a "composed" substance.[20] "Composed" is used in this case partly in the traditional Aristotelian meaning, that is, composed of matter and form, and partly meaning that the matter itself and even the corporeal form of the corporeal substance results from composition. The form of the composite substance thus results from all the entelechies, the primary entelechy or that of the dominating monad, and the entelechies of the others monads that enter into the organic body. This is quite relevant, since it implies

[18]The secondary passive is here meant as the principle of the secondary passivity that corresponds to *materia saecunda*, just as the primary passive corresponds to *materia prima*.

[19]He will still be sticking to it in 1716 (see for instance GP 6, 625 or D 5, 173). The arc beginning with the discovery of the essence-existence nexus, and ending with the "substantia-substantiatum" theory of the natural world, encompasses the main phases of development of Leibniz's metaphysics; its closing accompanies the birth of Leibniz's final monadology, a complex theory that rejects composed substances and admits composed entities in opposition to simple ones, that includes, or at least engenders, a complex theory of space and *continua*, and that perhaps has emancipated itself from Aristotelianism and its troubles. Some most useful hints are found in V. De Risi 2007.

[20]I refer the reader to my 2006.

that on Suarezian terms, the organic body has a "formalitas": organized matter has its particular formality, although it is a derivative, or resulting one. The notion of *resultatum* (as in a form that "results" from other forms) is now at Leibniz's disposal to supplement the lopsided matter-form distribution in his substance theory. This is not exactly a return to a more conformist Aristotelianism, since the essences remain for him always the individual essences[21] of every really or possibly existing individual substance; there seems to be no essence of this resulting form, at least in the restricted meaning that there isn't in God's mind an individual essence corresponding to it. Leibniz, as far as I know, never says it explicitly, nevertheless it is clearly impossible. Anyway, the "resulting form" performs quite well as one of the much sought after alternatives to the *nudae monades*, with their phenomena, and the *vinculum substantiale*.[22]

One may wonder whether the entelechy that "results" is a proper, living entelechy, one in itself, or not. We have already quoted a brief passage from a letter to Des Bosses: "Materia instar fluminis mutatur, manente entelechia etc." (GP 2, 306). Leibniz doesn't write "monad", i.e. *manente monade*, but *manente entelechia*. Which entelechy? The particular one of the dominating monad, which is the soul thereof, "donec mutatur passivum primarium," or the total, resulting entelechy? This question, by simply posing it, makes it clear that it would be impossible to consider the resulting total entelechy as the reason for the life of this organic body. Not only does it have, strictly speaking, no individual essence, but it lacks a suitable unity as well. It is a form whose unity is intelligible only when we set out from the primary entelechy, and that clearly shows what it means to be really just a *resulting* entelechy, and thus only a resulting form.

6 No Living Organisms

This brings us to our final conundrum: in this complicated and mutable para-Aristotelian metaphysical setting, in which Leibniz conceptualizes in various ways the substantial counterparts in the created world, of the individual essences that are at the core of his metaphysics, are the organisms of corporeal substances living things?

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[21] The essence is even more a distinctive trait of Leibniz's metaphysics, when there is an implicit theory of the *compositio substantiarum*; monads have the exclusive right to the individual essence, just as every monad seems to have the right to a biological history, as it is endowed with an instrumental (organic) body, and every monad which is a spirit is entitled to a biography, or at least to a moral history.

[22] In fact the "composite substance" theory is to be found in drafts composed while Leibniz is discussing transubstantiation with Des Bosses, the unity of aggregates and of true substances, *substantiata* and so on, namely, when he is seriously looking for explanations of the reality of phenomenal bodies that might be viable at the level of the theory of substance, both preserving the independence of monads, and not requiring God to create special *vincula* every time they are needed.

It is well known that Leibniz was eager to consider living beings, and their parts too, as made up of smaller living beings, as well as to compose material objects of microscopic living beings in their turn – so that everything in Leibniz's material world, from stones, water, and garden plants, to fingers, hair, and glands, is in fact made of tiny beasts, and those, in their turn, are made of other microscopic animals: not exactly turtles, but little critters, one might say, all the way down. In a manuscript hastily jotted down near the end of the Paris years, we find a transcript of a discussion he had with Tschirnhaus on such matters:

> Dn. de T[s]ch. putat ostendi posse, animalia esse quae non ex aliis animalibus oriantur. Pulices vel pediculos varii generis produci in variis animalibus, se ipsum varia animalia posse producere, ubi nulla species animalia antea accesserint. Redium habere experimenta, quae si secutus fuisset, eodem fuisse perventurum. Esse puncta quaedam nigra aliquando in hominum naribus, ea si comprimantur posse exprimi genus vermiculi, *eine Made*,[23] eadem confirmari exemplo morbi pedicularis. Sed haec forte probant tantum, animalia sensibilia saepe oriri ex insensibilibus quibus aer plenus."[24]

At any rate, as time passes he will become increasingly Aristotelian, as far as criteria for identifying life are concerned. "Vivum," Leibniz writes in 1683–1685, is a substance "corpore et anima praedita" (A VI 4A 567). *Vivens* is predictably opposed to *machina*, in the tables of definitions that Leibniz compiles during this phase, and for him, as for Aristotle, the parts of the organic body are not living: a detached part of a living body isn't a living thing any more, although it resembles something living.

During the period of *substantiata* and "composite substances" that we have briefly presented, Leibniz composes, among other things, four interesting and quite dense pages on the general principles of his philosophy, and particularly on the principle of reason, that have been published by Couturat in the *Opuscules* (O, 12–16). An ameliorated, critical edition of this text is provided as an Appendix to this volume. The manuscript has been dated to 1708 by way of the watermark[25] and is often called, from its opening line, *Principium ratiocinandi fundamentale*. This well-known fundamental principle of reasoning is that there is nothing without a reason,[26] a principle whose philosophical consequences are explained by Leibniz together with some metaphysical doctrines that it entails more or less immediately. We learn for instance, that all creatures can be classified as accidental or substantial, and the latter are, as we know, either *substantiae* or *substantiata*, i.e. aggregates of substances, such as all bodies. A substance is either simple, as the monad or soul, or composite of a soul and an organic body. The organic body is consequently an aggregate that is finally resolved into living things, "in viventia," which are ultimately

[23] German: "a larva".

[24] LH XXXVII, 2, 123v; it is available in facsimile from the *Online-Ritterkatalog* (http://ritter.bbaw.de). Rather uncanny, and that is in truth the main reason for the quotation, especially the passage on larvae and comedones. But I'd rather not translate it.

[25] I must thank Herbert Breger for this information.

[26] In the English paraphrases of this text I'll be following with some modifications G. H. R. Parkinson's version in G. W. Leibniz 1973.

substances. Therefore the body subsists fragilely on simple substances that alone exist genuinely. This rests, as usual, upon the infinite subtlety of created things: "Nec quisquam opera Dei ut par est intelligit, nisi qui infinitum[27] in illis satis agnoscit". To fittingly understand the works of God one must recognize in them the infinite, so as to let the effect be the trace of its cause.

If natural effects are best understood as traces of a wise and intelligent cause, the door is open to a general finalism. But we can sometimes arrive even at particular truths about natural things through final causes, as is shown by the doctrine *de usu partium* and by the modern adjournment of Galen's finalism proposed by Leibniz himself in demonstrating optical laws with the help of this or that principle of the minimum. Nevertheless, final causes coexist happily with mechanical causes and material beings are in harmony with intangible ones. In bodies everything occurs mechanically, that is, through the intelligible qualities of bodies (magnitude, shape and motion); likewise in the case of souls, everything is to be explained in vital terms: "omnia in corporibus fieri mechanice, idest per intelligibiles corporum qualitates nempe magnitudines figuras et motus; et omnia in animabus esse explicanda vitaliter", not noetically or ideally, but "vitally", "id est per intelligibiles qualitates animae". The intelligible qualities of the soul are perceptions and appetites, that is, the proper states of individual substances. Real-idealism requires seemingly mechanist-vitalism, and perhaps vice versa, and so the line between living and non-living is drawn exactly on top of the division between the mechanical organic body and the simple substance characterized in vital terms.

However, according to Leibniz, we detect in animated bodies a beautiful harmony between vitality and mechanism, such that what occurs mechanically in the body is represented vitally in the soul; and what is perceived exactly in the soul is handed over completely for execution in the body. Thus, as is often the case with Leibniz, who signs his writings as the *auteur du système de l'harmonie préétablie*, the animated body is maintained by pre-established harmony. But here the accord is posed between *vitalitas* and *mechanismus*, and not between soul and body, or spirit and flesh, or thought and passions. In the body, everything happens mechanically; in the soul, again, it is represented "vitally." Thus in composite substances the organic part, the animated body, corresponds to the vital part, i.e. to the soul, in the same manner as mechanical causes correspond to final causes.

Already in 1697, in a letter to Burnett, Leibniz described his philosophical positions as keeping the middle way between Plato and Democritus, and explained this in terms of the balance between mechanism and vitality:

> . . . puisque je croy que tout se fait mechaniquement comme veulent Democrite et Descartes, contre l'opinion de M. Morus et ses semblables; et que neantmoins tout se fait encor vitalement et suivant les causes finales, tout estant plein de vie et de perceptions, contre l'opinion des Democriticiens (GP 3, 216–17).[28]

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[27] Couturat omitted this very word, making the close of Leibniz's text somewhat awkward.

[28] The most Platonist trait here apparently being the implied panpsychist identification of life and soul. The passage is translated in C. Merchant (1979), at p. 258: "My philosophical views approach somewhat closely those of the late Countess of Conway, and hold a middle position between

In *De anima*, Aristotle writes: "Of natural bodies some have life in them, others not," and those that have are substances, "in the sense of a composite" (*De an*., II, 1). For Leibniz, apparently, "complete" and "living" apply, although differently, both to composite substances and to simple substances: but it is clear that only composite and simple substances are alive, and the first ones only thanks to the latter.[29] Organisms are not per se among the living.

7 A New Transcendental

I would like to suggest that in this context we may distinguish three different levels, which keep Aristotelian names, although they only roughly correspond to the usual Aristotelian distinctions. "Metaphysics" is at work where the discourse concerns essences, unities, individuals, and the infinite. "Physics" is in Leibniz's practice "natural science" in a modern sense, i.e. that doctrinal field wherein certain kinds of theories concerning natural entities are developed. It does not matter, if we follow Leibniz, whether those theories are mechanical, atomistic, or even based on infinitesimals, since the perfect rational organization of creation permits being studied with any kind of theory. And in the middle of these two there is a level that is not properly that of the metaphysical architecture, but is rather a cosmology, or a sort of philosophy of nature (in the later sense of the phrase), that is composed, we might advance tentatively, by the theory of substance, the architectonic principles, and the theory of general and particular finality. This level is not exactly the one where the most important metaphysical knots are solved – only relatively conditioned ones – but it is also independent, *subalternans* but also *subalternatum*. At this level, Aristotelian conceptual tools are instrumentally used by Leibniz to provide a theory that can describe the metaphysical components of his multi-level monadological universe as they exist in the natural created world. And, at this same level, at the core of his substance theory, connecting it to the theory of individuals as represented metaphysically by individual essences, we can find in the end a peculiarly Leibnizian identification of the true living and the "vere unum."

The organic body, which is not *unum* per se, is not, as we have seen, *vivum* per se. What then is eligible for being *stricto sensu* alive? If the properties of being alive, and of being able to make living beings out of mutable collections of other things, are possessed only by such individual beings that have the function of souls and principles of unity, as the form is a principle of the substance, this implies that "being *vivum*" is coextensional with the domain of those entities called by Leibniz "true unities." Only an *ens verum ac vere existens* could thus be both *vivum* and *vivificans*. Everything that is truly one, *unum* per se, is also living; everything that is not

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Plato and Democritus, because I hold that all things take place mechanically as Democritus and Descartes contend against the views of Henry More and his followers, and hold too, nevertheless, that everything takes place according to a living principle and according to final causes – all things are full of life and consciousness, contrary to the views of the Atomists".

[29] This imbalance holds perhaps for completeness too.

unum per se, conversely, is not living: it must come to be alive thanks to the action of the soul, or dominating monad, i.e., thanks to the correspondence, in the representations of the other involved monads, of the clearer representations that it has of it. Its activity, in fact, consists in this superior clarity, as well as passage to increasing clarity. Indeed *omne ens est unum*, as is well known; it is likewise *verum*, and *omne verum ens est unum*, since all such properties *convertuntur*; it is also *bonum*, inasmuch as God created it, and finally it is, as it seems, *vivum*. Consequently we might say, as a somewhat Bombastic conclusion, that from Leibniz's point of view "vivum" has to be a sort of new transcendental,[30] or at least that this is most likely true within that fabulous Leibnizian realm of per se attributes.

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[30]Transcendental terms and properties, in this sense, are those which, in the Scholastic tradition, belong to every possible being, and, for this reason, are convertible or equivalent with "being" (*ens*) and with each other. Therefore they transcend, or surpass, distinctions and categories.

Chapter 7
The Machine Analogy in Medicine: A Comparative Approach to Leibniz and His Contemporaries

Raphaële Andrault

1 Introduction

From the 1670s on, Leibniz designates living bodies by the word "machines". In the *Système nouveau* he expands upon this with a firm distinction between natural and artificial machines: the analogy between artificial and organic bodies, required for the intelligibility of living beings, does not diminish the ontological distinction between them.[1]

From an epistemological point of view, the Leibnizian machine analogy is often traced back, rightly,[2] to a partial adoption of the corpuscular philosophy, of which it is held to be a straightforward consequence: an organic body is a machine insofar as it is, first and foremost, an aggregate of material parts figured and moved in various ways.[3] A well-known difference, however, casts doubt on this interpretation:

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[1] See Michel Fichant 2003, p. 15.

[2] *Animadversiones in G. E. Stahlii Theoriam observationes, Responsiones* II, Dutens II-2, p. 144: ". . .organismum nihil aliud esse formaliter, quam mechanismum, etsi exquisitiorem et diviniorem, quia omnia in natura fieri debent mechanice. Cujus ratio dudum alata fuit in discursu objectionibus addito, quia omnia debent ita fieri in corporibus, ut possibile sit ea ex natura corporum, id est ex magnitudine figura et legibus motus distincte explicari, et hoc est, quod mechanicum appellamus."

[3] See *Letters to Arnauld,* GP II, 58: "Cependant quelque approbateur des Scholastiques que je sois dans cette explication generale et pour ainsi dire metaphysique des principes des corps, je suis aussi corpusculaire qu'on le sçauroit estre dans l'explication des phenomenes particuliers, et ce n'est rien dire que d'y alleguer les formes ou les qualités. Il faut tousjours expliquer la nature mathematiquement et mecaniquement, pourveu qu'on sçache que les principes mêmes ou loix de mecanique ou de la force ne dependent pas de la seule étendue mathematique, mais de quelques raisons metaphysiques." The identification of the mechanical philosophy with the corpuscular philosophy comes from Boyle, and is made by Leibniz himself. Corpuscular philosophy brings together the mechanist philosophy of Descartes, as it is explained in the *Principia*, with the atomist philosophies, which, against the former, admit the void and atoms. See Boyle, "Some specimens of an attempt to make chemical experiments useful to illustrate the Notions of the corpuscular philosophy," (1999), vol. 2, p. 87: "I esteem'd that notwithstanding these things wherein

J.E.H. Smith, O. Nachtomy (eds.), *Machines of Nature and Corporeal Substances in Leibniz*, The New Synthese Historical Library 67, DOI 10.1007/978-94-007-0041-3_7,

a machine always has some end or other that enables us to explain its functioning. Intelligibility by final causes is required for machines, whereas this is less obviously the case for a mere corpuscular aggregate. This initial consideration compels us to examine in detail the links between the machine analogy, on the one hand, and mechanical (or corpuscular) explanation[4] on the other. Does the designation of an organism by the word "machine" require the adoption of mechanistic presuppositions? And do these presuppositions enable us to explain all the various methodological meanings of the machine analogy? Indeed, regarding an organic body as a machine could be a mere consequence of a lexicalization[5] of the word "machine". In this case, using the word "machine" instead of "organic body" or "living body" would not be related to any particular philosophical thesis in preference to another one.

In order to answer these questions it will be necessary to compare Leibniz's use of the notion of "machine" with that of his contemporaries. Considering that this designation of living bodies occurs, notably, in a medical context, it seems to us relevant to study what the term "machine" meant in the anatomical texts that were known to Leibniz. We will mainly base this comparison on Leibniz's exchange with Stahl, and to avoid a misjudgment of some distortions of the Leibnizian positions produced by the controversy, we will further develop our initial answer with other texts in which Leibniz explicitly discussed the machine analogy in a medical context.

After Descartes, the habit of designating every sort of highly composite body by the word "machine" becomes so widespread that it is difficult to give it an *intensional* definition (that is, to define the word by its proprieties and not by enumerating the individuals it designates). In medical treatises, as well as in philosophical texts, the word "machine" often occurs as a mere synonym of *fabrica* (or mere "*dispositions des organes*"[6]) conceived as an artifact capable of executing some actions. On this view, it is above all a tool which facilitates abstraction in two ways. First, this term enables one to free the study of movements from any examination of the relations with the mind, a soul, or any immaterial and intelligent substance, to the extent that it is agreed that if the soul acted as a cause in a corporeal process, it would be only through the intervention of an organ with proper movements and figures, which

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the Anatomists and the Cartesians differ'd, they might be thought to agree in the main, and their Hypotheses might by a Person of a reconciling Disposition be look'd on as, upon the matter, one Philosophy. Which because it explicates things by Corpuscles, or minute Bodies, may (not very unfitly) be call'd Corpuscular."

[4]The links between corpuscular philosophy and the machine analogy have more often been studied in a physical context than in a medical one.

[5]By *lexicalization,* I mean the entry of a new way of designating a thing (for instance by a metaphor or a neologism) into the common lexicon of one language: does the word "machine" become just one usual way of speaking about living bodies, deprived of the initial and technical implications of true analogies between an artificial machine and a natural one?

[6]See Descartes, *La description du corps humain,* AT XI, p. 225: "…l'âme ne peut exciter aucun mouvement dans le corps, si ce n'est que tous les organes corporels, qui sont requis à ce mouvement, soient bien disposes."

are anyway describable by the anatomist. This meaning is clear in a well-known analogy developed by Malpighi[7]: whatever may be the physical agent of the movement, whether it be an angel, or a man, or a purely corporeal agent such as a stone, a mill executes its functions in the same way, that is, through the same structure and through the same corporeal movements. Second, since the word "machine" designates all natural corporeal organization with order, variety, and proper movements, it enables one to leave aside specific differences between bodies, and encourages heuristic analogies. Thus it expresses the presupposed uniformity of nature according to which differences between natural bodies are explainable merely by various degrees of complexity. For instance, Malpighi regards vegetables as very simple "machines", which are to be examined in order to understand more complicated ones, such as insects or animals.[8]

According to this usage, the concept of "machine" seems neither to refer to a definite kind of artificial organization, nor to imply any positive ontological thesis. Indeed, if employing the word "machine" to designate a natural body does not exclude the action of the soul upon the body (provided that the understanding of this action includes the description of the material structure that it requires), the image of a "body-machine" can be employed by an animist as well as by a mechanist who refuses any kind of efficient causation between mind and body.[9] Furthermore, since the "machine" enables one to refer only to the mere structure of bodies, i.e., to the respective relations between several parts in motion, the nature of the ultimate parts does not matter much: the concept does not necessarily indicate a postulate concerning the essence of matter, and its occurrence in a text on natural bodies does not allow one to ascribe to its author a Cartesian identification of matter with extension.

Because of this extreme generality, and since the meanings of "machine" in such a context appear to be determined more by its use than by what it designates, it seems to us relevant to take into account some particularly virulent debates in order to understand some effects of the analogy between living bodies and machines. In this respect, the polemical exchange between Leibniz and Stahl belongs to the medical disputes of the late seventeenth century, which revolve around the determination of the legitimate place of anatomy among the other medical disciplines.

According to both Leibniz and Stahl, an organism requires an aggregate of corpuscles, which are defined by their mechanical properties, i.e., by their figure, sizes, situation and motion.[10] Stahl as well as Leibniz identifies such an aggregate with what is called a "mechanism" or a "machine."[11] The disagreement concerns neither

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[7]Malpighi (1698), p. 292. See Catherine Wilson (1995), p. 232, and François Duchesneau (1998), p. 207.

[8]Malpighi, *Plantarum anatome*, in *Opera omnia* (Leiden, 1687), I, p. I.

[9]See for instance Johann Bernoulli (1694, vol. 87, pt. 3, § 20): "Thus in the whole machine of the human body, every smallest particle involved in a movement is moved either directly by an order of the soul or by muscles. All these muscles follow strictly and steadily the laws of mechanics."

[10]See Stahl (1706), p. 13.

[11]See Leibniz, *Animadversiones,* op. cit. II, Dutens II-2, p. 136: ". . .omnis organismus revera sit mechanismus, sed exquisitor, atque, ut sic dicam, divinior; dicique possit (ut jam notavi) corpora

the corpuscular representation which underlies the designation of a natural body by the term "machine," nor the acknowledgment of the partial relevance of the mechanical philosophy to the study of its functioning. The difference between the two has to do with the explanatory value ascribed to the analogy between natural and artificial machines, and it raises two issues: first, the relative autonomy that Leibniz ascribes to the machine, in comparison with Stahl, who regards it as a thing only endowed with "mobility" or a natural ability to receive a motion[12]; second, the role of chance in the generation and functioning of an artificial machine. According to Stahl, to *compare* organisms with artificial machines leads us to consider natural bodies *only as* "mechanisms," and this view speaks against the finality governing the motion of organic parts.

2 Description of the *Modus Operandi* and Explanation of Functions

According to Stahl in his first reply to Leibniz, every organ – i.e., every instrument – is a machine, but not every machine is necessarily an organ.[13] A machine becomes an organ only insofar as an exterior agent uses it with a determinate purpose. In the *Disquisitio de mechanismi et organismi diversitate,* the example of the machine is, as one might expect, the clock. As François Duchesneau emphasizes,[14] without the intervention of an engineer having organized the mechanical elements of the clock in order to make it indicate the hours, and without a worker regularly winding up its mechanism, the clock is only a machine, not an organ: finality is lacking in the clock itself.[15] In the exchange with Leibniz, Stahl uses the example of scissors, an

naturae organica revera machinas divinas esse". And Stahl: *Disquisitio de mechanismi et organismi diversitate*, op. cit., p. 13: "Maximo hodie, imo passim perpetuo & absoluto in usu est, appellatio Mechanismi, mechanici, machinae, potestatum mechanicarum"; p. 16: "Ad mechanismi itaque formalem rationem sufficit, tum in genere aliqua quantumcunque tandem mutabilis, magnitudinis, figurae, situs, motus, aut cuiuscunque mobilitatis praesentia, ut nempe res his modis affecta mechanice disposita dici mereatur. Absit autem ab illa omnis pecularis immediati usus respectus, quandoquidem illius intuitu statim ad instrumentalem indolem deflectere possit. Huiusmodi mechanica constitutio est tam in minimis quam maximis speciminibus passim obvia"; p. 17: "Organismi vero (loquimur autem hoc de illo, qui inter res et actiones physicas contingit) proprium omnino est, seu essentiale requisitum, ut mechanicam habeat dispositionem; & quidem hanc non solum in genere, quatenus in omni subjecto corporeo, mechanica dispositio absolute necessitate praesto est: sed prorsus etiam in specie ita, quemadmodum illa rei, cui proprie destinatur, omnino etiam mechanica proportione conspirat atque quadrat."

[12] Stahl (1720), p. 62: "Quod in Corpore nulli sint Motus praecedentes, sed sola mobilitas seu habilitas ad motus."

[13] In Stahl, the difference between organ and organism does not correspond to the difference between the parts and the whole.

[14] See 1995, p. 189–190, and *Les modèles du vivant de Descartes à Leibniz,* pp. 315–372.

[15] Stahl, *Disquisitio,* p. 19: "Revera enim, quotiescunque vel per intentionis vel per sufficientis peritiae defectum, temere intenditur tale horologium, vel nullas certas horas distinguet, vel omnino nullas veras. Interim quod simpliciter pergat elastice moveri, in respectu ad specialissimae suam

example of machine that, it is worth noting, is not peculiar to Stahl. In the introduction to the *Œuvres mécaniques et physiques,* Claude Perrault, who also admits the action of the mind on the body, takes scissors as an illustration of a machine. According to his definition, "a machine is a thing which is useful for doing something by means of an artificial and composite instrument more easily than by means of the hands or a simple instrument" (such as a knife).[16] So the machine in question is devoid of any autonomy, be this only temporary or apparent.

According to Stahl's analogy, the living body itself is nothing more than a passive mechanism capable of acting in accordance with a purpose: what transmits a movement and a determination to it is the soul, which knows and governs the parts of its own body. As mentioned in the *Disquisitio de mechanismi et organismi diversitate* (§ 98), a human body is organic in so far as it is the instrument or the "dispensary" of a reasonable soul.[17] Thus the organism is a mechanism used by an exterior and intelligent agent, and, in the present case, by the soul.

By contrast, in accordance with the mutual connection of efficient and final causations in the understanding of the machine, Leibniz emphasizes that functions are immediately dependent on inner structures and movements, even though our partial ignorance of the machine's details compels us to use our knowledge of its ends in order to discover its means.[18] In other texts, the analogy between the structure and functions of the animal on the one hand and the means and ends of the machine on the other hand is certainly used to compensate for the overuse of the mechanical philosophy.[19] Nevertheless Leibniz uses this analogy more often in order to emphasize

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efficaciam, qua horis exquisite distinguendis aptum, directioni etiam ad veras horas diei naturalis distinguendas sub iusta directione destinatum est, quoties, & quamdiu, & quocunque tandem defectu hunc effectum non assequitur, organum stricto sensa absolute non est. Imo hoc eodem sensu vero atque in refundato, machinula eiusmodi etiam quocunque interne defectu, effectur huic horas recte atque vero demonstrandi impar, revera nuda, absolute & simpliciter, machina dicenda est, minime vero instrumentum certae rei idoneum ac utile."

[16] *Œuvres de physique et de mécanique de Mrs. C. & P. Perrault* (1727), "Table des termes de science," pp. 65–78.

[17] Stahl, *Disquisitio de mechanismi et organismi diversitate,* op. cit., p. 51–2: "Firmum itaque atque ratum omnino volumus, & fundamenti loco, universis nostris dogmatibus hoc substernimus, quod corpus humanum simplici & genuino penitus sensu, sit Organicum; & quidem animae rationalis Organon (seu officina) illius necessitudinibus tam efformandum quam conservandum: undique et undique motibus gubernandum, & illis quidem scite atque recte ad finem optatum proportionatis atque conspirantibus."

[18] From the strict view of the understanding of corporeal phenomena, ends are mere effects of inner structures and movements of the machine (see Leibniz, *Animadversiones,* intro. § 3, Dutens II-2, 135:". . .effecta oriantur ex intestinis motibus structuraque machinae"). See Stahl, *Negotium otiosum*, op. cit., p. 46: "Haec relata sibi sunt ad vim vegetandi, qua corpus vivum sese perficit, nutrit, reparat, propaget: quodque hoc ipsa structura machinae consequi putet, etc."

[19] More precisely, mentioning the incoherencies in Epicureanism, which states that we do not have eyes to look at something, but rather that we are able to look at something because we have eyes, enables Leibniz, like Malebranche before him, to criticize the decline of final causation in the "moderns" see (1993, IV, v. 823 sq). See also Malebranche (1979), p. 156: "Quand je vois une montre, j'ai raison de conclure, qu'il y a une intelligence, puisqu'il est impossible que le hasard

that the finalistic understanding should not be separated from the knowledge of the particular structure capable of realizing those ends.[20]

This much is particularly clear in a text edited by Enrico Pasini entitled *De scribendis novis Medicinae Elementis* (1680–1682). Here Leibniz emphasizes that if it is quite easy to reveal the functions of a machine, it is more difficult to know which means, among all possible means, have been used by the artisan to obtain such a result.[21] The analogy is then employed to criticize the Cartesian model of the animal-machine that does not describe in accordance with experience the means of producing those functions, which the model might explain in other respects (here Leibniz follows Steno's criticism of Descartes).[22]

Medical treatises of Leibniz's time provide an illustration of methodological and institutional consequences which derive from the identification of the *modus operandi* of the machine with the structures and motions of living bodies. In the texts of Steno known to Leibniz, analogies with machines take on a polemical function, and are used for precise ends: First, to show that there is no solution of continuity between anatomy and physiology, that is, between the description of parts and the understanding of their functions. For example, in his *Lecture on Brain Anatomy,* Steno states that the "brain is a machine." What he means is that one cannot ascribe the uses to the organic parts without first showing in detail the natural situation of

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ait pu produire et arranger toutes ses roues. Comment donc serait-il possible que le hasard, et la rencontre des atomes, fût capable d'arranger dans tous les hommes, et dans tous les animaux, tant de ressorts divers, avec la justesse et la proportion que je viens d'expliquer; et que les hommes et les animaux en engendrassent d'autres qui leur fussent tout à fait semblables. Ainsi, il est ridicule de dire comme Lucrèce que le hasard a formé toutes les parties qui composent l'homme; que les yeux n'ont point été faits pour voir, mais qu'on s'est avisé de voir, parce qu'on avait des yeux. . ."

[20] See Letter to Conring (1677), GP I, p. 173: ". . . quia eadem phaenomena pluribus modis produci possunt: ipsum praecise modum quo Artifex usus est, nisi dissoluto opere definire non possum. Si qua tamen hypothesis non tantum experimentis praesentibus satisfaciat, sed et prophetiam quandam non fallentem praebat de futuris, ei valde fidendum est". See also *Discours de métaphysique* (§ 22): "je reconnais et j'exalte l'adresse d'un ouvrier non seulement en montrant quels desseins il a eus en faisant les pièces de sa machine, mais encore en expliquant les instruments dont il s'est servi pour faire chaque pièce, surtout quand ces instruments sont simples et ingénieusement controuvés." See lastly *De scribendis novis Medicinae Elementis* (1680–1682?), in Enrico Pasini (1996), p. 212.

[21] *De scribendis novis Medicinae Elementis*, ibid.: "In omni Machina spectandae sunt tum functiones eius, sive finis, tum modus operandi, sive quibus mediis autor machinae suum finem sit consecutus. Itaque cavere debemus, ne machinam fingamus quae forte praestet easdem functiones, sed tamen non iisdem modis, nam praecepta illius machinae imaginariae conservandae a verae machinae legibus diversa essent. Unde mirum non est novos quosdam philosophos quorum ingeniosissima de Homine cogitata habemus, parum ad rem Medicam augendam attulisse, quia hominem ex ingenio potius quam experientia delineavere."

[22] Steno, letter 11 to Bartholin, march 1663, in (1952), I, p. 171: "Certe quo plura tum aliorum animalium, tum varii generis avium aperio cerebra, eo minus animalibus convenire ingeniosissima et actionibus animalibus explicandis admodum alias conveniens cerebri animalium a nobilissimo Cartesio exgocitata fabrica videtur."

those parts.[23] According to Steno's analogy, the "artifact of the machine" is the inner structure and the movements of the organic parts. This position is taken up in the context of a virulent debate on the legitimate place of anatomy among the medical disciplines: a certain number of physicians held that bringing to light some organic parts which until then escaped their senses would not enable them to better understand the actions of living bodies, as if anatomy and physiology had two different ends, or did not depend on the same rules.[24] In this context, arguing that an organ is a machine consists in showing by contrast the medical usefulness of anatomy: anatomical descriptions are necessary for the understanding of functions. Similarly, in his *Zootomia democriteae* (1645), Marco Aurelio Severino defended himself against the Galenic physicians who cast doubt on the usefulness of "minute anatomy" by arguing that to dissect living bodies into their small parts was in itself an Epicurean project.[25] According to Severino, just as one who wants to understand and then to repair a clock has first to dismantle the machine, so too one who wants to heal a human body has to know the situation and the nature of its parts. To understand and control the whole requires that one first visualize the organization and the movements of the parts.[26]

The second role of the machine analogy is to specify the direct link between the development of anatomy and the progress of the art of healing, or practical medicine. According to Steno in the *Lecture* and in the *Myology*, "just like the construction of a machine built by someone else must be precisely understood by the one who must restore the movement of this damaged machine, similarly the nature of the blood, of the nerve fiber, and of the motor fiber must be investigated as far as human zeal permits by the one who wishes to cure not only by luck the symptoms affecting natural movement."[27] Steno develops this analogy in a letter in which he defends himself against the statement that the advancement of anatomy does not contribute to the

[23] Steno (1669), p. 32: "[Le] cerveau étant une machine, il ne faut pas que nous espérions d'en trouver l'artifice par d'autres voies que par celles dont on se sert pour trouver l'artifice des autres machines. Il ne reste donc qu'à faire ce qu'on ferait en toute autre machine; j'entends de démonter pièce à pièce tous ses ressorts, et considérer ce qu'ils peuvent faire séparément et ensemble"; p. 54: "Je n'ai rien dit jusqu'ici de l'usage des parties, ni des actions qu'on appelle animales, parce qu'il est impossible d'expliquer les mouvements qui se font par une machine si l'on ne sait l'artifice de ses parties."

[24] See Claude Perrault, *La mécanique des animaux*, in *Œuvres de physique et de mécanique* (Amsterdam: 1677), p. 513: "La dissection, qui présente à l'œil la composition & la structure artificieuse de toutes les parties des organes, n'en fait voir, pour ainsi dire, que le dehors. Pour être instruit autant qu'il est possible, de ce qui se fait dans les organes, il faut entrer plus avant, & passer outre, si l'on peut, par l'entremise des conjectures & des réflexions que les différents phénomènes peuvent fournir."

[25] *Zootomia democriteae* (1645), p. 1–2, and p. 38.

[26] On this issue, see Philippe Hamou (2001), p. 133: "Il est clair que pour Hooke la vision constitue un mode privilégié d'expérience. [. . .] En ce sens, voir, voir clairement et distinctement, c'est déjà comprendre. Et réciproquement comprendre un phénomène ou une propriété c'est, à certains égards, le rendre visuel."

[27] Troels Kardel (1994), p. 225, and *Elementorum myologiae specimen*, in Nicolaus Steno's *Opera philosophica*, op. cit., II, p. 106.

progress of the healing art. And when Malpighi defends himself against the same kind of criticism from an "empirical" physician, a detractor of minute anatomy, he similarly employs the machine analogy: since Nature builds all bodies by means of the organization of minute bodies, the physician who wants to heal those bodies should know their minute elements.[28] It might appear that these two cases do not necessarily involve a typical use of the machine analogy as it was employed in the period. Yet in the *Encyclopédie* of Diderot and D'Alembert we find just this in the article on "Anatomy": if a living body, or even the human body, is merely a kind of machine (however highly composite or complicated), then the best anatomist is also the best physician, since the understanding and the control of the functions derive from knowledge of the inner parts.[29] Thus the development of research in minute or comparative anatomy was constantly forced to confront criticism of its legitimacy. And, as we have seen, the response consisted in comparing the human body with a machine: showing that the mechanic has to perform a sort of autopsy of a machine in order to control and repair its functions demonstrates that the anatomical knowledge of a living body is necessary for the art of healing: that is, that inspection of the inner structure of a living body is required in order to repair its dysfunction.

Which assumptions are required to explain Steno's position and the way he uses the machine analogy? We will first provide a negative response: (1) the analogy is not used to establish a thesis concerning the identity, or even the homogeneity, of beasts and machines.[30] On the one hand, Steno often expresses doubts as to the Cartesian thesis that beasts lack souls[31]; on the other hand, he states that what we know about the essence of matter does not enable us to explain perception.[32]

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[28] See *Responsio* Marcello Malpighi *ad epistolam, cui titulus est: De recentiorum Medicorum studio dissertatio epistolaris ad Amicum,* in *Opera posthuma,* op. cit.

[29] See the Article "Anatomie": "Avantages de l'Anatomie. Lorsqu'on examine combien il est nécessaire de connaître parfaitement le mécanisme de l'ouvrage le plus simple, quand on est préposé par état, soit à l'entretien, soit au rétablissement de cet ouvrage, s'il vient à se déranger; on n'imagine guère qu'il y ait eu & qu'il y ait encore deux sentiments différents sur l'importance de l'Anatomie pour l'exercice de la Médecine. Lorsqu'on s'est dit à soi – même que, tout étant égal d'ailleurs, celui qui connaîtra le mieux une horloge sera l'ouvrier le plus capable de la raccommoder, il semble qu'on soit forcé de conclure que, tout étant égal d'ailleurs, celui qui entendra le mieux le corps humain, sera le plus en état d'en écarter les maladies; & que le meilleur Anatomiste sera certainement le meilleur Médecin [. . .]" (*Encyclopédie ou Dictionnaire raisonné des sciences, arts et métiers, par une société de gens de lettres,* éd. Diderot et d'Alembert (Paris: Priasson, 1751–1772), I, p. 409).

[30] Let us point out that the Latin word "*mere*" employed by Stahl and Perrault, as well as by Leibniz, is always used to change the machine *analogy* into an ontological *identification* (in this case, the adjective acts as a foil), and should be understood in connection with the Cartesian statement that beasts are without souls.

[31] See Letter 3 to Thomas Bartholin, September 1661, 12, *in Epistolae,* op. cit., p. 142. Steno seems anxious on this issue: he is doubtful whether Descartes is right to deprive animals of souls, yet the dissections he himself practices would be legitimate only if Descartes were right.

[32] Steno, *De solido intra solidum naturaliter contento*, in *Opera philosophica,* ed. V. Tryde, 1910, II p. 188: "Hactenus in natura materiae nihil cognitum nobis esse, cujus ope motus principium et motus perceptio explicentur."

(2) The analogy does not require him to say that the same mechanical process (for instance a hydraulic one) works towards the execution of a biological motion or in the motion of an artificial machine, for there is no functional analogy in Steno. (3) The analogy does not depend on the identification of matter with extension. Certainly, Steno assumes that bodies are at least aggregates formed by fluids and solids in motion, but he never excludes the possibility that in bodies – particularly in organic ones – there could be elements irreducible to mechanical properties (for instance in the explanation of hardness). Equivalence between a body and an aggregate is a widespread postulate requiring as few assumptions as possible: on the one hand, thanks to its extreme generality, the postulate accords with available experience; on the other hand, the postulate enjoys unanimous agreement, whatever the particular assumptions of any "sect" (Atomist, Aristotelian, Platonist, Chemist, etc.) may be concerning the essence of matter or the origin of motion. (4) The analogy does not further the criticism of final causation, apart from the fact that some finalistic arguments, such as "nature does nothing in vain," only conceal our ignorance: the explanation of the function of a part must follow the analytic understanding of bodies, since functionalist anticipation is often a source of mistakes.[33] Thus, this position is different from the Epicurean one to which the detractors of mechanism intend to reduce it with their criticism.

Given these conditions, what is the positive assumption implied by Steno's machine analogy? Any corporeal change, whether organic or not, can only be explained in relation to an antecedent movement which is material and visualizable, even if not seen. The positive assumption thus implies only a presupposition concerning the relation between the sensory description of a material thing, its intelligibility, and the conditions of actual progress in medical science.

In the exchange between Leibniz and Stahl, theses concerning the connections amongst the medical sciences are similarly based on some wider epistemological *partis pris*. First, Leibniz also uses the idea of "machine" to confirm the link between the intelligibility of functions (for instance nutrition) and the visualization of minute structures and their motions. Thus, "from the minute description [. . .] of the clock derives the understanding of the reasons why and how it acts."[34] There is no opposition between the "how" (efficient causation) and the "why" (final

[33] See *Le discours sur l'anatomie du cerveau*, op. cit., p. 53: "Les personnes raisonnables doivent trouver ces Anatomistes affirmatifs fort plaisants, lorsque après avoir discouru sur l'usage des parties dont ils ne connaissent pas la structure, ils apportent pour raison des usages qu'ils leur attribuent que Dieu et la nature ne font rien en vain. Mais ils se trompent dans l'application qu'ils font ici de cette maxime générale, et ce que Dieu, selon la témérité de leur jugement, a destiné à une fin, se trouve par la suite avoir été fait pour une autre."

[34] § VII. *Animadversiones,* Dutens II-2, p. 137. On the connection between the machine analogy and the identification of explication with visualization, see Philippe Hamou, op. cit., p. 136: "Le privilège d'intelligibilité du mécanisme sur toute autre forme d'explication naturelle était chez Descartes [. . .] déjà solidaire de sa qualité éminemment visuelle ou visualisable". See also P. *Guénancia* (1988), pp. 213–223, p. 215: "La machine est l'exemple par excellence de la visibilité intégrale à laquelle la science doit idéalement ramener l'ensemble des phénomènes naturels."

causation),[35] but rather between the description and the understanding of the action. Here Leibniz is opposed to Stahl's view that, "one would vainly claim to understand the *mechanical reasons* of the functioning of the clock only through a mere inspection (or description)."[36]

Second, exactly like Steno and Malpighi, Leibniz considers that the progress of the art of healing depends partly on that of descriptive anatomy. In the *Directiones ad rem Medicam pertinentes,* he encourages the discovery of all of the minute parts of the body.[37] In the exchange with Stahl, he refutes the idea that especially fields which are outside medical issues would benefit from the advancement of Anatomy: "It is why I do not really conceive by what right denying that in universal structure and texture of the organic parts of a body lies [. . .] [what is remarkably useful] for the purpose of the physician, which is to heal, to restitute, to repair." (*Itaque non satis capio, quo jure negetur [. . .] in universa structura atque textura partium corporis organicarum quicquam subesse, quod ad medicum pertineat, aut ei ad scopum medendi, restituendi, reparandi, utilitatem eximiam afferat*).[38] In this connection, Leibniz mentions Steno and Malpighi as two of the few anatomists worthy of mention.[39] He criticizes Stahl, who opposes a descriptive or historical medicine to a true

[35] *Réponse aux réflexions qui se trouvent dans le 23. Journal des savants de cette année touchant les conséquences de quelques endroits de la philosophie de Descartes* (1697), GP IV, 336: "En physique on ne demande point pourquoi les choses sont, mais comment elles sont. Je réponds qu'on y demande l'un et l'autre. Souvent la fin et l'usage fait deviner le comment, parce qu'en connaissant la fin, on peut mieux juger des moyens. Outre que pour expliquer une Machine, on ne saurait mieux faire que de proposer son but, et de montrer comment toutes les pièces y servent."

[36] Stahl, *Negotium otiosum*, p. 44 (on Leibniz's *Animadversio* VII: "Ex descriptiones exquisita horologi comprehensionem rationum, cur et quomodo agat, sequi pute"): "In via discendi, ubi nondum edoctus affatim sim, ex inspectione, imo descriptione historica, exquisita quantumlibet, immediate comprehendere velle mechanicas rationes, irritum fore (quia hae nusquam, nisi altiore experimento, edoceri possunt de energia Elateris, du ressort, der Feber (adeoque proportionis aequilibrii, der Unruhe) nullam invenire poterunt veram exquisitam mensuram), Tanta magis autem, artificium manuale, fabricandi, reparandi, etc. Nihil horum, inquam, sub tali tempore, & in ordine discendi, speratum usum praestiturum."

[37] Fritz Hartmann and Matthias Krüger (1976), Franz Steiner Verlag, pp. 40–68; p. 52: "Alle anatomien sollen modo diverso geschehen, wie Mr Stenonis vorgeschrieben in Anatomia cerebri"; p. 53: "Man soll in der anatomi alle minima auffzeichnen, alle ductus und passagen affusis coloratis liquoribus probieren, allerhand ligaturas brauchen. [. . .] Man muss den Menschlichen Cörper mit allen minutiis auffs aller genauste nach poussieen lassen. Umb allezeit gleichsam eine lebendige anatomie vor sich zu haben"; p. 64: "Man soll mittel finden immer mehr in das innerste eines lebendigen Cörpers kommen zu können."

[38] *Animadversio* X, Dutens II-2, p. 138. Stahl, *Negotium otiosum,*, p. 47: "Ut itaque rem ipsam aggrediar, bona plane fide allegatur assertio mea, quod Anatomiam recentiorem rebus a Medico scopo alienis foecundissimam esse, dixerim."

[39] See also *Animadversiones* X, Dutens II-2, p. 138: "Et vero maximus Chirurgia usus est Anatomiae etiam exquisitioris; credoque aucta arte hominess aliquando ad curationes nonnullas hactenus desperatas perventuros; aperiendo, separando, extrahendo, inserendo", and *Responsiones* X, p. 147: "Cum Medicina consistat in arte corporis humani tuendi, utique accurate corporis humani cognitio nimia esse non potest, ad scopum medicum, etsi omnes Medicos aeque eam possidere necesse non sit."

medical physiology and pathology (medical, that is, while still taking into account the action of the soul), for confusing the *de jure* and the de facto state of the disciplines[40]: in fact, anatomy is not yet so advanced that practical medicine might benefit from anatomical discoveries, but this does not mean that *de jure* the progress of the former is not at least partially dependent on the progress of the latter.[41] In an earlier text of 1680, Leibniz compares the physician with a mechanic who repairs a machine.[42] This thesis may be read as the promotion of a medical science which the so-called "empirical physicians" opposed to their own practice: at that time, some such "empirical physicians" contented themselves with correlating certain peculiar phenomena, or symptoms, without trying to discover their hidden corporeal causes. The "empirical" nature of medicine is not necessarily due to the importance of observations, but rather refers to the fact that the observations are not accompanied by the visualization of the inner parts, nor by an inquiry into the causes of what is observed. Leibniz certainly encourages the advancement of empirical medicine: he recommends the increase of medical observations and the development of a descriptive medicine paying attention to experience. At the same time, medicine should not be too "empirical": it should not lead to a substitution of the medical explanation of a patient's disease by the mere description of his behavior. And this is precisely that for which Leibniz reproaches Stahl, who maintains that the explanation of the diseases that come from the "affections of the soul" must consist only in observing noteworthy disordered movements, passions, and statements of the patient, and in identifying a mental representation as a cause. For Stahl, there is no need to examine any further what the corporeal process underlying the symptoms might be since the mind is capable of directly interacting with corporeal phenomena. On the contrary, against a neo-Platonist such as Cudworth or an animist such as Stahl, to refuse the interference of the mind in the domain of corporeal laws enables Leibniz to support the advancement of scientific observations in order to correlate the examination of the manifest "how" with an inquiry into the underlying corporeal causes (for instance, the motions of the minute bodies that compose our own body). Two meanings of "observation" are used here simultaneously. First, "observation" denotes the scientific examination of corporeal phenomena serving the general advancement of medical disciplines (not only pathology, but also anatomy, chemistry, etc.) –

[40] Stahl, *Negotium otiosum,* op. cit., p. 52: "Unde omnis dubitatio tum ex hac consideratione disperebit, tum in perpetuum exulabit, si prudenter & sufficienter intelligatur, non solum verissima, sed plane ponderosissima, differentia, inter Physiologiam atque Pathologiam Physico-historicam; & Physiologiam aeque, atque Pathologiam, vere medicam, & arti huic aditus vere Practicos pandentem."

[41] *Animadversiones,* ad X, op. cit., p. 138: "Responsio innuit inutilitatem Anatomiae maxime de recentiore illa exquisitiore intelligi. Sed argumenta ad eam probandam allata fere fundata sunt in praesenti statu scientiae medicae, quam in infantia hactenus constitutam esse nemo credo inficiabitur."

[42] *De scribendis novis Medicinae Elementis,* in Enrico Pasini, op. cit., p. 212: "Constat humanum corpus esse Machinam ad certas quasdam functiones ab autore sive inventore suo comparatam. Itaque Medicinam scribere nihil aliud est, quam alicui Mechanico methodum praescribere, qua Machinam suae fidei concreditam ita conservare possit, ut semper rite operetur."

this is the sense of observation defended by Leibniz; it implies a close connection between the fields encompassed by "natural philosophy" on the one hand (the description and understanding of the solids and fluids composing our bodies), and the disciplines related to the medical and practical arts on the other hand. Second, "observation" may be a mere superficial description of a certain behavior, which is no doubt important to Leibniz, but might have the disadvantage of preventing (or at least not advancing) the development of further examination and scientific progress: if the corporeal symptom is unrelated to another corporeal motion, it means that there is an anomic action of the mind, a sort of *Deus ex machina*.[43]

This explains why Leibniz sometimes laughs at empirical physicians for going through all of the same useful "*consecutions*" (or reasoning) as the beasts (though by these means making useful connections),[44] or advises physicians not to be too "empirical,"[45] and at the same time encourages the development of a descriptive medicine in the style of Sydenham[46]: such medicine has to be "empirical" insofar as the physician does not *oppose* his mere observations of phenomena to a rationalist understanding of efficient causes, and insofar as he considers that the understanding of efficient causation requires the increase of observations.

If the Leibnizian defense of the usefulness of anatomy against certain merely "empirical" physicians makes sense in the light of medical debates, Leibniz still changes, slightly but significantly, the meaning of the medical analogies: in arguing that the description of the parts is required for an understanding of the "uses" or actions, Steno employs neither the word "*officium*" nor the word "*finis*." On the contrary, Leibniz mentions the "functions" or the "ends" as well as the "uses."[47] Thus it seems that Leibniz's position in contemporaneous debates leads him to interpret medical theses in light of his own intention to reconcile final and efficient causation. Indeed, Leibniz combines these two doctrinal preferences: on the one hand, he prefers anatomists who examine the minute parts of bodies to "empiricists" – that is, paradoxically enough, speculative physiologists such as Stahl. On the other hand, he does not desire that mechanistic physics should prevent the ultimate intelligibility of bodies; this is why he refutes the "Epicurean" thesis (i.e., the identification of a biological phenomenon with the spontaneous organization of corpuscles without any intelligence or finality). To reconcile these two theses, he transforms the "uses" discovered by anatomists into "ends" or "functions": in this way, he introduces finality into the work of modern anatomists.

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[43] On this issue, see Jacques Roger (1993), p. 197, and François Bayle (1675), p. 85–6.

[44] See the *Monadologie,* § 28: "Les hommes agissent comme les bêtes, en tant que les consécutions de leurs perceptions ne se font que par le principe de la mémoire, ressemblant aux Médecins Empiriques, qui ont une simple pratique sans théorie; et nous ne sommes qu'Empiriques dans les trois quarts de nos Actions."

[45] *Responsiones*, ad X, § 3: "Saepe a me admonitum est, hactenus Medicinam nimis Empiricam esse, nec Anatomiam satis ad Physiologiam, aut Physiologiam ad Pathologiam, aut Pathologiam ipsam ad Pharmaceuticam prodesse."

[46] *Nouveaux essais sur l'entendement humain*, IV, VII, § 19; GP V, p. 408.

[47] GP I See letters to Conring, p. 173.

3 The Autonomy of Bodies: The Machine Analogy *Versus* Corpuscularian Epigenesis

The second disagreement between Stahl and Leibniz revolves around the autonomy that one might ascribe to the machine. Stahl points out that the main argument of this polemic consists in the role that one must ascribe to the *active motor principle*.[48] According to him, the soul is the motor force, which animates the body,[49] whereas Leibniz would consider that this motor is inherent in the machine. Stahl, as it seems, can ascribe such a thesis to Leibniz only to the extent that he misunderstands Leibniz's account of "substantial forms." Nevertheless, Stahl's interpretation of Leibniz may be easily understood, insofar as the polemical exchange between both authors revolves around the intelligibility of organic motion. Indeed, according to the Cartesian distinction between the *animation* of a body and the *motor force*, the concrete description of the *modus operandi* of the machine leads Leibniz to show that the principle of motion in the organism depends partly on mechanisms comparable to hydraulic and pneumatic processes, which enable the machine to maintain an initial motion. In addition, from this point of view organic bodies, which need air and food, are no more autonomous than artificial machines.[50] Thus, as the body protects itself by maintaining the circulation of the blood –the true "universal" movement of the organism – the machine sustains an initial movement in order to feed its subordinate parts. In a text edited by Enrico Pasini (the *Machina animalis* of 1677), the principle of motion is identified with the fermentation of the blood after coming into contact with the chyle. At this point, every peripheral part of the body is

[48] *Negotium otiosum,* op. cit., p. 139: "Inprimis autem de mechanismo, quatenus de corpore dicitur, perpetuo tenendum manet, quod ille hoc sensu, nihil aliud, aut amplius sit, quam purus habitus, ad subeundum, aut recipiendum active motorium impulsum. Unde, ut rem brevissimis expediam, totus nervus atque modus hujus disceptationis, positus est in constituenda sede, Principi active motorii."

[49] Ibid, p. 100: ". . . quod animae sint tale Agens, immanens corpori Organico, & Actum talem, immanenter exercens, qui est Corporeorum organorum, a minimis ad maxima, Motus seu Motio; [. . .] quod animae maxime omnium autem. . . Humana, sint tale Ens activam, quod ut alias actiones, ita actionem quoque Materiam exercere possint: quia Motus, ut res incorporea, praesupponit causam quoque incorpoream [. . .]. Ita aeternae veritatis est & manebit illud, quod, uti Motus differt a Materia, & vis talis actrix & author Motus ut actus differt a Materia: Ita in eo quo differt a conceptu de materia seu physice materiali certissime conveniat cum Anima, quomodocunque materialiter concepta."

[50] Leibniz, *Animadversiones,* ad IX, § 2, Dutens II-2, p. 137: "Analogia flammae se tunetis, intrientis, propagantis, comparatae cum animali eadem praestante exquisitius; non est tam spernanda, quam Responsio innuit. Quemadmodum enim Responsio ad rigorosos explicatus recurrens negat, flammam per se subsistere, se nutrire, se propagare, se tueri, sed aëris affluxu indigere; ita eodem modo negari potest, animal haec per se praestare, quia sine perpetuo ambientium affluxu, et permeatione intim, non tantum respiratio locum non haberet, sed etiam calor et fluiditas humorum, cessarent, ut ex intensi frigoris experimento constat; ut jam de vi Elastica non dicam et motu Tonico (qui credo nihil aliud, quam ut jam de vi Elastica exercitium esse) quae etiam a motu permeantium oriri constat. Experimento etiam Antliae Pneumaticae scimus, aëris ambientis pressione sanguinem aliosque liquores plerumque in sua debita consistentia contineri, eaque sublata spumescere, et vasa dirumpere, nec ut par est circulari. . ."

supplied with blood, and so the blood is what maintains unity in the machine (which is certainly not comparable with that conferred by the soul). In the *Animadversiones*, the idea of a machine is similarly used to defend the assumption that the "universal integrity of animal motion depends on matter and on the right proportion of the organs" (§ XV).[51] In contrast, Stahl supposes that what belongs to the "universal motion", i.e., what belongs not to the motion of the parts but to their coordination, must come from the soul.[52]

The demonstration of the homogeneity of the motion of an artificial machine on the one hand, and on the other the manifestations of "life" (that is, the endurance of functional unity and the coordination of simultaneous movements) is a classical undertaking of medicine in the late seventeenth century: Borelli compares the energy of the circulation of the blood and the spirits with the motor of a clock, which displays a regular and autonomous functioning.[53] According to Croone (1664), the "constant movement and agitation [of the most subtle parts of the blood] is exactly what we call life."[54] For Malpighi, the principle of life in animals is hypothetically ascribed to the endurance both of the motion of the blood as well as of the propagation of nervous liquor. This is maintained thanks to outside auxiliaries such as air.[55] The models of machines mentioned by Leibniz are endowed with, at least, momentary autonomy, of which Stahl's scissors are deprived, since their movements are partly auto-maintained through the action of fire (according to the *Corpus hominis* of the 1680s as well as the *Animadversiones*), through hydraulic circulation and fermentation (in the *Machina animalis*), or through the elastic force (in a letter to Michelotti in 1715, and even already in the *Machina animalis*, where Leibniz suggests an explanation of the action of the cardiac muscles).

However, on many occasions the explanation of organic phenomena is related to a "pre-existing" movement or element of which Leibniz does not try to give an

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[51] The connection between anatomical knowledge, on the one hand, and the understanding of the principle of movement on the other hand, is considered as a connection between analysis and synthesis; the latter is necessary, but always comes after the former. See *De scribendis novis Medicinae Elementis,* in Enrico Pasini (1996), p. 214.

[52] Stahl, *Negotium otiosum,* op. cit., p. 57: "Unde utique attendendum est ad expressam vebris luculentis determinationem, quod nempe non Universa integritas Motus (vitalis) dependeat ab organorum conditione. Ratio: qui salvis organis Motus potest non fieri, aut aliter fieri, quam tali tempore ulla organorum inclinatio, tendentia, aut quomodo tandem nominetur, ullam occasionem praebeat."

[53] Borelli (1743). For instance: "Quare, ut in horologio, sic in animali, seu automate Naturae ajungi debet machina regulatrix, quae necessitate mechanica refraenet vim motivam, ut non transgrediatur leges, a Divino Architecto instituas. Talis porro machina similis esse videtur regulatori pendulo horologii; nam illa quoque sua vi oscillatoria motum sanguinis & spirituum regulare debet, ne temerario & furibundo cursu eos diffluere permittat."

[54] William Croone (2000 with the Latin facsimile of the first London edition (F. Hayes, 1664)), § 12.

[55] Malpighi, "Objectiones contra Mechanicum urinae separationem ab Authore epositam responsiones ad easdem," in *Opera posthuma*, op. cit., p. 57.

account. For instance, there is no need for him to find the origin of the blood or its motion; it is enough to assume that it has been transmitted from the mother (as in the *De scribendis*). The references to a pre-existing element should be connected with what is of epistemological interest in the machine analogy: invoking a pre-existing element enables one to use the machine analogy to defend the analytic intelligibility of composite bodies and, at the same time, not to inquire into the sources of animal motion (for in the machine the motion is always already there in its original constitution). Thus, it would make it possible to disconnect the machine analogy from the Cartesian explanation of mechanical epigenesis. In the *Machina animalis,* Leibniz compares the pre-existence of motion, which, notably brings about the mobility of the blood, with the motion of a "pendulum already vibrating." In the letter to Michelotti, after having ascribed organic secretions to a "physical cause" (and not a "mechanical" one), that is, to the action of elastic force, Leibniz connects this cause with the presence of a liquor contained in the vessels since birth.[56] Leibniz explicitly identifies the difference between a physical cause and a mechanical one with the gap between his own explanation of organic movements and that of Descartes: "Even if all physical causes are reduced, in an ultimate resolution, to mechanical causes, I am however used to calling "physical" the causes whose mechanism is hidden." The Cartesians are not wrong about the correct assumption of the correspondence between what happens imperceptibly in our body and what happens in perceptible bodies, but they too quickly reduce the perceptible things to their first causes, or to the simple elements that produce them, while in fact they do not derive directly from them.[57]

Thus machines are subordinate to physical causes that are not yet completely reducible to their mechanical reason, which means that one cannot straightaway geometrize the machine, nor the circulation of blood. This suggests that machine analogies may imply two different things. The first (for instance, Leibniz's and Steno's statements) means that, *de jure,* living bodies should and can be explained exactly as are artificial machines. But this statement does not require a reduction *hic et nunc* of all motions of living bodies to figures, movements and sizes of an artificial machine. One may invoke for instance some pre-existing elements of the living machine or some "physical cause", which are not yet mechanically explicable. A living body is *essentially* a machine, even if no one is yet capable of explaining the former exactly as they would the latter. We have already seen what brings about this point (a close connection between anatomy and physiology, and the refusal of the soul's direct intervention in bodies). The second way of understanding machine analogies in this period (for instance the Cartesian one) leads one immediately to reduce every movement of artificial and natural machines (such as oscillations,

[56] Dutens II-2, p. 90: "Itaque inclino ad physicam secretionis caussam; ut putem, tubulos secernentes vel cognatos, inde a nativitate, continere liquores, qui sibi simile vel cognatos, in vasis sanguiferis adpellentes, facile adsumant."

[57] According to a well-known distinction between mechanical and physical causes (see for instance Boyle and the Royal Society), the two kinds of cause do not correspond to two different levels of reality, but to two levels of intelligibility of a given complex phenomenon.

streaming, boiling, explosions, elasticity), so as to exhibit their mechanical causes. This is the reason why, in the exchange with Stahl, Leibniz emphasizes that, in stating that "everything happens mechanically in bodies," he does "not care necessarily about the minute figures of the pores," and ascribes that "more to the movements than to the figures".[58] Similarly, some physicians (like Steno) who selectively compare the human body to an artificial machine do not set out to explain the source of motion with the mere tools provided by the mechanical philosophy,[59] and do not reduce *ipso facto*[60] organic phenomena to the effects of figures, pushes, sieves, etc. Steno's case, with his "limited" mechanism, compels commentators to firmly dissociate the machine analogies, which have a heuristic value in Descartes' *L'homme,* from the positive biological explanations of Descartes or Cordemoy, which require only geometrizable mechanisms, such as the aggregation of particles or filtration through pores. However, Stahl's criticism of the comparison between the organism and the machine reduces the first enterprise (the machine analogy) to the second one (the geometrization)[61]: the use of the machine analogy in medical fields is criticized in the name of the manifest inadequacy of crude geometrizations of nutrition, genesis, and growth. But the former does not always imply the latter (at least in Steno's and Leibniz's works).

In the *Elementorum myologiae specimen,* for instance, Steno identifies muscular fibers with motor fibers, for they can contract after having been separated from the entire muscle they compose. Yet he insists on his ignorance of the ultimate cause of this contraction. For instance, chemical analysis would probably enable one to better understand the nature of animal spirits that are at present more an assumption than a true element of organic bodies.[62] It is in this text emphasizing the ignorance of biological causes that Steno goes on to develop the machine analogy between the physician and the engineer.

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[58] *Responsiones,* XXI, § 21. Dutens II-2, p. 90: "Cum omnia in corpore mechanice fieri statuo, non ideo exquisitas pororum figuras moror, et plus hic motibus, quam figuris tribuo."

[59] Whether they refrain from any explanation, or whether they connect the motion to the animal spirits or to an elastic force whose behavior is not entirely geometrizable (as do Borelli and Bernoulli).

[60] Though a certain number of them do make this kind of reduction, in the style of Descartes. We simply point out the fact that the first operation (to compare the human body with a machine) does not *imply straightforwardly* the second operation (a corpuscular reduction of all organic motions to a play of figures and spatial shifts).

[61] *Negotium otiosum,* op. cit., p. 92: "Inprimis, cum etiam speculationes illae de nudo mechanico effectu, omnium secretionum, per exactissimorum poros collatoriorum, & nutritionis, per nudum allapsum & adhaesionem corpusculorum, in ipsa curcumstantiarum verarum vero historia, nullum plane fundamentum habeant: quorum prius demonstravi in Programmate de Paralogismo pororum secretiorium exquisitae figurae adhaerente. Sed immensum quantum debeant tonicae directioni, relaxanti, strigenti, appellanti, reprimanti, dirigenti specialissimae: sive tranquille & ordinate; sive per frivoles quoque causas, inordinate & perversa."

[62] See (1669), in, vol. II, pp. 67–111, p. 103. Let us note that this book is known to Leibniz: see letters to Bernoulli, GM III-2, p. 864.

Thus, in accordance with the pre-existence of the motion in a machine in proper running order, the machine analogy may, *de jure,* dissociate itself from the mere geometrical explanation to which the detractors of the machine analogy reduce it. If, in addition, as Canguilhem maintains, the machine analogy cannot account for the construction of the machine, the order must also pre-exist the growth, and thus the manifestation of living bodies. The machine analogy might fail to account for the genesis and growth of living bodies, but it might also appear as a *theoretical tool* that does away with the need of any accounting for the source of the order and motion in living bodies (order and motion which anyway may be transmitted by the mother and are not *ex nihilo*). For some anatomists of the late seventeenth century who assume that organic bodies may be defined *a minima* as aggregates of solids and fluids in motion, admitting the validity of physical laws (which justifies the machine analogy) requires the denial of the epigenetic hypothesis in the manner of Descartes. For instance, due to the fact that their description of the silkworm or of the "formation of the chicken in the egg" stops when nothing of the future structure of the animal is visible, the preformationism of Malpighi and Swammerdam derives from two things. On the one hand, from microscopic observations, which enable them to detect pre-existing structures and an underlying continuity where a naïve observer would see "*solutions of continuity*", or the fortuitous effect of *lusus naturae*. On the other hand, the preformationism of Malpighi and Swammerdam derives from the fact that they admit no qualitative change irreducible to the effect of a visualizable movement. In other words, to subordinate the explanation of organic movements to the same rationalistic demand which governs the understanding of inorganic motion has two indissociable correlates that contradict the epigenetic hypothesis: (1) the scientific prerogatives of visual observations, which make possible the defense of the machine analogy (as pointed out by Duchesneau, since microscopic observations only inform us of the unfolding of a given matter,[63] living beings seem to be always already formed, if only as a rudimentary structure, which later will develop through nutrition); (2) the refusal to invoke transformations that would introduce a "solution of continuity" in the set of corporeal modifications, in which the growth of every animal, even the animals supposed to "metamorphose", into another shape, consists: the admission of such an inexplicable change would have as a direct consequence the thwarting of the scientific observations required to discover the true modalities of such a change. This is why Swammerdam criticizes Harvey for mentioning a "*vis plastica*" or some "formative and vegetative faculties" in accounting for epigenesis.[64] One cannot disjoin the preformationist

[63] Malpighi, *De formatione pulli in ovo*, in *Opera omnia,* op. cit., II, p. 1:"…dum enim ab Ovo animalium solicitè perquirimus productionem, in Ovo ipso jam ferè animal miramur excitatum, ità ut irritus noster labor reddatur: Nam primum ortum non assquuti, emergentem successive partium manifestationem expectare cogimur." See François Duchesneau, *Les modèles du vivant de Descartes à Leibniz,* op. cit., p. 223 sq.

[64] Harvey (1651), praefatio (no page numbers), "De methodo in cognitione Generationis adhibenda", and Swammerdam (1685), p. 36.

hypothesis from the privilege ascribed to observation simply because one holds a priori that preformationism is blind to experience and, for that reason, biologically irrelevant.

Thus, there is a manifest gap between, on the one hand, the criticism of mechanism, which is often based on criticism of a corpuscular (and so "fortuitous") genesis and organization, notably in Stahl, and, on the other hand, the effective development of the positive sciences, which encourages a mechanism relating every action to a pre-existing structure and underlying visualizable motions, notably thanks to the machine analogy, but at the same time refusing (rather than simply failing) to account mechanically for the organization and the source of the motion of living bodies,[65] contrary to the Cartesian project.

Anatomists such as Steno, Malpighi and Severino use the machine analogy to refute those who deny the epistemological interest of the decomposition of highly composite bodies, especially of living bodies. This criticism of the machine analogy itself can be understood only in the light of a head-on conflict between, on the one hand, the Epicurean or Democritean philosophy, or any corpuscular philosophy considered as an impious materialism insofar as it does not have recourse to intelligent agents governing bodies by means of final causality, and, on the other hand, the philosophies of Plato or Aristotle, which were usually related by the physicians of that time to the authority of Galen.

Within this polemical framework, trying to account for corporeal actions by the configuration of their material parts, notably by means of dissection, consists in adopting *ipso facto* the Epicurean physics, which asserts the fortuitous nature of generation, which denies the reality of final causes, and so which may compare living bodies with machines only to refute the intervention of an intelligent designer in the formation of bodies. To refute this criticism, the anatomists employ the machine analogy to show the pertinence of decomposition and analysis: first, for the physiological understanding of organic bodies, and second, for the medical treatment of the diseases of these bodies. On the contrary, and strikingly enough, Malebranche, as well as Stahl, criticizes merely mechanical epigenesis by using the machine analogy in order to refute the strong-headed partisans of Epicurus (*esprits forts*).

In fact, promoting anatomical research (i.e., an analytic understanding of composite bodies) by using the machine analogy is always combined with an exaltation

[65]This enables us to understand why a physician known for his use of the machine analogy tries at the same time to emphasize the gap between organic bodies and artificial machines, when his research revolves around the very first formation of living beings. See Malpighi, *De formatione pulli in ovo,* in *Opera omnia*, op. cit: "Solent in excitandis machinis praevio operis apparatu singulas efformare partes, ita ut pateant ea, quae postmodum redigi debent in compagem. Hoc in Naturae operibus plures ejusdem Mystae, circa Animalium indaginem soliciti, accidere separabant: corporis etenim implicatam structuram cum difficilimum sit resolvere, disparatas in primordiis singulorum productiones intueri juvabat. Sed vereor mortalium vitam incertis nimium finibus claudi, & aeque obscurum esse carcerem, ac metum."

of the divine creation,[66] while it is not *necessarily* combined with a corpuscular physics, to which it has been often reduced[67]: the enlargement of what is visible inside organic bodies does not necessarily lead to a geometric representation of living bodies, even if both are sometimes connected (as in Descartes's *Principia philosophiae*, for instance, IV, art. 203).[68]

Stahl opposes the polemical effects of the machine analogy employed by the anatomists by defining the artificial composite machine as an instrument whose movements are not wholly suitable to their functions, or to their circumstances, when they are not in the process of being used by an exterior mind. By contrast, according to the anatomists we have treated, Leibniz argues that the motions may be organized, suitable and functional, and not presently governed by any intelligence: the machine analogy serves in this case to moderate the opposition between fortuitous facts and intentional facts, and to promote analytic understanding of living bodies. Nevertheless, in identifying the functions of artificial and natural machines with certain ends, Leibniz significantly changes the analogy, which then becomes a tool for demonstrating, sometimes negatively and sometimes positively,[69] the limits of the explanations collected loosely under the banner of Epicureanism.[70]

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[66] Assuming that God chooses, as economically and rationally as possible, the structural means of producing pre-determined ends, so that the ends are transparent to the one who would know all the means employed.

[67] See Jacques Roger, *Les sciences de la vie dans la pensée française du XVIII^e siècle*, op. cit., p. 207: "Une telle conception [mécaniste] de la vie favorisait évidemment les recherches anatomiques. Puisque tout était affaire de figures et de mouvements, il devenait essentiel de connaître la figure des organes, et les anatomistes s'émerveillaient de retrouver à chaque instant dans le corps humain quelqu'une de ces « machines », semblables à celles que l'homme fabriquait lui-même. . ."

[68] The difficulty comes notably from the polysemy of the word "machine": this word means (1) every aggregate of corpuscles which has a geometrizable behavior, whether this aggregate belongs to nature or artifice, and, at the same time, (2) a true artificial composite machine such as a mill, a clock, and so on. Used by anatomists to defend the worthwhileness of anatomical research, the analogy refers to authentic, highly composite machines such as clocks (see Steno and Severino). Used by a detractor of the new corpuscular philosophy to denounce the irrelevance of minute anatomy, the analogy refers more often to mere aggregates of particles interacting mechanically (see Stahl). It is therefore very important to be attentive to the examples of "machine", which always have some polemical significance. This distinction may lead to an opportune discussion about the relevance and the different significations of the very ambiguous (and often polemical) label, "iatromechanist".

[69] Leibniz is sometimes inclined to moderate the difference between inorganic and organic as far as finality is concerned. See *Responsiones*, I, 2, Dutens II-2, p. 143–4: ". . .etsi in organicis finis sit manifestior, non tamen sequitur, in caeteris esse nullum, cum fieri possit (immo ex supposita providentia absolutissima debeat) ut organica nihil aliud sint quam machinae, ubi divina inventio et intentio magis expressa est."

[70] *Annotations aux objections de Bayle,* GP IV, p. 540: "Je crois. . .qu'on doit estre Democriticien en rendant toutes les actions des corps machinales independantes des Ames, et qu'on doit aussi estre plus que Platonicien en jugeant que toutes les actions des Ames sont immaterielles et independantes de la Machine."

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Chapter 8
Sennert and Leibniz on Animate Atoms

Andreas Blank

1 Introduction

Famously, both in his early and later years Leibniz criticizes ancient atomism for describing atoms as absolutely indivisible. According to his view, matter is both infinitely divisible and actually infinitely divided. Nevertheless, in numerous passages the early Leibniz is committed to entities that he calls "atoms", and in his later years he continues calling composite substances "atoms of substance". Richard Arthur has recently described this situation as the "enigma of Leibniz's atomism": Leibniz consistently rejects the existence of absolutely indivisible atoms, while at the same time he is committed to the existence of atoms of a different kind. Most occurrences of Leibniz's early "atoms" and later "atoms of substance" share interesting properties: they are individuated by an immaterial, soul-like entity, and they possess a material body that displays internal complexity. Why did Leibniz characterize such complex, composite entities as "atoms"? Arthur suggests that the answer comes easily once we realize that in early modern chemical atomism the conception of atoms as absolutely indivisible was by no means the prevalent one. Rather, atoms were regarded as entities that are not further divisible by means of laboratory processes. Chemical atomism is consistent with the assumption that atoms have a complex internal structure. As Arthur puts it, in the chemical tradition "many authors proposed atoms that were regarded not only as divisible but also as possessing a variety of qualities, powers, and inner complexity" (2003: 203).

In particular, Arthur draws attention to the fact that there are substantial and illuminating parallels between Leibniz's early views on atoms and the chemical atomism of the Wittenberg-based physician and philosopher, Daniel Sennert (1572–1637). Arthur is not claiming that Leibniz was directly influenced by Sennert. Rather, he is claiming that key features of Leibniz's position "were implicit in the atomist tradition with which he was certainly familiar" (2003: 220). Arthur

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has brought to light striking analogies between Sennert and the early Leibniz: (1) Sennert and the early Leibniz maintain that atoms have the capacity to fuse into a continuum. Sennert adopts this property of corpuscles from Julius Caesar Scaliger, who invokes it to explain mixture (Sennert 1659: 458; Scaliger 1557: fol. 143 verso). Similarly, the early Leibniz uses the same property to explain the cohesion of corpuscles in motion (Arthur 1998: 113–119). And, like Sennert, the early Leibniz acknowledges the work of Scaliger as one of the major influences on his own thought (A VI, 1, 81; VI, 2, 433) (2) Sennert and the early Leibniz were committed to the Lutheran doctrine of Traducianism. According to this theological doctrine souls are propagated through the medium of parental seeds: souls share the capacity of other substantial forms of "multiplying" themselves, in the sense that they can produce copies of themselves that are substantial forms of their own (Arthur 2006: 148–151).[1] (3) Sennert and the early Leibniz hold that atoms possess substantial forms (Arthur 2006: 151). What is more, they share the view that while a living being has a substantial form, its body contains a large number of atoms that in turn have their own substantial forms.[2] In this respect, both Sennert and Leibniz carry on a tradition belonging to late medieval Aristotelianism, a tradition that is sometimes called "Latin pluralism". According to authors belonging to this tradition, there is a plurality of forms in a living being, in such a way that subordinate forms are dominated by the substantial form of the entire living being.[3]

I agree with Arthur that in these three respects there is a strong and illuminating consilience between Sennert and the early Leibniz. Moreover, as Arthur rightly points out, since Leibniz's early conception of animate atoms is a recognizable predecessor of his later conception of "atoms of substance", some points of consilience carry over to Leibniz's later metaphysics, especially his view that the body of a living being is constituted by "subordinate monads" that are in some way activated by a "dominant monad". However, focussing on the analogies identified by Arthur may lead one to overlook some substantial disanalogies between Sennert and the early (and later) Leibniz. In what follows I will argue that there are such disanalogies in two interrelated respects: (1) Sennert and the early Leibniz develop diverging interpretations of alleged observations of the regeneration of plants from their ashes (palingenesis). Leibniz holds that an essential part of the substance of a plant (a part that he calls "core of substance" or "flower of substance") can be reduced below observable size, such that numerically the same plant could be regenerated from its ashes. By contrast, Sennert holds that it is conceivable that in the ashes of the plant some formal principles survive that are sufficient to regenerate the external figure of the plant, but he denies that in the ashes the substantial form of the plant is able to survive (2) Sennert and the early Leibniz take different stances with respect to the role of emanative causation in animate atoms. Sennert and Leibniz

[1] On the role of Traducianism in Sennert's thought, see Stolberg (2003). In what follows, translations are my own except where otherwise noted. All emphases are Leibniz's.

[2] On the plurality of forms in Sennert, see Emerton (1984: 64–65); Michael (1997).

[3] On theories of the plurality of forms in medieval philosophers such as Jean of Jandun, John Baconthorpe and Paul of Venice, see Michael (1992).

share the view that Traduction is an instance of emanation, and that the influence of the substantial form on its organic body works by means of emanative causation. However, while for Sennert these are the only two cases of emanative causation in the created world, Leibniz ascribes to animal souls a third kind of emanative causation, namely the emanation of activities that remain immanent to the soul. This difference may explain why Sennert and Leibniz take opposite views as to the persistence of plant and animal souls: while Leibniz holds that animate atoms can continue their internal activities even if their organic bodies are diminished below observable size, Sennert holds that plants and animal souls require an organic body of a certain minimal size to be able to act on their bodies and, hence, are destroyed when their bodies are diminished below a given minimal size.

2 Animate Atoms and the Question of Palingenesis

Arthur sees strong analogies between Sennert's views and Leibniz's early views about the persistence of animate atoms. Referring to Leibniz's early "flower of substance" doctrine, Arthur maintains that Leibniz's atoms of 1676 are conceived as "cores" of organic bodies (2006: 163–164). According to the early Leibniz, the soul "is implanted as it were more firmly in certain parts. . ." (A VI, 1, 91). In a short response to Boyle's *Some physico-theological considerations about the possibility of the resurrection*, Leibniz writes that "the flower of substance is our body, subsisting perennially in all changes", or at least "is diffused throughout the whole body, and in a way contains only form" (A VI, 3, 478). According to Arthur, the conception of "flower of substance" brings Leibniz "in line with Sennert's view of the way the soul informs the body: the soul is implanted in the body, which is invisibly small prior to conception, and it occupies all of the body as it grows" (2006: 163–164).

I agree that Sennert's conception of a soul implanted in invisibly small seeds has close parallels with Leibniz's conception of visible living beings developing out of invisibly small living beings. However, do Leibniz's and Sennert's views on the persistence of souls and animate atoms coincide? For Leibniz, the "flower of substance" doctrine is meant to give a philosophical account of the persistence of the numerically same individual even if the body is divided no matter to what extent. As he puts it, the soul inheres "in a firm and inseparable flower of substance, which is mobile in a subtle way in the center of animal spirits, and is united with it substantially, such that it is not separated from it even by death" (A VI, 1, 533). Sennert's views about the persistence of souls have clearly something in common with Leibniz's. Sennert holds that "the soul itself can remain whole in. . . minimal bodies and conserve itself. . ." (1659: 453). This passage suggests that there are cases in which souls can be preserved in bodies of a certain minimal size.[4] However, it is worth emphasizing some of the implications that understanding atoms as natural minima has for the question of the immortality of souls and animated atoms. As Norma Emerton explains, "[o]f all the distinctions between minimism and atomism,

[4]On the combination of atomism with minimism in Sennert, see Clericuzio (2000: 26); Michael (2001); Hirai (2005: 402–406).

the most important and fundamental was that minimism was indissolubly tied to the concept of form, which supplied the basic definition of the scholastic *minimum naturale* as the unit material embodiment of the form" (1984: 90–91; see Maier 1949: 181–182). Minimism implies that, once a given *minimum naturale* is divided further than its minimal size, the form that it possessed previously is no longer able to persist (even if the parts of the former body continue to exist). Hence, minimism implies that animate atoms do not persist once the body associated with a soul is divided beyond a given minimal size.

That Sennert's and Leibniz's views concerning the persistence of animate atoms differ becomes obvious in their different responses to alleged cases of palingenesis. Both Leibniz and Sennert refer to a passage from a work by Joseph Du Chesne (Josephus Quercetanus, 1544–1609), a leading propagator of chemical medicine in late sixteenth century Paris.[5] It will be helpful first to have a look at the passage from Du Chesne, to which both Sennert and Leibniz refer. In his *Ad veritatem hermeticae medicinae* (1605), Du Chesne writes about an unnamed physician from Krakow:

> He... knew to make ashes appear in such an elegant and philosophical way, made out of all parts of a plant, and this with all the tinctures and impressions of all the parts of this plant, and to conserve their spirits, the producers of all their faculties, in such a knowledgeable way, that he had more than thirty such plants that were artfully prepared from ashes, and preserved them in various hermetically sealed glass vessels... [F]rom the bottom of such a vessel, when brought to the fire of a lamp and heated a bit, the most thin and ungraspable ashes emitted out of themselves an obvious image of the rose, which slowly began to grow, live, and [first] to express the entire form of the stem and the leaves, then the shadow and figure of the buds, finally to produce the most developed rose, as was evident to the eyes of the observer. There was nothing more certain and elegant than that fact from a shadowy rose the most obvious rose unfolded, and that it could be seen that it was perfect in all its parts... (1605: 231–232)[6]

Du Chesne also mentions that the alleged phenomenon was merely temporary and lasted only as long as the vessel was close to the fire: "This shadowy figure, however, once the vessel was removed from the fire, fell back into its ashes, and vanishing regained its former chaos" (1605: 232).[7] Nevertheless, he gives a subtle interpretation of the temporary phenomenon described by the Polish physician. According to Du Chesne, one "would have plainly called it corporeal, although it was merely a spiritual idea that gave itself an appearance, albeit endowed with a

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[5] On the controversies between Du Chesne and his opponents, see Debus (1991: 57–62); Brockliss and Jones (1997: 125–128); Zinguer (1998); Lüthy (2000: 474–477).

[6] "Is... usque adeo eleganter & Philosophice apparare norat cinerem, ex omnibus plantae cuiusvis partibus, idque cum omnibus tincturis ac impressionibus omnium plantae partium, earumque usque adeo scite spiritus conservare, omnium facultatum autores, ut plures quam triginta eiusmodi artificiose ex cineribus paratas plantas, easque diversas haberet vasulis suis vitreis contenta, Hermetico sigillo obsignatis..... [E]x cuius vasis fundo, lucernae igni admoto, aliquantum incalescens, tenuissimus ac impalpabilis ille cinis ex se apertam rosae speciem emitteret, quam sensim crescere, vegetari, ac formam penitus, caulis, foliorum, tandemque gemmae floridae rosae, umbram ac figuram exprimere, & tandem explicatissimam rosam producere, apertis oculis intueri liceret..."

[7] "Haec autem umbratilis figura, vase ab igne remoto, rursum in suos cineres relabebatur, suumque chaos evanescendo sensim repetebat."

spiritual essence as if nothing would be missing to it than that it be given to a suitable piece of earth, such that it may acquire a more solid body" (ibid.).[8] Although far from being crystal clear, this remark suggests that Du Chesne does not think that in the vessel a real living being was emerging. However, it also indicates that he does not think that what is emerging is a mere image of the previously living being. Rather, according to his view what emerges is an image that itself could function as the "essence" of a living being were it only to be conjoined with a suitable portion of matter. In fact, Du Chesne holds that the vital forces of living beings are contained in an entity that he calls "primary humidity" (*humidum primigenium*). As Hiro Hirai explains, Du Chesne, like many Renaissance chymists, took "primary humidity" to be the elementary substrate of the more subtle "vital spirits" that he regarded as material but non-elementary entities (2001: 27–31). According to Du Chesne, palingenesis shows "that by means of fire and calcinations the primary humidity is not consumed" (1605: 230).[9] Moreover, he holds that "all stronger tinctures and impressions, and properties of things, and the most potent of those qualities and potencies, such as tastes, odors, colors, and even forms themselves... are enclosed and hidden in this firm, constant and vital principle" (ibid.).[10] In Du Chesne's view, what palingenesis illustrates is that in the ashes there are qualities, potencies, and possibly even substantial forms that belonged to a living being.

In his *De chymicorum cum Aristotelicis et Galenicis consensu ac dissensu* (1619), Sennert, too, discusses palingenesis in the context of a theory of subtle matter. However, he shifts the focus from Du Chesne's "primary humidity" to a subtle material "spirit" that he finds both in the Pseudo-Aristotelian *De mundo* and in a work by Du Chesne on medication. Sennert mentions that in *De mundo* this spirit is described as an all-pervading substance, thus resembling the Stoic *pneuma* (*De mundo*, 394b9-13). He also mentions that Du Chesne invokes a material spirit when explaining why nitric acid is capable of penetrating a glass still, thus giving a chemical meaning to the concept of spirit.[11] Sennert describes this entity as follows: "This spirit and body that is analogous to the ether is lighter and faster than any element, and contains within itself a kind of heat that is able to carry through all actions that are suitable for its species... The same body also has the highest force of penetration" (1619: 257–258).[12] While Sennert's spirit shares with the Stoic *pneuma*

[8] "... ut plane corpoream diceres, quae spirituali tantum idea, revera tamen spirituali essentia dotata sese intuendam praeberet, cui nihil aliud restaret, quam congruae terrae mandari, ut solidius corpus assumeret."

[9] "Hinc discet Anonymus, ignis vi & calcinatione non fuisse absorptum humidum primigenium..."

[10] "[F]usius adhuc demonstraturi sumus ac probaturi, validiores omnes tincturas ac impressiones, proprietatesque rerum, nec non potentissimas illarum qualitates ac potestates, quales sunt sapores, odores, colores, imo etiam formas ipsas... in illo firmo, constanti ac vitali principio concludi ac delitescere."

[11] See Du Chesne (1613: Chapter 5).

[12] "Spiritus ille ac corpus aetherei analogum levius & celerius est omni elemento, & ad omnes actiones suae speciei convenientes obeundas aptum continet in se calorem... Idem etiam corpus summam penetrandi vim habet."

the characteristic of penetrating less subtle bodies, it also shares with the chemical spirits the characteristic of being differentiated into various species and to possess certain active dispositions according to the species to which it belongs. In this sense, Sennert's "spirit" comes in the plural. And while his spirits possess specific active properties, they are clearly characterized as material entities and, hence, differ from vegetative or sensitive souls as understood by Sennert.

Sennert regards the alleged cases of palingenesis as useful for the investigation of the nature of spirits (*naturam spirituum investiganda*) (1619: 262). He gives the following, slightly modified account of palingenesis:

> Du Chesne... reports that he once had seen a certain Polish physician who knew how to prepare a powder from all of the parts of any plant so skillfully, that it contained the spirits of the plant, the producers of faculties and functions: Such that if someone asked to be shown a rose... he took a powder of this plant, contained in a hermetically sealed glass vessel and brought it close to a flame, so that it became hot at the bottom. Once this was done, as he reports, the powder slowly extended itself and grew, and displayed the plant complete in all its parts, is such a way that one would have plainly thought it corporeal: while it nevertheless was only spiritual; and once the vessel became cold again... it was included again in the ashes or powder; albeit not without providing an image of resurrection and regeneration for another life (ibid.).[13]

Note that in this passage Sennert emphasizes Du Chesne's view that what is produced in the heated glass vessel is merely "spiritual" but omits Du Chesne's claim that this spiritual image contains the essence of a plant such that only some suitable matter would have to be added to obtain a complete living plant. While it is not very clear in which sense "spiritual" is to be understood here, one thing is striking: Sennert discusses the alleged observation under the heading of occult phenomena that do *not* involve the presence of a soul. A bit earlier in the text he writes: "Not all actions that are nobler than the elements proceed from the soul." In particular, "[t]he parts of dead animals and of plants devoid of life nevertheless have those forces and operations that can by no means be reduced to elements" (1619: 248).[14] This makes palingenesis akin to other phenomena (such as magnetism and contagion) that, in Sennert's view, are inexplicable by means of the properties of elements but nevertheless do not involve the agency of a soul-like entity. According to Sennert, what survives in the ashes is some portion of subtle matter that previously pertained to the plant and now explains some causal powers of the ashes that go

[13] "Refert... Quercetanus, se aliquando vidisse Medicum quendam Polonum qui adeo artificiose noverat ex omnibus plantae cujusvis partibus pulverem parare, qui Spiritus plantae, facultatum & functiones autores, contineret: Ita ut si quis rogaret sibi rosam... monstrari, pulverem illius plantae, vitreo vasculo, Hermetico sigillo obsignato, inclusum, lucernae admoveret, ut in fondo incalesceret. Quo facto illum pulverem sensim, in Speciem plantae se extulisse & crevisse refert, plantamque omnibus partibus absolutam exhibuisse, ut plane quis corpoream putarit: Cum tamen saltem Spiritualis esset, & vase refrigerato... iterum in cineres vel pulverem resideret; non sine Resucitationis & regenerationis ad alteram vitam imagine."

[14] "Non... omnes actiones, quae elementis nobiliores sunt, ab anima proveniunt... Partes animalium emortuae, & plantae vita jam destitutae, nihilominus eas vires habent, & operationes, quae ad elementa nullo modo reduci possunt."

beyond the powers of the elements. But in the ashes neither the plant soul survives, nor does the plant survive in the ashes as an invisibly small animate atom.

By contrast, Leibniz believes that Du Chesne's views about palingenesis are supportive of claims in favor of the possibility of the resurrection (A VI, 3, 479). According to his view, palingenesis supports the possibility of the resurrection because it indicates that the "core of substance" in which the soul is implanted "is so subtle that it remains in the ashes of burnt things and is able, as it were, to contract itself into an invisible center" (A II, 1, 108–109). Here it becomes evident that Leibniz's subtle matter remains animated in the ashes. This clearly distinguishes Leibniz's subtle matter from Sennert's "spirits", which do not remain animated in the ashes. While for Leibniz the alleged cases of palingenesis confirm the view that very small living beings persist in the ashes of plants, for Sennert these cases indicate that in the ashes of plants there are causal principles other than living beings. According to Sennert, vegetative souls and the plants animated by them are mortal. This sets Sennert's view of vegetative souls and animate atoms apart from Leibniz's early "core of substance" conception. And obviously, it also sets them apart from Leibniz's later conception of the apparent death of a living being as a transformation of an individual that retains its identity.[15]

3 Sennert on Animate Atoms and Emanative Causation

Sennert's remarks on palingenesis clearly indicate that he was committed to the mortality of vegetative souls. Arthur notices that Sennert also wishes to uphold the mortality of animal souls (2006: 153). For example, Sennert writes that "[o]n death... the dominant form is extinguished, and the body is reduced to the next lower grade of forms making up the substances that compose it" (1656, vol. 1: 218). On first sight, it may appear as if Sennert's stance is threatened by inconsistency. As Arthur points out, a "major reason for positing [atoms]... is that atoms – or rather certain molecules formed from them – are able to serve as units for the propagation of natural kinds, with their indivisibility ensuring the assumed incorruptibility of forms..." (2003: 207). Arthur notes that for Leibniz "all forms are immortal. This immortality, in turn, follows from their immateriality" (2003: 219). Moreover, Arthur observes that "this does not distinguish him from Daniel Sennert, who was perfectly explicit that forms... must be immaterial" (2003: 219–220). If immortality follows from immateriality, it would seem as if Sennert would have to give up his stance on the mortality of plant and animal souls. In fact, his views on the mortality of animal souls triggered an extensive controversy between Johann Freytag (1581–1641), who attacked Sennert's views, and Johann Sperling (1603–1658), who defended them.[16] Freytag argued that the transmission of souls from the parents *per traducem* would imply the immortality of the souls of beasts. Interestingly,

[15] On the biological side of Leibniz's conception of immortality, see Smith (2007).

[16] For a list of contributions to this controversy, see Michael (1997: 274, note 9).

Arthur takes sides in this controversy when he remarks that Sennert's "defence of self-multiplying of the soul seems only to reinforce Freytag's charges" (2006: 154).

However, minimism has interesting consequences for the consistency of Sennert's stance on the mortality of plant and animal souls. His animate atoms are divisible physically, in such a way that in the case of division below a minimal size they are no longer capable of sustaining a vegetative or sensitive soul. In his *Hypomnemata physica* (1636), Sennert mentions the following consequence of minimism: "[T]here are the smallest parts of Natural Bodies; *viz*. which if they be further divided they lose their Form and Essence" (1659: 181*).[17] Thus, division of a natural body beyond its minimal size brings with it that its previous substantial form no longer exists. Specifically with respect to the animate seeds of plants, Sennert emphasizes:

> Nor would I have any Man carp at what I have hitherto said… concerning Souls, and the Seminal Virtue in Atomes and smallest bodies, and charge me as if I held that such souls, because in so many mutations they remain entire, are immortal. For, as the seeds of non-Spontaneous Plants do many times remain long entire, and yet at last die: the same may also happen in the Spontaneous, *viz*. if they meet with some contrary, or the matter be too much divided (ibid.).

This passage leaves little doubt about the fact that Sennert regards the mortality of vegetative souls as a consequence of his minimism. But why would an immaterial substantial form cease to exist through the division of the bodies associated with it beyond its minimal size? After all, immaterial entities are not divisible themselves, since they are not extended. I would like to suggest that Sennert's view about the activities of plant and animal souls gives a clue as to why he thinks that their essence depends on the presence of an organic body of a specific minimal size.

As in the early Leibniz, the Neo-platonic notion of emanation plays a crucial role in Sennert's conception of the activity of souls. Some entries in the *Lexicon philosophicum* (1613) by Rudolph Goclenius (1547–1628), one of the leading figures in Protestant metaphysics, will be helpful here. Goclenius characterizes emanative causation as follows:

> To emanate is to accompany immediately the essence, albeit without any respect to existence, and before existence, and without any respect to an external cause. In the proper sense, it is to flow from another thing, or to exist due to the principles of the essence of the subject, or to arise out of the essence of something by means of an indissoluble nexus and connection (1613: 146).[18]

One of the examples that Goclenius gives is the relation between the essence of a thing and its real properties (ibid.).[19] In particular, he applies the concept of

[17] The entire fifth book of the Cole and Culpeper translation of the *Hypomnemata physica* has an erroneous pagination, marked henceforth with "*".

[18] "Emanare est immediate essentiam comitari, tamen sine respectu existentiae, & ante existentiam, & sine respectu causae externae. Proprie est fluere ab alio, seu ex principiis essentiae subiecti existere[,] ab essentia alicuius indissolubili nexu vinculoque proficisci."

[19] "Sic emanant reales proprietates."

emanation to relation between the soul and its potencies (ibid.).[20] Moreover, he describes the relation between rational souls and their intellectual potencies as an instance of immanent action:

> Immanent action... in the most proper sense has one and the same proximate principle that is both active and receptive. It remains in the same substrate, and in the same potency, from which it is brought forth, such as thought and appetition. Here belong the emanations or results of the spiritual properties of the soul, such that intellect and will arise proximately from the soul and are in the soul (1613: 40).[21]

As Goclenius explains, an action is either immanent (*immanens*), in the sense that it is an action of an agent within the agent itself (*actio... agentis intra se*); or it is transitive (*transiens*), in the sense that it is an action of an agent outside of the agent itself (*actio... agentis extra se*); or it is "in the middle between immanent and transitive" (*media inter immanentem et transeuntem*) (ibid.). But in which sense can an action be "in the middle" between immanent and transitive action? A few lines later, Goclenius recognizes an intermediary kind of action that is immanent and transitive at the same time. This kind relates to the agency of vegetative and sensitive souls. He writes: "Natural life remains immanent in the soul, from which it emanates, and is received in the body" (ibid.).[22] Goclenius here observes that the potencies of the souls that convey life to organic bodies involve both immanent and transitive action. Moreover, he describes both types of action as instances of emanative causation. In particular, emanative causation allows him to claim that natural life remains immanent in the soul while at the same time also inhering in the body. Goclenius describes this kind of action as immanent and transitive at the same time because it is immanent with respect to the soul and transitive with respect to the body.

Sennert uses the concept of emanative causation in various contexts. One is the context of Traducianism, where he holds that souls "emanate" from the parents (1659: 509–510). Using Goclenius' distinctions, this relation would count as an instance of transitive action since the newly generated souls are numerically different from the souls of the parents. Another context is the question of how elements relate to their manifest qualities (such as warm, cold, humid, dry) and of how compounds relate to their occult qualities (1609: 59). A third context is the relation between vegetative and sensitive souls and their properties. Sennert writes: "[T]he faculties of the soul are inseparable properties of the soul, and flow... from the essence of the soul by means of simple emanation; but they are received in the animated body as in a subject..." (1609: 19)[23] Accordingly, the relation between

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[20] "Sic ex anima emanant potentiae."

[21] "Actio immanens... maxime propria, habet unum idemque principium proximum & Activum & Receptivum. Manet in eodem supposito, & in eadem potentia, a qua elicitur, ut Cognitio & Appetitio. Huc pertinent emanationes seu resultantiae proprietatum spiritualium animae, ut, Intellectus & voluntas sunt proxime ab anima & in anima."

[22] "Vita naturalis immanet in anima, a qua manat, & recipitur in corpore."

[23] "[F]acultates animae inseparabiles animae proprietates sint, & ab animae essentia per emanationem simplicem... fluant; recipiantur autem in animato corpore, ut subiecto..." In his later years,

vegetative and sensitive souls and their properties is an emanation relation that involves immanent action since the properties inhere in the souls; however, it also involves transitive action, since the properties of the soul are received in the body, i.e., in a subject other than the soul.

Here one encounters a case of emanative causation that is "in the middle" between immanent and transitive activity because it is *both*, immanent and transitive. If it is essential for the properties of vegetative and sensitive souls to be received in the body, the body has to be in a shape that makes it possible that vegetative and sensitive processes take place within it. Otherwise, the properties of vegetative and sensitive souls could not be received in the body. If this is what Sennert has in mind, the emanative operations of vegetative and sensitive souls are essentially bound to an organic body of a certain minimal size. If the portions of matter associated with vegetative and sensitive souls become too small, such operations cannot be carried out any longer. Due to the transitive aspect of the emanative activity of vegetative and sensitive souls, the size and organization of the associated organic body is essential for the persistence of the soul-like entity and, hence, for the persistence of the animate atom. In this way, Sennert's combination of minimism with emanative causation implies the mortality of plant and animal souls and, hence, the mortality of the animate atoms associated with them.

4 Leibniz on Animate Atoms and Emanative Causation

As Christia Mercer has recently emphasized, the concept of emanation plays a crucial role in Leibniz's early metaphysics as well (2001: 223–224). Like Sennert, the early Leibniz also describes Traduction as an emanation relation: "[T]he mind is able to multiply itself through Traduction without new creation, with no loss to the incorporeal [principle]. . ." (A II, 1, 97; translated in Mercer 2001: 224). Moreover, he regards the relation between mind-like entities and the organic bodies that they individuate as an emanation relation. In a letter to Johann Friedrich of May 1671, Leibniz says that the passive principle in a corporeal substance "is diffused" by the mind or substantial form and that the mind acts "without being diminished" (A II, 1, 113; translated in Mercer 2001: 224). To judge from what Goclenius and Sennert say on this issue, the view that the mind emanates activities into the organic body without itself being diminished seems to have been an accepted category in Protestant metaphysics. From this perspective, it seems plausible to understand Leibniz's early views concerning the relation between mind-like entities and the organic bodies animated by them as involving both immanent and transitive emanation.[24]

Sennert expresses the same view. See Sennert (1633: 464): "Anima substantia est: [facultates] vero accidentia seu aptitudines & propensiones quaedam ad operandum; quae ab animae essentia, ut caussa prima, per solam emanationem fluunt, & pendent, & sine ullo medio in eodem corpore animato, in quo anima est, recipiuntur."

[24]For an alternative interpretation of the emanation relation between mind and body as an early version of pre-established harmony, see Mercer (2001: 331–340).

Whether or not the early Leibniz is committed to transitive emanative causation between mind-like entities and organic bodies, one point is crucial for the present purposes. In Leibniz's view, the causal role of all mind-like entities – even of those that are not capable of intellectual activities – involves a kind of activity that is purely immanent and, hence, does not depend on the presence of a body of a certain minimal size. It is at this juncture that Leibniz departs from the framework shared by Goclenius and Sennert. Clearly, for the early Leibniz the indestructibility of mind-like entities has to do with their point-like character: since points are not extended, they cannot be destroyed by means of division (A II, 1, 181). But then, he still has to explicate the nature of the potencies of mind-like entities associated with invisibly small portions of matter. Interestingly, in his notes for a projected work on *Elements of the Mind* Leibniz avoids restricting the application of the concept of thought to rational, human souls. Rather, he introduces "thought" as an indefinable concept that characterizes the activity of all mind-like entities: "*Thinking* is being the reason of change, or changing itself. Likewise, it is being the reason of itself. *Thinking* is indefinable, and the same holds for *sensing*, or rather *acting*" (ibid.). He maintains that "in the contents of thoughts (*cogitabilia*) themselves there has to be the reason why they are sensed. . ., but this is not in the thinking of a single thing, hence it will be in [the thinking of] many things" (ibid.). Accordingly, "[t]hought is nothing but the sense of comparison, or shorter, the sense of many at once or the one in many" (A VI, 2, 282). These cryptic remarks suggest that, in Leibniz's view, all mind-like entities are capable of comparing the impressions that they receive by means of their bodies. In this sense they act upon their own states and, hence, upon themselves. Hence, they are also the reason for the change of their states. This structure corresponds closely to the notion of immanent action: both the origin of the action and the result of the action are in one and the same being.

In notes from the Paris years, Leibniz reaffirms his conception of the structure of mind-like entities. For example, he remarks that "we do not act as a simple machine, but out of reflection, i.e., of action on ourselves" (A VI, 3, 480/PDSR 37). Even self-consciousness, in Leibniz's view, does not produce in the first instance reflexive activities but rather draws our attention to the fact that our previous, unattended mental activities already instantiated such a reflexive structure:

> I have not yet explained satisfactorily how there come about these different beats of the mind, with that constantly reciprocated reflection. . . They seem to occur by the distinguishing awareness of the corporeal intention; but, if you observe carefully, that beat only brings it about that you remember that you had this – namely, the reflection of a reflection – in the mind a little before. . . (A VI, 3, 517/PDSR 73–75)

In a note from 1680, Leibniz makes the connection between thought and immanent activity explicit when he writes that a thinking being (*cogitans*) is "the one that expresses many with immanent action" (A VI, 4, 745). Moreover, Leibniz regards the reflexive structure of the activity of mind-like entities as a further reason why such entities are naturally indestructible: "Thought, or the sensation of oneself, or action on oneself, is necessarily continued" (A VI, 3, 588/PDSR 113). The activity of a thinking being is necessarily continued because it is an immanent action.

One further consequence of immanent action deserves notice. Due to the immanent character of their activities, mind-like entities are not only naturally indestructible; they also can be associated with bodies of no matter what size. In another piece from the 1680s, Leibniz recalls his conception of mind-like entities as those beings that are characterized by the "action of the same thing on itself" (A VI, 4, 1507/LC 285). According to his view, such entities cannot be produced or extinguished by natural means since "the determinate parts of matter do not belong to its essence." The persistence of mind-like entities, as Leibniz goes on to argue, lends credibility to the view that the apparent extinction of a living being is nothing but a transformation. The concept of immanent activity turns out to be what provides an explication of the activities of the mind-like entities animating such invisible animate atoms. Leibniz writes: "[F]rom the evidence of dreams we learn that the senses are not always needed for perceiving, nor does it matter in the end whether the change occurring in matter is greater or less, except to the extent that the earlier perceptions would differ more or less form the later ones" (A VI, 4, 1508/LC 287). Hence, the activities that remain in mind-like entities no matter how much the bodies associated with them are diminished are purely immanent activities.

This is how Leibniz's conception of purely immanent emanation leads to a conception of animate atoms that is not bound to minimism. Due to the immanent activities of mind-like entities, animate atoms can persist no matter how far their bodies are divided. Moreover, Leibniz's later views on the persistence of living beings carry this idea one step further. Famously, Leibniz's later metaphysics eliminates transitive causal relations between individual substances altogether – hence also relations of transitive emanative causation. *All* activities of mind-like entities become immanent. One of the first explicit statements of this conception can be found in a piece probably written between 1680 and 1684: "No substance is capable of transitive action, but only of immanent action, except only God on whom all other substances depend" (A VI, 4, 1458). If no substantial action involves transitive causation, the persistence of the activities of mind-like entities and, hence, the persistence of living beings constituted by such entities can be as little bound to minimal sizes of organic bodies as in Leibniz's early years.

5 Concluding Remarks

It should be clear by now that Sennert's and Leibniz's views on animate atoms are connected by an intricate web of analogies and disanalogies. Sennert and the early Leibniz share the view that atoms are complex entities endowed with immaterial forms. In particular, they share the view that the complexity of atoms not only involves a multiplicity of material parts but also the presence of subordinate forms that together with material parts form subordinate individuals within animate atoms. These analogies are substantial. At the same time, Sennert and the early Leibniz diverge markedly over the question of palingenesis and the role of emanative causation. While Sennert's minimism implied the mortality of plant and animal souls that are no longer united with an organic body of a size sufficient to emanate

vital functions, Leibniz's conception of a kind of immanent emanative causation common to all substantial forms led him to the view that both substantial forms and animate atoms are naturally immortal. Hence also their different conceptions of what is going on in cases of palingenesis: For Leibniz, the soul of a plant survives in the ashes, while for Sennert only some subtle matter containing information about the figure of the plant is preserved. To be sure, palingenesis and emanation may seem rather arcane topics. However, the different stances that Sennert and Leibniz take on these issues indicate some profound differences in the structure that they ascribe to animate atoms – differences, moreover, that carry over to some aspects of Leibniz's later metaphysics.

Do these differences make the comparison between Leibniz's and Sennert's views on composite substances less interesting? By no means. On the contrary, emphasizing their differences reinforces a point made some years ago by Mercer under the heading of the "vitality of early modern Aristotelianism". Under this heading, Mercer discusses the insight that elements of the Aristotelian system contributed to the success and development of the new philosophy (1993: 39).[25] She points out that among the early atomists "many wanted to forge a synthesis of atomism and the Aristotelian philosophy" and mentions Sennert as an example for such attempts (1993: 61–62). Certainly, Leibniz's view of the structure of animate atoms diverges from Sennert's. But then, if one compares Sennert's views with those of some of his predecessors, other significant differences become apparent. Both the differences between Leibniz and Sennert and the differences between Sennert and his predecessors indicate that, within a shared theoretical framework, these philosophers found ample occasion for trying out novel ideas.

Arthur rightly points out that Leibniz could have derived the inspiration for his conception of dominant and subordinate forms as well from Sennert as from other early modern thinkers such as Julius Caesar Scaliger (1484–1558) and Fortunio Liceti (1577–1657). To be sure, there is a tight net of references in Sennert's work to writings by Scaliger and Liceti. Moreover, Sennert mentions Liceti as a source of inspiration for the view that souls persist in minimal bodies (1659: 453). However, Liceti's version of Latin pluralism differs considerably from Sennert's. Liceti analyses subordinate forms as well as the substantial forms of plants and non-human animals as configurations of particles. Such forms can be divided, and substantial forms and their fragments can be preserved in other material objects without functioning as the substantial forms of these objects.[26] By contrast, Sennert's subordinate and dominant forms are immaterial entities that cannot be divided and that are not able to exist without functioning as substantial forms of a material body.

Also Scaliger's version of Latin pluralism differs strongly from Sennert's. Scaliger analyses the relation between subordinate and dominant substantial forms in a living being in terms of teleological relations. Sennert accepts a teleological

[25] For a similar line of argument with respect to Renaissance Aristotelianism, see Schmitt (1973).

[26] On the role of subordinate forms in Liceti's theory of spontaneous generation, see Hirai (2006, 2007: 481–482).

analysis of the subordination relation, but he goes beyond Scaliger when he analyses the subordination relation also in terms of formal causation. Sennert maintains that, as long as they are dominated by higher-level forms, subordinate forms "themselves belong to the disposition and determination of matter" (1659: 176*). In Sennert's view, belonging to the determination of matter has two consequences: First, subordinate forms, as long as they are dominated by higher-level forms, do not inform living beings on their own. As he points out, it would be wrong to conclude that "this or that living Creature hath Worms or other live Things in it" (ibid.). This is an issue that separates Sennert's view of animate atoms from Leibniz's later conception of living beings within living beings.[27] Second, according to Sennert subordinate forms, as long as they are dominated by higher-level forms, function as the matter to be informed by the higher-order forms (1659: 180*). As he puts it, a subordinate form "was already present in other bodies, although not actually, nor performing the office of a form, but subordinate to the other more noble forms, and affording to them a matter and fit subject" (1659: 202*). By contrast, Scaliger explicitly rejects the view that forms could be informed by other forms (1557: fol. 11 recto).

The particulars of Scaliger's and Liceti's views are complicated and require a careful analysis of their own. For the present purposes it suffices, however, to realize that Sennert is far from taking over wholesale a position taken by other early modern Aristotelians. Rather, he modifies in significant respects a pattern of thought shared with other philosophers. Not only do Leibniz's views concerning the internal structure of animate atoms differ from Sennert's, Sennert's views concerning the internal structure of animate atoms also differ from those of other early modern "Latin pluralists". The intricate web of analogies and disanalogies that connects the works of Sennert, Leibniz, and their predecessors thus provides a vivid example of the ways in which early modern Aristotelianism was more variegated and innovative than is often recognized.[28]

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[27] On "nested" individuality in Leibniz's later metaphysics, see Nachtomy (2007: Chapters 9, 10 and 11).

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Chapter 9
Continuity or Discontinuity? Some Remarks on Leibniz's Concepts of "Substantia Vivens" and "Organism"

A.M. Nunziante

1 Introduction

First of all, a premise of a methodological nature that I hope will contribute also to clarifying the title and the background setting of my reflections. It is not my intention to fix different periods in the development of the thought of Leibniz and to set one against another (as too often, in other fields, has been done). The doctrine of natural machines, of organisms, of composite substances, assumes a marked consistency in Leibniz starting from his mature years (let us say, from the publishing of *New System* in 1695 onwards). There is no doubt, therefore, that for a full explanation of the conceptual content of the reflection of Leibniz on the nature of living substances we must turn to the "classic" places in which it took form: from the letters to De Volder and Lady Masham of the early 1700s, to the *Nouveaux Essais*, to the *Animadversiones contra Stahl* and, naturally to the *Princìpes de la Nature et de la Grace* and to the *Monadologie*. We can in any case ask what are the specific differences that emerge in this vast doctrinal *corpus* regarding those elements of the theory of the living being that had already appeared with a certain frequency in the texts of the early 1780s.

The reflection on the nature of the living being in Leibniz goes back a long way (in my opinion, the theoretical platform starting from which the first sketches on the concept of life begin to take shape is made up of the very first phases of the Cartesian reform of the mechanic, and therefore, starting from the end of the 1670s), but it is undoubtedly only with the appearance of the monadological lexicon, on the one hand, and with the marked thematizing of the notion of "machine of nature" on the other, that this reflection really takes shape. The question which arises in any case is this: what link of *continuity* subsists between the proto-theory of the living being of the 1680s and that of the mature years (let us say from *New System* on)? Or, overturning the formulation of the problem: what elements of *discontinuity* suddenly

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break into Leibniz's reflections from the second half of the 1690s compared to the immediately preceding phases of his thought? Certainly, the monads, the machines of nature. But is it possible to focus even more clearly the lens of our observations? That is to say: after a decade of intense theoretical debate on the nature of corporeal substances, on organisms, on machines of nature, is it possible to sketch a historical picture that accounts in a coherent manner for the development of Leibniz's thought in relation to the questions raised here?[1]

2 The Substantia Vivens of the 1680s

It seems to me that the theory on the living being of the 1680s can be characterized by means of two requisites of a conceptual nature:

1. the distinction *unum per se – unum per accidens*;
2. the fact that "the living being" is defined by its capacity to be the source of its internal actions.[2]

The two requisites are connected: the living being is *unum per se* and not *per accidens* because it derives from itself and not from anything else its capacity to be the source of its own activity. For this reason, the living being is happily defined by the Greek expression "automaton" (that is: *sponte agens*). The capacity to act spontaneously, that is, the capacity to initiate an action by oneself is seen by Leibniz as an element not otherwise deducible. On the contrary: this is a criterion of ontological distinction. Either it is there or it is not. The *Res physicae* can be divided into many classes and sub-classes: that particular class of individuals that is "capable of beginning an action by itself" is called a living being. And this is the reason why the living being cannot be artificially replicated.[3]

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[1] Studies dedicated to these topics gradually became more and more numerous, so much so that it is more than ever necessary today to proceed also to a work of summarizing in order to take stock of the situation regarding the critical acquisitions attained and shared. The bibliography on the theme here attached is not complete, but indicates several titles which seem to me to be particularly important for reconstructing the *status quaestionis* of the subject. See Schneider (1985); Pasini (1996), (2006); Duchesneau (1996, 1998); Ishiguro (1998, 2001); Smith (1998); Fichant (2003, 2004); Phemister (1999, 2005); Look (2002); Nunziante (2002, 2004); Carvallo (2004); Hartz and Wilson (2005); Hartz (2007)

[2] See Ishiguro (1998, 547).

[3] Regarding the definition of "living", among other places, see *Introductio ad Encyclopaediam arcanam* (1683–1685 (?)), A VI 4 A, 531; *Genera terminorum. Substantiae* (1683–1685 (?)), A VI 4 A, 566–568; and *Tabula notionum praeparanda* (1685–1686 (?)), A VI 4 A, 633. With regard, on the other hand, to the distinction between "natural" and "artificial", it could be interesting to quote this passage from *De machina animata* (1685 (?)): "A body perfectly like the human one cannot be manufactured by anyone, if not by he who is able to keep the order of division into infinity. So it is not possible for any angel to form a man or any animal, if not from the seed that in some way already exists. He could build a machine that could perhaps deceive with its outward appearance a man who did not examine it in sufficient depth, but again, this would be neither a man, nor an animal." (A VI 4 B, 1801)

There are various doctrines that chase each other here: there is the emergence of a theory of action, there is the connection between the concept of action and the concept of "individual" and there is, obviously, a "dynamic" substratum that supports the question ontologically (in the sense that the living being's own capacity to act has a physical correlation in the "force" that sustains it). But the gravitational centre toward which all these doctrinal fragments are attracted seems to me to consist in the notion of *unity.*

I believe that, as other scholars have stated, it is this very concept of "unity" that contains many of the tensions that animate Leibniz's reflections about the living being. And it is around the definition of this concept that I would like to develop my reflections.

If we speak of "life", in fact, the question of unity does not concern only the "phenomenological" side of the matter (according to which the living being is "one" unlike other types of aggregates whose unity is of a semi-mental type). The unity Leibniz speaks about should be understood on several levels, for example also from a finalistic (or generically *functional)* viewpoint, in the sense that the character of *unum* per se is attained by the animal machine also and especially through the carrying out of certain vital operations: this unity is a question of co-ordination between ends.

Living substances carry out a series of *functiones vitales*: they breathe, they feed themselves, they reproduce (though not always), they carry out specialized actions, both as a species (in the case, for example, of spiders that weave webs in order to procure food), and as individuals (the kidneys carry out a function different from that of the liver, etc.). But all these functions are directed towards a single common end: the animal machine constantly seeks to keep itself alive. This self-maintenance is the superior vital function in which all the mechanical activities carried out by the animal are directly or indirectly involved. Life is born and sustains itself starting from a co-ordinated play of structurings, and has as its end the constant preservation of itself: the animal is *sui perpetuativum* because in this act is translated the overall scope of its nature:

> *Corpus vivens* est Automaton sui perpetuativum ex naturae instituto, itaque includit nutritionem et facultatem propagativam, sed generaliter *vivens* est Automaton (seu sponte agens) cum principio unitatis, seu substantia automata.[4]

From this point of view, "perception" represents the principal tool employed to this end. But perception is, in its turn, the single terminal (*unum*) of a complex matter. Because one thing is the *act* of perception, another thing is the way in which perceptions are obtained and managed by the physiological apparatus of the animal machine. To the first form of activity are delegated the organs of sense (*organa sensum*), while over the second preside the organs of movement (*organa Motum*).[5] Let

[4] A VI 4 A, 633.

[5] "Functio hominis primaria est perceptio, at secundaria (quae prioris gratia est) perceptionis est procuratio". Thus writes Leibniz in *De scribendis novis medicinae elementis* (1680–1682). And he continues: "Perceptionis gratia sunt organa sensuum; procurandae perceptionis sive actionis gratia sunt organa Motus". The text can be found in Pasini (1996, 212).

it be clear: it is only on a descriptive level that we can conduct a separate consideration of these two forms of activity, because in the practice of living reality they are always and constantly co-ordinated *ad unum*.[6]

The simple capacity to experience perceptions represents, therefore, a unity interwoven with correlations, or, as has been said, a unity that presupposes the deployment of different kinds of *unions*.[7] And this because only insofar as the animal machine is able to picture *one* world is it able to practice unitary environmental relationships with it (avoiding that which is harmful and pursuing everything which leads to an increase of its own perfection).

We have, therefore, different levels of unity: there is *one* overall end toward which the animal machine tends and this is gained through *one* general perceptive capacity, which in its turn takes shape as *one* co-ordination of parallel and concomitant mechanical activities. There is something like a play of articulations within articulations, such that at each level the unity is realized like a beginning that co-ordinates a multiplicity of different factors.

"Be careful", writes Leibniz to Arnauld, "not to confuse the soul or form of everything as if this were composed, as if it were the result of many subordinate minimal aggregations."[8] Because the contrary is true: the soul as *perceptive unity* acts as a "magnet" towards the infinite entelechial perceptions that structure every portion of matter.[9]

It has been well said: organic does not mean "living". Every substance is originally organic (in its most basic form interwoven of innumerable entelechial centres), but not every substance is *eo ipso* living. In order for there to be life something more is necessary: it is necessary to have a source of formal attraction towards which converge and direct themselves (con-vibrating, so to speak) all the perceptive activities expressed by the entelechial forms subordinate to the "form" of the whole.

Naturally, during the 1680s the solutions to all of this are not clear. But the problems themselves are very clear. That is, from my point of view, it is by following the line of this factor "unity" that it is possible to realize and to justify the idea of a continuity of development in Leibnizian thought: of a development with differences; or of a continuity with variations.

So the lexicon of *unum* per se, which is peculiar of the 1680s, is followed by the lexicon of *domination,* so typical of the late years.[10]

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[6]Ibid., 214.

[7]On the difficult question of the relationship between "unity" and "union", as well as the reasons for their distinction, see Pasini (2006).

[8]Letter to Arnauld of 30 April 1687: GP II, 100.

[9]According to Mugnai (2001, 127), the image of the "magnet" could be misleading because it reminds of the atomistic doctrine which Leibniz never embraced. On this point see *infra*.

[10]Rightly speaking, the expression "domination" is almost never used by Leibniz in its abstract meaning: he usually refers to an entity which is "dominans". This point has been highlighted by J. Roland: see the paper included in this volume.

3 From unum per se to unum Dominans

When exactly does the lexicon of domination appear (and therefore the idea of a dominant monad that acts as an attracting centre for infinite subordinate monads)? This is the point on which I would like to reflect now. Let us try to establish some terms of reference: in 1695 Leibniz published the *New System* and with this matures the idea of a distinction between "machines of nature" and "machines of art". That is: in 1695 the embryonic doctrines of the 1680s have already taken on a systematic form that we could define as "mature" (§ 64 of the *Monadologie* will only repeat the thesis of the distinction between natural and artificial set out in the *New System*).

So, the years around 1695, just to fix a time reference, can be assumed as a good meeting point between different levels of the same theory. The doctrine of the monads begins, and a little later "dominant monads" are begun to be spoken of. When exactly? It is not easy to give a precise answer. But it is possible to identify some references that I hope can raise some interest in this regard.[11]

First of all, the expression "Monas dominans" is not univocal. Leibniz frequently uses other terms in his writings: he speaks of "substantia praeminens seu entelechia primaria" (in the abovementioned letter to De Volder),[12] of "Monade centrale" (PNG § 3), and "anima dominans" (*De Ipsa natura*, NE, letter to Sophie Charlotte of 4th May 1704, Monad.),[13] of "Unité dominante et principale" (to Sophie 12th June 1700),[14] "Monas actuatrix" (in the *Animadversiones contra Stahl*),[15] and finally of "Unum Dominans" (although in this case, in the text on *De rerum originatione radicali*, the reference is to the One that "not only rules the world, but also creates it and makes it").[16]

Then there are problems of dating. According to some scholars, the "first appearance" of the expression "Monas dominans" can be found in the famous letter to De Volder of 1703 already quoted.[17] Some further considerations however could perhaps be added, in the sense that if we accept the idea that the abovementioned expressions have close "family ties", or at least that they have the same conceptual basis, then we have to go back a few years. The text of the letter to Sophie in which Leibniz refers to the "Unité dominante et principale" present in the "organic body" in fact seems to me to be quite explicit and is dated 12 June 1700. But also in *De ipsa natura* of 1698 he writes about "dominant souls" although in this case the expression seems to be exclusively confined to the consideration of "intelligent" souls, that is, those which are "human". In a letter to De Volder, which was written

[11] The subjects that follow are taken up in Nunziante (2006).

[12] GP II, 252.

[13] *De ipsa natura*, GP IV, 512; NE, A VI, 6, 220; GP III, 347; *Monad*. § 70.

[14] This letter reads "dans un corps organique il n'y a qu'une seule Unité dominante et principale, qui est son ame." See GP VII, 553.

[15] Dutens, II, 2, 157.

[16] GP VII, 302.

[17] Look (2002, 380).

by Leibniz between August and September 1699, he refers to a soul "dominating the whole".[18] Then there is the case of a text edited by Pasini with the title *De substantia simplici ac composita*, in which Leibniz speaks expressly of "dominant monads" and for whom the editor has identified a terminus a quo of dating referring to 1695.[19] Finally, if we confine our interest to a purely linguistic plane, the expression "Unum dominans", which appears in *De rerum originatione radicali* of 1697, although referring to God, can be significant for the very conceptual implications that it contains:

> Praeter Mundum seu Aggregatum rerum finitarum datur Unum aliquod Dominans, non tantum ut in me anima, vel potius ut in meo corpore ipsum ego, sed etiam ratione multo altiore. Unum enim dominans Universi non tantum regit Mundum sed et fabricat seu facit, et mundo est superius et ut ita dicam extramundanum, estque adeo ultima ratio rerum (GP VII, 302).

In summary: rather than concentrating on individual instances I think it is more appropriate to refer to a kind of "lexical constellation" that gravitates around the expression and the concept of "Monas dominans", and which showed signs of appearing around the turn of the century (1695–1700).

There is therefore a lexicon of "domination" that makes a sudden appearance in Leibniz and goes along naturally as much with the doctrine of the monads as with the mature reflection carried out on organized substances. This last aspect, it goes without saying, is the one that most attracts our attention, but before analysing it I would like to explore another reference which, in spite of its apparent oddity, can perhaps help us to clarify, at least at an imaginative level, what Leibniz meant when speaking of a monad that "dominates" others.

The reference is contained in the *Nouveaux Essais* and it is curious because it is a quotation that refers to a novel that was very entertaining and, at that time, very successful; that is *Histoire comique des Etats et Empires du Soleil* written by Cyrano de Bergerac and first published in Paris in 1662.

Let us read Leibniz's passage:

> Moreover, I am also of the opinion that *geni* apperceive things in a way that has some relationship with ours, even if they had that curious gift that the imaginative Cyrano attributes to some animated natures in the Sun, composed of an infinity of small birds that, moving according to the command *of the dominant soul,* form bodies of every kind.[20]

To allow oneself these kinds of digressions could perhaps be considered a luxury, and yet, if only to lighten the tension of the analysis carried out so far, I think it is interesting to go and read the text of Cyrano just to see what could have stimulated Leibniz's interest. Also because chronologically we are in the right place, in the sense that the *Nouveaux Essais* are from 1703 to 1704, but if we consider the long preparatory work for the text we arrive more or less around the years we are considering.

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[18] GP II, 193.

[19] See *De substantia simplici ac composita*, in (Pasini 1996, 208). Of course, the composition of this text could be later, but what I am attempting to recollect here is a circumstantial framework.

[20] Op. cit. 196–197.

In the *Histoire,* then, are accounts of the animals native to the Sun, which have the surprising capacity to produce extraordinary metamorphoses in their outward appearance. In the illuminated regions of the Sun, in fact, where "the principle of matter is to be in action," live animals with a very lively *imagination* and a rather *subtle* body. Because of these properties, these creatures of the Sun can arrange matter as they please and the description of how this comes about greatly strikes the attention of the protagonist, as well as, we can imagine, that of readers of the time.

At a certain point in the story, the protagonist wakes up in the middle of a clearing, under a tree that was not there before. And, in fact, it is not a real tree because soon after, before his astonished gaze, a pomegranate fallen from the tree assumes the appearance of a tiny man who introduces himself as "the king of all the people that make up this tree." As if this were not enough, the entire plant then breaks down into "many small beings" that begin to dance, and their dance is described as a "vortex" that – says the protagonist – "moved every part of my body"(45).[21]

The event, in effect, is extraordinary: the king joins hands with his entire people and all begin dancing in unison "with a series of movements that I would not be able to represent, as nothing of the kind has ever been seen." And the dizzier the dance becomes, the more the dancers mingle so closely together that it is possible to discern only "an enormous giant open on all sides and almost transparent."

As the vortices become faster they become narrower, almost becoming absorbed by their centre, until every vortex disappears completely from view and that human "mass" that before was immeasurable, now takes on the form of a young man of perfect form in whom "all the parts" are joined together: some beings form the heart, others the head, others the bones. And when the form of the youth becomes concrete, the nightingale – the king of that people – enters his mouth (perhaps "attracted by the breath of the body itself") and the simulacrum comes to life and becomes an "animated being".[22] And this begins to speak and to tell the story of the creatures generated in the illuminated regions of the Sun: "All our transformations come about with movement," says the dominant-nightingale-king, specifying that it is the movement they carry out that gives them their "shape" and specific configurations. "This is why you saw us dancing before the formation of the giant," the king-nightingale concludes, "because it was necessary, in order to produce it, to devote ourselves to all the general and particular movements that are necessary to constitute it, so that this agitation, closing together our bodies little by little and absorbing them into each one of us with the movement, created in every part the specific movement it should have." And at the end of the narrative the animated creature opens its mouth, the nightingale "creator of itself" comes out and the whole human appearance dissolves: all its members fall to pieces and fly away in the form of eagles, thus finishing the story.

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[21] See *Histoire comique des États et Empires du Soleil*, in Cyrano de Bergerac, *Histoire comique des États et Empires de la Lune et du Soleil*, Nouvelle Edition par P.L. Jacob, Paris 1962, 269–270 and 272.

[22] Ibid., 273.

Now, although Cyrano says that the imagination of the earth's inhabitants is rather "colder" than that of the peoples of the sun, I do not think that it is too difficult for us to imagine why these pages could strike Leibniz's fancy (*Histoire* is quoted four times throughout the *Nouveaux Essais*).[23] Apart from the liking that Leibniz might have had for a generically "dynamic" theory of the matter, the point is that here is well described the idea of the pervasive organicity of matter (each body, as we know, is like a pond full of fish, of vegetation and so on) to which however does not correspond directly and automatically the property of "life". To be alive the *substantiatum* must be "animated". It is only when the king-dominant enters the mouth of the simulacrum that this latter comes to life. It is only the character of the dominant that can render "alive" (*actuate*) the organic body.

Here is once again the problem of the relationship that subsists between "aggregation" and "substantiality" that, at a given moment in the development of Leibniz's thought, starts a kind of point of no return regarding the question of "unity". The problem is that of the *infinite* wrapping of machines inside machines to which Leibniz refers in the *New System*.

The idea that there exist "worlds upon worlds unto infinity" goes back to the years of *Theoria Motus Concreti* and, more generally, is connected to the enthusiasm of Leibniz for the studies carried out by the *Micrographi* (often quoted in his works). But the problem in this case, that is in the middle of the 1690s, becomes that of combining the so to speak "open" element of infiniteness with the "magnetic" one of substantiality, that is to elaborate a model of unity strong enough to overcome the risk of "dispersion". Also, because the infinity Leibniz talks about does not have to do only with the question of the "wrappings", but also, and at the same time, with the management of the *flows:* bodies are like constantly running rivers, whose parts are constantly being renewed.

It could be interesting then to go back over Leibniz's letters of the 1690s because, especially in the rich correspondence of a scientific nature, maintained for example with Huygens, with Bernoulli, with the Swiss mathematician Nicolas Fatio De Duillier (who will have a sadly important role in the dispute with Newton), there is a flood of themes apparently already discussed and re-discussed but evidently still open. For example, there is the thorny question of the *cohesion* of matter on which Leibniz had written since the time of *Hypothesis physica nova* and which is still presented in the *Nouveaux Essais* as "quite difficult to explain".[24] There is the question of the *weightiness* of matter, on which during those years all the most important scientists wrote something (and this is comprehensible, considering the explosion produced by the publication in 1687 of Newton's *Principia mathematica),* and regarding which Leibniz confesses candidly to his interlocutors that he didn't know whose side to take.[25] And then there is the atomist solution regarding the

[23] See NE, in A VI 6, 220; 235; 356; 472.

[24] NE, A VI 6, 222.

[25] The question of weight, as is known, was debated especially in the physics of the time, so much that in 1669 the Académie des Sciences of Paris organized an animated debate on the question.

problem of the cohesion of matter: Leibniz, as is well known, never subscribed to the atomist school, not even in the years of his early education, yet the last years of the correspondence with Huygens (let us say from 1693 to 1695) are marked by a real dispute on the question of atomism. In a letter of March 1693 Leibniz disputes the atomist solution, which should act according to him like a "glue" to attach the parts of the body together. But the fact that the atoms "touch" each other, says Leibniz, does not mean that they "glue" themselves together. It is interesting because in this letter is stated that cohesion can be explained only starting from movement; there is nothing "primitive" in matter, neither atoms nor "primitive consistencies". Yet, unless we have recourse to Newton's hypothesis, which is several times declared "inexplicable", it remains to be understood how bodies cohere together.[26]

And above all, if we consider Leibniz's philosophical system of that time (as I said, we can settle on the *New System* of 1695) we note how there is at the bottom a

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Huygens participated fully, both presenting a *Memoria* and – interestingly for us – publishing in Leiden in 1690 his fundamental *Traité de la lumière* which contained also a *Discours de la cause de la pesanteur*. Still in 1690 Nicolas Fatio De Duillier and Pierre Varignon had also published works on the subject, entitled respectively *De la cause de la pesanteur* and *Nouvelles conjectures sur la pesanteur*. These are works that Leibniz knew well, to the point that he discussed them directly with their authors. But perhaps the most interesting thing of all to note regards the uncertainty shown by Leibniz himself on the subject and amply testified to by his correspondence. Thus, 8 May 1694 Leibniz writes, through Wilhelm De Beyrie, a letter to Nicolas Fatio De Duillier, affirming the following: "Quant à la pesanteur ou attraction en general, j'ay temoigné autre fois dans une dispute que j'avois avec M. Papin que *j'estois encor en suspens sur la cause de la pesanteur*, et quoyque ce que M. Hugens en dit, en employant la force centrifuge soit extremement beau et plausible" (A III 6, A 85; italics mine). And in fact, confirming his uncertainty, on 26 April 1694 (some days earlier), he replied to Huygens reaffirming the same considerations and declaring: "je me trouve comme suspendu entre ces deux sentimens" (A III 6, 72).

[26]Leibniz writes thus in the letter to Huygens of 10/20 March 1693: "Mais je reponds, qu'il n'y a point de dernier petit corps, et je conçois, qu'une particelle de la matiere, quelque petite qu'elle soit, est comme un monde entier, plein d'une infnité de Creatures encor plus petites; et cela à proportion d'un autre corps fut il aussi grand, que le globe de la terre. Comme il semble qu'on ne sçauroit rendre aucune raison, pourquoy les parties d'un atome sont inseparables, que parce quelles se touchent une fois parfaitement par leur surfaces, durant quelque temps; c'est pour cela que, j'ay dit, que dans l'Hypothese des Atomes l'attouchement fait l'office d'un *gluten*. Il semble aussi que si l'attouchement par surfaces fait une connexion infiniment forte; l'attouchement par lignes et par points deuvroit aussi faire des connexions, mais surmontables, en sorte que deux corps se touchant par des lignes plus grandes seroient plus aisés à separer, et des corps se touchant par plus de points auroient plus de connexion, que ceux qui se toucheroient par moins de poincts caeteris paribus. Et mêmes, point contre point, et ligne contre ligne, il semble que *contactus osculi* deuvroit donner plus de connexion, que *simplex contactus*. De plus, si un attouchement superficiel durable faict un attachement insurmontable, il semble qu'un attouchement momentanée feroit une connexion surmontable, mais plus forte, selon que le corps, qui rase l'autre en le touchant, a moins de vistesse. Enfin quoy que j'aye parlé cy dessus des fermetés ou consistences primitives; j'ay tousjours du panchant à croire, qu'il n'y en a aucune primitive, et que le seul mouvement fait de la diversité dans la matiere, et par consequent la cohesion. Et tant que le contraire n'est pas encor demonstré, il me semble, qu'on doit eviter la supposition d'une telle nouvelle qualité inexplicable, laquelle estant accordée, on passeroit bien tost à d'autres suppositions semblables, comme à la pesanteur d'Aristote, à l'attraction de Mons. Neuton, à des sympathies ou antipathies et à mille autres attributs semblables." (A III 5, 520–521; italics in the text).

double movement of breaking to master: *vertically* in the structuring of bodies one goes from the macroscopic to the microscopic *ad infinitum* (that is, without a stopping point); *horizontally* for the theory of flows, there are parts that are substituted by others *ad infinitum (*without however any alteration or the loss of the "code" or the "form" of the information copied). These are difficulties upon which interpreters shed light already a long time ago.[27]

Yet we can also reformulate the same question using other terms (keeping always the same attention for the historical-genetic point of view), or we can take up again an observation made by Fichant and subsequently by Phemister, according to which the "secondary matter" of a substance A, if A is a real substance, is not a simple phenomenon (like a rainbow), but must be linked with an internal principle of unity (an entelechy). Given that in A are aggregated a multitude of corporeal substances *x, y, z,* the same structuring must be reproposed for each of them: each substance will have its unity principle that directs and orients the flow of its own and corresponding portion of secondary matter.[28]

Right here enters the model of domination, which could regulate and direct this otherwise "dispersive" dynamic of the flows and wrappings. The hypothesis is that there subsist formal basins of organization towards which in some way converge the perceptive flows of the "peripheral" entelechial centres diffused through the entire organism (each one, in its turn, directed by its own dominant), and through which is guaranteed, in a manner of speaking, constancy in the replication of the infinite organic microstructures of which the folds of natural machines are interwoven.

Two connected and distinct problems, therefore, that the domination model must face: the infinite dispersion of the flows (which, from a physical point of view, must account also for the question of the cohesion of matter in bodies) and the "constancy" factor in the replicability of the organic folds (in the sense that copies of the structures of the infinite foldings, no matter how small, must keep the *same* order as that which is macroscopically observable, because it is in this that consists the difference of *genre* of nature in relation to art).

An analogy of an acoustic type (although *not* explicitly present in Leibniz's texts) could help us to better understand the question from the theoretical point of view.[29] In his *De secretione animali* addressed to Pietro Antonio Michelotti, Leibniz speaks, on the subject of the internal physiological apparatuses of the animal, of a "harmony of consentient vibrations".[30] It is not my intention to force this type of reference,

[27] Duchesneau (1998, 329) in this regard observes: "Par suite de la régression à l'infini dans la recherche du constituant "materiel" de l'être vivant, la limite de l'organisation ne peut être fixée dans la nature. Il faudrait pour y parvenir se rendre infiniment au delà de l'animal spermatique, pour prendre cet exemple. Par ailleurs, les limites de l'organisation sont proprement inassignables."

[28] See Fichant (2004, 66–67) and Phemister (2005, 41–52).

[29] I assume this suggestion, although indirectly, from Ishiguro (2001, 535–537).

[30] The text speaks of a "αρμονια consentientium vibrationum motuumve intestinorum" (*De secretione animali, ad P.A. Michelottum*, D II, 2, 90).

but the idea that the "vibrating" structure of harmony can be read in a formal and I would say musical way is perhaps not so extraneous to Leibniz's intentions.[31]

If we consider the example of a melody, in fact, we must note how also in this case is posed the problem of how to understand the melodic unit as a whole starting from the "aggregation" of the many subordinate notes, which in their turn are the expression of a scale of infinite descending vibrations. The question is in some ways similar to the composition of a continuum, in the sense that it cannot be said that it is the infinite subordinate vibrations that "compose" the melodic texture, although this latter is realized and expressed only through these.[32]

The laws of musical harmony, which Leibniz knew well, rather say something else: in every melodic composition there are formal elements that act as "attractors" (I put this word deliberately in inverted commas) in relation to the infinite multiplicity produced by the notes and by the subordinate vibrations. The melody takes shape as something of "one" because in it there are constant forms around which coagulate, that is around which are organized, the multiple musical vibrations that are otherwise lost. Naturally, it is not my intention to push the accelerator too hard on this analogy: I would like to say that as in music the "dominant" sums up in itself the theme of the melodic progression as a whole, at the same time prefiguring its development, in the same way the soul "directs" the infinity of the entelechial centres that compete to give form to the individual. I would like to, but I cannot; because if Leibniz had wanted to use this type of analogy, considering also his musical skills, he would certainly have done it himself.[33] Yet, I do not think that the musical example should be completely neglected, because I think that it contributes to the clarifying of the *formal* dimension of the role exercised by the dominant monad towards the organic aggregate. The problem, again, is that of unity, and at the same time that of a model of "causality" compatible with the exclusion of a causal action of an efficient type. It is about the tracking down of a model of unity

[31] As has been observed: "In the picture of the consideration of the artistic phenomena, as the examples frequently used show, music occupies for Leibniz a position of real importance, if not pre-eminence." (Luppi 1989, 125)

[32] Again Luppi observes that "in music one perceives a system of relationships immediately given." That is, one sensibly perceives an infinite in progress, made of infinite sub-vibrations that interact according to an order. There is a profound analogy, according to Luppi, between the laws of music and the organization of the universe. See Ibid., 127–128 and 130–131. But on the importance of musical reflection in Leibniz, as well as its possible ontological reverberations, at least in the ethical ambit, see Erle (2005).

[33] To clarify any possible ambiguity: in his writings of musical theory Leibniz does not use the term "dominant" in the sense in which we mean it. In his correspondence with Henfling and with Goldbach he always expresses himself in terms of "intervalla" and "rationes" and, in one specific case, "quinta" (see e.g. A.P. Juschkewitsch, A.P., and Kopelewitsch, Ju. Ch. 1988. La correspondance de Leibniz avec Goldbach. *Studia Leibnitiana* 20: 182). The term "dominant" already existed in the theories of the "Gregorian" modes, and was, as such, in common use in the seventeenth century (S. de Caus – 1615 – attributes it to the 5th degree of the "authentic modes" and Brossard – 1703 – uses it as a synonym of *repercussa*). It was only with Rameau that, as is known, "dominant" came to mean a specific harmonic function that from then on was to become "classical". On these subjects, see. Erle (2005, 36–44).

that is not by composition "from the bottom" and that at the same time is strong enough to support the infinite articulations that are carried out inside it (*dominating* the centrifugal instances that risk making it explode). Moreover, it is about doing all this excluding the hypothesis of causal action of an efficient type: the organism is a system, we said using Leibniz's words, of "harmonized" con-vibrations, that is a system of vibrations that for a certain period of time play along one "melodic progression". It is just this formal characterization (not derivable from anything else in its simplicity), that itself permeates the individuality of its whole nature.

The idea of *unum per se*, then, is not excluded in the mature years, but remains valid: it is the entire organism, it is the entire organic machine united with its dominant monad that shows itself to be "one" as a "whole".[34] But it is as if the domination model allowed Leibniz, from a certain point on, to better articulate this concept, or to better express the completeness of articulations that are *expressed* in it. Speaking of domination and of historical references our thoughts could naturally run to the *eghemonikòn* of stoic tradition, to the separated *voùs* of Anaxagoras and to the ever decisive and important Aristotelian mediation.

The thesis that I would like to suggest is essentially this: it is consistent to think that the dominant monad "attracts without being attracted", with an implicit reference to classical Aristotelian doctrines. According to these, it is possible to hypothesize the presence of an activity that "attracts" and itself regulates the rhythm of what is subordinate stirring up uniform and well co-ordinated movements. This in any case does not imply an efficient involvement of the first mover in the movement that it has stirred up. Of course, one could object: all this cannot be explicitly found in Leibniz's texts and this is true. All the same, I suggest that what is hypothesized here is not just any doctrinal reference. The doctrine of the prime mover states that it is necessary to admit the presence of a form that "moves without being moved", and it is not just any one of Aristotle's theories, but the fulcrum itself of his ontology.[35] This is in fact the point that at the same time justifies and supports the distinction between "physics" and "metaphysics" in his thought and represents the most universally known doctrine of his philosophy. For this reason, it is perhaps plausible to claim that Leibniz could implicitly assume this Aristotelian model of reference for the elaboration of a doctrine so important for his system. Because whether this is the right path to follow or not, the dominant monad does exactly this: it "renders one the animal machine" (to De Volder, GP II, 252). This means that it collects

[34] See the letter to Nicolas Remond of 4 November 1715 in which the distinction *unum per se* – *unum per accidens* is clearly reaffirmed: "Et la materie seconde (comme par exemple le corps organique) n'est pas une substance, mais par une autre raison; c'est qu'elle est un amas de plusieurs substances, comme un étang plein de poissons, ou comme un trouppeau de brebis, et par consequent elle est ce qu'on appele *Unum per accidens*, en un mot, un phenomene. Une veritable substance (telle qu'un animal) est composée d'une ame immaterielle et d'un corps organique, et c'est le Composé et ces deux qu'on appele *Unum* per se" (GP III, 657).

[35] "If, then, everything moved is moved by something, and the first mover is moved, but not by another, it must be moved by itself". See Aristotle, *Phys*., VIII, 5, 256 a 20–22 in *Aristotle Physics. Book VIII*, trasl. with a commentary by Daniel W. Graham, Clarendon Press – Oxford: New York 1999, 13.

and co-ordinates the activities of the infinite subordinate entelechial centres without intervening *directly* with them, but at the same time rendering them concretely "substantial", or making of them a *real* and *concrete* unity.

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Chapter 10
"The Organism, or the Machine of Nature": Some Remarks on the Status of Organism in the Substantial Composition

Jeanne Roland

At the beginning of the eighteenth century, the Leibnizian concept of "animal" directly illustrates the middle years' concept of "corporeal substance", worked out in the *Discourse on Metaphysics* and in the correspondence with Arnauld. But what is it about the "organism", as Leibniz defines it in the famous 1704 letters to Lady Masham? Is "organism" a word that simply means what the available term of "organic body" had already signified since the *Système Nouveau*, namely, a "machine of nature"? Can we strictly substitute one term for the other?

"The organism," Leibniz writes, "*or* the natural machine". These words from the letter to Masham of June 30, 1704[1] seem to support the idea that "organism" is strictly substitutable for "machine of nature". Accordingly, the organism can be understood as one aspect of the corporeal substance – the mechanical one – but not as the "animal", or the corporeal substance in its entirety, which results only from the composition of an organic body *and* a soul.

Although in the letter to Masham of May, 1704, "organism" is famously defined as "l'ordre et l'artifice," which is "essentiel à la matière produite et arrangée par la sagesse souveraine,"[2] we must acknowledge that in this definition, the organism can hardly be understood as one aspect or component of a complete substance: here, it is connected to the concept of matter, not to the concept of substance. The organism is essential to matter, that is, to Nature, seen as the field of the law-governedness of the artistic and mechanical power of God. We then can discern in the notion of organism the application of the natural mechanism going through organic bodies and inorganic aggregates which contain organic bodies in each of their parts to infinity. Thus "organism" does not refer to any particular organic body, but rather to the mechanism, the organization and the general natural law-governedness which applies to the matter. More than a particular being, organism is a universal *principle*.

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[1] GP III, 356.
[2] Ibid., 340.

J.E.H. Smith, O. Nachtomy (eds.), *Machines of Nature and Corporeal Substances in Leibniz*, The New Synthese Historical Library 67, DOI 10.1007/978-94-007-0041-3_10,

A few lines before defining "organism", Leibniz writes: "les âmes ou les entéléchies ont toutes une manière de corps organique avec elles proportionné à leurs perceptions" – a statement he often repeats in this period of his life – and after providing the definition, he writes: "Cela me fait juger aussi qu'il n'y a point d'esprits séparés entièrement de la matière, excepté le souverain être."[3] How does the famous definition of "organism" fit within these considerations?

First, we have to recognize that the organic reality somehow contains what in a body naturally corresponds to the soul. Organic reality may be interpreted as an outward sign in the body of the presence of the soul. According to this, one must not reduce the organism to the living bodies' mechanism alone, which can be understood apart from the soul; we rather have to acknowledge in it the universal order according to which the body is attached to the soul, without exception, in virtue of the preestablished harmony.

Organism may thus be considered as a harmonic concept, not only as a mechanical one.

Two related questions now arise:

Supposing that "organism" means the same thing as "organic body", conceived as a "machine of nature", can we really consider it as one part or one aspect of the corporeal substance, i.e., as an aspect to which a soul must be joined in order to make a complete being? To deal with this question, we'll start by examining whether the machine of nature itself can be considered as one of the pair of terms in a substantial composition.

If, instead, we consider that "organism" is the name of a certain need for a rule-governed proportion between the body and the soul, according to its harmonic meaning, what kind of continuity can we presume there to be between the concept of organism and the concept of corporeal substance?

1 Machine of Nature: A Component of the Corporeal Substance?

Let us start by examining whether the machine of nature, as Leibniz defines it can be easily considered as a component of the complete corporeal substance.

The system of the preestablished harmony grounds the automatic (and not only the mechanical) nature of the body: it accounts for the autonomy of the living being whose operations are free from any external incorporeal principle. The structure of the machine of the body alone is enough to account for the functions for which it has been constructed, with no need for continuous assistance. If there is no real action of the soul upon the body, the living being is a real automaton, that is, a machine of nature. This automatic feature is precisely what the theoretical power of the preestablished harmony allows one to explain, without recourse to any miraculous explanation of natural living beings. It thus legitimizes a strict mechanical

[3] Ibid.

law-governedness. Thus defined, the machine of nature is the organic body quite apart from any consideration of the soul.

Nevertheless, the status of the machine of nature in the composition of the corporeal substance cannot directly be concluded from this.

In fact, it is not clear how we can reduce the machine of nature to one of the two terms of the substantial composition, inasmuch as this machine is itself composed by other machines. These machines do not have exactly the same status as the machine of the body taken apart from the soul, since they repeat the preestablished harmony between the body *and* the soul, as to any machine in the parts of the larger machine there corresponds a determinate entelechy which makes this machine the organic body of a living being, i.e., of a corporeal substance.

So the machine of nature is only conceivable apart from the soul on one condition: that the soul be considered as completely external to the machine. But according to Leibniz, we have to conceive of a plurality of souls, and not only one soul, in the machine. Souls infinitely contained within the machine of nature constitute the *internal* principles of its spontaneity.

We must go further. Machines of nature have to be distinguished from two other kinds of aggregates. Firstly, natural inorganic aggregates like fishponds or piles of stones; second, artificial inorganic aggregates, i.e., machines made by human art. What is the ontological difference between machines of nature and natural inorganic aggregates, given that the latter contain an infinity of machines of nature? The difference consists in the presence of a soul or a dominant monad. The Leibnizian concept of machine of nature, then, allows one to acknowledge the continuity between the organic and the inert, but also to clarify the very special status of the living being. Hence if the machine of nature has to be considered only as one of the pair of terms in a substantial composition, what exactly distinguishes it from an inorganic aggregate, such as a fishpond? Leibniz himself refuses to attribute substantiality to the machine of nature, whereas he does attribute it to the soul and to the complete corporeal substance. May we conclude, then, that the machine of nature is nothing but an aggregate of substances without any unity in itself, but only receiving it from an exterior soul or something similar?

The distinction drawn between machines of nature and machines of art is crucial for clarifying this question. In the *Système nouveau* this difference is grounded in two main distinctions. Firstly, machines of nature have infinite organs and remain machines in their least parts. On the contrary, a part of an artificial machine taken away from the whole is no longer connected to the machine's characteristic function or totality ("ne marque plus rien de la machine totale," *Monadologie* §64). Secondly, machines of nature, in contrast with machines of art, do not result merely from a set of parts, since they are endowed with a real unity that machines of art definitely lack. This unity is due to the presence of a soul, and this is why an animal cannot be reduced merely to the organization of material parts, while a clock can.[4]

[4]GP IV, 482.

We must note here that, according to the second distinction, the soul is not an entity exterior to the machine, but a principle rooted "in" it, composing an indivisible whole with it, so that the machine of nature may be said to be "animated".

According to the first distinction, the machines infinitely embedded in the machine of nature are not strictly material instruments at the service of the whole and forever subordinated to the order of the bigger machine, in the way of mere means, but rather in the way of living animals or plants possessing their own identities.

Under these conditions, it is very hard to isolate even conceptually the machine of nature from the subordinate entelechies which are its active principles and which become concrete in corporeal substances endowed with their own individualities, without missing the concept of secondary matter which is an aggregate of *achieved* or complete substances.

Can we take the machine of nature apart from the soul, considering it as one of the two terms in the composition of the corporeal substance resulting from an organic body and a soul? If we were to do so, this would be in view of the status of incomplete being that the machine of nature has insofar as it cannot be taken as one substance endowed with a true unity. On the other hand, the link between the soul and the subordinate entelechies seems crucial in accounting for the irreducibility of the machine of nature to machines of art. If one sets aside the order which determines the proportion between the soul (or the dominant monad) and the subordinate monads, one misses the organization of the given machine of nature itself. The relation of domination or "dominance" is then essential to having the ontological status of machine of nature. If one understands the machine of nature merely as a set of homogeneous parts, quite distinct from the soul, one misses the heterogeneity of the beings which are the requisites of the machine. Hence, the necessity of a double animation in the machine of nature must be acknowledged: animation by the soul, according to the second distinction defined in the *Système Nouveau*, as well as animation by a plurality of subordinate entelechies implied in the very organic composition of the body. Both distinctions from the *Système Nouveau* are in fact indissociable; they both form the order, i.e., the organisation, of the natural machine.

Let us summarize what we have seen thus far: a machine of nature cannot really be distinguished from an inorganic aggregate or from a machine of art if it is considered apart from the soul, that is, apart from the order conserving the mode of subordination of the entelechies embedded in the organic body. In this case, the soul is not an external principle that must be joined to the machine so that they both compose a corporeal substance. Thus, the machine of nature may not be thought of as one of the two terms of a substantial composition, since the soul and the subordinate entelechies are mutually expressed *in* the machine itself. In a letter to De Volder of 1703, the dominant monad is said to be *in* the machine, not to be a separate principle in charge of making up the unity of the body. That is why it is so difficult to deal with the machine of nature as if it were a part of the corporeal substance. The same letter suggests that the machine of nature may instead be considered

as the middle term between the simple substance (monad) and the composed one (the animal).

We are now ready to turn our attention to the concept of organism more directly. To what extent can "organism" be considered as a synonym of "machine of nature"? What sort of consequences must one infer for the status of the organism in the substantial composition?

2 Is Organism Merely a Microphysical Concept?

If "organism" is simply a synonym of "machine of nature", understood as completely distinct from the soul in a dualistic sense, it may then be reduced to a mere microphysical concept. In fact, however, the notion of organism is a complex one, standing at the intersection of several of Leibniz's concerns.

2.1

First of all, organism as the essential order of matter responds to the exigency of the universal connection of individuals. This exigency gives rise to another one: souls separated from bodies cannot exist. The organism is the condition which allows every individual to take part in the order of the universe. It is more readily used as an adjective than as a noun in this sense.

Pierre Bayle asks: would the perceptions of the soul which are independent from the body in the system of preestablished harmony remain the same if bodies did not exist? Leibniz in turn argues against this interpretation of his own system[5]; moreover, Bayle's question is beside the point. In truth, the fact that the soul follows its own laws, independently of the laws of the body, means that there must be a corporeal change for every perception of the soul. If God had ensured that a dog could perceive the pain, even if it is not in fact beaten, he would have created as many unconnected worlds as there are substances. Even in dreams, Leibniz writes, thought never ceases to relate to organs. The soul is connected to the other substances in the universe thanks to its expressive power, which applies to what happens in the organs of its body at any moment:

> Il est vrai que Dieu n'a pas besoin du corps, absolument parlant, pour donner à l'âme les sentiments qu'elle a, mais il en a besoin pour agir dans l'ordre de la nature qu'il a établi, ayant donné à l'âme dès le commencement et une fois pour toutes cette force ou tendance qui la fait exprimer son corps.[6]

[5] GP IV, 519.

[6] "It is true, strictly speaking, God does not need the body to give the soul the feelings it has, but He needs the body to act in the order of nature he established, having given the soul as its beginning and once and for all this force or tendency with which it expresses its body." (GP IV, 574)

The following sentence is similarly revealing:

> Si l'âme de César devait être seule dans la nature, L'auteur des choses aurait pu se passer de lui donner des organes. Mais ce meme auteur a voulu faire encore une infinité d'autres êtres, qui sont enveloppés dans les organes les uns des autres. Notre corps est une espèce de monde plein d'une infinité de créatures qui méritaient aussi d'exister, et si notre corps n'était pas organisé, notre microcosme ou petit monde n'aurait pas toute la perfection qu'il doit avoir, et le grand monde même ne serait pas si riche qu'il est.[7]

Thus, in the letter to Masham (1704, May), Leibniz explicitly grounds the thesis that no violence of nature can prevent the body from remaining organic, on his definition of the "organic" as "order and artifice".

Requiring that the soul always be connected to organs is by no means the expression of a materialist inclination. Perceptions of the soul cannot emerge from material properties. On the contrary, the supporters of the separation of the soul from the body at the time of death encourage precisely the opposite reaction from that expressed by the thesis of a material soul. In a letter to Burnett of 1699 Leibniz writes: "la philosophie vulgaire donne quelque raison de se récrier et de trouver à redire à ce qu'on enseigne ordinairement des substances immatérielles créées comme si elles étaient séparées, au lieu qu'elles sont toujours accompagnées de corps organique."[8]

Paradoxically, in maintaining that "l'office de l'âme est en partie d'exprimer son corps. Sans le corps, sans les organes, elle ne serait pas ce qu'elle est. Toute la nature est liée par le lien de l'ordre,"[9] Leibniz saves the immateriality and the immortality of the soul.

Yet a question remains: what is the bond that concretely attaches the soul to its organs? We can already notice that the notion of organism does not belong to a theory of the union of the body and the soul, but rather to the direct continuation of the concepts associated with preestablished harmony.

The frequent use of the adjective "organic" and the rarity of the substantive form show that organism does not refer to a particular body, but rather to the principle of connection of every soul to a body. "Organic body" and "organism" are not strictly synonymous. If the two nouns could be substituted the one for the other without any significant change in the Leibnizian thesis, it is odd that Leibniz never writes that the corporeal substance is composed of a soul and an organism, whereas the conjunction of the words "soul" and "organic body" is very frequent in the texts from around 1704.

Nevertheless, we must acknowledge at least a tenuous continuity between the organic body and the organism. The organism can indeed be conceived from another

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[7] To Masham, GP III, 356.

[8] GP III, 298.

[9] *Eclaircissement sur les natures plastiques*, GP VI, 570.

point of view. The organic body seen as a machine of nature corresponds on a physical and a phenomenal level to the requirement of corporeality, which fixes all souls in the same world. In accepting preestablished harmony, we must also subscribe to the thesis of the infinite division of matter.

Accordingly, let us now consider the "material" sense of the notion of organism.

2.2

A second perspective on organism would have it correspond to the need for an active artifice that governs the material composition. Only such an artifice can account for the real origin of animals and for the gap between the process of generation and the working of the machines of art. Leibniz writes to Sophie Charlotte: "Ce qui forme le foetus est un automate dont l'artifice passe tout ce que les hommes peuvent faire par la raison."[10]

In the *Considérations sur les principes de vie*, we read: "l'âme ne fabrique pas son corps par cette raison même de la préformation et d'un organisme à l'infini qui me fournit des natures plastiques matérielles propres à ce qu'on demande."[11] Once again, organism fills the need expressed by the system of preestablished harmony: a natural law-governedness with no need of assistance from the soul.

In fact, there are three connected requirements here:

1. The soul must necessarily be related to organs,
2. Organic operations are not directed by the soul,
3. The soul can in no way be conceived as material.

Requirements 1 and 2 define an essential bond, with neither direct interaction nor inseparability without mutual influence. The organism as the machine of nature meets these requirements: the infinite envelopment of machines in the machine of nature prevents us from conceiving a direct and immediate action of the soul upon the body. The link is always indirect, since there are infinite corporeal substances embedded in the machine.

The natural machine does repeat to infinity the organisation of the artificial machines: it is a primitive natural fact that no intelligence or reason in this world could reproduce, even if it were possible to gradually increase as far as one might wish the organisation undertaken by humanity.

Indeed, "organism" refers to naturalness as defined in *De Ipsa Natura*. Nature is the conjunction of a law and the force that produces instances of this law in creatures. The law and the correlative force are given once and for all. The organic

[10] GP III, 344.
[11] GP VI, 544.

character of bodies is a primitive quality: it is "ingénérable", indestructible, and coeternal with the world itself. Organism starts with the world and cannot be shaped in it according to mechanical laws. At the same time, it has the power to develop according to the laws that apply in all bodies uniformly. Hence, organism is an intermediate reality between God and the world: a mark impressed on all creatures, and also the name of an infinite distance in virtue of which God enables the world to be and to become.

The mechanism of machines of nature implies a prior structure whose origin is unintelligible on the mechanical model. As Leibniz writes to Masham: "la matière est destituée de connaissance mais peut agir d'une manière propre à obtenir une fin sans qu'on ait besoin de lui appliquer une direction particulière de Dieu ou de quelque intelligence durant l'action. Dieu lui a d'abord donné une structure propre à produire dans le temps des actions conformes à la raison."[12]

From this, it follows that the organism is necessarily preformed. It is the name of the origin of natural shapes and the fundamental condition of any mechanism.

Let us paraphrase what Leibniz writes to Lady Masham: organism is the means by which the creator wrote, so to speak, upon matter, in order that bodies should act as spirits require; having done so, God grounds the mechanical intelligibility of the processes of the living body.[13]

2.3

There is a third requirement that follows from the previous two: organism is the mode of composition of matter that provides expressiveness to each individual.

The machine of nature expresses the whole universe in its own way, as Leibniz writes to de Volder in a famous letter of 20 June, 1703. This is why, according to Leibniz, the machine of nature has an infinity of organs. In *Monadology* §63, Leibniz clarifies the organic status of the body of a living being. This body is necessarily organic. Why? Leibniz explains: every monad is a certain mirror of the universe; yet the universe is ruled by a perfect order; so it must also be an order in the "representant", i.e., in the monad which expresses the universe. The singular mode of expression, which must be in the monad, implies a certain order in the body that is "représenté", i.e., the prism through which the universe is represented by the monad. The organism achieves the singular organisation that allows the monad to represent the order of the universe. Leibniz specifies (§65) that if the matter were not organic everywhere, i.e., subdivided infinitely, it would be impossible that each of its parts should express the whole universe.

[12] GP III, 374.

[13] "Dieu, pour faire que la matière agisse comme les esprits le demandent, lui en a tracé le chemin." GP III, 342.

2.4

There is a fourth and final requirement that results from the previous three: organism is the corporeal sign of the soul. When we observe an organic body, we can be certain that the being in question is endowed with a soul. In the *Addition à l'explication du système nouveau*, Leibniz writes: "lorsqu'il s'agit des plantes, bêtes, et toute sorte de vivants en général, on a sujet de croire qu'aussitôt que le corps est véritablement organique par soi, l'âme lui est unie."[14] And in the *Système Nouveau*: "Dans toutes les espèces organiques, il faut quelque chose qui réponde à l'âme."[15] Later, in the letter to Masham of May, 1704: "ces âmes que je mets dans les bêtes et dans les autres créatures autant qu'elles sont organiques."[16]

We now see better the extent to which the notion of organism is connected to that of machine of nature. They are linked, but are not synonymous. To put it succinctly: whereas we can speak of "one" machine of nature, we speak of "the" organism (I would say that in English what happens is that "organism" has no article at all, definite or indefinite, whereas "machine of nature" could be described as "the machine of nature"; i.e., the particular machine).

We can now go back to our first question, namely, how to define the status of organism in the composition of the corporeal substance?

3 Substantial Composition, Dominant Monad and Organism

The corporeal substance is composed of an immaterial soul and an organic body, as Leibniz writes to Rémond: "c'est le composé et ces deux qu'on appelle unum per se."[17]

This kind of conjunction is again asserted, without any further precision or explanation, when Leibniz writes to Jaquelot: "Je ne compte pour substances corporelles que les machines de la nature qui ont des âmes ou quelque chose d'analogue, autrement il n'y aura point de véritable unité."[18]

These claims are brought into question by the notion of organism.

In order to clarify the composition which is here at stake, we must turn our attention to the concept of dominant monad since for Leibniz there is no composite substance other than where there is a dominant monad together with a living organic body.[19] How, now, are we to conceive such 'domination'?

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[14] GP IV, 573.

[15] GP IV, 473.

[16] GP III, 339.

[17] GP III, 657.

[18] GP III, 457.

[19] "there is no composite substance, that is, a being truly constituting a per se unity, except where there is a dominant monad with a living body." (2007. Leibniz-Des Bosses Correspondence. Look and Rutherford. 327)

Our purpose is not to answer such a tricky question, but we'll content ourselves with suggesting some interpretative clues.

A first remark: Leibniz never talks about the "domination" exerted by the monad upon the body, but only about a dominant monad or a monad "which dominates". The domination does not define a particular activity of the monad describing the way it subjects other monads. Leibniz writes to de Volder (1699, September 1): "il faut une âme qui domine dans le tout."[20] The soul or dominant monad does not dominate the whole, but is rather *in* the whole. The dominant monad can thus be understood as the most distinguished perceptive power in a given whole, rather than the external imposition of a unity upon a given multiplicity. The dominant monad can be compared to the dominant tone in a melody. We can then talk about "dominance" rather than about real "domination".

Leibniz writes to Sophie Charlotte: "dans chaque corps organique il n'y a qu'une unité dominante et principale qui est son âme. C'est le moi en nous."[21] In an inorganic aggregate the "dominances" are multiple, and they prevent us from observing a unique centre. But in a machine of nature or an organic body, a singular dominant perception giving the appetitions their direction can be observed through numerous and partial dominances. It complies with the nature of the monad: one monad cannot be considered without others, as Leibniz says to Sophie: it cannot be taken "sans compagnie; car autrement elles seraient sans fonction et n'auraient rien à représenter."[22] So dominance is not the property of a particular monad, as we might think about a soul truly distinct from the body and conceivable without it, since every monad is dominant to its own degree or in its small department. How are we to conceive the terms of the substantial composition in these conditions?

Far from clearly defining the terms of such a composition, the letter to Burnett of 1699, as well as that to De Volder of June 20, 1703, leave a kind of indeterminacy as to the order of the components.

In the letter to Burnett,[23] Leibniz first distinguishes the corporeal substance from the matter. But instead of explicitly defining the components of the corporeal substance, he distinguishes the primary matter from the secondary and defines the latter as an aggregate of several corporeal substances. Corporeal substantiality is so defined first as a plurality in the secondary matter, before being considered as a unity (like an animal), which enters into the composed beings, i.e., a reality that is no longer composed. Only afterwards is the corporeal substance conceived as having in itself the principle of its unity: a soul. But as soon as Leibniz posits the soul as one term of the composition, he sets it aside, immediately writing: "outre le principe de l'unité, la substance corporelle a sa masse ou matière seconde, qui est encore un

[20] GP II, 193.

[21] A, I, 18, 114.

[22] "without company, because otherwise it will be without a function and will have nothing to represent." (GP VII, 556)

[23] GP III, 260.

agrégé d'autres substances corporelles plus petites, à l'infini."[24] Leibniz constantly mixes unity and multiplicity, the active and the passive, defining the composition as a kind of weaving in which components alternately appear and disappear, rather than an addition worked out by a soul upon a body deprived of unity in itself. Likewise, the famous letter to De Volder of 20 June, 1703 does not describe five distinct, logically ordered steps of the substantial composition, but three general levels of analysis: the monad, the secondary matter or machine of nature, and the corporeal substance (the animal). In my view, there is no conceptual indetermination here but rather an overlapping of the different levels.[25] It is precisely the concept of organism that points out this interweaving.

The substantial composition then can no longer be thought from the concepts of the whole and its parts. Rather the organism allows us to conceive a composition in terms of folds and envelopments, which are the real artifices of the matter.

Up until his final years, Leibniz hesitates to attribute real substantiality to bodies. In the "Entretien de Philarète et Ariste", for instance: "Il semble que dans la rigueur philosophique les corps ne méritent point le nom de substances, ce qui paraît déjà avoir été le sentiment de Platon, qu'ils sont des êtres transitoires, qui ne subsistent jamais au-delà d'un moment."[26]

Hence the dominant monad brings about the substantiality of the animal, but not the substantiality of its organic body. The concept of organism is of a pair with the idea that the body in itself cannot constitute a real substance in spite of the existence of corporeal substances. Indeed, in order to maintain the order and artifice it is necessary that the organic flow remain continuous, that is, that the soul can at any time express the universe through the mediation of living beings embedded in its body. The alterity and the heterogeneity of the composition of the natural machine imply that the body is not a substance, but rather the constant flow of a changing aggregate of substances. Hence the individual is organic inasmuch as the parts of its body continuously and imperceptibly exit the whole and permit other parts to come in. The soul is able to remain attached to the body on the condition that the body is organic, that is, if the body contains substances separable from the machine of which they are temporary requisites.

To conclude, the notion of organism is of a pair with a new conception of substantial composition. This composition is not the addition of a body to a soul, but rather only comes to make sense within the infinite artifice of the machine of nature itself.

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[24]". . .out of the principle of the unity [i.e., the soul], the bodily substance has its mass or secondary matter, which again is an aggregate of other, smaller bodily substances, to infinity." (Ibid.)

[25]In a letter to Bayle (1702), Leibniz writes: " l'indestructibilité entière de l'animal ou de la machine même" (GP III, 67), as if an equivalence was possible between both terms, i.e., between the complete corporeal substance and the machine of nature supposed to be only a part of the corporeal substance.

[26]GP VI, 586.

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Chapter 11
Action, Perception, Organisation

Anne-Lise Rey

Prior to Leibniz's invention of dynamics, his new science of power and action, the term "action" contained within it two usages that were not only distinct, but indeed opposed, as between the action of the body that accounted for movement, and the action upon oneself, characteristic of the spirit, that underlay the definition of thought. The entire interest of the novelty that, beginning in 1690, Leibniz introduced along with the dynamics, was to conceive of the action of the body, designated as a motive action, as in its very root an action upon itself. In essence, Leibniz conceives of an action upon itself [*actio in se ipsum*] as occurring in every body, which the body itself exercises upon itself, and which attests to its reality, even when one appreciates the movement of the body in terms of this movement's ideal conditions. In the context of the dynamics, the bodies in question are first and foremost heavy bodies, but the explanatory apparatus is also deployed in the letters sent to De Volder beginning in 1699,[1] in order to explain the transformations at work within corporeal substances.

Thus I hypothesize that the explanatory framework for action, put in place by the dynamics with the aim of accounting at once for the action that is exercised within bodies as well as for the relation of these bodies to the simple substances, may aid us in thinking about the status of organic bodies and their relation to substantiality, by tracking down, in the manner of the incredulous readers of the *Lettre sur un*

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[1] One thinks for example of the undated letter, composed between the letter of August, 1699, and that of November, 1699, in which Leibniz, in the course of explaining the relationship of the active principle to extension, invokes the entelechy of the animated body in order to make the action of the dominant soul in the totality of the animated body comprehensible by analogy to the soul, "en raison de la structure du tout." (GP II, 194: "[. . .]respondeo corpus tale [corpus animatum] aliam Entelechiam praeter animam et entelechias partium privatim actuatarum non habere; quin ipsa anima totius non foret nisi anima partis privatim animatae, nisi ob structuram totius ipsa dominans in toto anima esset").

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automate qui joue aux échecs[2] (1770) of Dutens, the animal that lies hidden in the machine.

Right away, this action may be thought of as perception, that is to say as the expression of order. For in order to conceive of this order as organisation, and in this way to justify the connection, up until now merely presumed, between action and organisation as a progression of perception,[3] we must adopt a differential index: the animal, which singularizes these bodies by distinguishing them from merely heavy ones.

Given this much, it is possible to think of action as organisation on the condition that one accords an apprehension of organisation as the expression of the agency of organs amongst themselves,[4] at a superior level of complexity as well as of subtlety. It is a matter not only of expressing the order of the world, but also of the transformations at work in the body in the form of the enfoldings and the unfoldings of the organs. Thus the complexity of the transformations is correlated to perceptibility, that is to say to the capacity for perception.

That which resists the schema of intelligibility of heavy bodies in terms of the dynamics of action seems at first glance to be the living being, understood in the ordinary sense. The problem, or rather the entire interest of Leibniz's thinking on this question, as we well know, is that the formula, "all is filled with life", can be fully transformed into a formula of the sort, "all is filled with perception". It is thus perhaps not so much the living being as such that is singular, but rather the manner in which Leibniz, while placing it strictly within a framework of mechanical intelligibility, invites us to comprehend the body from the dual point of view of both its mass and its structure, as well as of its corporeality and its organisation, or, finally, of its secondary matter and its entelechy.[5]

In the manner of an investigation at the phenomenal level that, while expressing the derivative forces, invokes their relation to the primitive forces and so leads us back to the substantial level, in this way collapsing two levels of intelligibility as well as the path permitting us to move from the one to the other, we hypothesize that

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[2]Dutens (1770), s.l., s.n.

[3]In order to justify this claim, we may refer back for example to that passage addressed to De Volder in a letter of June 30, 1704, where Leibniz writes: "There is thus in reality something internal to every simple substance, since there is no reason why this should be in the one rather than in another, and this internal principle consists in the progress of the perception of each monad, and the entire nature of things involves nothing more than this." ("Revera igitur est internum omnibus substantiis simplicibus, cum ratio non sit cur uni magis quam alteri, consistitque in progressu perceptionum Monadis cujusque, nec quicquam ultra habet tota rerum natura." (cf GP II, 271)).

[4]In the *Système nouveau de la nature et de la communication des substances* (1695) Leibniz writes: "il n'y a qu'une transformation d'un même animal, selon que les organes sont pliés différemment, et plus ou moins développés." (GP IV, 481)

[5]Here we are referring to the formula presented in the 12th of Leibniz's *Doubts concerning the True Medical Theory of Stahl*: "All bodies come under the scope of chemistry to the extent that they are treated not as structures but as masses, and to the extent that one applies to them physical operations that consist in an imperceptible process." See *Stahl-Leibniz, Controverse sur la vie, l'organisme et le mixte*, introduit, édité et annoté par S. Carvallo, Paris, Vrin, 2004, 90–91: "Imo corpora omnia ad Chymia pertinent, quando secundum operationes physicas, insensibili processu constantes, non ut structurae, sed ut massae tractantur."

an incursion into what Leibniz describes as a physics of practice or applied physics, which comprehends both chemistry and anatomy, could lead us to the specific form of substantiality implicated in the corporeal substance.

Indeed, it seems to us that what it is that constitutes the specificity of each domain of knowledge is not so much the object that it has in view, as it is the explanatory modality that it adopts. It is in this respect that we seek to discover in what manner the intelligibility of organic bodies is apprehended by Leibniz.

If, as Michel Fichant has shown in his article, "Leibniz et les machines de la nature",[6] the degree of substantiality of organic bodies corresponds to the intermediate level between the monad, on the one hand, and on the other the aggregate lacking unity which articulates them or assures the progression from the one to another, the task here is to determine the substantiality involved in the body, or, which is the same, to comprehend the reality of the body.

My hypothesis is thus that action – in its ambivalence, and, following upon the lesson of the dynamics, in its identification with perception – may be used as an index of the intelligibility of the organisation that is at work in machines of nature, precisely to the extent that it proposes a connection between the corporeal dimension of an organic body and its substantial dimension.

The entire task of this elucidation is thus to comprehend in what manner these different meanings of substantiality may be articulated as degrees, testifying to the presence of a greater or lesser quantity of reality in the different forms of substance, and insisting on the fact that the recognition of the different existence of a corporeal substance is not so much the proof of an ontological duality at work in Leibniz's thought, as it is the paradigmatic expression of the construction of a continuity between the different degrees of substantiality.

1 Perceptual Action: A Way of Understanding the Machine of Nature?

By "ambivalence of action", we understand the transference of the initially metaphysical concept of action to dynamics, endowing this concept with its own measure by recourse to *mathesis*. The concept of action is in this way inscribed at two explicitly distinct ontological levels: that of substances, where action is manifested as immanent action, internal to simple substances or monads and characterized as perception; and that of phenomena, where action is exercised in the body (or in composites) as the source of motion.

Dynamics thus constitutes a necessary mediation between substances and phenomena, to the extent that the presence of formal action, understood as *actio in se*

[6]Fichant, "Leibniz et les machines de la nature", *Studia leibnitiana* XXXV/1 (2003), p. 27: "Ainsi s'esquisse comme une des possibilités pour la thèse monadologique de rejoindre la description la plus rigoureuse des régions de la réalité, une ontologie à trois niveaux: ceux de la monade, du pur agrégat ou substantié sans unité réelle, et, entre les deux, de la substance corporelle, ou machine de la nature" citant un texte de l'éd. Couturat et un fragment « De substantia simplex ac composita » cité par Pasini dans son *Corpo e funzioni cognitive in Leibniz* (Milan, F. Angeli, 1996).

ipsum, action on oneself and by oneself, is the mark of substantiality in the body. And if this action can constitute the object of a measure, thanks to which one is able to estimate the degrees of reality or perfection in things, then it is action that permits us to differentiate more and less distinct perceptions, and from there to discern a hierarchy among substances. It is in this sense that dynamics permits us to understand the simple substance, or, more precisely, to understand action as perception. In this connection, a passage in the letter to De Volder of June 30, 1704, reports: "You know that according to my calculus, by which I have demonstrated a priori the true estimation of (derivative) forces, the force (which I have mentioned) carried over into time brings about an action and, much more, it is that which is momentary in action, yet in relation to the following state."[7]

Leibniz explicitly makes use here of the understanding of motive action as the force that is exercised at a given time, in order to show its fruitfulness within metaphysics, and to offer an account of the presence of time in reflection upon action. Leibniz specifies here that action, in its temporal dimension, contains the internal necessity of being in relation to another action. Time is thus apprehended as the element that justifies the progression from one perception to another, or from one action to another. But this consideration only assumes its entire meaning to the extent that it can aid in the appreciation of the significance of the corporeal substance, to the extent that the transformations at work in the mass and in its folds bear, in a certain sense, the mark of time.

In the letter of November 10, 1703, Leibniz affirms – in a passage that was subsequently suppressed – that the only thing that can be understood in monads that are in themselves active is the perception that envelops the action.[8] This text is decisive to the extent that it indicates that in the monad all action presupposes perception. Perception is the sole level of intelligibility at which we are able to arrive when we attempt to grasp that very form of reality that is the monad. But insofar as perception takes account of the relations of monads themselves to the phenomena with which they are mutually bound, here it is also a matter of the relation between the monad and the phenomenon, a relation that Leibniz says is rendered intelligible thanks to perception. Elsewhere, in a letter to De Volder of June 23, 1699, Leibniz says in connection with this: "I maintain that perception is enveloped in extension."[9]

Perception is presented by Leibniz as a new form of action, to the extent that it makes it possible to propose a hierarchy of substances correlated with a hierarchy of phenomena, based on the greater or lesser quantity of perfection or reality in them, a quantity that can only be thought of as measurable on the condition that one comprehend the process of mathematization of the ontological concepts to which the measure of this perfection gives rise in the dynamic calculation of motive action. To

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[7]GP II, p. 270: "Et scis ex meo calculo quo veram virium (derivatarum) aestimationem a priori demonstravi, vim (quam dixi) ductam in tempus quo exercetur facere actionem esseque adeo quod in actione momentaneum est, sed cum relatione ad statum sequentem."

[8]GP II, 256: "Monades per se activas agnosco, in quibus etiam praeter perceptionem quae actionem utique involvit, intelligi nihil potest."

[9]GP II, 183: "[. . .]et extensione perceptionem involvi arbitror."

put it differently, the gradations of this substantial hierarchy can be comprehended through the capacity of each substance for expressing, as distinctly as possible, the maximum of relations between substances – a conception informed by the mediation of the notion of dynamic action.

Beginning from this brief summary, it will be worthwhile to justify the transposition of the lesson of the dynamics into the project of explaining organic bodies. This justification can be provided, first of all, in the form of an analogy, which makes explicit the relationship between dynamic and organic laws, as François Duchesneau has shown in his *Les modèles du vivant de Descartes à Leibniz*, where he brings to light a handwritten note on a text that is cited in Bodemann's edition of Leibniz's *Handschriften*.[10] In this passage, Leibniz makes two points: first, that the laws of nature are twofold, that is, that there exist dynamical laws of nature as well as other laws that are organic; second, Leibniz adds the crucial element, whereby an analogy is introduced ("*est tamen et in dynamicis hoc velut organicum*") between these dynamic laws and the organic laws, to the extent that he makes the elasticity of extended matter correspond, as an arrangement or *emboîtement* of system within systems, to the arrangement of organs that themselves always possess organs.

This analogy has a threefold function: it reveals the explicative association between dynamic and organic laws; it introduces elastic matter, governed by the same principle of infinite *emboîtement* as are the organs, which brings with it a new understanding of the elasticity of matter through the notions of *emboîtement* and of system, which is to say of progression to infinity; finally, it enables us to understand the arrangement of the organs in terms of the elasticity of matter as a particular property of the organs, namely, their capacity to possess within themselves the same organisation, though with different degrees of perceptibility.

Essentially, we may draw from this fragment the fact that the dynamic laws of nature are able to constitute a tool for the intelligibility of organic laws.[11] The question is thus to understand wherein the difference lies. Our hypothesis here is that it consists in the degree of complexification – which is to say in the degree of perceptibility, – thus introducing a correlation between organic complexity and perceptive capacity. The perceptive capacity, in effect, is increased in organic bodies by the very fact of the infinitely many possible degrees of activity.

I believe that if the dynamics reveals, at first glance, that the heavy body is a condition of the expression of the order of the world, what it is that the analysis of the organic body specifies is the *complexity of this order*. Effectively, it makes this complexity explicit in appealing to the terms "organ" and "organism", conceived above all as organisation, or the infinite *emboîtement* of worlds within worlds.

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[10]Cited by Duchesneau (1998), 350: see LH, IV, 1, 2a, f 15, in E. Bodenmann *Die Leibniz-Handschriften*, 51–52: "Duplices naturae leges dynamicae et plasticae seu organicae. Est tamen et in dynamicis hoc velut organicum, quod obtineri non possint nisi materia ubique elastica esset, neque elasticum ubique in materia, nisi systemata in systematibus collocarentur. In quo dynamica respondent plasticis, quae semper organa in organis habent."

[11]See Pasini, op. cit., 122: "La sua interpretazione della funzione degli spiriti serve infatti a introdurre nella fisiologia della sensazione il rapporto tra metafisica e dynamica."

In the same manner, in the correspondence with De Volder Leibniz makes use of his model of the intelligibility of the dynamics of action in order to explain what corporeal substances are.[12] The justification of this transposition rests on the fact that Leibniz explains straightaway the active principle at work in matter, and which goes beyond simple extension, by means of an "analogy of the soul". Evidently, it is force, but at the same time the limitations of these justifications of the transposition, that is the analogical connection that Leibniz uses to join these two domains together. Indeed, the analogy is not only a convenient way for Leibniz to make sense of a difficulty; it also has its own function: to propose a relation of continuity between two distinct levels of reality.

It is in connection with the affirmation of the ambivalence of action that Leibniz, in the correspondence with De Volder, introduces the notion of machine of nature in 1703. In the first instance, the concept of machine is employed in a letter of 1699 (undated, but sent sometime between the letters of August and November), as an example of the extended body from which, just as in an army or a flock, one may subtract the soul in order to illustrate the case of an aggregate without real unity, and to show from there that it is only the monad that makes this unity real. But from the letter of June 20, 1703 on the term "machine" is used in order to make sense of the constitution of the corporeal substance, insofar as the corporeal substance is said to contain infinite machines.[13] On a first reading, then, Leibniz makes the distinction between corporeal substance and machine of nature in the course of establishing their relation: a relation of *envelopment.* Then, in the same letter, he evokes the existence of a singular composite machine from among these machines *ad infinitum*, a singular machine actualized by an entelechy that guarantees its unity. His recourse to the terms "actualized" (*actuatum*) and "entelechy" is at the same time a return to an Aristotelian motif that is explicitly formulated for the first time in the letter to Pélisson of 1691. Here, he reintroduces entelechy as a condition for the comprehension of dynamics, but one could almost say that he is equally interested in understanding in what sense the entelechy that unifies the multiplicity subsumes the body under a dominant monad.

Leibniz, then, affirms that in the phenomena one need consider only the derivative forces, and that it is consequently necessary to explain the phenomena mechanically, to the extent that one understands their origin, which is to say "that the phenomena of aggregates arise from the reality of the monads."[14] Leibniz thus makes explicit the two different uses he makes of the notion of machine: "when

[12]This transposition, moreover, does not pose any problem for De Volder, who even considers that these domains are capable of having reciprocal relations. Thus in the letter of De Volder to Leibniz of November 12, 1699 (GP II, 198), De Volder writes: "Si igitur entelechiae tuae genere non differant ab anima, nonne sequitur ut anima nihil potest in corpus nec corpus in animam, ita nec entelechias quidquam posse in materiam, nec materiam in illas ? Unde sicut in corpore vis quaedam ponenda est, distincta ab Anima, qua corporis functiones peraguntur, ita in materia vis quaedam erit mutationis ab ipsa entelechia distincta."

[13]GP II, 250: "Cum dico substantiam, quamvis corpoream continere infinitas machinas [. . .]"

[14]GP II, 250: "nempe phaenomena aggregatorum ex realitate Monadum."

I say that a substance, though corporeal, contains infinite machines, I think that it is necessary to add at the same time that it includes a singular machine composed from these, and that it is moreover actualized by an entelechy, without which there would be no principle of true unity in it."[15] If, in using the term, Leibniz reaffirms the double function of the entelechy – unifying and making real – he also indicates, within a tight conceptual scheme, the difference between composing and constituting, while explaining containing (*continere*) as envelopment or comprehension. Leibniz adopts the term "machine" here according to its double meaning: both as a collection of organs that are themselves constituted out of organs, and also as organisation, which is to say as that which takes account, thanks to the entelechy, of the unifying principle that is responsible for activating these organs. Finally, in a last occurrence in the same letter, Leibniz characterizes the machine as an organic machine of nature that is identified with a substance:

> [A] new organic machine of nature is never born, since it is composed of infinite organs, thus expressing the whole universe in its own manner, and since it envelops all past and present times within it, which is very certainly the nature of all substances. And it has been thought that whatever is expressed in this way in the soul is also expressed in the body. Thus the soul as well as the body animated by it, and the animal itself, are as indestructible as the universe itself.[16]

Let us note here that it is because the machine "envelops" the different states of time that its substantial nature can be affirmed.

Through these different usages of the term "machine of nature", what Leibniz shows is the relationship between the corporeal substance and the machine of nature. As Michel Fichant has shown, corporeal substances contain machines of nature that can be unified by an entelechy into a singular machine. Thus the corporeal substance is a machine of nature on the condition that the organs that constitute the machine *ad infinitum* are unified by the entelechy.

The entelechy that brings about the unity in the body and guarantees their reality is the condition of the expression of the order of the world in corporeal substances. Thus, the letters to De Volder of 1703 explicitly formulate the *problem* of substantiality in Leibniz's mature metaphysics: on the one hand, every substance is simple, which is to say endowed with perception and appetite; on the other hand, the machine of nature, composed of infinite organs, is a substance.

If the corporeal substance has appeared as an ontological level intermediate between the aggregate and the monad, I would like to show how the relationship between the monad and the corporeal substance is to be understood, by seeking to

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[15] Ibid: "Cum dico substantiam, quamvis corpoream continere infinitas machinas, simul addendum puto ipsam complecti unam machinam ex ipsis compositam et praeterea esse una Entelechia actuatam, sine qua nullum esset in ea principium verae Unitatis."

[16] GP II, 251: "Meo judicio nunquam oritur machina organica nova naturae, quia semper infinitorum organorum est, ut totum universum suo modo exprimat, imo semper omnia praeterita et praesentia tempora involvit, quae certissima est omnis substantiae natura; ratumque estquod in anima, idem et in corpore exprimi; unde et anima et machina per eam animata, et ipsum animal tam indestructibilia sunt quam ipsum universum."

explain the sense of "envelopment", a term that is often used to account for this relationship.[17]

2 *Situs*: The Question of Continuity Between the Monad and the Organic Body

The term "situs", as well as, to a lesser extent, the terms "diffusion" and "determination", permits us to better delimit the meaning of "envelopment", and thus the nature of the relationship between simple substance and corporeal substance.

We find an illustration of this theme in the *Considérations sur les Principes de Vie, et sur les Natures plastiques, par l'Auteur du Système de l'Harmonie préétablie*[18]:

> [A]nd that thus there are machines in the least parts of the natural machine *ad infinitum*, and so many envelopes and organic bodies enveloped the one within the others that one would never be able to produce an organic body entirely de novo, without any preformation, nor entirely destroy an animal that already subsists.

This passage attests to the usage of "envelopment" as an indication of the substantial permanence of the organic body. But strictly speaking Leibniz does not provide an explanation. What I would like to elucidate, in the analysis of *situs*, is this other motif, this time addressed to Sophie Charlotte[19]:

> It will be asked how the composite can be represented in the simple, or the multitude in the unity. I respond that it is something like the infinity of rays that come together and create angles in the center, however simple and indivisible this is. And these rays do not consist only in lines, but also in the tendencies or efforts of lines, which are cut without being confused with one another, as the motion of fluids leads us to understand.

Now, can *situs* be understood as offering an account of envelopment? At the end of the letter to De Volder of June 20, 1703,[20] Leibniz explains the status and function of *situs*. This term is used generically to describe the position of the monad in extension. Thus Leibniz writes: "Even if the monads are not extended things, they nonetheless have a certain sort of situation [*situs*] in extension, that is to say that they have a certain ordered relation of coexistence with other things, through the intermediary of the machine that they govern."[21] Leibniz indicates in this passage

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[17] This will lead us to deepen our understanding of perception, understood, for example, as in the seventh point of Leibniz's twenty-first Response to Stahl's Observations, as "a certain figuration, so to speak, or indeed a representation of a composed multitude within the monad," (Carvallo 130–131): "Et *perceptio* quidem figuratio, ut sic dicam, seu repraesentatio est compositi in simplice multitudinis in monade."

[18] GP VI, 544.

[19] GP IV, 522.

[20] GP II, p. 253.

[21] Ibid.:"Monades enim etsi extensae non sint, tamen in extensione quoddam situs genus, id est quandam ad alia coexistentiae relationem habent ordinatam, per Machinam scilicet cui praesunt."

that the machine (and here it is the machine of nature, defined earlier in the same letter as an organic machine) is that which gives a *situs* to the monad. Thus he defines the *situs* as an ordered relation.

The end of the letter explicitly says that simple things (and here a variant of the manuscript shows that Leibniz had initially written "monads"), even if they are unextended, are able to have a position within extension, even if, in turn, it is not possible to designate this position as a point, as in the case of incomplete phenomena.[22] And it is in this context that Leibniz, just prior in the letter, reveals something essential: "extended things envelop [*involvunt*] within themselves many things that are endowed with a position, yet are simple."

The entire question of the relationship to *situs* seems to be concentrated here in the length to which Leibniz goes to characterize the function of the machine in relation to substance: to express the relation of order that brings substances into a relation to one another. And correspondingly Leibniz explains in what manner the *situs*, which cannot be reduced to a physical point, is able to formulate more than it makes explicit in the relationship between extended things and simple things: a relationship of envelopment. It is precisely this that we must seek to understand now, while refusing, clearly, to transform *situs* into a physical point that would easily materialize the monad. In the series of exchanges with De Volder, Leibniz, in order to explain the relation between the simple substance and the machine, will make clear the relation between the composition and the constitution by means of the notion of *diffusion*.

Leibniz formulates the "problem" of diffusion as one of the relation between the unextended and extension. In this way, he seems *prima facie* to place it within the classical but nonetheless aporetic framework of a relation of composition. Yet he does this in order to indicate that it is not at this level of relation that we need to understand the relation in question, but rather at the level of a relation of *constitution*. What does this mean?

He explains this relation by means of two examples: that of the whiteness of milk and that of the supreme substance. In the 23rd letter, undated but written in 1705, with the example of the whiteness of milk Leibniz shows that one must understand diffusion as continuation: in fact, the whiteness is not a component of milk; it is present everywhere in the milk as that which ensures its continuity.[23] In one sense, the level at which the problem should be understood is formulated when Leibniz writes, this time in the 34th letter, of 11 October, 1705: "[the Duke of Burgundy] wrote that he had left an irresolvable difficulty, according to which, while

[22] One might also see here a sort of anticipatory response to the problem, raised by Dutens in the letters, of the chess-playing automaton.

[23] See GP II, 277: "La diffusion que je conçois dans l'étendue et qui semble avoir jeté en vous le soupçon de je ne sais quel paradoxe implicite, je souhaite qu'elle ne soit rien d'autre que la continuation par laquelle une partie est semblable au tout, comme nous concevons dans le lait la blancheur diffuse [. . .]," "Diffusionem quam in extensione concipio et quae Tibi suspicionem nescio cujus paradoxi latentis injecisse videtur, nihil aliud esse volo quam continuationem qua pars est similis toti, ut albedinem concipimus in lacte diffusam [. . .]"

the geometers show that extension does not arise from points, the metaphysicians show, by contrast, that matter should result from unities or simple substances."[24]

It is thus in a relation to perception that this problem should be treated, to the extent that, through the mediation of dynamical action, perception allows us to comprehend this figure of constitutive unity. This is a figure that is also defined as the expression of "the multitude of things of the same nature, existing together according to a certain order."[25]

In the same way, at the end of the undated 23rd letter to De Volder[26] Leibniz makes use of an analogy between the supreme substance and simple substances (which are "imitations of divinity") in order to explain in what sense there could be diffusion in simple substances: that which is diffused is the quantity of perfection or reality, through the medium of the body, in the corporeal substance. And it is within this context that one can understand Leibniz's introduction of *situs*: a mediation understood as the point of view on the world in the dual sense proposed by Belaval: "both a *point* of view (as a form in relation to its matter), as well as a point of *view* (since it is a perceiver)."[27]

In this letter, it is very clear that the machine, as that which expresses a relation of order, is the *situs* of the monad. The *situs* is the manner in which the metaphysical point or formal atom gives its point of view to the simple substance and at the same time permits it to be expressed through the intermediary of the body. Thus, the *situs*, if it is to function as a principle of individuation of the simple substance in the body, will be that which makes it possible to affirm the presence of simple substances in the body.

In this connection, if it is agreed that *situs* makes it necessary that every simple substance or monad must be accompanied by a body, it also indicates the function of the machine of nature: to express the order of the world.

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[24] See GP II, 278: "[. . .] etsi quisquis scripsit, insolutam reliquerit difficultatem, dum Geometrae ostendunt extensionem non constare ex punctis, at Metaphysici contra Materiam ex unitatibus seu simplicibus substantiis resultare debere."

[25] This passage is also found in the letter of 11 October, 1705.

[26] See GP II, 278: ". . . vous voyez facilement en effet que les substances simples ne peuvent être autre chose que des sources ou principes (en même temps les sujets) de tout autant de séries de la perception se développant elles-mêmes en ordre, exprimant la même totalité des phénomènes avec une variété maximale et très ordonnée, par lesquelles la substance suprême diffuse sa propre perfection autant qu'il lui est permis dans les nombreuses substances qui dépendent d'elle, qu'il faut concevoir chacune comme des concentrations singulières de l'univers et (les unes en comparaison des autres) comme des imitations de la divinité. Et je pense qu'on ne peut comprendre ni (en un mot) souhaiter d'autres raisons des choses et que les choses ont du exister de cette manière ou ne pas exister du tout. » « Facile enim vides simplices substantias nihil aliud esse posse quam fontes seu principia (simul et subjecta) totidem perceptionis serierum sese ordine evolventium, eandem phaenomenorum universitatem maxima ordinatissimaque varietate exprimentium, quibus suam perfectionem quantum fas fuit suprema substantia in substantias multas ab ipsa pendentes diffudit, quas singulas tanquam concentrationes universi et (alias prae aliis) tanquam divinitatis imitamenta concipere oportet. Neque alias rerum rationes puto intelligi et (summatim) vel optari posse, et vel nullo vel hoc modo res existere debuisse."

[27] Belaval (1976).

Let us note, to conclude, that the concept of determination makes it possible to explain the sense of this expression of the order of the world according to another point of view: no longer that of the envelopment of the law of the series, but rather that of the limitation of this law. Indeed, the term "determination" is most often associated with the notion of derivative force, in the course of explaining the relation between primitive and derivative forces. Thus Leibniz writes in his 19th letter, of 21 January, 1704: "Derivative force is the present state, which at the same time tends towards or pre-envelops the following state, as everything is filled with the future. But what it is that persists, to the extent that it envelops all of the cases, has a primitive force, such that the primitive force is the law of the series, while the derivative force is a sort of determination that designates a limit to the series."[28] I understand determination here as a sort of scansion that in some way temporalizes the progression of the perception by carving out stages in time, and in this way expresses not the influence of substances the one on the other, but rather the action of a substance upon itself that, in every organic body, expresses the law of order. Determination amounts, then, to temporalization.

The conceptual apparatus just described makes it possible to show the *necessity of a correspondence* between the simple substance (or monad) and the secondary matter (or the organic machine, to adopt the equivalency noted by Leibniz in his letter of June 20, 1703): the presence of simples in the body, and, by means of the entelechy, the factor of unity and of reality, is the condition of their intelligibility (to be able to grasp them as a unity beneath the multiplicity, which is to say as a body). Reciprocally, as we saw with the analysis of *situs*, bodies are the condition of the expression of simple substances.

We can now establish a preliminary understanding of the machine of nature: it is the *situs* of a monad, and to this extent, insofar as it perceives, it expresses at the same time the order of the world. This idea of temporality is introduced in order to represent the manner in which the variations of bodies appear to us.

3 What Reality for Organic Bodies?

At this point what is needed is to make sense of the sort of reality of bodies that is reaffirmed in the last words of the last letter to De Volder, dated 19 January, 1706, in which Leibniz writes: "We do not have –or we should not wish for– another mark of reality in the phenomena than the fact that they correspond to one another equally and through the eternal truths."[29]

The claim that the monads ground or constitute the phenomena (and not that they compose them) is what we have retained from the analysis of *situs*. It is not so much

[28] GP II, 262: "Sed ipsum persistens, quatenus involvit casus omnes, primitivam vim habet, ut vis primitiva sit velut lex seriei, vis derivativa velut determinatio quae terminum aliquem in serie designat."

[29] GP II, 283.

a matter of resolving the problem as it is of acknowledging its very existence. In the same fashion, to speak of a rule-governed correspondence between bodies and souls is in no way an elucidation of the problem: at most, it is perhaps only a more stimulating formulation of it.

There is a first response to this problem that is attested in Leibniz's writings, according to which corporeal substances are composed only in a mediate way by the monads, yet are directly composed by corporeal substances *ad infinitum*, with each of the corporeal substances realizing its unity thanks to the action of the dominant monad. This response is in evidence in all of the texts of Leibniz that take into account the infinite *emboîtement* of organs within organs, of systems within systems, etc., and can be understood, as Pauline Phemister shows,[30] within the context of an interpretation of the relationship between the monad and the corporeal substance, conceived as two logical levels of one and the same substance.

It seems to us that this interpretation, to the extent that it is situated at the level of ontology, is supported by a reading of what it is that the corporeal substance, from the strict point of view of its structure, consequently leaves to the side everything that is properly speaking corporeal in the organic body, namely, that mass whose articulation, together with the structure, constitutes the biological singularity. For this reason, the path that we would like to follow at this point amounts to taking into account what it is that the intelligibility of the organic body as a mass, which is to say at the phenomenal level, teaches us, correspondingly, about the organic body. Here it is not a matter of falling back on a strictly mechanical explanation of the intelligibility of the ontological singularity of the organic body, but on the contrary of learning the "lesson of the dynamics", according to which, at the heart of mechanical intelligibility itself, there are reasons that exceed and ground this intelligibility. Just as at the root of motive action we find action upon oneself, would we not also find, in the transformations of organic bodies, something like a root of their activity? What we must seek to trace out, then, is the *singularity of the transformations that are particular to the living being*, in order to understand at what degree of perceptual perfection they may be situated. These transformations are often presented in the form of folds and unfoldings of organs, or as "the growth and diminution of an animal that is transformed and developed."[31]

It seems evident to me that, given the apparatus that Leibniz puts into place in correlating the levels of intelligibility to levels of reality, the singularity of the ontological level of the corporeal substance imposes a methodological singularity. From here, what we must understand very precisely is the manner in which the analysis of organic bodies as masses reveals a relationship with its organisation. With one central idea in mind, namely, that the machine of nature articulates an expression of order as well as a mass, it is from this double point of view that we must seek to understand it.

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[30] Phemister (2005), p. 82.

[31] *Considérations sur la doctrine d'un Esprit universel unique* (1702), GP VI, p. 533.

We are relying here on the role that Leibniz attributes to chemistry, though one could refer equally productively to anatomy in order to make bodies intelligible. It is clear that it is not possible, by means of chemistry, to illuminate everything that happens undetected in the soul.[32] It seems nonetheless that chemistry fulfills the function of a "cognitive practice".[33] If chemical analysis of the mass of the organic body leads us back to its structure, as that which grounds it, this analysis will at the same time indicate to us the path by which its singularity is expressed.

3.1 A Worthwhile Digression on Chemistry

The legitimacy of chemistry is made clear in two claims Leibniz makes to Stahl. The first indicates that chemistry is concerned first and foremost with bodies. As Leibniz writes, "all bodies are affected by chemistry, to the extent that they are treated in terms of physical operations that consist in a non-sensible process, not as a structure but as a mass."[34] In the second claim, Leibniz speaks of a special physics in connection with chemistry, which he finds to be too empirical at present (like medicine), but which he thinks could be useful in the future. As he writes in the 12th response: "To the extent that it observes the phenomena of bodies that are similar, or somewhat similar, to those that constitute organic bodies, it will be useful to make use of chemical observations in the animal kingdom."[35]

My purpose in proposing this digression on chemistry, then, is to grasp that which is distinct from the structure that is expressed, as organisation, in the organic body, that is to say, simply, to grasp the body as a mass and to understand that to which its intelligibility leads us. The function of chemistry is affirmed by Leibniz right away: to make the imperceptible constituents of bodies legible. In this connection, Leibniz emphasizes the cognitive function of the practice of chemistry, as for example in the third section of his "Plan for the Creation of a Society of Arts and Sciences in Germany",[36] where he indicates that knowledge of the various procedures of distillation, precipitation, fermentation, and chemical reactions make it possible to

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[32] This is a passage from the controversy with Stahl, also cited by Pasini (1996, 121): ". . .facile concedo non admodum magnum hactenus Chymiae usum esse ad explicanda, quae in animalibus insensibiliter fiunt. Sed aucta Chymiae scientia, augebitur etiam ejus applicatio. Nam fiunt in animalibus eruptiones et explosiones pyriis similes, quales nobis multas exhibet Chymia" (Dutens, II, 2, 148–149).

[33] See Rey (2011).

[34] In the 12th of Leibniz's doubts in the *Negotium otiosum*. The complete text of the controversy is found in Stahl, *Negotium otiosum seu Skiamachia adversus positiones aliquas fundamentales theoriae verae medicaea Viro quodam celeberrimi intentata sed adversis armis conversis*, Halle, Impensis orphanotrophei, 1720 and in Leibniz, *Animadversiones circa assertiones aliquas Theoriae Medicae Verae clarii Stahlii*, Dutens, 1768, II, 2, pp. 131–161. See also Huneman and Rey (2007)

[35] Cf pp. 114–115.

[36] *Œuvres complètes de Leibniz*, Ed. Foucher de Careil, VII, p. 85.

get at "the majority of the internal functions of nature, and principally those of the human body."

I hypothesize that the role of chemical experiment (once Leibniz has asserted that he refuses to accord any reality at all to chemical principles, even though he appreciates the heuristic fruitfulness of chemical practices), understood as revealing the intimate secrets of nature within the body, corresponds to a specific level of intelligibility in the machine of nature that, even if it was initially traced back to mechanism, nonetheless in the late texts comes to exceed it in a certain sense. And it is this gap that is of interest to us here. In this connection, the treatment of chemistry changes between the 1670s and the 1690s. In fact, one could say that in the 1670s, Leibniz gives to chemistry an illustrative function: chemistry illustrates the mechanical explanation of the motion of bodies. In this context, it is a matter of reducing the mystery of nature to mechanical explanation.

This reduction is of course also to be understood as the possibility of a relation. Thus, for example, as Leibniz writes to Tachenius: "I have traced back to manifest causes this mystery that is hidden in nature."[37] Or as we find in an unpublished essay from the beginning of the 1670s: "I may now dare to hope to have discovered a reason for connecting the mechanical philosophy, which traces everything back to size, figure, and motion, with chemistry, which traces everything back to certain reactions and solutions."[38]

In the first case, that of figure, chemistry is presented more as a level of expression[39] than as a true level of intelligibility, since it is necessary in a certain sense to trace it back to mechanical explanation in order that the mystery is resolved by comprehension. One of the questions posed by this characterization of chemistry will be to understand whether every level of specific expression corresponds to its own level of intelligibility, as the series of reflections by Leibniz on intelligibility will confirm. Particularly interesting is what Leibniz writes in a letter to Oldenburg of April 29, 1671, explicitly mentioning the reduction of chemical operations to elastic force: "Nam omnes reactiones, fermentationes, solutionesque, et praecipitationes ferme reduci possunt ad reactionem, quae est inter acidum et alcali, haec vero pendet a Vi Elastica."[40]

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[37] See A II, 1, p. 100, cited by Bodéüs, p. 330.

[38] See A I 2, 325. This previously unpublished text was translated by Richard Bodéüs, in his edition of the correspondence between Leibniz and Thomasius dans son édition de la Correspondance entre Leibniz et Thomasius (1663–1672) (Paris, Vrin, 1993), 330.

[39] See the letter, already cited, to Lambert van Velthuysen of 5 May, 1671, in which Leibniz writes: "Videbis simplicem satis, brevem, claram, phaenomenis explicandis fortasse sufficientem: concordare experimenta vetera novaque, conciliari posse plerorumque hypotheses, rationem redditam reactionum, fermentationum, solutionum, praecipitationum chymicarum; explicatum est, quid sit illud acidum et alcali, quorum reactione et lucta velut animatur natura, *quae Chymici nominarunt potius quam explicarunt.*" (our italics)

[40] See A II, 1, 167.

What I would like to try to understand at this point is the articulation of the claims in which Leibniz insists upon the utility of chemistry for physics (for example, the claims made in response to Descartes, who, in Leibniz's eyes, knew nothing about chemistry[41]), and also those in which Leibniz insists on the idea that chemical explanations are useful for representing things but not helpful in comprehending them. These claims seem to us to be contradictory, for two reasons: on the one hand, it seems that for Leibniz any form of expression is, in a certain sense, connected to a form of intelligibility; on the other hand, we must try to understand what a chemistry that is not useful for reasoning might be, that is, what non-cognitive utility might be.

In order to respond to this apparent contradiction, it will be worthwhile to mention a text entitled *Veritates physicae* (approximately dated to around 1678–1680), in which Leibniz characterizes the chemical experiments in which bodies are modified as perceptible physical truths arrived at by induction. He delimits their function in the process of cognition as follows: in view of their conjectural character, they do not enable us to identify the causes of the phenomena that we observe, but they do permit us to formulate the hypotheses that will make knowledge of natural phenomena possible. Beginning from a strong analogy in the "preface to Nizolius"[42] between the method of the philosophers who conceive bodies and the qualities of bodies that cannot be conceived by others, and that of the chemists who, with their mixtures and their decompositions (*resolutiones*) produce new bodies that had previously been unknown, as well as the method of the compositions of the physicians, Leibniz conceives of the production or the making apparent of new bodies by the chemists as a sort of anticipation, to the extent that it leads us to see that which remains imperceptible until the microscope makes it visible.[43]

In the 1690s, a letter to Henri Justel of August 27, 1692, reaffirms the proximity between the method of the philosopher and that of the chemist, yet goes further in showing how chemical operations help us to understand nature. Beginning from the recognition of a similarity between the changes that occur in the world and those that are produced in chemical laboratories, he proposes an explanation of the changes in the world conducted via the elements of chemistry. In this case, the chemical vocabulary is used in order to make intelligible those phenomena that had previously remained unexplained.

This detour through chemistry made evident the chemical activity of reproducing or anticipating the natural transformations of organic bodies, which had as its end

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[41] A II, 1, 782.

[42] A VI, 2, 413.

[43] Our interpretation is similar to Duchesneau's (1982), p. 90: "Leibniz ajoute que l'intérieur des processus organiques nous étant caché au-delà d'un certain niveau d'observation, l'analogie qui lie les processus phénoménaux suivant les suggestions de l'expérience peut nous permettre d'anticiper sur la raison suffisante mécanique des processus."

the goal of making visible or, better, intelligible, the structure of these bodies. If chemical practice, just like medical practice, reveals to us the invisible structure of nature, it also makes clear the connection between mass and structure, a connection made through a cognitive practice. Here, then, it is just a question of showing the mediation through which it is possible to encompass the totality of the singularity of an organic body: not only at the most complex level of organisation, but also at a level that is so complex that we are required to consider a specific degree of transformation at work in nature.

Thus, we see the connection of Leibniz's reliance on *situs* and on chemical evidence, the envelopment of the corporeal machine by the natural substance, via the entelechy, as well as the development of the order of the world expressed in the organisation of these machines in the form of their perceptual capacity.

4 Conclusion

The search after the singularity of the living in the organic body is caught up in a well-known difficulty: there is no ontological singularity; in fact, there is a "biologization of Leibnizian natural philosophy", to take up a phrase of Justin Smith that could help to explain the omnipresence of the vocabulary of seed, life, and organism. There is nonetheless no "reality of the living as such", such that we should be led either to see in it a sort of general metaphorization that in no way signals the presence of the living being,[44] or, by its very omnipresence, to see in it a denial of any singularity whatsoever. In a word, if everything is life, nothing, specifically, is life. In the same way, and as a consequence, neither is there a singularity of the living from the point of view of its intelligibility: this is something mechanical, to the extent that organic bodies are considered as machines.

And so, if life turns out to be elusive in Leibniz's thought by dint of its omnipresence, this is perhaps because we take somewhat too literally his claim to be in search of a strictly mechanical intelligibility. In a word, life amounts to a specific perceptual change that takes account of transformation in organic bodies, which itself can only be understood thanks to the mediation of the notion of action, which is simultaneously both the action on the body of chemical practice, as well as the action upon oneself by the organisation that it makes it possible to attain.

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[44] It seems to me nevertheless that we are not dealing with the same sort of figure, in the case of the omnipresent usage of the notion of life, as in the apparently more classical case of aquatic metaphors. Thus, as Cristina Marras has shown in her article, "The Role of Metaphor in Leibniz's Epistemology" (in Marcelo Dascal (Ed.), *Leibniz: what Kind of Rationalist?* Springer, 2008, pp. 199–212), metaphors play a determinative role in Leibniz's argumentative strategy, to the extent that his relationship to knowledge is very closely connected to his use of language. It seems however that here the relationship to the living is somewhat different, to the extent that it is at once an object of study in its own right (even if Leibniz very consistently expands the field of its validity), as well as being that which, in the very opening up of it, loses its ontological specificity.

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Chapter 12
Perceiving Machines: Leibniz's Teleological Approach to Perception

Evelyn Vargas

1 Introduction

In recent years, many of the debates surrounding the issue of perceptual experience have focused on its representative nature. For those who claim that our experiences are vehicles that enable us to attend to things in the world, perceptual experience has been thought to be able to contribute to our epistemic lives only on the condition that it is fundamentally representational. Those who defend the non-conceptual character of perceptual experience often appeal to the need to correctly describe the overlap between human perception and that of non-linguistic animals in order to account for the content of perceptual experience.[1]

The notion of perception appears prominently in Leibnizś thought. It is not only a key concept of his theory of monads, since monads can be distinguished by the contents of their perceptual states. He also ascribes the ability to perceive to animals. However, a number of difficulties may arise as soon as we attempt to clarify the Leibnizian concept of perception. For example, if the term is not equivocal, it is unclear what the perceptions (and perceptual experiences) of humans and animals have in common. Moreover, Leibniz offers two definitions of perception throughout his writings. According to one of them, for Leibniz perception is a case of *cogitatio*, or thought that is related to an object, yet in his second characterization, perception consists in *expressio*, or representation of the many in the one. Yet insofar as the former depends on the possibility of conscious thought, it would not be possible to extend the ability of perceiving to animals. Moreover, while the former might be used to argue for the view that perception can put us in contact with physical objects or bodies, it is at least controversial whether the latter can play this epistemic role.

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[1] Mainly as a response to John McDowell's views on perceptual content.

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Rather than attempting to provide a complete description of Leibniz's account of perception, my aim is to focus on some texts written between the late 1670s and middle 1680s, in order to analyze whether Leibniz was able to combine the advantages of both definitions into a single view, that is, whether his mature conception could provide a univocal description of both human and animal perception, while also preserving its cognitive role.

2 Perceptio est cogitatio

In a list of definitions probably written between 1678 and 1679, Leibniz defines sense perception (or *sensus*) in terms of the more general concept of thought. He writes:

> *Perceptio* est cogitatio sui et alterius simul (. . .).[2]
> *Sentire* est percipere mutationem aliquam cujus causam in me non percipio (A6.4.73).[3]

Now, although the Latin term "perception" can be applied to both conscious thought and sense perception, we can distinguish the latter, more specifically, as a kind of thought in which the subject is aware of some change but the cause of change is perceived as different from the perceiving subject. In "perception", or conscious thought more generally, we are simultaneously aware of ourselves and something else, so that in reflective thought the cause of change is in ourselves.[4]

More precisely, as Leibniz explains in another list of definitions, when we have a sense perception two bodies resist each other, in such a way that we perceive one as our own, the organ, and the other body as alien to us, the object:

> Si duo corpora sibi resistant, et nos actionem passionemque unius percipiamus velut ad nos pertinentem, alterius velut alienam, illud corpus dicetur *organon*, hoc dicetur *objectum*; ipsa autem perceptio dicetur *sensus* (A6.4. N 267).[5]

On this approach, sense perception involves conscious thought and conscious thought involves an awareness of otherness as complementary to self-awareness. What distinguishes sense perception is its explicit reference to bodies, that is, to the perceived object and the body to which the mind is organically united. As regards the perceived object it is explicitly acknowledged as an external body and if we assume that sense perception involves a change in our mental state, which we perceive, then the perceived object is also the cause of change, or the cause of cognition.[6]

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[2] "Perception is thought of oneself and other simultaneously."

[3] "Sensing is perceiving some change whose cause I do not perceive in me."

[4] In other words, reflection is perception of oneself as opposed to the perception of a variety.

[5] "If two bodies resist each other and we perceive one as pertaining to us and the other as alien to us, we call the first body an organ and the second body an object; but the perception itself is called sense."

[6] In a later text cognition is explicitly defined as thought referred to an object (A6.4. 802).

We can find a similar view in Leibniz's commentaries on Simon Foucher's response to Malebranche where Leibniz draws a distinction between a cause and an immediate object in order to characterize concepts and sensations. Leibniz writes:

> Par consequent les objécts immediés de nos perceptions, ou les causes prochaines de ces differentes pensées different aussi entre elles (. . .) et la cause immediate hors de nous des pensées de l'etendue, des couleurs, etc. (s'il y en a une hors de nous) est apellée matière (A6.3.318).[7]

The cause of sensation is matter, and since we are the cause of intellectual notions, their cause coincides with their object. In other words, concepts and sensations are different kinds of ideas with different representational contents which represent their different causes:

> J'apelle ces sensations des *idées* (. . .) Je les appelle encore les effets que les objets exterieurs produisent en nous par nos sens; et je dis que ces idées ne nous represent pas ces objets tels qu'il sont en eux-mesmes; mais seulement ce qu'ils produisent en nous (A6.3.323).[8]

Now sensations, such as our ideas of color, do not represent their cause accurately, since they do not represent physical objects directly but through their effects on our organs. These impressions or effects on our organs are themselves signs (A6.3.322).

Sense perception is relational, but what stands at the other side of this relationship, or the external body, is in fact our own body. Consequently, one may think that Leibniz's definition of perception in terms of thought, on the one hand, and this characterization of sensation, on the other, are slightly different, not only because the one emphasizes the activity of the mind and the other its representational content, but also because of its focus on the mediating role of the organ, insofar as our bodily impressions are signs or effects of the material object causing the perception. The second view, on the other hand, explains the recognition of otherness in terms of our awareness of two bodies reacting to each other, and so it might seem that the representational view, in which sensations are ideas, is more easily associated to skeptical doubts.

Leibniz had discussed the skeptical arguments against the existence of the external objects of perception in a letter to Foucher of 1675:

> . . .or cette varieté des pensées ne scauroit venir de ce qui pense, puisqu'une même chose seule, ne scauroit estre cause des changemens qui sont en elle. (. . .) puisqu'il n'y a point de raison de cette varieté qui ait esté de toute eternité en nos pensées; puisqu'il n'y a rien en

[7] "Consequently, the immediate objects of our perceptions or the near causes of these different thoughts differ from each other too (. . .) and the immediate cause outside of us of our thoughts of extension, colours, etc. (if there is an "outside of us)" is called matter."

[8] "I call these sensations ideas (. . .) I even call them the effects the external objects produce on us by our senses; and I say that these ideas do not represent those objects to us as they are in themselves; but only what they produce on us."

> nous qui nous dettermine a cellecy plus tost qu'à une autre. Donc il y a quelque cause hors de nous de la varieté de nos pensées (A2.1.248).[9]

So, by applying the principle of sufficient reason, he can claim that the better explanation of our perceptual experience of objects is to accept that the external things are the cause of the complexity of our perceptual thoughts. Otherwise there would be a change without a reason.

In sum, Leibniz's early account of perception conceives perception as a relational act of thought, in which the self is related to something else; what is represented as other is an external body through our own reacting organs. The representational content of the perceptual experience inform us of the changes taking place in our bodies, that is, although reflection and sense perception belong to a common class of mental experiences under the term *perceptio*, it is what causes the change in their representational content that distinguishes them. The mental act approach and the representational approach can be related in terms of the cause which explains its reference to external objects. However, in order to refer the representation to an object, an awareness of the object as an object for me is required. But for this very reason only minds can perceive.

3 Cogitatio est expressio

Although Leibniz had already introduced the doctrine of expression, in April 1679 he is still uncertain as to how the mind passes from one thought to another. In other words, he seeks to explain how affections are produced in the mind. This is the aim of a series of definitions and reflections collected under the title of *De affectibus*.

First, Leibniz regards affections as the actions and passions of the mind. He then reports Descartes' classification of the actions and passions of the soul, according to which its actions consists of volitions and its passions are perceptions, whether of concepts or sensations. But Leibniz's successive attempts to offer his own definition attest to his dissatisfaction with the Cartesian sharp demarcation.

In different passages Leibniz proposes provisional definitions of affection and other related concepts. For our present purposes we are concerned with one particular issue, that is, whether Leibniz believed that external objects can give rise to new thoughts as he did according to my previous quotation. One passage seems to rule out this possibility since Leibniz writes that "... the cause of thought is another thought ..." (A6.4.1424), or a series of thought, as he adds later.

From this point of view a new thought is some change or aggregate of two contradictory states (Ibid.), and as such only an action can be its cause. But an action can also be seen as an effect of change. When these definitions are applied to the

[9] "... this variety cannot come from that which thinks, since a single thing by itself cannot be the cause of the changes in itself. (...) for we would always have to admit that there is no reason for the particular variety which would have existed in our thoughts from all eternity, since there is nothing in us to have one kind of variety rather than another. Therefore there is some cause outside of us for the variety of our thoughts." (Translated in AG 3)

mind, we can say that a judgment or belief is a thought from which an endeavor or *conatus* to act follows, but Leibniz still hesitates to consider volitions as actions or endeavors.

In another series of related definitions Leibniz acknowledges two kinds of judgments according to their origin, reason or the senses, and since cognition is now defined as true judgment or belief, and a true judgment is that which can be resolved into other judgments that we believe, but which cannot be resolved into other more basic judgments, it must be explained what justifies our perceptual belief in external objects. Although he refers to the plurality involved in our thought as the cause of a new series of thoughts, the method of resolution he introduces here cannot provide the necessary evidence. Even if Leibniz also claims that the "matter of thought," or its representational content, can lead the mind to new thoughts, an independent argument to establish that external objects are the causes of complex perceptual content seems to be required. So it is not clear from the text what Leibniz means by the claim that perception is "the affection of the mind which involves the existence of its object" (Ibid.). We can only speculate that the reason for this assertion is his belief that phenomena are ordered in a common spatio-temporal framework, and this is a sign that they refer to something outside the mind.[10]

Interestingly, Leibniz also appeals to final causes in his account of affections. According to one of his definitions:

> A f f e c t u s est determinatio animi a cogitatione boni et mali ad quandam cogitandi progressionem (Ibid).[11]

However, these final causes directing the course of thoughts are the conscious purposes of the thinking subject:

> Cogitatio animum duas ob causas occupat, vel quia a finis sive boni consideratione avertit, et oblivionem finis inducit, quod facit cogitatio aliqua singularis, sive multam cogitandi materiam ab aliis remotam in se continens; vel quia finem seu bonum aliquod ipsa continet. Finis autem nobis est voluptas aliqua aut quod ad eam confert (Ibid.).[12]

Now, as some scholars have pointed out, modern natural philosophers tended to limit the scope of final causation to intentional action, that is, final causes can act on the world only as instruments of rational agents.[13] In Leibniz's definition final causes give rise to new acts of thought. In the next section we will see that only

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[10] And this is a sign of existence that abstract or merely ideal things lack.

[11] "Affection is the determination of the soul by the thought of good and evil to the progression to some thought."

[12] "Thought occupies the soul because of two causes, or because it diverts itself because of the consideration of an end or good and induces the oblivion of the end, which some single thought makes or contains in itself a lot of different matter of thought; or because it contains an end or good. But for us an end is some will or that which contributes to it."

[13] See Des Chene (1996) for an account of the transformation of the notion of final cause in the context of late Aristotelian and Cartesian natural philosophy.

by reintroducing substantial forms in his program for natural philosophy[14] can final causes regain a wider scope of application which would include animal perception.

Despite the provisional and incomplete character of the text, some points deserve to be remarked on. First, in any of these definitions Leibnizian perceptual experiences involve an awareness of otherness to constitute the kind of experience they are. Second, perceptual content, to which he refers as the matter of thought, is now characterized in terms of its complexity alone. But then one may wonder how an act of the mind is related to its representational content. A clue to this question might be found in the following principle:

> In omni actione et passione necesse est agens in patiente exprimi (A6.4. 1093)[15]

The relation of expression is introduced to define thought as the expression of multiple objects in one subject (Ibid.). At the same time thought requires some action by the subject and thus perception results in a case of action "on oneself." Consequently, even if according to the principle of expression of actions and passions just cited our mental acts can be representational insofar as they can be described in terms of the actions and passions of the mind, those actions which are expressed in the thinking subject are referred to the thinking subject who perceives his own passions rather than to an external object acting on her. In addition, since perception is a case of expression only because it is a kind of thought, no room seems to be left for perception in animals. What is required is a way to apply this principle to a more general conception of cognition and the ability to represent.

4 Animal Perception

In recent decades, epistemologists of a naturalist leaning have advocated externalist accounts of perception which would explain perceptual abilities in both humans and animals. Some medical texts written between 1680 and 1682 provide us with evidence that in those years Leibniz as well believed that an adequate account of organic functions would not be complete unless it includes perceptual functions in animals. Now, even if the final goal of animal physiology is a better understanding of the human body, this aim can only be obtained by studying animal anatomy and functions if these are similar in humans.

"The body of humans, like that of any animal, is a sort of machine," Leibniz writes in a text devoted to the physiology of living machines (Smith 2007, 150; Pasini 1996, 217). Within the framework of mechanical theory animal perception occurs when a disturbance in the sensory organ's state of equilibrium occurs and

[14] As Michel Fichant has put it, ". . .la "Réforme [de la dynamique]" a contribué, conjointement avec d'autres justifications complexes, à la rehabilitation des formes substantielles, sur la voie d'un nouveau concept de substance et d'une "correction de la Philosophie première."" (Fichant 1994, 60).

[15] "In every action and passion it is necessary that the agent be expressed in what is acted upon."

the equipollence of forces must be restored by motion. The animal's body responds to the changes in its environment and the corresponding changes in its organs are ruled by the recently established dynamical principles governing motion and motive forces:

> Cum vero ab externa vel interna causa aliqua facta est inaequalitas, quod fit cum sensus animalis solicitantur tunc tota vis flatus nititur vel ad restitutionem vel (. . .) compensationem, . . . quoniam causa motus semper praesto est . . . (Ibid., 162; Ibid., 223)[16]

Yet, the changes in the sensory organs are not themselves perceptions, since the origin of sense is some substantial form or soul in which the force inheres:

> Quoniam autem aliquando demonstrabimus, aliud longe esse vim, aliud motum, et motum quidem inesse moli extensae, vim autem motricem[17] inesse alteri cuidam subjecto, quod in corporibus promiscuis formam substantialem, in viventibus Animam vocant, <in Homine Mentem> inde *sensus* quoque atque *appetitus* in Animalis origo, et motus quo vel in corpus agit Anima, vel a corpore patitur, poterit explicari, inexpectata claritate (Ibid., 164; Ibid., 223–224).[18]

As a mechanical and dynamical event, the motion in the perceptual organs is subject to the rules of motion which are grounded in the force intrinsic to the soul. But without a reference to mental conscious states it may seem that the attribution of perceptual abilities to both animals and humans is only an equivocal way of speaking. Nonetheless Leibniz explicitly qualifies animal perception as a case of cognition, which is defined as a certain representation or expression of external things in the individual:

> Forma substantialis est principium actionis seu vis agendi primitiva. Est autem in omni forma substantiali quaedam cognitio hoc est expressio seu repraesentatio externorum in re quadam individua, secundum quam corpus est unum per se, nempe in ipsa forma substantiali, quae repraesentatio conjuncta est cum reactione seu conatu sive appetitu secundum hanc cognitionem agendi (A6.4. 1508).[19]

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[16] "When to be sure a certain inequality has arisen from an external or an internal cause, which happens when an animal's senses are aroused, thereupon the entire force of the breath pushes either towards a restitution or, when it can not do this, towards an offsetting of very short duration [which, since often, on account of the structure or the present location of the parts, cannot be obtained without tremendous upheaval]. Hence at length there arises from a small cause a great *motion in the animal*, since the cause of motion is always at hand to the thing to be moved, and awaits release." Note that I did not quote the complete paragraph. I use "[ ]" to indicate the omitted parts.

[17] Leibniz previously wrote "Vim substantiae cuidam incorp . . ." and "vim activam".

[18] "Since moreover we will at length demonstrate [that] force is one thing, motion quite another, and motion indeed inheres in an extended mass, while motive force inheres in a certain other subject, which is called in common bodies the substantial form, in living bodies the Soul, in Man the Mind, whence in animals the origin of *sense* as well as *appetite*, *and the union of the soul and the body*, and the way in which either the Soul acts in the body, or is acted upon by the body, will be able to be explained with unexpected clarity."

[19] "The substantial form is the principle of action or the primitive active force. But in every substantial form there is some cognition, that is, some expression or representation of the external things in an individual thing, according to which the body is *unum* per se, that is, in the substantial

Cognition is then a case of the relation of expression whose terms are external things and a certain principle of action or substantial form by which its body receives its unity.[20] Organisms, such as the macroscopic animals we observe, are endowed with an organic unity. As to the relation of representation, Leibniz summarizes the results of its original enunciation in *Quid sit idea*:

> Repraesentare autem dicitur quod ita respondet, ut ex uno aliud cognosci possit, etsi similia non sint, dummodo certa quadam regula sive relatione omnia quae fiunt in uno referantur ad quaedam respondentia illis in alio (A6.4. N 78).[21]

The related terms are not required to be similar, but a certain rule must obtain so that every relation in one term can be referred to something in the other term of the relation. Consequently, if perception is some sort of cognition, the perceptual representation is only a sign of the perceived object.

But Leibniz goes further. In our previous quotation he also claims that in the soul this representation is united to a certain reaction to act according to this cognition. It can be argued that this follows from the fact that the soul is the principle of action of the animal.

Now this is not to say we have explained how animal perception can fulfill its informative role. On the one hand, perception, insofar as it is some action performed by the animal, involves a physiological aspect. This in turns involves a soul or substantial form, since the reaction of the sense organ is some kind of motion. Perception as a representational process, on the other hand, involves a relation between the object and its perceptual representation according to a rule.

These two approaches can converge into a single view once we appeal to the concept of organic unity. Basically, by organic unity we mean an intra-organic teleology. In things endowed with an organic unity, the particular functions can be integrated, since an organism can control and coordinate its processes in an integrated way. For Leibniz self regulation and autonomy are grounded in the principle of action of the organic being.

According to Leibniz's project for developing "the new elements of medicine",[22] perception is the primary function in humans, to which all other organic functions are subordinated. But not only are functions ranked in order of priority; the account of anatomical structures is also subordinated to their physiological functions.[23]

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form itself, representation that is united to a reaction or *conatus* or appetition to act according to this cognition."

[20] Compare this definition with cognition as true judgment in *De afectibus* (see Section 3 above).

[21] "But it is called representing that which so corresponds, in order to be possible one to be known from the other, although they were not similar, in such a way that by a constant rule or relation all the things which happen in one are referred to something that corresponds to them in the other."

[22] *De scribendis novis Medicinae Elementis* (1680–1682)

[23] For an account of the use of final causes as a methodological tool in the study of living beings see Duchesneau (1998).

More precisely, the organ is the means or requisite for the animal to perform a certain function, which is the end of the organ:

> In omni Machina spectandae sunt tum functiones eius, sive finis, tum modus operandi, sive quibus mediis autor machinae suum finem sit consecutus. (. . .) Functio hominis primaria est perceptio, at secundaria (quae prioris gratia est,) perceptionis est procuratio. (. . .) Perceptionis gratia sunt organa sensuum; procurandae perceptionis sive actionis gratia sunt organa Motus (Pasini 1996, 212).[24]

If my analysis is in its broad outlines correct, perception as an organic function can be explained by means of final causes. That is, a certain anatomical feature may be said to exist for the sake of the effect which constitutes the purpose of that feature (for example, if the anatomical structure of the heart facilitates the pumping of blood, pumping blood is the purpose of that feature). In a similar way, perception as an organic function is end-directed as well as representational. As we have seen above, the processes in the sensory organs are the effects of external objects physically connected to them, and can be regarded as their signs even if they do not resemble them. As I also indicated earlier, Leibniz claims that the representation of external things in the individual is united to a certain reaction or endeavor to act according to that cognition. Thus it is possible to say that perceptual experience is a case of a representational relation in which a certain action, such as the animal's behavior, is formed in response to a certain informative content representing an object. A perceptual experience is then related to its object insofar as it is end-directed and the purposeful behavior can be seen as interpreting signs. This interpretation can only occur for the sake of some end in the sense in which we can say, for example, that the prey's behavior interprets its predator's odor as a sign of danger.[25]

Now end-directness does not presuppose consciousness, and so the object of perception is not specified by conscious thought; rather, there is an inseparable connection between purpose and object. For Leibniz, perception is an end-directed process insofar as the substantial form is the principle of action of created substances, the primitive force from which the series of its changes result. Perceptual experience without reflection as it is required in animals can take place because the changes in the animal soul are correlated to changes in its environment according to a rule, and the corresponding motion represented in the soul is the final cause. The details of this "quasi-externalist" account of perception as an organic function will have to be developed further. However, for my present purposes it suffices to say that

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[24] "In every machine it must be considered their functions or ends, or their way to operate or by which means the author of the machine has achieved his end (. . .). The primary function of man is perception, but his secondary function (which exists for the sake of the primary function) is to obtain perceptions (. . .) The organs of sense exist for the sake of perception; the organs of motion exist for the sake of obtaining perception or action."

[25] For Leibniz this behavior would involve the representations of memory, for example when ". . . a dog runs away from the stick with which he was beaten. . ." (AG 208; see also AG 216)

my construal is grounded in two major Leibnizian doctrines: his general definition of expression, and his doctrine of the actions and passions of created substances, from which the relation of expression[26] can be specified to include perceptual cognition in both humans and animals.

5 Perception of the External World

We share perception with animals in the relevant sense. In animals, perceptible images do not turn into perceptual judgments, of course, but into some specific behavior; in humans, on the other hand, the end of perceptual experience can be a perceptual judgment concerning external objects. It is the case that in certain circumstances we have a perceptual experience without the associated belief.[27] The belief-independence of perception is a fact about perceptual experiences that may be used to account for the similarities as well as the differences between human and animal sentience, in the sense that perceptual belief is not a constituent of perceptual experience qua experience of external objects, and the relation between experience and judgment may account for what is specific to human perception.

According to the conception of perceptual experience I introduced in the previous section, perception is not a kind of thought but it is nonetheless representational. Moreover, it can be distinguished from reflection since it takes place through mediating signs while self awareness does not involve signs because we are immediately aware of ourselves:

> Reflexio itaque seu memoria vel conscientia, mentium propria est. Reflexio proprie est memoria cogitationis proxime praecedentis. In sui ipsius perceptione consistit imago divina nobis indita. Non puto ab ullo bruto exerceri illam vim quam in me experior cum volo ut cogitem me nunc cogitare, et hoc ipsum admirer, et continue in me replicem, nullo signi alicujus usu interveniente sed intima quadam perceptione, ubi vim simul nobis facimus imagines ab ea cogitatione avocantes amoliendo (A6.4. 1490).[28]

The autonomy of reflection is required to ground the privileged position of man in creation as a moral agent endowed with an immortal soul:

> Illae solae animae sunt Mentes in quas cadit cognitio sui ipsius seu conscientia. Hae solae praemiorum poenarumque sunt capaces, et solae habendae sunt pro civibus ejus Reipublicae

[26] Note also that the equipollence principle which grounds dynamical processes is a case of the relation of expression (A6. 4. 1371).

[27] When we doubt, for example, whether an appearance corresponds to a determinate object, since there is no judgment involved in an act of doubting (A6.4. 1414). Consider also the case in which the perceiver is experiencing an illusion (e.g. the Muller – Lyer illusion) well-known to her, and she refrains from judging that things are as she sees them (i.e., that one line is longer than the other).

[28] "So reflection or memory or consciousness is proper to mind. Reflection is properly the memory of the preceding thought. In the perception of oneself consists the divine image given to us. I do not believe that force I experience in myself when I will to think myself as thinking is exerted by any brute, and I admire it and I unfold continuously in me, not by any intervening sign but by an intimate perception, when we exert the force by deflecting the distracting images from this thought."

> cujus Rex est Deus. Ex mentibus autem eae solae felices sunt, quibus datur cognitio Dei. Aliud est percipere, aliud percipere quod perceperis, seu meminisse. In brutis itaque perceptionem agnosco sive sensum eorum quae fiunt, (. . .) sed non agnosco in illis conscientiam, . . . (Ibid.).[29]

In our teleological account of perception, three terms were considered: not only the object and its expression in the soul or the mind, but also the action or tendency to act involved in representing the object. If perception is a kind of cognition that is independent from judgment and belief, making a judgment is a free act of the will. Yet that perceptual experience introduces an external constraint on our judgments is a condition for any robust theory of perception. In any case Leibniz acknowledges the fact that humans usually believe that external objects are the cause of their perceptions. Now although the dynamical framework makes use of causal vocabulary, the meaning of our causal statements concerning the objects of perception has to be properly understood. As Leibniz explains in the *Discourse on Metaphysics*, we can meaningfully say that we know external things through our senses in the same way we can still say that the sun rises even after the Copernican hypothesis has been generally accepted. We can justify this way of speaking because "some external things contain or express more particularly the reasons that determine our soul to certain thoughts" (AG 59). The action of external objects on the sense organs is expressed in the perceiver's representation in a way that this representation is constrained from outside and supplies the "matter of thought." What counts as a reason for holding a perceptual belief is –potentially– present in the perceptual experience, which does not require the presence of causality, in the ordinary sense, in order to be veridical.[30]

6 Conclusions

I have concentrated on two main problems concerning perceptual cognition: the possibility of animal perception, and the arguments in favor of its objective value. Once perception is conceived as some affection or transition from one thought to another, the confused matter of thought can be developed by the will into a series ordered in space and time. But when perceptual experience is conceived as an organic function, it can be regarded as the exercise of force. Leibniz's solution is intimately related to his treatment of animal perception and the introduction of final causes into the account of the actions and passions of created substances. An analysis of these features puts into question the argument in favor of external things as the cause of

[29] "The only souls which are minds are those in which a cognition of oneself or consciousness takes place. Only they are capable of reward and punishment and are to be considered citizens of the Republic whose king is God. But among minds the only happy ones are those in which the cognition of God is given. One thing is to perceive, another to perceive that we perceived or to remember. So I acknowledge perception or sense of what happens in brutes (. . .) but I do not acknowledge consciousness in them."

[30] What we need is a reliable method to elicit distinct knowledge from the content of experience.

perceptual experiences. However, I suggest that Leibniz's mature definition of perception can account for representation without thought by introducing teleology into the world.

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Abbreviations

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Appendix: PRINCIPIUM RATIOCINANDI FUNDAMENTALE

[1708]

Source: G.W. Leibniz-Bibliothek, Hanover, mss., LH IV I 15 (4 in-folio pages).
E first edition by Louis Couturat, *Opuscules* (O, 12–16)
L manuscript in Leibniz's hand
Translated by Parkinson, in Leibniz 1973, 172–78, from *E*.

The piece is dated by watermark evidence. Paragraph numbers were added by *L* during the revision of the text. The apparatus follows the style of the *Allgemeine Schriften und Briefe*. (*ep*)

(1) Principium ratiocinandi fundamentale est, *nihil esse sine ratione*, vel ut rem distinctius explicemus, nullam esse veritatem cui ratio non subsit. Ratio autem veritatis consistit in nexu praedicati cum subjecto, seu ut praedicatum subjecto insit, vel manifeste, ut in identicis, veluti si dicerem homo est homo, homo albus est albus; vel tecte, sed ita tamen ut per resolutionem notionum ostendi nexus possit[,] ut si dicam novenarius est quadratus, nam novenarius est ter ternarius, ter ternarius est numerus ternarius in ternarium multiplicatus, ternarius in ternarium est numerus in eundem numerum, is autem est quadratus.

(2) Hoc principium omnes qualitates occultas inexplicabiles, aliaque similia figmenta profligat. Quotiescunque enim autores introducunt qualitatem aliquam occultam primitivam[,] toties in hoc principium impingunt. Exempli causa, si quis statuat esse in materia vim quandam attractivam primitivam, atque adeo ex intelligibilibus corporis notionibus, magnitudine nempe figura et motu non derivabilem, velitque per hanc vim attractivam fieri ut corpora sine ullo impulsu ad corpus aliquod tendant, uti quidam Gravitatem concipiunt, tanquam gravia a corpore telluris attrahantur, ita ut ulterior rei ratio ex horum corporum natura reddi nequeat aut velut sympathia quadam ad eam alliciantur, neque explicabilis sit attrahendi modus; is agnoscit nullam rationem naturalem subesse huic veritati quam experimus quod lapis tendit ad terram. Nam si rem non qualitate occulta corporis, sed voluntate Dei,

J.E.H. Smith, O. Nachtomy (eds.), *Machines of Nature and Corporeal Substances in Leibniz*, The New Synthese Historical Library 67, DOI 10.1007/978-94-007-0041-3,

seu lege divinitus lata contingere statuat, eo ipso rationem reddit aliquam, sed supernaturalem sive miraculosam. Idem de omnibus dicendum est qui pro corporum phaenomenis explicandis ad nudas facultates[,] sympathias, antipathias, Archaeos, ideas operatrices, vim plasticam, Animas, aliaque incorporea confugiunt, quibus nullum cum phaenomeno nexum explicabilem esse agnoscere coguntur.

(3) Hinc consequens est, omnia in corporibus fieri mechanice, id est per intelligibiles corporum qualitates nempe magnitudines figuras et motus; et omnia in animabus esse explicanda vitaliter, id est per intelligibiles qualitates animae nempe perceptiones et appetitus. Interim in corporibus Animatis pulcherrimam esse Harmoniam deprehendimus inter vitalitatem et mechanismum, ita ut quae in corpore fiunt mechanice, in anima repraesententur vitaliter; et quae in anima percipiuntur exacte, in corpore executioni demandentur plene.

(4) Unde sequitur nos saepe ex cognitis corporis qualitatibus animae, et ex cognitis animae pathemati[bu]s corpori mederi posse[;] saepe enim facilius est nosse quae in anima quam quae in corpore fiunt, saepe etiam res contra habet. Et quoties animae indicationibus utimur ad corporis auxilium, medicina vitalis appellaripotest; quae latius porrigitur quam vulgo putant, quia corpus non tantum animae respondet in motibus quos voluntarios vocant, sed etiam in aliis omnibus, etsi nos ob assuetudinem non animadvertamus animam motibus corporis naturalibus affici, aut consentire; vel hos perceptionibusanimae appetitibusque respondere. Nempe horum perceptiones sunt confusae, ita ut consensus non ita facile appareat. Anima quidem corpori imperat quatenus perceptiones distinctas habet, servit quatenus confusas sed interim quisquis aliquam perceptionem in anima obtinet, certus esse potest sese ejus effectum aliquem in corpore obtinuisse, et viceversa. Quicquid ergo in Archaeistis vel similibus autoribus boni est, huc reducitur: etsi enim illae quas statuunt irae turbationesque et placationes Archaei in corpore non sint nec nisi in anima concipi possint[,] est tamen aliquid in corpore quod illis respondet.

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2 veritatem | (praeter identicas) cujus ratio (saltem ab omniscio) <ne?> *del*. | *L* 4 identicis, | vel tecte, ita tamen ut *del*. | *L* 5 per | analysin *del*. | *L* 12–14 attractivam (*1*) per quam fiat *del*. (*2*) primitivam, (*a*) ex (*b*) atque ... derivabilem, | et *ins. and del*. | (*aa*) | cujus proinde nulla ex natura corporum (*aaa*) possit amplius (*bbb*) reddi possit ratio *del*. | ; (*bb*) velitque ... fieri *ins*. *L* 12–14 primitivam ... fieri *ins*. *L* 14 ut | alia *del*. | *L* 15 impulsu | <conte> *del*. | *L* 15 ad | eam *del*. | corpus aliquod *ins*. | *L* 16–17 attrahantur, (*1*) statuatque | huius *accid. not del., del. by ed.* | qualitatis nullam amplius reddi posse rationem (*2*) inexplicabili *ins. and del*. (*3*) quomodo *ins. and del*. (*4*) ita ... ex (*a*) horum (*b*) corporum ... nequeat; *L* 17 aut ... alliciantur *ins*. *L* 17–20 neque | explicabilem *corr*. | esse *del*. | ... | modum *corr*. | agnoscit hujus veritatis: lapis tendit ad terram nullam subesse rationem. Nam si rem *del*. | is ... sed *ins*. | *L* 18 naturalem *ins*. *L* 20 lege | a Deo *del*. | divinitus *ins*. | *L* 21 miraculosam | si res ex naturis rerum a Deo explicari non possit *del*. | *L*

(5) Et perinde res habet, uti interdum in rebus naturalibus veritatem indagamus per causas finales, quando ad eam facile non perveniri potest per efficientes, quod non tantum doctrina Anatomica de Usu partium patefacit, ubi recte a fine ad media ratiocinamur; sed etiam ipse notabili exemplo in Specimine Optico ostendi. Quemadmodum enim in Corporibus animatis organica respondent vitalibus, motus appetitibus; ita in tota natura causae efficientes respondent finalibus, quia omnia non tantum a potente, sed etiam a sapiente causa proficiscuntur. Et regno potentiae per efficientes, involvitur regnum sapientiae per finales. Atque haec ipsa harmonia corporeorum et spiritualium inter pulcherrima et evidentissima Divinitatis argumenta est, cum enim inexplicabilis sit unius generis in alterum influxus, harmonia rerum toto genere differentium a sola Causa Communi seu Deo oriri potest.

(6) Sed ad eundem perveniemus generaliore via, redeundo ad principium nostrum fundamentale. Nimirum considerandum est spatium, tempus et materiam, nudam scilicet, in qua nihil aliud quam extensio et antitypia consideratur, esse plane indifferentes ad quaslibet magnitudines, figuras et motus, nec proinde hic in rebus indifferentibus et indeterminatis rationem reperiri posse determinati, seu cur mundus tali modo existat et non sub alia quacunque non minus possibili forma sit productus. Unde consequens est, rationem existentiae rerum contingentium tandem quaerendam esse extra materiam, et in causa necessaria, cujus nempe ratio existendi non amplius sit extra ipsam; eamque adeo Spiritualem esse, verbo Mentem et quidem perfectissimam, cum ob rerum nexum ad omnia extendatur.

(7) Porro Creaturae omnes sunt vel substantiales vel accidentales. Substantiales sunt vel substantiae vel substantiata. Substantiata appello aggregata substantiarum, velut exercitum hominum, gregem ovium[,] et talia

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1 qui (*1*) | ad *del*. | ... phaenomena explicanda *corr*. | (*2*) pro *ins*. | ... *L* 1–2 | ad ... facultates *ins*. | ad *del*. | *L* 2 Archaeos | animas *del*. | *L* 3 plasticam, (*1*) aliaque co (*2*) aliaque (*3*) | Animas, ... incorporea *ins*. | quarum *del*. | *L* 5 est *ins*. *L* 5 corporibus | esse exprimenda *del*. | fieri *ins*. | *L* 5–6 intelligibiles ... nempe *ins*. *L* 5–6 intelligibiles (*1*) ma *ins. and del*. (*2*) corporum *ins*. *L* 7–8 per ... nempe *ins*. *L* 8 nempe | perce *del*. | *L* 8 et appetitus *del*. *and ins*. *L* 9 deprehendimus *ins*. *L* 11 percipiuntur ... plene *del*. *and ins*. *at the bottom of the prec. page L* 12 || (4) *ins*. *L* 12 nos | interdum *del*. | saepe *ins*. | *L* 13 pathematis *corr. by ed. L* 13 posse | <m> *del*. | *L* 13 enim | melius n *del*. | *L* 15 indicationibus (*1*) utimur *del*. (*2*) indicationibus utimur *ins*. *L* 16 potest; | eaque *del*. | quae *ins*. | *L* 17 motibus | <suis> voluntariis *corr*. | *L* 17 vocant, *ins*. *L* 18–20 etsi ... respondere. *ins*. *L* 18 nos | non *del*. | ab *corr. by ed*. | assuetudine *corr*. non | percipiam *del*. | *L* 19 consentire; (*1*) aut *del*. (*2*) vel*ins*. *L* 19 animae | respondere *del*. | *L* 20 respondere. | Nempe *del*. | *L* 20 Nempe horum perceptiones (*1*) | sed tunc *del*. | perceptiones | animae*del*. | (*2*) Nempe horum *ins*. *L* 21 appareat. (*1*) Mens enim *del*. (*2*) Anima enim *ins. and del*. (*3*) Anima quidem *ins*. *L* 21–22 perceptiones (*1*) confusas *del*. ... quatenus | distinctas *del*. | (*2*) distinctas habet, *ins*. ... confusas *L* 22–24 sed ... versa *ins*. *L* 22 interim *ins*. *L* 25 enim (*1*) illae irae *del*. | (*2*) illae quae *part. corr. and del*. (*3*) quas <con?> *ins. and del*. | (*4*) anxietates *ins. and del*. illae ... irae, *ins*. *L* 26 nec ... possint *ins*. *L* 27 respondet. (*1*) Et perinde res habet *del*. (*2*) | (5) *ins*. | Et ... habet *ins*. | *L* 102.29–103.2 efficientes, (*1*) quemadmodum *del*. (*2*) quod ... etiam ins *L*

sunt omnia corpora. Substantia est vel simplex ut Anima, quae nullas habet partes; vel composita ut Animal, quod constat ex anima et corpore organico. Quia autem corpus organicum ut omne aliud non nisi aggregatum est ex animalibus vel aliis viventibus adeoque organicis, vel denique ex ruderibus seu massis, sed quae etipsae tandem in viventia resolvuntur; hinc patet omnia tandem corpora resolvi in viventia[.] Et ultimum in substantiarum analysi esse substantias simplices, nempe Animas vel, si generalius vocabulum malis, Monades, quae partibus carent.

Etsi enim omnis substantia simplex habeat corpus organicum sibi respondens, alioqui ordinem in universo caeteris accommodatum non haberet nec ordinate agere patique posset; ipsa tamen per se est partium expers. Et quia corpus organicum aut aliud corpus quodvis rursus in substantias corporibus organicis praeditas resolvi potest; patet non nisi in substantiis simplicibus <consisti> et in iis esse rerum omnium, modificationumque rebus evenientium fontes.

(8) Quia autem modificationes variant, et quicquid fons variationum est, id revera est activum, ideo dicendum est substantias simplices esse activas, seu actionum fontes, et in se ipsis parere seriem quandam variationum internarum. Et quia nulla est ratio qua una substantia simplex in aliam influere possit, sequitur omnem substantiam simplicem esse spontaneam seu esse unum et solum modificationum suarum fontem. Et cum eius natura consistat in perceptione et appetitu, manifestum est esse in una quaque anima seriem appetituum et perceptionum, per quam a fine ad media, a perceptione unius ad perceptionem alterius objecti ducatur. Atque ideo animam non nisi a Causa Universali seu a Deo dependere, per quem, ut omnia, perpetuo est et conservatur; caetera vero ex sua natura habere.

(9) Sed nullus foret ordo inter substantias simplices, mutui influxus carentes, nisi sibi saltem mutuo responderent. Hinc necesse est talem esse inter

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1 Anatomica *ins*. *L* 1 patefacit, | sed etiam *ins. and del.* | *L* 2–3 ipse ... Optico (*1*) in *del*. (*2*) ipse ... in *ins*. *L* 3 in *ins*. *L* 4 causae | fi *del*. | *L* 6–7 Et ... haec (*1*) Atque | ex *del*. | haec ... | (*2*) Et (*a*) regnum *corr*. (*b*) regno potentiae per efficientes, involvitur regnum sapientiae per finales. Atque *ins*. | *L* 9 unius | substantiae *del*. | *L* 10 Causa Communi seu Deo oriri potest | causa communi *corr*. | (*1*) oriri potest *del*. | (*2*) seu ... potest *ins*. | *L* 11 (6) *ins*. *L* 11 Sed (*1*) idem conficiemus *del*. generalius *corr*. (*2*) | ad ... perveniemus *ins*. | generaliore *L* 14–15 proinde (*1*) in (*2*) his (*3*) hic (*4*) | hic ... indeterminatis *ins*. | *L* 15 in rebus *ins*. *L* 15–16 determinati, seu *ins*. *L* 16 tali | form *del*. *L* 17 possibili (*1*) . Unde consequens est *del*. (*2*) sit ... est, *ins*. *L* 18 tandem | quaerendum *corr*. | *L* 18 et *ins*. *L* 22 (7) Porro *ins*. *L* 22–23 accidentales. (*1*) Sunt (*2*) Substantiae sunt quod (*3*) Substantiales *L* 24–25 et ... corpora *ins*. | *Near to it in the margin, without clear reference to the text:* nudae sumtae cum *ins. and del*. Animae seu Substantiae Simplices *ins. and del*. | *L* 27 est *ins*. *L* 27–28 aliis (*1*) vivis (*2*) viventibus adeoque *ins*. organicis *ins. and del*. *L* 29 in | corpora *del*. | *L* 30 viventia | , *corr. by ed*. | (*1*) sed(*2*) Et pa (*3*) <–> *L* 30 ultimum | analyseos principium *del*. | esse *accid. not del., del. by ed*. | substantias simplices *del*. | *L*

2–3 ipse ... Optico See G. W. Leibniz, *Unicum Opticae, Catoptricae et Dioptricae principium* (in the *Acta Eruditorum* of 1682, pp. 185–90; D 3, 145–50); and also his *Tentamen anagogicum. Essay anagogique dans la recherche des causes* (GP 6, 270–79, esp. 274 ff.).

eas respectum perceptionum seu phaenomenorum, per quas dignosci possit, quantum tempore aut spatio differant inter se earum modificationes: in his enim duobus, tempore et loco, ordo existentium vel successive, vel simul, consistit.

Unde etiam sequitur omnem substantiam simplicem aggregatum externorum repraesentare, et in iisdem externis, sed diversimode repraesentandis, simul et diversitatem et harmoniam animarum consistere. Unaquaeque autem Anima repraesentabit proxime sui organici corporis phaenomena, remote vero etiam caeterorum in corpus ipsius agentium.

(10) Et sciendum est per naturam rerum fieri, ut quemadmodum in corpore animalis Hippocrates ait, σύμπνοια πάντα; ita in toto universo sint et quidvis cuivis certa quadam ratione conspiret. Nam quia omnia loca corporibus plena sunt, et omnia corpora quodam fluiditatis gradu sunt praedita ita ut ad quantulumcunque nisum nonnihil cedant; hinc fit ut nullum corpus moveri possit quin contiguum nonnihil moveatur, et ob eandem rationem contiguum contigui, atque adeo ad distantiam quantamcunque. Hinc sequitur unumquodque corpusculum ab omnibus universi corporibus pati, et ab iis varie affici; ita ut omniscius in unaquaque particula universi cognoscat omnia quae in toto universo fiunt[,] quod equidem fieri non posset, nisi materia ubique divisibilis esset, imo actu divisa in infinitum. Et proinde cum omne corpus organicum a toto universo determinatis ad unamquamque universi partem relationibus afficiatur, mirum non est, Animam ipsam quae caetera secundum corporis sui relationes sibi repraesentat, quoddam universi speculum esse, repraesentans caetera secundum suum ut sic dicam punctum visus. Uti eadem urbs a diversis plagis spectanti diversas plane proiectiones praebet.

(11) Non autem putandum est cum speculum dico, me concipere quasi res externae, in organis et in ipsa anima semper depingantur. Sufficit enim ad expressionem unius in alio, ut constans quaedam sit lex relationum qua singula in uno ad singula respondentia in alio referri possint. Uti Circulus

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1–2 malis, (*1*) Entelechias (*2*) Monades | , quae partibus carent *ins*. | *L* 3 enim *ins*. *L* 3 habeat *ins*. *L* 3–4 respondens | habeat *del*. | *L* 4 caeteris (*1*) respondentem (*2*) accommodatum *L* 7 patet | omnia reduci in substantias *del*. | *L* 8 omnium, | et in iis *del*. | modificationumque (*1*) fontes iis (*2*) | rebus *ins*. | *L* 8 fontes. | (*1*) Hinc patet unam Substantiam simplicem (*a*) non (*b*) seu Animam non posse in aliam agere. <Et> in metaphysico (*2*) Porro (*a*) su (*b*) natura substantiarum simplicium in hoc consistit, ut sint activae, seu ut unaquaquae sit fons modificationum suarum (*3*) Quicquid autem fons modificationum est, seu variationum, id est activum (*4*) est *del*. | *L* 9 (8) *ins*. *L* 9 id *ins*. *L* 10–11 simplices (*1*) activas esse *del*. (*2*) esse ... fontes *ins*. *L* 11 ipsis | continuam <se> *del*. | *L* 12–13 sequitur *ins*. *L* 13 esse ... seu *ins*. *L* 13 solum | substa *del*. | *L* 14 cum | subst *del*. | *L* 15 est | omnem animam a *del*. | *L* 15–16 perceptionum, (*1*) per quas ab unius <pe> *del*. (*2*) per quam *ins*. *L* 16 media, | ab *del*. | *L* 20 (9) *ins*. *L* 20 inter (*1*) | has *del*. | substantias (*2*) substantias | simplices, ... carentes, *ins*. | *L* 20 simplices, (*1*) commercio *accid. not del., del. by ed*. <accurat> *del*. (*2*) mutui *ins*. *L* 21 saltem *ins*. *L* 22 possit *ins*. *L* 23 inter se *ins*. *L* 23–24 duobus, (*1*) ordo, (*b*) loco et t (*3*) | tempore ... ordo *ins*. | *L* 25 simplicem (*1*) ex *del*. (*2*) externa *corr*. (*3*) aggregatum externorum *L* 26 et (*1*) harmoni (*2*) diversitatem *L* 27 Anima *ins*. *L* 28 remote *(1)* et *corr*. (*2*) | vero *ins*. | etiam *L*

per Ellipsin seu curvam ovalem repraesentari potest in perspectiva projectione; imo per Hyperbolam, etsi dissimillimam, ac ne quidem in se redeuntem; quia cuilibet puncto hyperbolae respondens eadem constante lege punctum Circuli hyperbolam projicientis assignari potest. Hinc autem fit, ut Anima creata necessario plerasque perceptiones habeat confusas, congeriem quippe rerum externarum innumerabilium repraesentantes[,] quaedam autem propiora vel extantiora, organis accommodata distincte percipiat. Cum vero rationes praeterea intelligit Mens non tantum est speculum universi creati, sed etiam imago Dei. Hoc autem solis substantiis rationalibus competit.

(12) Ex his autem sequitur substantiam simplicem nec incipere naturaliter (nisi cum origine rerum,) nec desinere posse, sed semper eandem perstare. Cum enim partes non habeat, dissolvi nequit; et cum sit fons variationum, in continua variandi serie pergit; et cum natura sua sit speculum universi, non magis cessat quam ipsum universum. Sed si forte ad eum statum perveniat, ut pene omnes perceptiones confusas habeat, id nos mortem appellamus, tunc enim stupor oritur, ut in profundo somno, aut Apoplexia. Sed cum natura paulatim confusiones evolvat, tunc illa quam fingimus vel concipimus mors perpetua esse non potest. Solae autem substantiae rationales non tantum individuitatem suam, sed et personam servant, conscientiam sui retinentes, aut recuperantes, ut possint esse cives in Civitate Dei, praemii poenaeque capaces. Ita in iis regnum naturae regno gratiae servit.

(13) Imo amplius procedo, dicoque non tantum Animam sed et Animal ipsum inde ab initio rerum perpetuo durare. Semper enim Anima corpore organico praedita est, ut habeat per quod caetera externa ordinate repraesentet, ideo etiam corpus ejus ad magnam quidem subtilitatem redigi, penitus autem destrui non potest. Et licet in perpetuo fluxu consistat corpus [neque dici] possit ullam materiae particulam eidem animae perpetuo assignatam esse; nunquam tamen corpus organicum totum animae dari aut eripi potest. Sed quantumcunque animal conceptione crescat, habebat organismum seminalem antequam per conceptionem evolvi crescereque posset; et quantumcunque moriendo decrescat, involvaturque, semper licet amissis exuviis retinet subtilem organismum omnibus naturae viribus superiorem, cum is replicatis

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1 ait, | ita ... sint *ins*. | σύμπνοια πάντα; *L treated by ed. as a misplaced correction* 1 et quidvis (*1*) quod (*2*) et quidvis *L* 2 cuivis (*1*) quadam *del*. (*2*) certa quadam *ins*. *L* 2 conspiret. | Nam omne corpus motum movet *del*. | *L* 2 omnia (*1*) plena et fluiditatis *del*. (*2*) loca ... plena *ins*. *L* 3 praedita (*1*) (firmitas enim (*a*) non nis (*b*) non nisi a motu (*aa*) conspi (*bb*) conveni (*2*) seu nonnihil divisibili (*3*) ita ... *L* 5 et | con *del*. | *L* 7–8 omniscius (*1*) ex una (*2*) ex (*3*) | in *ins*. | *L* 8 universo | universi *corr. by ed*. | *L* 9–10 quod ... infinitum *ins*. *L* 11 ad (*1*) | unumquodque *corr*. | (*2*) unamquamque | eius par *del*. | *L* 12 Animam | suam *ins. and del*. | *L* 13 universi (*1*) speculum esse. Et quemadmodum in respect *del*. (*2*) speculum *L* 13 caetera *ins*. *L* 14 urbs | ex *del*. | *L* 15 plane (*1*) repraesentationes *del*. (*2*) proiectiones*ins*. *L* 21 quia | qua *del*. | *L* 25 innumerabilium *ins*. *L* 25–26 quaedam ... percipiat *ins*. *L* 27 creati, *ins*. *L* 29 sequitur | substantia simplicis *corr*. | *L* 30 sed | per *del*. | *L* 30 perstare. | Cum enim *ins. and del*. | *L* 31 partes | habeat *del*. | *L* 31 cum | (*1*) natur (*2*) sit (*3*) cum *del*. | (*4*) sit *L* 32 cum (*1*) sit (*2*) ex (*3*) natura *L*

subdivisionibus in infinitum pertingat. Natura enim cum a sapientissimo artifice fabricata sit, ubique in interioribus organica est. Et nihil aliud organismus viventium est, quam divinior mechanismus in infinitum subtilitate procedens. Nec quisquam opera Dei ut par est intelligit, nisi qui infinitum in illis satis agnoscit, ut scilicet effectus sit vestigium causae.

Critical edition by Enrico Pasini

3 vel concipimus *ins*. *L* 8 (13) || *ins*. *L* 11 etiam | <num> *del*. | *L* 12 corpus *ins*. *L* 12 neque dici *The edge of the page is worn away: Couturat (O, 16) was still able to decipher the second word as* dici *and aptly conjectured the reading that we have accepted here*. 15 animal (*1*) nascendo (*2*) conceptione *L* 16–17 decrescat, (*1*) retinet subtilem organismum, omnibus naturae viribus s *del*. (*2*) involvaturque, semper *ins*. *L* 17 licet *ins*. *L* 17 retinet (*1*) subtilitatem *corr*. (*2*) subtilem | organismum *ins*. | *L* 18 is *ins*. *L* 19 artifice | pro *del*. | *L*

Appendix: The Fundamental Principle of Ratiocination

(1) The fundamental principle of ratiocination is, that *there is nothing without a reason*, or to explain the matter more distinctly, there is no truth without a subsisting reason. And the reason of truth consists of the connexion of the predicate with the subject, that is, that the predicate is within the subject, whether manifest, as in identical propositions, just as if I should say a man is a man, a white man is white; or covertly, but in such a way that nevertheless the connection can be shown by the resolution of notions, as if I should say nine is a square number, for nine is thrice three, and thrice three is three multiplied by three. Three by three is a number multiplied by the same number, and this is precisely a square.

(2) This principle finishes off all inexplicable occult qualities and other similar figments. For every time the authors introduce some primitive occult quality, they strike against this principle. For example, if someone ascribes to matter a primitive attractive force, such that is not derivable from the intelligible notions of the body (such as magnitude, shape, or motion), and if he should wish, through this attractive force, that bodies should tend toward some other body without any other impulse – as some conceive gravity – as heavy objects are attracted by the body of the earth, so that the nature of these bodies can not provide any further reason for it; or that a kind of sympathy attracts them to it, nor the mode of attraction be explicable: he recognizes that no natural reason is underneath this truth that we experience, that a stone tends towards the earth. For if it is not by an occult quality of the body, but by the will of God or by a law divinely imposed, that it happens, then it in itself provides the reason, but it is a supernatural or miraculous one. The same thing is to be said of all who, in order to explain the phenomena of bodies, have recourse to bare faculties, sympathies, antipathies, Archaeus, operative ideas, plastic force, souls, and other incorporeal things, for which they are obliged to recognize that they bear no explicable connection with the phenomenon.

(3) From this it follows that everything in bodies comes to be mechanically, that is, by the intelligible qualities of bodies, i.e. their magnitudes, shapes, and motions; and everything in souls is to be explained vitally, that is, by the intelligible qualities of soul, i.e., perceptions and appetites. At the same time we perceive that there is a most beautiful harmony in animate bodies between the vital and mechanical, the things that come to be mechanically in the body are represented vitally in the soul;

and those things that are perceived exactly in the soul are sure to be fully deployed in the body.

(4) Whence it follows that for us it is often possible to heal qualities of the soul from cognitions of the body, and to heal afflictions of the body from cognitions of the soul; for it is often easier to know things in the soul than those in the body, and often the contrary. And every time we use the indications of the soul for the aid of the body, it can be called vital medicine, which is extended wider than the common people reckon, because the body not only corresponds to the soul in motions that they call voluntary, but also in every other motion, even if out of habit we do not observe that the soul is being affected by the motions of natural bodies, or acting together with them; or that those motions correspond to the perceptions and appetites of the soul. Indeed the perceptions of these motions are confused, and thus consensus does not easily appear. Certainly the soul commands the body to the extent that it has distinct perceptions; it is subordinate to the extent that they are confused, but meanwhile whoever holds some perception in his soul can be certain that he has held the effect of it in his body, and vice versa. Therefore whatever was good in the upholders of the Archaeus or similar authors is reduced to this: although those wraths, rousings, and pacifications of the Archaeus that they establish are not in the body nor are they be conceived but in the soul, yet there is something in the body that corresponds to them.

(5) And it is the same thing as when sometimes we seek the truth of natural objects through final causes, when it cannot easily be pursued by efficient ones, which is not only brought to light by the anatomical doctrine of the usage of the parts, where we reason correctly from the end to the means; but I myself have shown it by a noteworthy example in my essay on optics. For just as in animated bodies that which is organic corresponds to what is vital, the motions correspond to the appetites; thus in all of nature efficient causes correspond to final causes, because it all originates not so much from a forceful cause that arises from power, but from a wise cause as well. And the kingdom of power through efficient causes is enveloped in the kingdom of wisdom through final causes. And this harmony between the corporeal and spiritual is itself the most beautiful and evident argument for the Divinity, because, since the influx of one genus into another would be inexplicable, the harmony of things belonging to totally different genera can arise by a sole common cause, that is, by God.

(6) But we shall arrive there by a more general road, returning to our fundamental principle. No doubt one should consider that if space, time, and matter (bare matter, that is, in which nothing other than extension and antitypy are considered), are fully indifferent to whatever magnitude, shape, and motion, consequently no reason can here be discovered, in indifferent and indeterminate things, of that which is determined, that is to say [a reason] why the world exists in such a way or why it should not be produced in whatever other no less possible form. Whence it follows that the reason for the existence of contingent things is to be sought beyond matter, and in a necessary cause, of which the reason to exist should not go beyond itself; and consequently that it is spiritual, that is, a mind, and a most perfect one, because on account of the connection of things it extends to everything.

(7) Furthermore all creatures are either substantial or accidental. The substiantial ones are either substances or substantiated. I call substantiated the aggregates of substances, like an army of men or a flock of sheep, and such are all bodies. A substance is either simple like a soul, which has no parts; or it is composite like an animal, which consists of a soul and an organic body. But since an organic body, like every other body, is an aggregate of animals or other living (and thereby organic) things, or at least of raw materials, which themselves in the end resolve into living things, from this it is evident that all bodies resolve into living things. And the last term in the analysis of substances are the simple substances or souls, or, if you want a more general word, monads, which lack parts. And indeed every simple substance has an organic body corresponding to it, otherwise it would not have a suitable position in [the order of] the universe alongside other things, nor could it act and undergo passions in an orderly arrangement; nevertheless they are themselves without parts. And because an organic body or any other body can always be resolved into substances endowed with organic bodies, they are seen to consist in simple substances, and in these are the founts of all things and of the modifications that things undergo.

(8) Because modifications vary, and whatever is the fount of variations is in fact active, therefore it must be said that simple substances are active, or the founts of actions, and that they provide in themselves and for themselves some series of internal variations. And since there is no reason by which a simple substance can influence another, it follows that every simple substance is spontaneous or is the one and only fount of its own modifications. And because its nature consists in perceptions and appetites, it is manifest that in every soul there is a series of appetites and perceptions, through which it is led from an end to the means, from the perception of one object to the perception of another. And therefore the soul depends only on the universal cause or God, by which, as all things, it perpetually is and is preserved; other things in truth are from [the soul's] nature.

(9) But there would be no order between simple substances – influxes being unable to pass between them – unless they should at least mutually correspond to each other. Thus it is necessary that there be between them such a correspondence of those perceptions or phenomena, by which it is possible to distinguish how much their modifications differ among themselves in time and space: for in these two things, time and location, consists the order of existing things, successive and simultaneous. Whence it follows that all simple substances represent the aggregate of external things, and both the diversity and harmony of souls consists in these same external things, but represented in diverse ways. Any soul will represent proximally the phenomena of its organic body, and distally also the phenomena of the other bodies that act on its own.

(10) And it must be known that through the nature of things it comes about that, just as in the body of an animal Hippocrates says that all things breath together (σύμπνοια πάντα); thus they do in the whole universe, and each thing conspires with every other by some certain reason. Now because every place is full of bodies, and all bodies are furnished with a certain degree of fluidity, so that at however small a pressure they yield something, from this it arises that no body can be moved unless the contiguous body is moved somewhat, and on account of the same reason

the body contiguous to the contiguous one [is also moved], and this at whatever distance. Hence it follows that any one corpuscle is accessible from every body in the universe, and by these it can be variously affected; thus if one were omniscient, in any particle in the universe one could acquaint oneself with all that exists in the whole universe, and indeed this could not exist unless matter be everywhere divisible, indeed actually divided to infinity. So then, because every organic body is affected by relations to every part of the universe, relations that are determined by the whole universe, it is no wonder that the very soul which represents to itself other things according to the relations of its own body, is a particular mirror of the universe, that represents other things according to its own point of view, if I may call it so. Thus a city from diverse places offers to the viewer plainly diverse perspectives.

(11) It is moreover not to be feared when I say 'mirror' that I come close to maintaining that external things are constantly depicted in the organs and in the soul itself. Indeed it suffices for the expression of the one in the other that there be a certain constant law of relations by which singular [states] in the one may be referred back to corresponding singular [states] in the other. As the circle can be represented by the ellipsis or the oval curve in a perspectival projection, indeed by a hyperbola, even if it is very dissimilar, and does not even return into itself, since to any given point of a hyperbola the point of the hyperbola-projecting circle that corresponds to it by the same constant law can be assigned. From here moreover it is brought about that a created soul necessarily has many confused perceptions, naturally representing a congeries of innumerable external things; moreover, certain closer or more prominent things, suited to the organs, are distinctly perceived. As in truth the mind also understands reasons, it is not only a mirror of the created universe but an image of God as well. Of this only rational substances are capable.

(12) From this moreover it folows that a simple substance can neither begin naturally (unless at the origin of things), nor can it finish, but must always endure. As it in fact does not have parts, it cannot be dissolved; and as it is a fount of variations, it proceeds in a continually varying series; and as its nature is that of a mirror of the universe, it can no more cease than can the universe itself. But if perchance it arrives at that state where all of its perceptions are confused, we call this death, where in truth a stupor arises, as if in a profound sleep or apoplexy. But since nature unfolds confusions little by little, that death which we imagine or conceive cannot be perpetual. Rational substances alone, however, preserve not so much their individuality, as also their person, retaining or rather regaining consciousness of themselves, so that they are able to be citizens of the City of God, capable of reward and punishment. Thus in them the kingdom of nature is a servant to the kingdom of grace.

(13) Indeed, I go further, and say that it is not so much the soul, but rather also the animal itself that perpetually endures from the beginning of time. The soul is in fact always provided with an organic body so that it should have something through which to represent external things in an ordered way; therefore also the body is reduced to a certain great subtility, but it cannot be thoroughly destroyed. And although the body consists in a perpetual flux, nor can any particle of matter be perpetually assigned to the same soul; nevertheless the whole organic body of

the soul can never be surrendered or snatched away. Yet any animal whatever that grows from a conception had a seminal organism before it was enabled to develop and to grow through conception; and any animal whatever, in dying, shrinks down and is enveloped, while always retaining from among its cast-off possessions a subtle organism that is superior to all the forces of nature, with reiterated subdivisions extending to infinity. Indeed nature, as it is made by a most-wise artificer, is everywhere organic in its inner parts. And the organism of living beings is nothing other than a more divine mechanism that proceeds to infinity in its subtility. Nor can anyone understand the works of God correctly, unless he sufficiently recognizes the infinity in them, as indeed the effect is a vestige of the cause.

Translated by Daniel Ruderman and Justin E. H. Smith

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