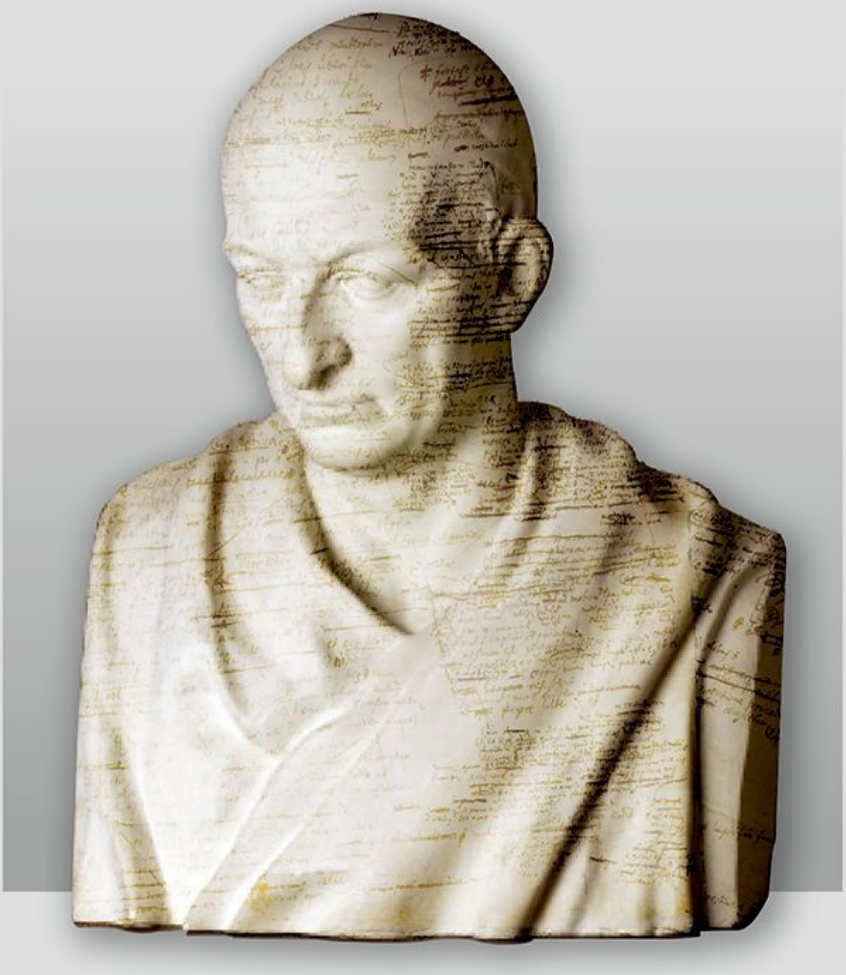
RICHARD T. W. ARTHUR

MONADS, COMPOSITION, AND FORCE

Ariadnean Threads Through Leibniz's Labyrinth



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Richard T. W. Arthur

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For Gabriella

Preface

This book has undergone a profound transformation from the proposal that I first submitted to Peter Momtchiloff of Oxford University Press in the summer of 2008. Back then it consisted of eight chapters based largely on previously published essays, each chapter concerning itself with one of the issues that Leibniz had identified (in 1676) as making up the labyrinth of the continuum: "on the *composition* of the continuum, on time, place, motion, atoms, the indivisible and the infinite" (A VI iii 77/ DSR 88–91). But as I worked these chapters into a continuous narrative, it became clear not only that it was getting too big and unwieldy, but that I was trying to address two different audiences with divergent interests and competencies. The more technical material on the infinite and infinitesimals, mathematical continuity, and the theory of space and time, would appeal more to an audience of philosophers of science and mathematics, whereas the material on the theory of substance would be of more interest to historians of philosophy and metaphysicians. So I clove off the more technical material, saving it for a projected companion volume, and concentrated on providing an account of how monads, Leibniz's atoms of substance, were introduced by him in order to solve the problem of the composition of matter and motion, both of which appear to the senses as continuous phenomena. That is not to say, of course, that Leibniz's views on the infinite, on time and space as relational, and even on the differential calculus, are of no relevance to what I discuss here—just that I do not discuss them here in any technical detail.

Even shorn of the technical material, this is already quite a large book. Partly this is a consequence of my genetic approach, trying to follow the development of Leibniz's ideas from his youth to his maturity. But also, in order to explain otherwise puzzling features of Leibniz's thought, I found it necessary to include a substantial amount of exposition of the views to which he was reacting. This is particularly the case in Chapters 3 and 4, where I treat the writings of early atomists and scholastic thinkers who comprise that context, and whose views are less likely to be familiar to those scholars of early modern philosophy who are used to beginning with Descartes. On the suggestion of one of the OUP readers, I have appended a glossary of these thinkers as an aid to understanding that historical context.

I have freely availed myself of material from previous publications. Most obviously the first two chapters owe much to my "Russell's Conundrum" (1989), the third to "The Enigma of Leibniz's Atomism" (2003), the fourth to "Animal Generation" (2006), although there are sprinklings of text from other papers too. In some ways this progression duplicates the course of my own thought on Leibniz's solution to the continuum problem over those years, although all of it has been subjected to revision and reinterpretation in response to the reception of those papers.

There are very many scholars and friends who have helped in the formulation of the ideas of this book. I immediately found common ground with Dan Garber when I met him in the late 1980s in Chicago in our shared opposition to the traditional branding of Leibniz as an idealist *tout court*—although my heterodoxy was born of my reading of the Leibniz–Clarke correspondence, whereas Dan has always been more reticent to extend a non-idealist interpretation into the eighteenth century, when he believes Leibniz eventually opted for a "monadological metaphysics". Our conversations on this have continued from the early days of the Midwest Seminar in Early Modern Philosophy until now, and I am greatly indebted to him for his inclusiveness and generosity of spirit. My interactions with Don Rutherford extend back even farther, to Robert Butts' seminar at Western in 1984, when I was teaching Applied Mathematics and he was there on a post-doc. Although our interpretations of Leibniz diverge subtly on the status of corporeal substance in Leibniz's mature thought, I have profited immensely from his scholarship (as will be evident below), and Don has been exceptionally generous in giving me feedback in writing on early drafts of this book. Sam Levey was a doctoral student of Jonathan Bennett's at Syracuse when he first contacted me (in 1995), and I shared with him drafts of the translations I had made for the Yale University Press volume that was eventually published in 2001. His penetrating questions and suggestions for alternative interpretations were of huge benefit to me then, and he has been keeping me on my toes ever since. I have known Massimo Mugnai since we met at the 5th Internationaler Leibniz-Kongreß in Hanover in 1988, and got to know him well during my time as visiting professor at the Università di Bologna in Italy in 1998, an appointment he had helped engineer. Massimo has been an enduring source of encouragement and fruitful dialogue on the interplay between Leibniz's logic and his metaphysics ever since, and I am particularly grateful to him for invitations to workshops in Florence and Pisa, and to give a series of lectures at the Scuola Normale Superiore in Pisa. Pauline Phemister and I were pleasantly surprised when we met in 1997 to find that we had been thinking along similar lines, and we have been exchanging ideas on Leibniz ever since. Our agreement crystallized around the shared conviction that, for Leibniz, once God had created simple substances, he had *ipso facto* created corporeal substances too. Peter Loptson and I had already worked together as department chairs in the Tri-U Ph.D. programme (Guelph, McMaster, and Wilfrid Laurier) for a couple of years before we began engaging on Leibniz interpretation. An amicable collaboration led to a joint talk to the Department of Philosophy at McMaster in 2006 and a co-authored publication in the *Leibniz Review* of that year, outlining our agreements and differences. Peter's stroke in 2012 unfortunately prevented us from collaborating further. It is also a pleasure to acknowledge the input of my former MA student, Adam Harmer, who persuaded me that my arguments implied that even the body of a corporeal substance, for Leibniz, is still a plurality and not a unity, the unity being the form adapted to it. I have a special debt to Hiro Hirai and Kuni Sakamoto for deepening my understanding of Scaliger and Sennert (evident in Chapter 4 and the Glossary), and also to Shinji Ikeda for helping arrange my visit to Tokyo and the workshop

in Toyama in 2016 so we could discuss all this in person; and also to Andreas Blank for stimulating exchanges of view on the same topics. Chapter 4 owes its origin, however, to the stimulus of Justin Smith, who, in the course of many profitable exchanges of views, had encouraged me to develop what I had written about Scaligerian and Sennertian themes in Leibniz into an article (Arthur 2006), on which that chapter is based. My appreciation of the importance of matters biological and medical to Leibniz's thinking is largely due to Justin's work. Lately that appreciation has been deepened by my increased familiarity with the work of François Duchesneau, and I have been much encouraged by the closeness of our readings of Leibniz's metaphysics. This is equally true of Ohad Nachtomy, with whom I have had many enthusiastic interchanges, both on his idea of nested individuals in Leibniz, and about the infinite. To Maria Rosa Antognazza, too, I am indebted for stimulating challenges to my reading of Leibniz's syncategorematic understanding of the infinite, as well as for all I learned from her wonderful biography of Leibniz. Everything to do with my understanding of Leibniz's mathematics, even if it is in the background in this book, is informed by the wise and benign counsel of David Rabouin, to whom I am grateful for invitations to Paris, long discussions, and many subtle insights. It is also informed by the extraordinary erudition of Vincenzo De Risi, whose invitations to Berlin and Leipzig have given me many opportunities for profitable discussions both with him and with other colleagues in Europe. I am also indebted to many other fine Leibniz scholars for our interchanges down the years: Bob Sleigh, Glenn Hartz, Christia Mercer, Jan Cover, Philip Beeley, Nico Bertoloni Meli, Catherine Wilson, Nicholas Rescher, Ursula Goldenbaum, Hidé Ishiguro, Mark Kulstad, Gregory Brown, Brad Bassler, Doug Jesseph, Herbert Breger, Enrico Pasini, Robert Adams, Brandon Look, Stefano Di Bella, Jeff McDonough, Martha Bolton, Paul Lodge, Jean-Pascal Anfray, Stephen Puryear, Michael Futch, and John Whipple. No doubt there are other scholars whose names are not appearing distinctly to me in my confused concept of contributions to my reading of Leibniz, for which I duly apologize: you are in there somewhere!

I owe no small debt also to students of my seminars on Leibniz, on whom I have foisted drafts of the manuscript of this book. Particular thanks for their feedback, ranging from the substantial to the finding of typos, go to Sean Dudley, Paul O'Hagan, Joshua Maurin, Katie Boudreau, Ryan Mosoff, Marten Kaas, John Roman, Matthew Gardhouse, David Corman, Michael Bennett, James Sikkema, Kathi Gardhouse, and Jason Coutts.

It remains to acknowledge the Oxford University Press readers for their detailed feedback on the draft manuscript I submitted in May 2016, and for their excellent constructive suggestions on how to improve it. That obliged me to do a lot of rewriting, but if the book is the better for it, it is in no small part due to their contribution.

And finally, a particular debt of thanks is due to my family for their love and encouragement, and toleration of all the many hours I had to sequester myself away to complete this project.

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List of Abbreviations

A	G. W. Leibniz, *Sämtliche Schriften und Briefe*, ed. Akademie der Wissenschaften (Leibniz 1923–); cited by series, volume, and page, e.g. (A VI ii 229).
AG	Ariew and Garber, eds. Leibniz: *Philosophical Essays* (Leibniz 1989).
AT	*Oeuvres de Descartes*, 12 vols., Nouvelle présentation, ed. Charles Adam & Paul Tannery. Paris: J. Vrin, 1964–76; cited by volume and page, e.g. (AT VIIIA 71).
BA	*The Complete Works of Aristotle*, 2 vols. (Aristotle 1984).
C	Couturat, *Opuscules et fragments inédits de Leibniz* (Leibniz 1903).
DSR	G. W. Leibniz, *De Summa Rerum: Metaphysical Papers 1675–1676*. Translated with an introduction by G. H. R. Parkinson. New Haven: Yale University Press, 1992.
E	*God. Guil. Leibnitii quae extant Latina Gallica Germanica Omnia*, ed. Joannes Eduardus Erdmann. Berlin: Olms, 1840.
GM	Gerhardt, *Leibnizens Mathematische Schriften* (Leibniz 1849–63); cited by volume and page, e.g. (GM II 157).
GO	Pierre Gassendi, *Opera Omnia*, 6 vols. Lyon, 1658 (repr. Stuttgart-Bad Canstatt: Friedrich Frommann, 1964); cited by volume and page, e.g. (GO I 280).
GP	Gerhardt, *Die Philosophische Schriften von Gottfried Wilhelm Leibniz* (Leibniz 1875–90); cited by volume and page, e.g. (GP II 268).
H	G. W. Leibniz, *Theodicy: Essays on the Goodness of God, the Freedom of Man, and the Origin of Evil*, trans. E. M. Huggard. La Salle, IL: Open Court (Leibniz 1985).
L	Loemker, *Leibniz: Philosophical Papers and Letters* (Leibniz 1976).
LDB	G. W. Leibniz, *The Leibniz–Des Bosses Correspondence*, trans. Look and Rutherford (Leibniz 2007).
LDV	G. W. Leibniz, *The Leibniz–De Volder Correspondence*, trans. Lodge (Leibniz 2013).
LLC	G. W. Leibniz, *The Labyrinth of the Continuum*, trans. Arthur (Leibniz 2001).
MP	*Leibniz: Philosophical Writings*, trans. Morris and Parkinson (Leibniz 1995).
RB	*New Essays on Human Understanding*, trans. Remnant and Bennett (Leibniz 1981) of *Nouveaux essais sur L'entendement humaine*, which has page numbers keyed to A VI vi.
WFT	Woolhouse and Francks, G. W. Leibniz: *Philosophical Texts* (Leibniz 1998).

Introduction

Leibniz frequently stressed that his theory of substance was intended as a solution to the problem of the "labyrinth of the continuum", the problem of whether or how continuous entities, such as matter or motion, could be composed of indivisible elements. Thus, in the course of a concerted attempt to explain his position to Antoine Arnauld in October 1687, he wrote:

> Also, philosophers have recognized that it is form that gives determinate being to matter, and those who have not taken this into consideration will never escape from the labyrinth of *the composition of the continuum* once they enter into it. It is only indivisible substances and their states that are absolutely real. (A II ii 250/L 343)

Similar claims abound in his writings. "No one will arrive at a truly solid metaphysics who has not passed through that labyrinth" (A VI 3, 449), he wrote in 1676, and the same concern is reiterated as late as 1710 in the preface of his *Theodicy*. There (as elsewhere) he depicts the labyrinth of the continuum as the second of the two famous labyrinths in which the human mind is wont to lose its way.[1] The first labyrinth, of course, is the subject of the *Theodicy* itself, a thorough discussion of determinism, fatalism, the nature of freedom and the origin of evil, and related theological controversies. But in 1710 Leibniz is still expressing the desire to give a similar treatment of the second labyrinth, consisting in "the discussion of continuity and the indivisibles which appear to be elements in it, which must involve a consideration of the infinite", and to point out how, "for lack of a true conception of the nature of substance and matter, people have taken up false positions leading to insurmountable difficulties" (GP VI 29/H 53).[2]

On most interpretations of Leibniz's philosophy of substance, though, these are puzzling pronouncements. Leibniz is famous for his doctrine of *monads*: these are the

[1] Cf. *On Freedom* (*c.*1689): "There are two labyrinths of the human mind: one concerns the composition of the continuum, and the other the nature of freedom, and both spring from the same source: the infinite" (A VI iv 1654/AG 95); and this from an unpublished manuscript of 1686: "There are two famous labyrinths of errors, one of which has principally exercised theologians, the other philosophers: the former, that of freedom, the latter, that of the composition of the continuum; for the former touches on the inner nature of the mind, the latter, that of body" (A VI iv 1528).

[2] "I shall have perchance at another time an opportunity to declare myself on the second, and to point out that, for lack of a true conception of the nature of substance and matter, people have taken up false positions leading to insurmountable difficulties, difficulties which should properly be applied to the overthrow of these very positions" (GP VI 29/H 53).

indivisible substances that he took to be the basic constituents of the world and the foundation of all the phenomena we experience. He conceived each of these substances as endowed with *perception* (whereby it represents all the others, each such representation being a *state*), and as undergoing continuous changes of state through *appetition*, its inbuilt tendency to pass from present to future states.

This much is clear. But exactly how to interpret this doctrine has been a source of controversy ever since. One tendency, beginning with some of Leibniz's own contemporaries, has been to see his philosophy as a species of idealism. Because monads are described as essentially immaterial and analogous to souls in having perception and appetition, it has been widely supposed that Leibniz's aim was therefore to reduce all created reality to an infinite plurality of purely mental entities, with the whole physical world being simply the content of the mental representations of these beings. Such a view had particular appeal to later idealists rebelling against Hegel's monism, for whom Leibniz's essay, the *Monadology*, came to be seen as a manifesto for the refutation of materialism through the re-assertion of the primacy and plurality of individual souls.[3] A recent example of such a reading of Leibniz as an idealist is Robert Adams' carefully argued *Leibniz: Determinist, Theist, Idealist* (Adams 1994). For Adams, assertions such as Leibniz's insistence to Burchard de Volder in 1704 that "there is nothing in things except simple substances, and in them, perception and appetite" (GP II 270/ L 537), exemplify "a broadly idealist approach to metaphysics" (Adams 1994, 217), in which bodies and other well-founded phenomena are simply the harmoniously interrelated intentional contents of an infinite multitude of perceivers.

On this reading, monads are the only actual existents, and the solution to the continuum problem is simply to see that as such they could not be constituents of a mathematical continuum, which is an ideal object. All else—bodies, light, motion, animals, and the rest of the material world—are mere phenomena resulting from monads' perceptions, some of them well founded in the mutual agreement of perceptions, and some of them not.

This phenomenalist reading does not fit very well, however, with the characteristic way in which Leibniz describes his solution. A classic instance of this is what he wrote to Nicolas Remond in July 1714:

> In the ideal or the continuum, the whole is prior to the parts, as the arithmetical unity is prior to the fractions which divide it, and which can be assigned arbitrarily; its parts are merely potential. In the real, however, the simple is prior to the aggregates, parts are actual, and are prior to the whole. (GP III 622)

Here "the simple" uncontroversially refers to Leibniz's "simple substances", another term he used for monads. But what about the "actual parts" that are supposed to be

[3] This includes Hermann Lotze (1817–81), Eduard Dillman (1891), Dietrich Mahnke (1848–1939), and Ernst Cassirer (1874–1945) in Germany, and those in England opposing the neo-Hegelian Absolute Idealism of F. H. Bradley and T. H. Green, for whom reality consisted in a single unified conscious spirit. Cf. Rutherford's remarks in his (1990b, 13, n. 4).

prior to the whole? These can't be monads composing to form a whole, since Leibniz denies that monads are parts of anything. And what are the "aggregates" to which they are alleged to be prior in real things? Well, it is clear from numerous passages that it is *bodies* that are aggregates of monads. As Leibniz told Michel Angelo Fardella in 1690: "A body is not a substance, but an aggregate of substances" (A VI iv 1668/AG 103).[4] This is a real difficulty for the phenomenalist interpretation, since it is hard to see how immaterial substances can be "aggregated" to produce a material body if the latter is simply the content of veridical perceptions.[5] Moreover, Leibniz's inclusion of aggregates of simple substances among "the real" appears to imply that bodies, in the dichotomy between the real and the ideal, fall on the side of the real.

There are also numerous passages in Leibniz's writings where he refers to matter as *containing* monads, as in this letter Leibniz wrote to Des Bosses (14 February 1706):

> Since monads or principles of substantial unity are everywhere in matter, it follows from this that there is also an actual infinity, for there is no part, or part of a part, that does not contain monads. (LDB 24–5)

Some commentators acknowledge that bodies must be more than intentional contents of perceptions if they are to be aggregated, but want the word 'contain' not to be taken as a literal containment, otherwise something immaterial would be spatially located. An example of this kind of interpretation is that of Donald Rutherford (1990a, 2008). Acknowledging that bodies have a certain reality independent of perceivers, Rutherford interprets this as a reality of essence, rather than of existence: bodies may be said to be aggregates of monads external to the perceiver in the sense that their reality essentially presupposes that of the monads that constitute them; but the monads do not exist in space, since space is simply ideal.

But Leibniz seems to intend his talk of bodies containing monads more literally than this. For example, when asked by Des Bosses for clarification of his meaning in the above-quoted remark, Leibniz replied as follows:

> When I say 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 again contain in themselves other animals and plants. And this, I believe, must be reiterated of any part of these living things, and so on to infinity. (11 March 1706; LDB 35)

[4] Similarly, Leibniz writes to Arnauld, also in 1690: "bodies are only aggregates, and not substances properly speaking; it must therefore be the case that there are substances everywhere in bodies, substances that are indivisible, ungenerable and incorruptible, having something corresponding to souls" (A IIb 311–12/WFT 136).

[5] Following Rutherford, I take a phenomenalist interpretation of Leibniz's metaphysics as a species of idealism that consists minimally in the claim that "the content of a monad's perceptions as though of bodies reflects no external reality; the being or reality of material things consists solely in the fact that they are perceived" (1990b, 15). As he observes, various differing phenomenalist interpretations have been given in the literature. Adams (1994, 219–24) distinguishes the phenomenalism he ascribes to Leibniz from a Berkeleyan view where bodies are identified with perceptions; but he still takes them to have existence only in the modifications of perceiving substances (223).

This passage suggests a notion of containment that is as literal as the idea that my stomach contains micro-organisms that aid in my digestion. Likewise, in *Considerations on the Principles of Life, and on Plastic Natures* published in 1695, Leibniz is quite explicit that matter is infinitely divided into parts, each containing organic bodies equipped with a soul (or soul-analogue):

> I have already said . . . that there is no part of matter which is not actually divided, and which does not contain organic bodies; that there are also souls everywhere, just as there are bodies everywhere; that the souls, and even the animals, always subsist; that the organic bodies are never without souls, and the souls are never separated from all organic body—although it is true, however, that there is no portion of matter of which you could say that it is always affected by the same soul. (GP VI 545)

In these passages Leibniz's monads appear to be living things, soul-like substances with their own organic bodies. If indeed a soul is never separated from an organic body, perhaps this is the intended meaning of monad: a substance with a body, a corporeal substance. Pauline Phemister has given an interpretation along these lines in her *Leibniz and the Natural World* (2005). Leibniz presented his simple substances as purely immaterial, she argues, so as to make his views more acceptable to the Cartesian audiences he was addressing. His official view, though, was a variety of hylomorphism: every substance, every monad, has both an immaterial and a material aspect, form, and matter. A monad is simply a corporeal substance. Insofar as it is actual, its matter is "secondary matter", an aggregate of further monads made actual by its dominant form.

Such an interpretation is consistent with Leibniz's remark to Arnauld, quoted above, "that it is form that gives determinate being to matter". When Leibniz "rehabilitated" the substantial forms of the scholastics in the late 1670s, he did so in order to distinguish true unities from mere aggregates: a true unity (or *ens per se*) is distinguished from a mere aggregate (or *ens per aggregationem*) by the possession of a substantial form. But interpreting corporeal substances as these true unities engenders some troubling difficulties about composition. For Leibniz distinguishes corporeal substances from simple substances like souls or the ego, and there are numerous occasions on which he clearly states a kind of reduction to simple substances, for instance, in his last letter to De Volder: "there can be nothing real in nature but simple substances and the aggregates resulting from them" (19 January 1706; GP ii 282/AG 185).

Scholars are split on how to interpret this quandary. Some, like Adams, doubt that Leibniz's commitment to corporeal substances was ever sincere (in spite of evidence that he continued to uphold them till the end), whereas others attribute to him different views in different periods. Thus Daniel Garber has been influential in arguing that Leibniz did indeed adopt a hylomorphic ontology in his "middle period", where a corporeal substance is an aggregate of other corporeal substances to infinity, each one being a composite of organic body and form (Garber 1985, 2009). But this corporeal substance ontology is unstable, since nothing composite should properly be regarded

as substance; certainly, it cannot be regarded as "simple".[6] Consequently, Garber contends, Leibniz abandoned corporeal substances in the early 1700s (even if reluctantly, and not without reversions) for a monadological idealism.

None of these readings sits well, however, with Leibniz's claims that monads, his indivisible substances, are the key to resolving the problem of the composition of the continuum. If the idealist reading is correct, and bodies are merely intentional objects of the perceptual states of monads, it is hard to see why their composition would be a problem that would exercise Leibniz at all. If they exist only in the representations of perceiving monads, their extension might as well be continuous, without this implying anything more about the monads than would the continuous spectrum of colour (since for Leibniz extension and colour alike are secondary qualities). Again, if bodies are aggregates of monads, but their aggregation is interpreted to mean only that their reality presupposes the reality of monads, we lose the connection that Leibniz stresses between bodies as the actual parts of matter and the discreteness of aggregates of reals. Why couldn't a really continuous matter, divisible into all possible parts, still presuppose monads for its existence?

There are also difficulties, though, for the non-idealistic readings. If it is "only indivisible substances and their states that are absolutely real", as Leibniz was already claiming to Arnauld in 1687, this would seem to rule out a corporeal substance interpretation: for corporeal substances are not indivisible if they have bodies that are actually infinitely divided. If, on the other hand, one insists that "corporeal substance is an indivisible whole without parts . . . even though its organic body is divided to infinity" (Phemister 2005, 117), it is hard to escape the suspicion that no escape from paradox has been found. Aggregates are contrasted with true wholes for Leibniz: so how could the possession of a dominant form weld the substances constituting a body into a true whole?[7] There is also the difficulty pointed out by Garber of how to square the infinite complexity of corporeal substance with the simplicity of simple substances. Yet if Leibniz had converted to a monadological idealism in the early 1700s as a result of this and other difficulties with the notion of corporeal substance, as Garber proposes, then it is odd that in his explanations to Des Bosses in 1706 he should have chosen realistic talk about animals to illustrate what he meant by monads being contained in bodies.

A different picture emerges, I submit, if instead of beginning with interpretations of Leibniz's theory of substance and then considering how to make sense of his remarks about the problem of the composition of the continuum, we begin by taking seriously

[6] Garber (2009, 88): "Even though corporeal substances are indivisible and immortal, they are not simple. Indeed, they are infinitely complex, bugs in bugs that go to infinity."

[7] Phemister acknowledges difficulties with this account in her chapter on the composition of the continuum. She argues that "the presence of souls and substantial forms has not served to introduce determinate divisions throughout the material continuum since, although the souls and substantial forms unify the corporeal substance itself, they do not unify the organic bodies themselves", and their introduction into aggregates to "mark the boundaries of indivisible creatures seems unable to alter the ideality of the extended in the slightest degree" (2005, 121).

his claim that this is a central problem of metaphysics for which he introduced indivisible substances as the solution, and examine how his theory of substance crystallizes around this as his thought progresses. When we adopt this perspective, Leibniz's introduction of monads appears closely interwoven with foundational problems in natural philosophy, and far less like a fanciful exercise in dogmatic metaphysics. We find ourselves obliged to examine exactly what the connection is between the actually infinite division of matter and the necessity of introducing true unities, what hangs on the contrast between the discreteness of division and the continuity of bodies and motions considered abstractly, and what is involved in monadic aggregation. To understand why Leibniz thought it necessary to revive forms or entelechies, we need to investigate what function they performed in late scholastic philosophy, and his response to the criticisms of that philosophy offered by leading mechanists like Robert Boyle. We need to explore not only how Leibniz's reinterpretation of forms as forces is supposed to provide a foundation for the continuity of motion, but also how it is supposed to solve the problem of the relativity of motion, as he claimed. And this will require us to re-examine his new science of dynamics without prejudging it as being in competition with his theory of forms.

This is the approach I take in this book. Each chapter treats an issue that Leibniz himself described as being implicated in the labyrinth of the composition of the continuum: composition, aggregation, atoms, forms, motion, substance, and continuation in existence. Also embroiled in the labyrinth are other issues of a more mathematical nature concerning time, space, the infinite, and indivisibles;[8] I will consider those here only insofar as they are relevant to his theory of substance, deferring a fuller treatment to another work. The first two chapters of this book deal with the problem of composition of matter and how monads are supposed to function as the solution; the third and fourth with Leibniz's atomism and his rehabilitation of substantial forms, showing the relevance to his views of seventeenth-century theories of chemical composition and animal generation, as well as the Latin pluralists' views on forms; the fifth examines Leibniz's argument that motion is a phenomenon whose reality requires a foundation in force; the sixth treats spatial continuity in relation to Leibniz's mature views on substance, especially in relation to his analysis of extension and his flirtation with substantial bonds; and finally the seventh deals with continuity of existence through time, including a detailed examination of Leibniz's position on divine concurrence and continuous creation.

Some foretaste of the argument can be given by returning to the issues raised above, and examining them from the perspective of the continuum problem. A prominent theme is the notion of the indivisibility of substance. As we have seen in his exchanges

[8] Cf. Leibniz's description of his second labyrinth as concerning "the *composition* of the continuum, time, place, motion, atoms, the indivisible and the infinite" (*Guillielmi Pacidi de Rerum Arcanis* of 1676; A VI iii 527).

with Des Bosses quoted above, Leibniz insists that the bodies of corporeal substances are actually infinitely divided. But this does not prevent him from giving animals as an illustration of entities possessing the kind of real unity that he saw as required for a "truly solid metaphysics" that escapes the labyrinth. The real unity possessed by living beings is contrasted with kind of unity possessed by bodies, which are mere beings by aggregation. The idea is that a living being, as a being, cannot be divided, even if its body can. A living being *has* a body, according to Leibniz, but dividing this (as in amputation) does not divide the animal itself, which has a metaphysical unity. As he explained to Des Bosses in his letter of 11 March 1706:

> A material unity…, according to the mathematicians, may be composed of two halves, when their subject allows, as ½ + ½ = 1, for example, as the value of a *groschen* is an aggregate of the values of two half *groschens*. But I was speaking of substances. A fraction of an animal, or a half-animal, therefore, is not a unity per se, since this can only be understood of the body of an animal, which is not a unity per se, but an aggregate, and has an arithmetical unity, not a metaphysical one. (LDB 30–1)

Leibniz went further, holding that *no* division would divide the animal, as opposed to its body. From this it follows that each animal is coeval with the created universe: "an animal never has a beginning naturally, neither does it end naturally, so that there will be not only no generation, but also, rigorously speaking, no total destruction or death", Leibniz wrote in the *Monadology* (§76/L 650); "What we call *generation* is a development and an increase, just as what we call *death* is an envelopment and diminution" (§73/L 650). Leibniz held this view from the late 1670s until the last year of his life, even through the vicissitudes of his epistolary exchange with Des Bosses: "as I have often said," he wrote in a letter of 29 May 1716, "it is not only the soul that endures, but the animal as well" (LDB 369).

It is quite otherwise with bodies taken in themselves. In the continuation of the above passage from his letter to Des Bosses, Leibniz wrote: "just as matter itself, if it lacks an adequate entelechy, does not make one being, neither does a part of it.… Matter (that is, secondary matter), or a part of matter, exists in the same manner as does a herd or house, that is, as a being by aggregation" (LDB 31). This is the same position that Leibniz had proposed in rehabilitating substantial forms in the 1670s and 1680s. Without a form or entelechy adequate to it, a body is merely an aggregate of beings, and not itself a unity. It has a merely arithmetical unity, not a substantial unity.

So we have the following picture. Each monad is the principle of unity of a living being. It is a principle of unity in the sense that it remains the same one thing through all the changes undergone by its body. His favourite example of this is the transformation of a caterpillar into a butterfly: it remains the same animal with the same genetic information encoded within it despite the drastic change of its body, most of which is sloughed off in the process. The difference is that Leibniz conceives such metamorphoses as continual in each animal: no living thing retains precisely the same

body, in the sense of possessing the same material parts, for longer than a moment. Every animal has a body at each moment: in this sense it is a corporeal substance.[9] But what is substantial is the principle of unity itself, that which explains how it is the same individual (its principle of individuation); and that which, so Leibniz holds, is the source of all its actions. This principle is not material, else it would be divisible. It is what Leibniz means by the indivisible substance.

This gives the theory of substance in its broadest outlines. But it does not answer any of the questions raised above in relation to the problem of the continuum. Why did Leibniz think a body could not be a substantial unity? What does Leibniz mean by describing bodies and motion as phenomena, and in what sense are bodies aggregates of monads? Why does he rehabilitate substantial forms to explain what endures through time instead of adopting atoms like his contemporaries? And what relation could there be between this revised Aristotelianism and his new science of dynamics?

These are the questions I shall try to answer in the chapters that follow. In keeping with the theme of the labyrinth, I proceed by following certain clues that function as *Ariadnean threads* suggesting a path through the labyrinth towards an exit. The thread I pursue in the first chapter is the question of *what Leibniz means by "actual parts"*. The most naïve interpretation is to suppose that monads are the indivisibles one arrives at after a process of infinite division: they would be the "actual parts" that are prior to the whole in real things, as opposed to the merely potential parts into which an ideal mathematical continuum might be divided. Although most scholars have recognized that this runs counter to Leibniz's insistence that monads are not parts of matter, many have nevertheless found themselves forced to equate his indivisible substances with the "actual parts" of phenomenal bodies, even if they put the expression in scare quotes to show that this should not be taken literally. What moves them to do so is the conviction that only monads are actual, while phenomena are not; so, even if monads are not properly parts, they must be what Leibniz is referring to. Pursuing this thread, however, we find that, despite their being classed as "actual", the actual parts Leibniz refers to are in fact parts of bodies: they are the determinate parts into which phenomenal bodies are divided by the motions internal to them. This has profound consequences for understanding Leibniz on the continuum. For it means that the contrast he makes between the ideal and the actual is not between the ideal realm and that of monads:

[9] Cf. Adams: "The monad can be called a corporeal substance inasmuch as it *has* a body" (1994, 269). Adams dubs this reading of Leibniz's corporeal substances the "qualified monad conception", attributing it to Ernst Cassirer, who claimed that it "denotes the substance 'insofar as it is endowed with a determinate organic body, according to which it represents and desires'", citing Erdmann (E 678, n. 5) for the quotation (Cassirer 1902, 408). Cassirer qualifies this by adding: "This by no means records a new and alien moment in the monad, which seemingly treads close to the function of consciousness, but concerns only a determination in the content of consciousness itself." This makes his reading a wholly idealistic one, in contrast to the reading I give it, where the organic body, although derivative, is not reducible to a "determination of consciousness"—not only because most monadic representations are not conscious, but also because what is represented (namely, the substances constituting the body) exist independently of their being represented, and thus underwrite the reality of the body.

phenomena themselves are actual when they have determinate parts, as opposed to the indeterminate parts into which they could be divided when regarded abstractly.

Moreover, we see that Leibniz holds not just that some bodies are actually divided by motions internal to them, but that every body, and every part of every body, is so divided by the differing motions of its parts. He reiterates this on numerous occasions in both published and unpublished papers, early and late. Thus in the *Monadology* of 1714 we find: "Every portion of matter is not only divisible to infinity, as the ancients realized, but is again actually subdivided without end, each part into further parts, each one of which has its own motion" (§65; GP VI 618). This idea that each actual part of matter is individuated by its own motion is the key to the argument for monads from the actual division of matter, for each such motion must have its own principle, and this is one of the things that monads provide, as we shall see. That matter is divided by its internal motions into co-moving portions constituting actual parts is Cartesian in origin, although Leibniz insists that such a division is not merely indefinite, as Descartes held, but actually infinite.

Implicit in this criticism of Descartes is an understanding of the actual infinite in multitude that Leibniz inherits from certain scholastic philosophers. According to this "syncategorematic" interpretation, advocated by such thinkers as William of Ockham, there is no infinite number. To say that there are infinitely many parts in a division is simply to say that whatever number may be assigned to them, there are more. This conception of the infinite (arising especially out of Leibniz's work in mathematics) is of profound significance for his philosophy. For it is part and parcel of his argument that there is no "bottom level" of division. If the division of matter resulted in actual indivisibles, then these could indeed be regarded as the elements of matter: simple substances would be the primary elements out of which all bodies are aggregated and therefore composed. As I argue in Chapter 1, such an interpretation would make for a physical monadology somewhat like Wolff's. On Leibniz's interpretation, by contrast, matter is actually divided in such a way that every part of it is further divided, but there is no least part. It follows that none of its parts can be indivisible. Since substance is by definition indivisible, it follows that no part of matter can therefore be a substance.

But there is a further conclusion to be drawn from this argument from infinite division. This is that since each actual part of a body is individuated by its motion, and these motions necessarily differ at each different moment, the aggregate of parts making up a body are not the same from one moment to another. That is, body as an aggregate does not remain precisely the same thing through time. Leibniz habitually alludes to Plato in this connection. As he writes in the *Conversation of Philarète and Ariste* of *c*. 1711, "Thus it seems that in philosophical rigour bodies do not deserve the name substances; this seems already to have been the view of Plato, who remarked that they are transitory beings that never subsist longer than a moment" (GP VI 586/L 623). They are not substances, enduring beings, but phenomena, always changing. This is one sense in which bodies are phenomena for Leibniz: they are phenomena because, unlike substances, they do not remain the same being from one moment to another.

So far the argument has delivered the conclusion that every body is an aggregate of its parts, but not that it is an aggregate of substances. For that Leibniz appeals to two further premises, that any body which appears to sense is real (that is, given an agreement among perceivers in normal viewing conditions), and that a plurality derives whatever reality it has from the unities from which it is aggregated. But since each of the actual parts of a body is a plurality, it cannot be a unity: in fact, nothing material can constitute a unity for this reason. Body must therefore derive its reality from unities that are not in themselves material, i.e. indivisible substances.

But *how can a body be an aggregate of immaterial substances it presupposes*? This is the Ariadnean thread dictating the course of Chapter 2. What does it mean to say that aggregates *presuppose* monads as their constituents, or that monads "are in" bodies? Why, if they have such substantial constituents, does Leibniz insist that aggregates are phenomena? And, finally, how can Leibniz sustain a belief in corporeal substances while maintaining, sometimes in the same breath, that all that exist are simple substances and the aggregates resulting from them?

I begin with Leibniz's own analysis of bodies as aggregates in his correspondence with Antoine Arnauld. There he insists that "where there are only beings by aggregation, there will not in fact be any real beings", so that "if there are aggregates, there must also be some true substances from which all those aggregates result" (30 April 1687; A II iiB 185/WFT 123). He presents four options as to what those true substances might be: (i) points; (ii) atoms; (iii) nothing at all; or (iv) true substances that "possess a genuine unity" (185/123). The first option, associated with the "Zenonists", is that the continuum is composed of points. This is dismissed as untenable, although (as we shall see in Chapter 5) it is one that Leibniz himself came close to advocating in his youth. The second, adopting the atoms of Epicurus and Cordemoy, is likewise rejected (although we shall have much more to say on that in Chapter 3 below). The third, "that there is no reality in bodies", is the view of Academic Sceptics like Foucher. It is important to see that this is another view that Leibniz is trying to avoid—a point I shall return to below. This leaves only the fourth option, "that there are in bodies substances which possess a genuine unity". Leibniz is careful not to say "there are bodies possessing a genuine unity"; rather, these unities "are in" bodies.

Here he appeals to a very strong principle, namely that a being by aggregation "derives its reality only from that of the things that make it up". This is easy to accept with his example of the two diamonds, the Grand Duke's and the Great Mogul's, since these make only a conceptual unity. But in fact Leibniz denies that any kind of structure—even contact, shared motion, hooks, or chains—would provide substantial unity to a composite. All such physical bonds reduce, he believes, to changing relations among the real constituents. They constitute "accidental unities" of varying degrees of unity, depending on how many relations there are among the ingredients. So it is not that Leibniz denies the reality of structure, it is just that it is a consequence of substances possessing certain modes, and the fact that "those modes contain within them certain relations to other substances, as a result of which the mind has occasion to join

them together in thought" (191/127). This is a second sense in which bodies are phenomenal for Leibniz. Like all aggregates, their reality derives only from the reality of the unities presupposed in their parts. The unity of an aggregate, however, is supplied by the minds perceiving the relations among these unities: aggregates are thus "semi-mental". So, Leibniz contends, what are real are the substances; any structure has a unity only as a result of the relations among those substances, but these relations are ephemeral. The reality of body, therefore, depends on that of its constituent substances, the entities that endure through time.

On this reading, then, Leibniz does not claim that the principle of unity is something that unifies matter, in the sense of taking all its parts at a given time and making them into one being. Matter, by the above argument, is necessarily only an aggregate, even if it is aggregated from true unities.[10] It is therefore not one being, but many. What is "truly one being" is rather "the animated substance to which the matter belongs" (to Arnauld, 9 October 1687; A II ii 249/WFT 131). This is therefore my resolution of the debate about corporeal substance described above. Commentators have taken Leibniz's commitment to corporeal substance to depend on whether he regards body as a substance,[11] and have taken Leibniz's affirmations of corporeal substance to commit him to a form that unifies matter into a synchronic unity. But on my analysis, a substantial form for Leibniz is a diachronic unity, not a synchronic unifier. It constitutes a unity not by unifying matter into a whole at a given time, but by providing a thread through the various material manifestations of the substance through time, which differ at every moment. At every one of these moments it has a body, although the body will be a different aggregate of unities from one instant to another.[12]

Coming back to the notion of presupposition, we have seen that the reality of body depends on that of its constituent substances. It therefore presupposes them. As Rutherford has cogently argued, Leibniz has a generalized notion of aggregation that makes it the inverse of presupposition: if a body presupposes substances as its immediate requisites, then it may be regarded as the aggregate of those requisites. For an entity A to be an immediate requisite of B is equated by Leibniz to A's "being in" or "being contained in" B. Now since the reality of an aggregate reduces to that of its constituents,

[10] This differs from the position I had outlined earlier in my (1999b) and (2001b). I was persuaded to adopt my present interpretation largely by the arguments of Adam Harmer in his MA thesis, "Leibniz's Actual Infinite" (McMaster University, 2006). See further n. 33 of Chapter 2 below.

[11] On such grounds Robert Sleigh perceives Leibniz to have moved from hesitation about the true substantial reality of bodies in the draft manuscript of his correspondence with Arnauld to a more positive endorsement of corporeal substances in the revised copy he was preparing for publication in the 1690s (Sleigh 1990, 95–115). For a critique, see Pauline Phemister (2001). Cf. also Levey (2007, 92): "Without the premise that some bodies are substances, the whole train of argument for simple substances just collapses." See Rutherford (2008) for a critique.

[12] As Samuel Levey has pointed out to me (private correspondence), this brings Leibniz's view into line with Aristotle's under recent influential interpretations. According to Mary Louise Gill's reading of Aristotle, for example, "An animal's functional matter is its organic body. This organic body can be specified in two ways, either functionally with reference to the form or simply as the stuff in which those functions are realized" (Gill 1989, 127). As the latter stuff, the body does not endure, but body as functional matter does. Levey's own interpretation of Leibniz's theory of substance is given in his (2007).

this means that a body's reality reduces to that of the monads that are in it. Rutherford therefore concludes that this is the way to interpret Leibniz's claim that monads are contained in a body: the reality of a body, its essence, reduces to that of the monads it presupposes. Monads are no more spatially contained in a body than predicates are in a subject.

Against this, I argue that this misses the all-important connection with the problem of the continuum. It is because bodies are actually infinitely divided that they contain an actual infinity of monads. Thus a body presupposes substances in the sense that every actual part of the body is either an organic body or an aggregate of such, and each organic body presupposes a monad. That is, it has a monad or entelechy that is "adequate to it", that "actuates it" or "gives determinate being to it". So although a body does not have monads as its spatial parts, it is spatially divided into actual parts containing monads, each one being the dominant monad of an organic body. Monads are therefore *in* matter in a stronger sense than merely being generally presupposed by its reality, in that each one is where the organic body it dominates is and has its effects. As we shall see in Chapters 5 and 6, Leibniz's articulation of this is through his dynamics, where substance is interpreted as primitive force. The differing parts of matter are individuated by their differing endeavours at each instant, and these are explicated in terms of the derivative active forces that are modifications of primitive active force. The extendedness of body, on the other hand, consists in a diffusion of the derivative passive forces resulting from resistance to the active forces in every actual part of the body.

Nevertheless, it remains true that although bodies have these forces constituting their actual parts, forces that are modifications of the monads, bodies are not *composed* of monads. The parts of bodies are always further bodies, either organic bodies or aggregates thereof. But however far matter is divided, there are no ultimate material components. Each organic body presupposes immaterial unities and parts presupposing further organic bodies: it is therefore resolvable into immaterial unities, and (material) aggregates of organic bodies. As I show by a kind of Leibnizian "characteristic", since the matter is always further resolvable into organic bodies whereas the monads are not further resolvable, it follows that in an "ultimate resolution" matter is resolved into immaterial unities. Bodies are *resolved* into immaterial unities, but they are not *composed* from them. This means that without the monads, there would be no bodies; but any existing body is constituted by monads in all its actual parts, although not composed of them.

But here one might wonder, if Leibniz was looking for indivisible substances, why did he reject atoms? He could still have maintained his nominalistic principle that aggregates are nothing more than their constituents, as indeed had Democritus, as Leibniz reminds us. The mystery is deepened when it is realized that Leibniz's early writings are peppered with positive references to atoms. But this presents an enigma: why do atoms feature so prominently in his earlier writings when indivisibility is precluded by actually infinite division, which he upheld from his earliest writings? This constitutes the thread I follow in Chapter 3, *Leibniz's changing views about the status of*

atoms. Subsequent investigation reveals that the atoms Leibniz upheld in his youth were not the infinitely hard and homogeneous portions of extension favoured by his contemporaries, but owed much more to lesser known currents of atomism in the seventeenth century, especially to the alchemical and medical traditions (as I argue in this and the following chapter). The solution this suggests to the enigma of Leibniz's atomism is this: his atoms are only physically indivisible—they maintain their integrity in the face of physical collisions and chemical reactions—but are nevertheless divided within by the motions of their constituent parts: inside they are heterogeneous and teeming with activity.

But this investigation also reveals how indebted Leibniz's thought is to a brand of atomism exemplified particularly in the influential natural philosophy of Daniel Sennert. For Sennert's atoms were (like Leibniz's) animated: they contain immaterial forms that function as their principles of individuation. From this point of view, Leibniz's corporeal substances can be seen as developing out of his earlier atomism. The difference, I argue, is that whereas up until 1676 Leibniz conceives souls as implanted either in atomic nuclei or at least encased within an unbreakable shell, after 1676 this atomic "protection" is seen as unnecessary. Forms are intrinsically indestructible; and organic bodies are also indestructible in that there are no elements into which they could be broken down. Being themselves always further divided, there is no division or removal of parts that can destroy them, provided they still function as the body proper to the animating form.[13]

The perspective opened up by this examination of the roots of Leibniz's atomism raises several further questions. It is all very well to see the parallel between his rehabilitation of substantial forms and Sennert's some fifty years earlier, but they were working in very different contexts. Leibniz was well aware of the abandonment of forms by the mechanical philosophers, so what could their appeal have been to someone who had already "completely given himself over to the moderns" by the age of fifteen? This is the thread I take up in Chapter 4: *why does Leibniz abandon his physical atoms of 1676 for a natural philosophy in which "every body is animate" or at least a collection of such animate bodies?*

Leibniz himself offers various clues. There are his several references to a youthful infatuation with the philosophy of Descartes' rival, Pierre Gassendi (1592–1655), who was so influential in reviving Epicurean atomism; there are his references to the controversy about the origin of forms in the theological context of his time; and there is his enlisting of the doyen of the mechanical philosophy, Robert Boyle (1627–91), in support of the doctrines of matter as incessantly active, and of final causes in nature as being crucial to the operation of divine providence. In this chapter I give a thorough

[13] This has been well expressed by Justin Smith: organic bodies "are not naturally generable or corruptible; insofar as they are infinitely complex, there is no process of rearranging preexisting matter so as to bring them into existence, and no process of decomposition that would take them out of existence" (Smith 2011, 135). But the proviso I added is all-important: "provided they still function as the body proper to the animating form".

exploration of these three apparently unrelated matters, showing how they are all connected in the rich intellectual environment of the seventeenth century. This involves substantial discussion to establish the intellectual milieu in which Leibniz was operating, for which I ask my readers' indulgence. I show how Leibniz's critique of the passivity of Cartesian matter can already be found in the criticisms made by Gassendi, who advocates the necessity of form as a principle of activity in matter. He gives form as materialistic an interpretation as he can (with the exception of rational souls, which he concedes must be immaterial), insisting that there is no matter without form and no form without matter. All biological generation can therefore only occur from matter already pre-formed, with the form embodying the genetic information—a point on which Leibniz will follow him. I contrast Gassendi's exempting of the human soul with the more consistent position of Sennert, who upholds the immateriality of the souls of all living things, each contained in a seed or organic molecule, while opting for an account of their origin in a splitting of the genetic material of their progenitors. This is the doctrine of traduction, where souls are multiplied in animal reproduction rather than divinely created. In the theological controversies, this was Lutheran orthodoxy, and Leibniz had formulated a mathematical argument for it in his youth.

This contextualizing of Leibniz's thought in debates about animal generation and its theological implications, I argue, throws much light on many of his mature doctrines. His replacement of atoms by living substances no longer seems a drastic change of metaphysics, but a subtle shift enabled by his reconceptualization of their forms as forces. As such they are responsible for the actuality and plasticity of the parts of matter, in agreement with the hierarchy of forms of Scaliger and Sennert. As in that tradition too, they are conceived as immaterial substantial forms in each body that are the source of the body's activity; and each is a dominant form in an organic body containing within it further bodies with their own subordinate forms. Impressed by the observations of Hooke, Kircher, Leeuwenhoek, and especially the work of Malpighi, Leibniz assimilates this doctrine of the hierarchy of forms to his own conception of the infinite division of matter, so that the living creatures seen through the microscope on ever-decreasing scales are taken as evidence for the folds within folds of matter to infinity. Given this context we also see that created monads must be embodied in order for them to perform their role as forms of bodies, responsible for the degree of organization, development, and function found in chemical and biological phenomena. But he comes to see that to suppose any direct action of the form on the matter (such as he himself entertained as late as 1676) is to commit a "kingdom mistake", attributing efficient causality to something that cannot cause material consequences.[14] Now, Leibniz is at least as committed to mechanism as is Boyle, and construes all living beings as machines. He also agrees in detail with Boyle's criticisms of the unintelligibility of the generation and destruction of substantial forms. But he finds inadequate Boyle's explanations of the teleology required by divine providence, and his account of action

[14] I am indebted to John Roman for the term 'kingdom mistake' to describe this error.

only in terms of mechanical motions. Here he agrees with Scaliger, Sennert, and Lutheran orthodoxy, that the means for purposive action must be immanent in created things, and cannot be simply imposed from without by divine fiat. With them he insists that the continuance of any living being as the same substance is only explicable by appeal to its containing an immaterial form through which its continued functioning can be explained. His solution is then threefold: the problem of the origin and dissolution of forms is resolved by denying that this takes place naturally at all—all substantial forms are created in the creation of the universe, and will only perish in its destruction; the problem of teleology is finessed by noting that machines are defined by their purposes, so that mechanism and teleology are complementary, not in conflict; and, thirdly, it is the end-directedness of the forms immanent in nature that enables the derivation of the laws of nature governing its mechanisms: forms do not act on matter.

So far we have been tracing Leibniz's thought on how bodies presuppose substances. Equally important, however, is his analysis of the phenomenon of motion. This is the subject of Chapter 5, where the thread we follow through the labyrinth is Leibniz's changing thought on *what constitutes the reality of motion*. According to the argument of the first four chapters, Leibniz infers the existence of monads from the reality of matter, whose parts are made actual by their containing these entelechies. Matter is a phenomenon, but a real phenomenon, whose reality consists in the unities that constitute it. As we shall see, a parallel reasoning applies to force and motion, where the reality of the phenomenon of motion is a crucial premise in the argument for forces in things. The monadic endeavour or active force underpins the reality of motion just as the principles of unity, or monads, underpin the reality of the matter containing them.

I proceed by tracing the development of Leibniz's views from his earliest theories on the continuity of motion through to his mature dynamics. The key idea here is the Hobbesian notion of endeavour. In his earliest theory, Leibniz had adopted a version of continuous creation, according to which God recreates bodies at assignable instants in their motions, their being non-existent during the unassignable intervals between these instants. In the *Theoria Motus Abstracti* of 1671–2, however, he is able to reconstitute a true continuity by appeal to the idea of endeavours. These he conceives as actually indivisible elements of motion, which result in the body occupying overlapping and thus interpenetrating points at successive instants. With the abandonment of these actual indivisibles, and his reinterpretation of the infinitesimals of his calculus as fictions in 1675–6, Leibniz is forced to reconsider the foundations of motion, and he reverts to something similar to his earliest view, where motion depends for its continuation on direct divine action.

Another consideration concerning the reality of motion that pushes Leibniz to construe motion as a pure phenomenon arises from the relativity of motion. When two bodies are in motion relative to one another, he reasons, the same phenomena will be produced whichever of the bodies is taken to be the subject of motion; even the force of impact on collision will be the same, provided the relative velocities are the same. Moreover, as he had learned from Huygens, it is relative motion whose quantity

is conserved. But if the quantity of motion is relative to the point of view from which it is perceived, then what is conserved is not an attribute of individual bodies, but rather of the whole world.[15] Relative motions, moreover, as mere changes of situation, are extrinsic denominations. But motion cannot be merely extrinsic: something must be the subject of relative motions we observe in bodies. Thus bodies, on this analysis, are not substances, because they are not the subjects of the actions we attribute to them. They are only modes of the whole material universe, and since nothing else can be attributed to purely material bodies than their "being sensed in accordance with certain definite laws",[16] they will be pure phenomena appearing in succession and constrained by the laws of motion chosen by God.

Leibniz is not comfortable with this conclusion; he does not wish to deny the reality of the phenomenon of motion. Here he finds his own Ariadnean thread to lead him out of this part of the labyrinth in the estimation of causes in accordance with his Principle of Equipollence, that "the entire effect is always equal to the full cause" (GM VI 245/WFT 166). Noting that we assign true motion to that body that is best understood as the cause of the relative motions, he was led to see that the true measure of a body's activity was not quantity of motion but quantity of *force*, with force understood as the capacity for acting and being acted upon. In refuting the Cartesian identification of force with quantity of motion, Leibniz used his Principle of Equipollence to argue that a body must possess a power of bringing about effects and must have this power at all times, and not just when it is in motion. This is the "primitive active power", an endeavour producing the changes of state of each substance within the body, taking it from one state to those following, resulting in the differing relations that constitute the phenomena. Moreover, bodies could not even obey the laws of impact if they did not have in them an enduring power of resisting changes of motion—a "primitive passive power" in bodies responsible for their "natural inertia", as Kepler had called it. The primitive active and passive powers in a body are aggregates of those powers in their constituent substances, each of which is constituted by its primitive active and passive force.

This, then, is the key to Leibniz's solution of the problems of the continuum: the identification of substance with primitive force. If we are to avoid ascribing all true action to God, it is necessary to recognize that force must "constitute the inmost nature of bodies", as Leibniz wrote in the *Specimen Dynamicum* of 1695 (GM VI 235/WFT 154). "For to act is the mark of a substance, and extension, far from being able to comprise substance, indicates nothing other than the continuation ôr[17] diffusion of an already presupposed striving and counter-striving (i.e. resisting) substance" (235/154).

[15] "For when two bodies collide, it is clear that it is not the mind of each one that makes it follow the law of compensation, but rather the universal mind assisting both, or rather all, equally" (*On Motion and Matter*, April 1676; A VI iii 493/LLC 77). "Motion is something respective, for one cannot distinguish which of the bodies is moving. Thus if motion is an affection, its subject will not be any one individual body, but the whole world" (*Motion is Something Respective*, February 1677; A VI iv 1970/LLC 229).

[16] 15 April 1676; A VI iii 508/DSR 58–9; my translation.

[17] Throughout this book I have used the notation of a circumflex over the 'o' in 'ôr' as a way of signalling that it translates the Latin *sive* or *seu*, which is an "or of equivalence". It could be translated by "that is to

In this doctrine, however, commentators have found a problem. For if substance is necessarily active, then what is the status of passive force? This would seem to entail that passive force is not substantial. But then, since Leibniz identifies primitive passive force with matter, matter itself would not be part of substance, and we would be thrown back into idealism, where all that exists are immaterial substances.[18] Moreover, there are two other considerations that have been adduced as evidence of idealism in Leibniz's last years. One is an alleged relegation in the status of derivative forces from being denizens of the physical world to being mere phenomena.[19] The other concerns the notorious issue of the substantial bonds Leibniz hypothesizes in his correspondence with Des Bosses, which have been taken to be a last (and failing) attempt to salvage a realism about corporeal substances. These issues concerning the status of force and corporeal substance in Leibniz's mature philosophy are the subject of my Chapter 6.

With regard to the first issue, I argue that the actions of a created substance are always constrained by the actions of the other created substances with which it coexists, and that this constraint on its actions manifests itself in each substance as a passive force. As a permanent power in the substance, passive force is essential to the substance. But like active force, it is not a pure potentiality, but is always manifested at each instant. Active force is manifested in the derivative active forces obtaining in a body at each instant—its impetus, *vis viva*, centrifugal force, elastic force, etc. Passive force is manifested in the resistance to motion or penetration, and therefore presupposes the active forces of the entelechies within the body. These derivative forces are phenomenal in the Platonic sense outlined above: they are instantaneous modifications of the enduring primitive forces constituting substance. There is therefore no incompatibility between the substantiality of primitive force and the phenomenality of the derivative forces of physics. The latter are real in the sense that they result from the substances, of which they are modifications. They have this in common with body and motion, even while providing a foundation for the reality of both body and motion at each instant. There is, I maintain, nothing to indicate any discernible change in the status of these forces in the writings of the last two decades of Leibniz's life.

say", although this is a little cumbersome; translating simply by 'or' can make it seem as though Leibniz is vacillating between alternatives. I first introduced this notation (in preference to Edwin Curley's italicized '*or*') in drafts of my (LLC), although I was obliged to drop it in the published version.

[18] Thus Adams writes: "I think [Leibniz's] talk of 'corporeal substance' was usually rooted in an interest in accommodating within his system, at least verbally, a common sense or traditional realism about body" (1994, 285); but he cedes that it is hard to see how physical forces that pertain essentially to the phenomena of motion could be modifications of internal principles of indivisible substances "when the primary operations of those internal principles are also internal to indivisible substances" (379).

[19] Thus Garber discerns "a fundamental change from the thought of Leibniz's middle years" (Garber 1985, 91) in his explicit pronouncement to De Volder in 1705 "I relegate derivative forces to the phenomena" (GP II 275/LDV): "the derivative active and passive forces that had earlier been real parts of a real physical world—modes of corporeal substances—are now taken to be phenomenal" (Garber 2009, 362–3). Phemister, in contrast, denies that derivative forces are phenomenal: "The derivative force belongs to the aggregate, but, as observed earlier, this does not mean that derivative forces are themselves phenomenal" (2005, 199).

This analysis coheres with the account of Leibniz's solution to the continuum problem I have outlined above. Primitive force is the principle of activity that is presupposed in bodies, "the principle of acting and being acted upon" that Leibniz says is diffused throughout any given body. The modifications of these active and passive forces at each instant are the derivative forces responsible for the elasticity and resistance to deformation which exist in the body, and which, according to Leibniz, give rise to its being extended. The differing motions that these forces produce, moreover, are what individuate the actual parts of the body described above. They are constantly being folded and unfolded according to the varying motions and degrees of resistance existing at different instants, resulting in the differing partitions existing moment by moment. These partitions and folds are therefore not simply modal, or dependent on being perceived; it is the perception of particular bodies as constituting unities that is observer-dependent. Although the folds in matter are actual, they are also infinitely variegated, on ever smaller scales. Bodies, or unities of matter, however, appear only on certain scales and relative to particular observers and the fineness of their sensory discrimination. The continuity of extension likewise results from the inability of sense-perception to discern inhomogeneities below a certain threshold (although because of the infinitude of the division the divergence from mathematical continuity is rendered vanishingly small). So bodies are aggregates of actual parts, but their unity is perceptual or relative to the observer, in agreement with the analysis I give in Chapter 2.

In his correspondence with Des Bosses, however, Leibniz offers a different account of the unity of bodies through the notion of substantial bonds. Here he experiments with re-instituting a real continuity in matter, so that a corporeal substance forms a unified and continuous composite through time. On my reading, Leibniz is trying to accommodate the Jesuits' insistence that the soul is really united to its body, which it thereby endows with a real unity. His own "official" account, where successive aggregates constitute (strictly speaking) different bodies accidentally unified with the same soul, falls foul of the Jesuits' proscription of the doctrine of the accidental unity of body and soul. This difficulty, Leibniz hoped, could be remedied by positing in addition a "substantial bond" that would provide a real and lasting continuity among the monads contained in a body, so that they form one real entity that can be united with the soul or dominant entelechy. But in the face of Des Bosses' penetrating criticisms, Leibniz is forced to recognize that his various attempts either contradict his own metaphysics or fail to produce the required real unity of body and soul.

A significant factor in this failure, on my reading, is the fact that Leibniz subscribes to the plurality of forms, and not to the Thomist metaphysics adopted by the Jesuits. According to the Thomist view, an entelechy or substantial form bestows actuality on an otherwise merely potential and undivided matter. Because of the convertibility of 'being' and 'one', the substantial form, in making this continuous matter actual or existent, also constitutes it as one thing. Matter could not have a *plurality* of actual parts while possessing a substantial form, since that would make them into a *unity*.

This Thomist interpretation of forms is incompatible with Leibniz's view, where the subordinate monads constitute the reality of the actual parts of a body independently of whether the body possesses its own substantial form, in accordance with the doctrine of the plurality of forms. I argue that the hypothesis of substantial bonds is his attempt to provide a unifier of the body into a composite with real spatial continuity. But the addition of such an extraneous unifier is at odds with the discreteness of the actual at the heart of Leibniz's solution to the continuum problem, and Leibniz never manages to resolve this incompatibility.

Consideration of unity through time signals the second way in which Leibniz's substances constitute a solution to the continuum problem: monads are temporal continuants, the indwelling substances producing all existing phenomena by their continuous activity. But this immediately raises some profound difficulties for his account. For *how is Leibniz entitled to posit a continuous temporal activity to his monads* without this violating his solution to the continuum problem? This is the topic of Chapter 7. The difficulty is accentuated by the fact that Leibniz appeals to the traditional doctrine of Continuous Creation, according to which the continued existence of substances through time—their continuous duration—is vouchsafed by divine concurrence, the continued creative action of God. On the one side, this seems incompatible with Leibniz's insistence that created things are the sources of their own actions; on the other, it threatens to reduce duration to a discontinuous sequence of discrete moments in which God creates the world anew, in contradiction to Leibniz's prized Law of Continuity.

In this chapter I tackle these issues in three stages. First, I examine the difficulty about the actions of creatures requiring God's concurrence, and whether this is compatible with his assertion of the autonomy of creatures, producing their own actions spontaneously through their primitive active force. I argue that Leibniz distinguishes between a substance producing or causing its own actions and its being continuously created with these actions. On my reading, Leibniz claims that God continually creates each substance with the power to effect its own actions, but that its receptivity to God's continuous creation of it is limited in three respects: in respect of divine omnipotence, divine omniscience, and divine goodness. These limitations combine to produce in it its resistance to the actions of other substances in the same world (its passive force), and in the moral sphere, sin.

Second, I examine Leibniz's understanding of continuous creation. This, I contend, is not susceptible to the difficulties of the composition of the continuum that he saw afflicting rival views. On the understanding of the Cartesians, the states of bodies and minds change in synchrony from one moment to another, as God successively recreates the world according to the laws he has put in place. In the case of thinkers like La Forge, this goes along with an explicit temporal atomism. But even with occasionalists like Weigel and Sturm who did not advocate time atoms, there is a radical discontinuity between the world at one instant and another. Leibniz's advocacy of the discreteness of changes of state appears to put him in the same company. But this

he denies, arguing that nothing that does not last for longer than a moment can be a substance. Here he appeals to the ego as a model of a substance that endures through its changes of state or perception. Real physical identity is the continuity of existence through these states, a continuity that is provided by memory, traces of previous states found in each present state. A profound consequence of this position, I contend, is that every perception requires time, that all monadic states have duration. This, I argue, is consistent with his doctrine of *petites perceptions*, where every perception contains within it smaller perceptions that are indiscernible below a certain limit of discrimination.

In support of this interpretation I return to Leibniz's dialogue on the continuity of time and motion, *Pacidius Philalethi*, analysed in Chapter 5, and show how he continues to uphold the analysis of change he reached there throughout his mature philosophy. On this interpretation, change is an aggregate of two contradictory states that are immediately next to one another; the states themselves have duration, and the moment of change is the aggregate of the last moment of the preceding state and the first moment of the following state. Each of these states, however, is "vague": it is taken as undivided, but is in fact internally divided into further distinct states, in keeping with the doctrine of *petites perceptions*. In the *New Essays* Leibniz explains this by an appeal to his Law of Continuity: each state or perception of a given individual substance contains traces of all its previous states, thus constituting its duration as continuous. These states thus form a physical continuum: although each is divided internally by discrete changes marking the boundaries of the different states within, these states themselves are further divided without end, in such a way that there is no assignable time in which a change is not occurring. Here, I contend, Leibniz's thought is deeply informed by his understanding of his calculus and the syncategorematic interpretation of infinitesimals. On this interpretation, to say that the changes of state of a substance are momentaneous is to say that there are no differences between states that do not involve further differences within that are governed by the same law of the series, in such a way that the difference can always be made less than any pre-assigned difference. But this is the same sense of continuity as that involved in Leibniz's differential calculus, where a difference that can be made smaller than any given difference is null. Monadic series are precisely as continuous as is any curve in nature.

A good way to understand how all this fits together is to return to the third option that Leibniz rejected in his exchange with Arnauld, "that there is no reality in bodies". This was a live option in Leibniz's day for dealing with the difficulties of the problem of the composition of the continuum, since it was the solution adopted by Academic Sceptics like his friend Simon Foucher (1644–96). They concluded from the difficulties of the continuum that extension and motion have no substantial reality, since the continuum can be composed neither of partless points, nor of physical points. Partless points could never compose into an extension, and physical points—hypothetical smallest observable parts of extension—will themselves be extended, leading to a vicious regress. Leibniz cedes that they are right to reject such composition. Where

Foucher and the rest go wrong, however, is in concluding from this that "the essential principles of extension could not really exist".[20] In taking extension and motion in their purely mathematical sense, Leibniz objects, they fail to realize that such abstract entities "have no constitutive principle at all". What is to be explained is "not the principles of extension, but those of what is actually extended".[21] So just as we are saved from a pure phenomenalism about bodies by the assumption that they derive their reality from the substances within them, so we are saved from a pure phenomenalism about motions by assuming that they derive their reality from the forces within bodies, there being "nothing real in motion but that momentary something which must be constituted by a force striving towards change. Whatever there is in corporeal nature beyond the object of geometry ôr extension therefore reduces to this" (GM VI 235/AG 118).

Here Leibniz is opposing not just Foucher, but all those post-Cartesian philosophers (pre-eminently Spinoza, Malebranche, Hartsoeker, and Sturm) who consider the nature of body to consist solely in extension and movability; and this is precisely the position he sought to avoid by positing force as the inmost nature of body. As I discuss in Chapter 6, this function of monads is brought out most clearly by Leibniz in his critique of Sturm. Without the differing states of motion of the parts of matter at each instant there will be nothing to differentiate its various parts, Leibniz argues. But these states, and the boundaries of the parts consequent on them, result from "the modifications of the indwelling monads" (GP IV 515/WFT 220). Without such principles *in* matter, "everything would be reduced to just transitory, evanescent modifications or phantasms, so to speak, of one permanent divine substance" (508/214).[22] The important point here is that if the sources of phenomena and activity are not really *in* things, all the phenomena will be mere transitory accidents and modifications, but there will not be substances in things—"indwelling monads"—of which they would be the accidents or modifications.

This point applies equally to the phenomenalist view that most modern commentators have ascribed to Leibniz. If motion, extension, and shape are mere appearances for the monads which apprehend them, but do not actually correspond to anything in the organic bodies of monads that actuate them, Leibniz's position will collapse into the very one he is opposing. For the appearances could as well be modifications of one divine substance (perceived through participation in the divine

[20] This is what Foucher himself concludes in his published reply to Leibniz's *New System* (GP IV 487/WFT 181).

[21] These last two quotations are from Leibniz's remarks on Foucher's reply (from GP IV 491/WFT 184 and GP IV 494/WFT 187, resp.). See Stuart Brown (2004) on the changes in Leibniz's attitude towards Foucher's scepticism (which by the time of his *Theodicy* has become rather trenchant).

[22] Cf. Leibniz's contention further on in *On Nature Itself*: "[Sturm's] doctrine seems, with Spinoza, to make God into the very nature itself of things, and to reduce created things to mere modifications of a single divine substance. For that which does not act, which has no active force, which is robbed of any distinguishing characteristic, and finally of all reason and ground of permanence, can in no way be a substance" (GP IV 515/WFT 221).

mind), and there would be no inference from the plurality of the parts of matter to a plurality of monads.[23] If Leibniz's monads are not situated derivatively through their organic bodies' situations in a real spatial ordering, his whole justification for positing a plurality of such substances vanishes.

Thus the world that the standard phenomenalist interpretation imputes to Leibniz bears a closer resemblance to the view that he was trying to avoid than to his own system. On the position he attributes to the post-Cartesians, God alone is active and bodies and their motions are mere transitory and unreal appearances lacking a form to give them "determinate being". Motion is founded only by divine fiat, so that, lacking a foundation in moving things themselves, and being merely relative, it is a pure phenomenon. Likewise, extension, as on Foucher's sceptical view, is a mere abstraction for which there cannot be foundations. It is to avoid these undesired consequences that Leibniz promotes his philosophy of monads. The way to prevent phenomena from reducing to mere modes of the divine being is to posit substantial and enduring existents everywhere in matter that are the sources of the phenomena and of the activity within things. Leibniz urges that actually extended things are not abstractions or phantasms in the perceiver, but are real phenomena made actual by their constitutive principles, just as phenomenal motions and forces are made actual by the primitive forces within bodies. Substances and the forces that comprise them are foundations of these actual phenomena, not of the abstract Cartesian bodies and motions his contemporaries took for reality. As he never tired of stressing, "it is the confusion of the ideal and the actual that has embroiled everything and produced the labyrinth of the composition of the continuum" (GP IV 491).

So, if the argument I present here is correct, Leibniz's monads contribute to the solution of the labyrinth in more than one way. In the first place, as entelechies they are what make phenomenal bodies actual, rather than mere abstractions. But they do not make bodies actual by being simple component parts: although they are substantial and enduring existents, they are not material *atoms* which compose bodies by being juxtaposed. For material atoms, being utterly rigid, cannot be the source of any activity and cannot give rise to the perception of phenomena. Nor are these substances *points* that could be composed into a continuous body; in fact, they do not compose bodies at all. Instead, by providing a foundation for what is real in motion at an instant (namely derivative force), they determine the actual divisions of each body into parts, so that each body presupposes monads within it.[24] Because each body presupposes monads,

[23] That Leibniz's system, interpreted as a phenomenalism, collapses into a Spinozist monism was argued by Russell (1900, 115–17), following Hegel's lead (see my essay, "The Hegelian Roots of Russell's critique of Leibniz" in Arthur, Griffin, and Galaugher, forthcoming). Similarly, Cover and O'Leary-Hawthorne (1999) argue that "[Leibniz's] views on relations… render him prone to a Spinozistic world-view" (58). On their reading of his principles he is not entitled to claim that there is a plurality of substances, so that this must be "the posit either of practical reason or religious faith" (291).

[24] "If there were no divisions of matter in nature, there would be no different things, or rather there would be nothing but the mere possibility of things: but the actual division in masses makes the things that appear distinct, and presupposes simple substances" (to De Volder, undated: between 14 November 1704 and 11 October 1705; GP II 276).

and each body is divided into further bodies, "the multiplicity of monads ôr simple substances is in fact greater than any number in any aggregate that is sensible, i.e. corresponds to the phenomena" (to De Volder, 19 January 1706; GP II 282). The aggregate of monads comprising the organic body is therefore infinite, but this infinite multiplicity is a syncategorematic infinite; and this prevents the body from comprising a collection of all its parts. The unity of a body at an instant is a mere accidental unity. Even an organic body does not remain precisely the same thing through time, except insofar as its differing constituents contribute to the achieving of the ends of the substance. The principle of this unity—i.e. what accounts for the unity of function through time—is the dominant monad of the organic body. And this monad is the primitive force of which all the derivative forces are only modifications, the derivative forces being responsible for the reality of body and motions that result.

Monads, even if they are the solution to the labyrinth rather than the Ariadnean threads that led Leibniz out of it, are threads nonetheless, since it is out of them that the fabric of the world is woven.

1

Composition and Division

> "If there were no divisions of matter in nature, there would be no diverse things, indeed there would be nothing but the mere possibility of things. In fact, the actual division in masses makes appearing things distinct, and presupposes simple substances."
>
> (to De Volder, unsent draft, January 1705?; GP II 276/LDV 323)

How is Leibniz's introduction of monads supposed to resolve the problem of the composition of the continuum and explain the composition of bodies?[1] If this is not the central problem in Leibniz's metaphysics, then it is certainly a chief difficulty in its interpretation. In this chapter and Chapter 2, I survey various interpretations of the relation between Leibniz's monads and bodies, from Leonhard Euler's in the eighteenth century to those of Glenn Hartz and Samuel Levey in the twenty-first. The difficulty is simply stated: Leibniz avoids the paradoxes attendant on composing the continuum from indivisibles by proposing that his monads, although indivisible, are not parts of matter. But if monads are not parts of continuous bodies, it is difficult to see how Leibniz could have supposed that their introduction would solve the problems of the continuum. This difficulty is compounded by the fact that in several places Leibniz derives the necessity for positing monads from an argument whose premise is that matter is actually divided into parts. Thus, in his reply to Foucher of 1695 Leibniz writes:

> Everybody agrees that matter has parts, and is consequently a multiplicity of many substances, as would be a flock of sheep. But since every multiplicity presupposes true unities, it is evident that these unities cannot be matter, otherwise they would in turn be multiplicities, and by no means true and pure unities, such as are finally required to make a multiplicity. Thus the unities are properly substances apart, which are not divisible, nor consequently perishable. For whatever is divisible has parts, which can be distinguished even before their separation. (GP VII 552)

According to Bertrand Russell in his influential book on Leibniz (Russell 1900), "in obtaining many reals, [this argument] assumes that these are parts of matter—a premiss which it is compelled to deny in order to show that the reals are not

[1] The overall framework for this chapter is taken from "Russell's Conundrum" (1989), where I argued for the heterodoxy that "there are always corporeal substances for Leibniz—indeed, an actual infinity of them—from the time of his solution of the continuum problem in the early 1680's till his dying day" (n. 19).

material" (110). This led him to charge that Leibniz's "whole deduction of Monadism from the difficulties of the continuum, seems to bear a close analogy to a dialectical argument". For, he claimed, Leibniz infers the reality of monads "from premisses admittedly false, and inconsistent with each other" (110). Accusing Leibniz also of courting "the essentially Hegelian view that abstraction is falsification",[2] he added sarcastically: "Those who admire these two elements in Hegel's philosophy will think Leibniz's argument the better for containing them" (110).

Now, when he wrote this Russell had only just begun to liberate himself from the Hegelianism of his teachers. Consequently, he tended still to view Leibniz through that prism, attacking doctrines held by the likes of Francis Bradley, J. M. E. McTaggart, and Hermann Lotze in the belief that he was attacking one of their main sources.[3] I doubt that many commentators today would interpret Leibniz as applying Hegelian logic.[4] Nevertheless, it is clear that Russell has uncovered an important problem for the interpretation of one of Leibniz's most central concerns. For it is hard to see how monads, which Leibniz describes in the *Monadology* as mind-like units containing perception and appetition, could be *derived* from the premise that matter has many parts, or how their introduction contributes towards a resolution of the difficulties of the composition of the continuum. Yet as we saw in the introduction above, Leibniz is adamant that his doctrine of substance is a solution to these difficulties, the only exit he can find from the "labyrinth of the continuum". This problem has tended to haunt Leibniz's interpreters from Euler through to the present, and few have been able to avoid finally falling into the same kind of difficulty as Russell. For no matter how subtle their attempts to explain the relation between monads and the continuum, the commentators I shall consider here all end up subscribing to some version of the view that immaterial monads are actual parts of extended material bodies.

This is what I call "Russell's conundrum": if monads are not parts of continuous bodies, it is difficult to see how Leibniz could have supposed that their introduction would solve the problems of the continuum; whereas if they are, his position seems to lapse into inconsistency. In order to resolve it, I shall begin in this chapter with the question

[2] On the contrary, Leibniz never deviated from the view that abstract ideas contain truth, particularly the mathematical idea of continuity. As he writes to De Volder in a passage quoted by Russell (1900, 246): "But the science of continua, i.e. of possibles, contains eternal truths, which are never violated by actual phenomena, since the difference is always smaller than any assignable given difference" (GP II 282/LDV 333). Indeed, in the Preface to his *New Essays on Human Understanding* Leibniz explicitly repudiates the view ascribed to him by Russell: "an abstraction is not an error, provided we know what we are ignoring is really there. This is the use made of abstractions by mathematicians when they speak of the perfect lines they ask us to consider, and of uniform motions and other regular effects…" (A VI vi 57; MP 159).

[3] I have given an analysis of how Russell's understanding of Leibniz is not only refracted through the interpretations of the neo-Hegelians Bradley, McTaggart, and Lotze, but also indebted directly to Hegel, in an as yet unpublished paper, "On the Hegelian Roots of Russell's Critique of Leibniz". I am grateful to Jolen Galaugher for first alerting me to the importance of Russell's familiarity with the monadology of Lotze.

[4] One recent commentator who does compare Leibniz with Hegel on the matter of contradiction is Gilles Deleuze; but he contrasts the Hegelian drive to find contradictions in nature with the more subtle reasoning he finds in Leibniz, which he terms "vice-diction" (Deleuze 1994, 46–50).

of *what Leibniz means by "actual parts"*, taking this as the first of the *Ariadnean threads* I shall pursue as possible paths through the labyrinth of the continuum.

1.1 Physical Monadologies

The most straightforward misinterpretation of how monads are supposed to ground the continuum is the *naive atomist* one, which reads Leibniz's "atoms of substance" as *indivisible parts of matter*. Closely related to this, although not so naive, are those views which interpret simple substances as elements of the physical continuum in the sense of centres of force whose interactions give rise to the basic extended particles. These are the physical monadologies, like Christian Wolff's, the pre-critical Immanuel Kant's, and Maupertuis' and Boscovich's systems too. Although none of Leibniz's modern interpreters offers such an interpretation,[5] a consideration of these physical monadologies will set the stage for an appreciation of the difficulties to come.

The term 'monad' was used before Leibniz started to use it in the mid-1690s, by Giordano Bruno as well as by the Cambridge Platonist Henry More, and by Francis van Helmont (1614–99). Although Bruno's influence cannot be discounted,[6] it was More's advocacy that helped to re-establish the term in early modern philosophical currency. But More's monads were material atoms. As Wolff notes, "Among more recent philosophers, *Henry More* in his *Enchiridio Metaphys*. part 1., ch. 9, p. 174, albeit [agreeing] with the Atomists, made the elements of material things particles so minute that they could not naturally be further divided, and called them *Monads*" (Wolff 1737, §182). This, it turns out, was exactly how Leonhard Euler understood Leibniz's monads.[7] Consequently, in one of the more ironic episodes in the history of philosophy, Euler set about attacking what he took to be Leibniz's solution to the problem of the continuum—with arguments very reminiscent of Leibniz's own.[8] For, in his *Letters to a German Princess* of 1761, Euler supposed monads to be *parts* of bodies that result from a "limited division" (Euler 1843, 48–9), "ultimate particles which enter into the composition of bodies" (39). Naturally, he had little difficulty in drawing out the

[5] Such an interpretation of Leibniz's monads as elements of matter was offered as recently as the late nineteenth century, however, by Georg Cantor. See Arthur (2011a).

[6] Maria Rosa Antognazza reports: "Although as late as the mid-90's Leibniz appears not to have read Bruno's *De Monade* and his use of the term was not directly influenced by Bruno, he certainly had an extensive knowledge of the work of other authors in the Neoplatonic and Kabbalistic tradition who employed the term in various ways, notably Ralph Cudworth, Henry More, Christian Knorr von Rosenroth, Anne Viscountess Conway, and Franciscus van Helmont, with the last of whom . . . Leibniz spent long hours of discussion in the mid-90s" (Antognazza 2009, 352).

[7] Thus, as we shall see, More's monads correspond to what Wolff will call 'material atoms' or 'primitive corpuscles'.

[8] Vincenzo De Risi (2007) remarks in a similar vein: "The paradoxical conclusion we are presented with here is that the anti-monadological arguments developed by the best minds of the eighteenth century, which all rested on mathematics . . . had already been brilliantly disproved some fifty years before by Leibniz's sharper and more forward-looking geometrical intuition" (311).

contradiction between this idea of a limited division and the fact (acknowledged by Leibniz) that matter is infinitely divisible, and therefore divisible without limit.

Leibniz, as we have noted, was adamant that although the reality of any phenomenal body is constituted by an infinite aggregate of monads, these monads, having no extension, are not *parts* out of which any extended body can be *composed*.[9] As he writes to De Volder in 1704 in a typical passage:

> But, accurately speaking, matter is not composed of constitutive unities, but results from them, since matter ôr extended mass is nothing but a phenomenon founded in things. like a rainbow or mock-sun, and all reality belongs only to unities . . . Substantial unities, however, are not parts but foundations of phenomena. (to De Volder, 30 June 1704: GP II 268/LDV 303)

Euler's interpretation is also flatly contradicted by Leibniz's repeated assertions that phenomena are not only infinitely divided, *they have no smallest part*: "There is no last little body, and I conceive that a particle of matter, however small it may be, is like a whole world, full of an infinity of still smaller creatures" (to Christiaan Huygens, 20 March 1693; GM II 157); "I hold that matter is actually fragmented into parts smaller than any given, i.e. that there is no part that is not actually subdivided into other parts exercising diverse motions" (to Des Bosses, 11 March 1706; GP II 305/LDB 33); and that monads, far from being such smallest parts of the bodies, are contained or presupposed in as small a part of a body as we want to consider: "we ought not to say of monads, any more than of points or souls, that they are parts of bodies, that they touch each other, or that they compose bodies" (to Des Bosses, 5 February 1712; GP II 436/LDB 227); "there is no part of matter that does not contain monads" (to Des Bosses, 11 March 1706; GP II 305/LDB 35); "the actual division in masses makes appearing things distinct, and presupposes simple substances" (to De Volder, unsent draft, January 1705?; GP II 276/LDV 323). Finally, in a very clear statement to Bierling in 1712: "Monads should not be confused with atoms. Atoms (as they are imagined) have shape. Monads no more have shape than do souls; they are not parts of bodies, but requisites" (GP VII 503).

Euler may perhaps have been conflating Leibniz's philosophy with Wolff's, although if that is so, he does not seem to have appreciated the intricacies of Wolff's position, let alone its differences from Leibniz's. Indeed, the composition of matter is one of the respects in which Wolffian ontology differs most profoundly from Leibniz's, despite its evident philosophical debt to the latter and the similarities of nomenclature. For Wolff agrees with Leibniz that bodies are aggregates of simple substances,[10] which both authors regard as unextended centres of force. But whereas Leibniz denies that his

[9] This is no less true on Wolff's philosophy. In the *Cosmologia*, he writes: "*every body has its origin in that which is not extended, even though it is itself extended*" (Wolff 1737, §223). Euler seems to have confounded Wolff's simple substances with the (extended) primitive corpuscles constituted by their interactions; such corpuscles are finitely extended and only physically indivisible, whereas the simple substances are unextended because partless, and give rise to, or aggregate into, extended bodies. See below.

[10] "A body is not a substance but an aggregate of substances" (Leibniz 1690: A VI iv 1668); "*Bodies are aggregates of simple substances*" (Wolff 1737, §176).

monads are elements of a physical continuum, calling them "metaphysical atoms", Wolff, in conscious opposition, asserts that his simple substances (which he also calls "elements" or "atoms of nature"—he declines to call them "monads"[11]) are spatially united, so that they "could also be said to be physical atoms" (Wolff 1737, §207, 158). For while Leibniz categorically denies any kind of interaction between monads, Wolff's simple substances "are acted on by one another" (§207, 158), and it is by virtue of this dynamic interaction with one another that they are able to constitute a material continuum.[12]

Thus even if Euler's naive reading of Leibniz's monads as atomic parts of extended bodies is a non-starter, the case of Wolff's notion of composition is more vexed. So it will be worth taking the time to explore his physical monadology in some detail, for the contrast with Leibniz's own views on composition will illuminate many points in the discussion below. First, it is clear that Wolff's views are highly indebted to Leibniz's, and have many themes in common. According to Wolff, bodies are aggregates of simple substances, and indeed "there is nothing substantial in bodies besides simple substances" (Wolff 1737, §177). Moreover, for him as for Leibniz, matter and motive force are phenomena, not substances (§199). Extension is perceived confusedly (§214); it is a secondary quality, like colour, a result of the actions of the simple substances produced in the perceiver (§224, note). His relating of the phenomenal character of extension to the problem of the continuum also echoes Leibniz:

> Those who take extension for a substantial thing find in their way inextricable difficulties concerning the composition and division of the continuum and the cause and communication of motion, about which those authors who have treated the division and composition of the continuum have spoken abundantly. (Wolff 1737, §226)

Like Leibniz too, Wolff rejects the idea that simple substances are the end result of the division of extended bodies. Although bodies are made up of subvisible, microscopic corpuscles, these are extended and completely distinct from simple substances (elements), which are unextended (§223). In fact Wolff distinguishes corpuscles into two kinds, depending on whether a "reason can be assigned for their composition out of anything except elements" (§229): if it can't, they are *primitive corpuscles*; if it can, they are *derivative corpuscles*, which not only *can* be composed out of other corpuscles

[11] "I do not define the specific difference between these elements and other simple substances belonging to the same genus, nor do I trouble to try to work out such a definition, since in Physics we totally disregard it. For this reason I leave to *Leibniz* his opinion about monads, nor am I moved to make controversy with men not yet born over these sublime discussions, even though it is not difficult to respond to their burgeoning objections. It is exactly the same to me whether someone makes *Leibnizian* monads the most important things, or whether he condemns and rejects them" (Wolff 1737, *preface*, 14); "But we are content with the appellation 'elements', and will not use the name 'monads' " (Wolff 1737, §182); see also Rutherford's long scholarly note in n. 22 of his (2004), and the other Wolffian statements to this effect quoted therein.

[12] Through their interactions Wolff's simple substances give rise to primitive corpuscles or material atoms, which are then aggregated into the composite body in extension (which Wolff terms "particular space"). A succinct and accurate summary of these aspects of Wolff's philosophy is given in the *Stanford Encyclopedia of Philosophy* by Matt Hettche (2006).

smaller than them, but *are* in fact, as is proven a posteriori by chemical analysis (§228). He gives as an example iron (which like gold he classes as a "mixed body"), all the corpuscles of which are "composed of other smaller parts different from the mixed body, namely from simpler particles of matter, out of which the mixture is formed" (§228). But any extended particles not divisible into extended parts by any naturally existing cause would be primitive corpuscles, according to him, although they would still be composed of elements.[13]

> Commonly people acknowledge nothing but derivative corpuscles. For this reason they consider every corpuscle as if it is composed out of smaller ones, and therefore do not acknowledge any mode of composition other than through other explicable corpuscles. But then they fall into the labyrinth of composition and division, from which there is no way out, owing to the fact that one never reaches a last term in division, nor a last reason in composition. (Wolff, 1737, §229, note)

Evidently Euler's conception of simple substances as bodies that result from a "limited division" is an example of just such a confusion of elements (simple substances) with corpuscles, and a failure to distinguish the two kinds of composition in Wolff's scheme: for while the composition of derivative corpuscles is the inverse of their division, primitive corpuscles are not naturally divisible into the elements from which they are composed.

Here we see a crucial point of difference between Wolff's notion of composition and that of Leibniz, for whom strictly speaking there is no composition of bodies out of constitutive unities, as we saw above. This difference stems from the fact that Wolff's elements, unlike Leibniz's monads, are spatially juxtaposed so that they can compose an extension by being next to one another.[14] What is interesting about this difference is that, on the face of it, it would seem to give Wolff's conception greater intelligibility than Leibniz's. For although his simple substances are not extended, they physically interact, so that one can understand how their action on one another could give rise to their union: "the force of inseparability through which the aggregate is determined, makes it one thing (*Ontol.* §328)" (Wolff 1737, §220).[15] It is worth remarking that this is consistent with the state of affairs existing in modern physics, where the extendedness of macroscopic phenomena is indeed the result of the interplay of forces of quantum systems which themselves have no determinate location or extent in space.

[13] In the encyclopedia article referred to above, Matt Hettche identifies primitive corpuscles with material atoms, since Wolff defines primitive corpuscles as "those in which no reason can be assigned for their composition out of anything except elements" (§229), and a material atom as a corpuscle "divisible in itself, but for the dividing of which no causes existing in the nature of things suffice" (§186). But Wolff appears to reject such material atoms: "the nature of things admits no other atoms but those which are seen to be indivisible in themselves, and thus cannot be divided even by divine omnipotence" (§187).

[14] "*Things in the universe are connected with regard to space*" (Wolff 1737, §56). I assume Wolff deliberately uses the odd expression "connected with regard to space [*connexae quoad spatium*]", rather than "connected in space", in order to avoid any implication that space exists prior to the elements.

[15] Indeed it is just this feature of Wolff's physical monadology that is exploited by Kant in his analogies of experience. For Wolff emphasizes that it is the physical possibility of the interaction of things that accounts for the phenomenon of extended space.

But when we come to Wolff's arguments for how this composition of bodies from elements is to be effected, we are confronted with the staggeringly poor quality of his demonstrations, a shortcoming often remarked upon by other commentators. In Wolff's exposition the foil for his theory of elements is the rival theory known as Zenonism, the theory of the composition of the continuum out of points put forward by various Jesuit thinkers in the early 1600s, and ascribed to Zeno of Elea.[16] According to Wolff, since Zenonian points are such that it is not possible to conceive anything in them besides their lacking parts, any two of them are necessarily similar to one another (§216). This prohibits them from existing outside one another, which they must if they are to compose an extended thing (§218). Again, on an Aristotelian definition of continuity there must be a common term between two elements in order for the elements to be joined continuously; but Zenonian points, just like mathematical points, "do not have different endpoints distinct from each other", so that "it is manifestly prohibited that they could be joined together" (§218, note). Wolff's elements, by contrast, "are dissimilar from one another (§195), and are thus distinguished one from another (*Ontol.* §211). Therefore each is outside of the other, that is, all of them exist outside each other (*Ontol.* §544)." Furthermore they are united, as we saw above. On this basis, he contentedly concludes, aggregates of elements are extended. Here is his proof:

> §221. *Aggregates of elements are extended*. For when elements are aggregated, they exist outside each other (§219) and are united with one another (§220). Whence, since the individual elements are dissimilar (§195), those things by means of which they must be distinguished from one another are different (*Ontol.* §211), and consequently they themselves are different (*Ontol.* §183). So we have many different beings, ôr things existing outside each other, co-existing in one. Whence, since that in which many different things, ôr things existing outside each other, are united must be extended (*Ontol.* §548), aggregates of elements are extended.

As Donald Rutherford rightly observes, this argument "seems to rest on a simple conceptual error: the conflation of the idea of non-identity with that of externality" (Rutherford 2004, 232). Two numbers, for instance, or two succeeding perceptions, could be distinct from one another without this in any way implying that they are "outside" each other in a sense which would support the idea of spatial externality. Moreover, they could be distinct without this implying in any way that they form a continuous whole. Wolff shows some awareness of this objection, pointing out that "whereas in discrete things the many things are not united together, in continuous ones there also occurs a union of the multiplicity" (§221, note), and for this reason adds a demonstration that he takes to prove "that the elements are certainly united together, insofar as they are dissimilar and aggregated in such a way that a sufficient

[16] Pierre Gassendi, Pierre Bayle, Giambatista Vico, and Roger Boscovich all endorsed versions of Zenonism, as did Leibniz in his early theories of the continuity of motion, as we shall see below. For the importance of Zenonism in the early modern philosophy and critiques of its neglect, see Paolo Rossi (1999, 2001). I discuss Rossi's claim that the Zenonists were a decisive influence on Leibniz's theory of substance in my (2003a). See also Rossi's reply (Rossi 2003).

reason for their coexistence is found in them, and consequently continuity results from their union" (§222, note). But this proof of the continuity of the aggregate of elements is quite as inept as his proof of their extendedness. I will leave aside the ponderous steps by which Wolff ascends to his conclusion. The nub of the proof is this:

> Since, assuming some aggregate of elements, none of them can leave the aggregate and be substituted by another with the aggregate remaining the same, as was demonstrated, the individual elements are arranged next to each other in such a way that others cannot be interposed among them. The aggregate of elements is therefore continuous. (Wolff, 1737, §222)

Even if we grant Wolff that the union can be explained by the action of physical forces centred in points,[17] clearly nothing follows from this about the continuity of the order of the substantial points. Discretely ordered points could still be ordered in such a way that they were all distinct and not substitutable. The trouble is that Wolff needs to be able to derive the order of the elements of the aggregate from specific assumptions about the properties of the simple substances that ground it (beyond their mere diversity), properties that would actually yield "a sufficient reason for the coexistence" of the elements.[18] In default of that, he has failed properly to distinguish his elements from the Zenonian points he disparaged, so that Euler can almost be forgiven for failing to see the difference. Wolff is on slightly firmer ground with his conception of extendedness as a phenomenon,[19] a point I shall return to later. But now it is time to return to Leibniz.

We have seen that the interpretation of monads as physically constituting continuous bodies is a complete misreading of Leibniz's views, assimilating them to a physical monadology. And despite the fact that Euler also misunderstands Wolff's physical monadology, the latter's attempt to show how an aggregate of simple substances could constitute a continuous, extended body is woefully inadequate, if not an unmitigated disaster. Thus although the naive atomist reading had the merit of clarity in suggesting a plausible connection between Leibniz's monadology and the problem of the continuum, it is evident from the above objections that no such simple connection is to be expected, but something considerably more labyrinthine.

[17] "This union depends on the essence and nature of elements, that is, on their constant intrinsic denominations and the active force with which they are endowed (§196)" (§220, note).

[18] Vincenzo De Risi's observation on the deficiencies of Wolff's reasoning are also worth quoting: "As he cannot conceive a simply situational difference, Wolff seeks a qualitative difference between his points. As a result, he obtains a set of elements different from one another, but by no means a space" (De Risi 2007, 306). For Leibniz, on the other hand, "Space turns out . . . to be a set of relations between unextended (but situated) elements" (174).

[19] On this basis, Wolff gives an alternate "proof" in §221 for the extendedness of bodies, derived from the fact that "the idea of a thing is a representation in the mind". It is from the fact that "we represent to ourselves many things existing outside one another as one" that we derive our notion of extension, and therefore "the notion of extension has its origin in the mind". This is appalling logic: the notion of anything at all is a representation in the mind; this does not show that the thing represented—here, extendedness—has its origin in the mind. So as an argument purportedly showing "where extension comes from", it is a total non sequitur. It also depends on his prior proofs that "those elements exist outside one another (§219) and are united with one another (§220)", and is consequently defective for the same reasons as they are.

1.2 Monads as Actual Parts

But before proceeding to more elaborate interpretations of the relation of monads to the continuum, it is worth enquiring how in the face of this uncompromising preliminary conclusion, there could remain any justification for interpreting monads as actual parts of extended phenomena. The answer is that the tendency to interpret monads this way has been fostered largely by Leibniz's frustratingly terse statements of his solution. These usually consist in the remark that in ideals the whole is prior to its parts, which are merely potential or *indeterminate*, whereas in actuals the parts are real and *determinate*, and prior to the whole; and that confusion about the continuum could be avoided if we would only heed this distinction between determinate and indeterminate parts, and refrain from looking for actual parts in ideal wholes, and vice versa. Here it is natural to interpret these "actual parts" of the real whole as the monads that give rise to a phenomenal body, as the following passage from the end of Leibniz's correspondence with De Volder would suggest:

> It is also obvious from what I have said that in actuals there is nothing but discrete quantity, namely the multiplicity of monads ôr simple substances, a quantity which is indeed greater than any given number for any aggregate that is sensible ôr corresponds to the phenomena. But continuous quantity is something ideal, which pertains to possibles and to actuals considered as possibles. The continuum, that is, involves indeterminate parts, whereas in actuals there is nothing indefinite—indeed, in them any division that can be made, is made. Actuals are composed as is a number out of unities, ideals as a number out of fractions: the parts are actual in the real whole, not in the ideal whole. Indeed, we are confusing ideal things with real substances when we seek actual parts in the order of possibles, and indeterminate parts in the aggregate of actuals, entangling ourselves in the labyrinth of the continuum and inexplicable contradictions. (to De Volder, 19 January 1706: GP II 282/LDV 333)

Thus just as any number can be divided into parts in innumerable different ways, so that it has no parts that can be identified as *the* parts out of which is composed—no determinate parts—so too, for the same reason, no continuous quantity such as time or Cartesian matter can have determinate parts either. But it is axiomatic for Leibniz that anything actual must have such determinate parts, just as integers are made up out of a determinate number of units. It therefore follows that continuous quantities, such as time and Cartesian matter, must be *entia rationis* or ideal entities.

On the basis of such considerations, Nicholas Rescher has proposed in his lucid introduction to Leibniz's philosophy (1967, 1979)[20] that Leibniz offers us a two-tiered ontology: the actual, in which the actual monads are constituents of a phenomenal continuum, and the ideal, in which the line segments are real and points are their merely ideal limits. Accordingly, Rescher contends that Leibniz locates the source of the difficulties of the continuum in the "failure to distinguish between the ideal or

[20] Rescher's exposition of Leibniz's philosophy (1967) was subsequently reissued by him in an abbreviated form as Rescher (1979); I shall index both where possible.

phenomenal and the real or actual" (1967, 111; 1979, 104). For it is not the case that "both the indivisible constituent and the continuum to which it belongs [can] both at once be real":

> In mathematics the continuum, the line, is real and the point is merely the ideal limit of an infinite subdivision. In metaphysics only the ultimate constituents, the monads, are actual, and any continuum to which they give rise is but phenomenal. This is the Leibnizian solution of the paradoxes of the continuum. (1967, 111; 1979, 104)

Despite its obvious neatness, however, there are several difficulties with this scheme. In the first place, with regard to the mathematical side of the solution, a point for Leibniz (after 1676) is always an *endpoint* of a line segment, and is not defined as the ideal limit of an infinite subdivision.[21] The infinitesimals of his mature theory, on the other hand, are *not* indivisible, and are in any case fictions rather than actual parts, as we shall see later. But more importantly, Leibniz is explicit that the continuum or line, like any mathematical object considered in the abstract, is ideal, and (*contra* Rescher) no such ideal entity can be regarded as *real* since it is not *composed* of its parts:

> Thus, properly speaking, the number ½ in the abstract is a simple relation, in no way formed by a composition of other fractions, even though among numbered things there is equality between two quarters and one half. And the same can be said of an abstract line; for there is composition only in concrete things, or masses, the relations between which are marked by such abstract lines. And this is also the way in which mathematical points come about; they too are mere modalities, that is, extremities. And as everything about an abstract line is indefinite, they have regard only to what is possible, as do the fractions of a number; we are not concerned with the divisions actually made, which mark out these points in a different way.
>
> (Remarks on the Objections of M. Foucher [1695]: GP IV 491/WFT 184–5)

And conversely, on the metaphysical side, any phenomenal whole resulting from an aggregate of monads ("secondary matter" or "body") must be well founded or *real*, and cannot therefore have the indeterminate parts characteristics of the continuous: "But in real things, namely bodies, the parts are not indefinite (as they are in space, a mental thing)" (to De Volder, 30 June 1704; GP II 268/LDV 333); "in actuals there is nothing indefinite—indeed, in them any division that can be made, is made . . . the parts are actual in the real whole . . ." (to De Volder, 19 January 1706; GP II 282/LDV 333). Consequently such a real phenomenal whole is *discrete* rather than a continuum: "In fact, matter is not continuous, but discrete and actually divided to infinity . . . [It is the same with changes, which are not really continuous.]" (to De Volder, 11 October 1705; GP II 278/LDV 327).

Where Rescher's scheme appears to go wrong is in the starting supposition that there is a dichotomy between ideal or phenomenal, on the one hand, and real and

[21] The same mistake can be found in J. E. McGuire's otherwise very penetrating analysis of Leibniz's solution to the continuum: "mathematical points . . . are mere modalities, or the limit of a process of subdivision" (McGuire 1976, 307–8).

actual on the other.[22] But as we have seen, the phenomenal whole that results from an aggregate of simple substances is *real* in the sense that it is actually divided into determinate parts; and, on the other hand, monads cannot "compose a continuum" (Rescher 1967, 110; 1979, 103), a continuum being merely an abstract entity, not a real phenomenon.

This has led other commentators to propose instead a *trichotomy* of the ideal, the phenomenal, and the actual. J. E. McGuire has been influential in pursuing this line in his penetrating analysis of the development of Leibniz's philosophy of substance and continuity (1976, 309). In this he is followed by Glenn Hartz and Jan Cover (1988), who contend that Leibniz changed his position from a two-realm view to the three-realm view of his mature metaphysics, after a period of transition between the years 1695 and 1709. In Leibniz's mature metaphysics, these authors correctly observe, space, time, and motion are *entia rationis* (McGuire 1976, 307; Hartz and Cover 1988, 504, 513); they are arbitrarily divisible, though not composed of parts (McGuire 1976, 309; Hartz and Cover 1988, 505).[23] For Leibniz space and time are *resolvable* into points or instants, but neither divisible into nor composed out of these, since points and instants are mere modalities (McGuire 1976, 309–10). Well-founded phenomena, on the other hand, are extended aggregates, and as such presuppose a plurality of entities from which their extension results. This distinction between *resolution* into constituents, on the one hand, and *division* into parts, on the other, is very important, and we will return to it in Chapter 2.

From this analysis, however, McGuire concludes that the only *actuals* are the substantial unities into which phenomena are resolved, and it is this claim that I wish to explore. Since "extended things have a plurality of coexisting 'actual parts' " (306), he argues, and they have this coexistence "in common even with things that are not extended" (to De Volder, 23 June 1699: GP II 183), it follows that "the 'actual parts' of extended things are non-extended substances" (306).[24] (Here the scare quotes are presumably a tacit acknowledgement of Leibniz's insistence that monads can *not* be parts of the phenomena.) Similarly, he claims, phenomenal changes "involve a succession of

[22] Hartz and Cover (1988, 494–5) offer similar criticisms of Rescher's dichotomy. They note that Stuart Brown in his (1984) and John Earman (1979) also subscribe to the "2 realms" view, which has its origins in Russell's interpretation (1900).

[23] Actually, McGuire distinguishes geometrical lines, "which are divisible into finite parts", from the notion of the spatial continuum, which "is different from the geometrical, since it involves the ideal of a possible order of coexistence. As such, it does not involve actual distances that are extended and presuppose division into parts." A similar distinction between space and geometric extension can be found in Martial Gueroult's "Space, Point and Void in Leibniz's Philosophy" (Hooker 1982, 284–301). As I noted in a previous publication (1985, 310), I am unconvinced by it; but since nothing concerning continuity hangs on this disagreement, I have ignored their distinction here.

[24] McGuire's actual wording here is that "extended things have a plurality of coexisting 'actual parts' *that they have* in common even with things which are not extended" (McGuire 1976, 306, my italics), implying that it is the actual parts they have in common. This is not supported by Leibniz's text, according to which it is *coexistence* that extension "has in common even with things which are not extended".

extraneous 'parts' . . . these 'parts' are in reality the diverse states of substances that exist at one time but not at the next" (306–7).

Hartz and Cover criticize McGuire for his "misuse . . . of 'actual' to distinguish monads from bodies" (1988, 519). Nevertheless, they interpret Leibniz's reply to Foucher in 1695 quoted above (GP IV 492) as saying that "extension conceived as an abstract continuum has no actual parts, but extended bodies do have such parts: they are the genuine composites whose actual parts are Leibniz's 'atoms of substance' (cf. L 539, GP II 282)" (Hartz and Cover 1988, 497). Again: "The monads are actual, definite, and determinate, and are thus the right sorts of things to be parts or foundations of phenomenal bodies" (506). Indeed, on Hartz and Cover's interpretation, Leibniz's monadology begins to sound more like a Wolffian physical monadology: "First the parts, or monads, are given, and then bodies arise in virtue of the joining of a lot of monads together to form or well-found the bodies" (505–6).

Now, of course, we are right back in Russell's conundrum, and the challenge is to see how the above claims can constitute any sort of solution to the problems of the continuum. McGuire attempts this by allowing Leibniz's phenomenal wholes an *apparent* continuity. He reasons that since extended things are resolvable into simple substances, which are discrete, this means they are "in reality a plurality of substances that *appear* to be continuous and extended" (McGuire 1976, 306): their continuity is simply an appearance. Likewise phenomenal change: McGuire interprets Leibniz's remark to De Volder in 1705 that "the same holds for changes, which are not truly continuous" as meaning that "the perceptual continuum is not truly continuous, but comes into existence in a series of discrete chunks" (311).

This interpretation is endorsed by Hartz and Cover, who provide important textual support in the form of a letter Leibniz wrote to Princess Sophia only twenty days after writing the above words to De Volder:

> Matter appears to us to be a continuum, but it *only* appears so, just as does actual motion. It is rather as alabaster dust appears to form a continuous fluid when one boils it over fire, or as a spoked wheel appears continuously translucent when it turns with greater speed—without which one could tell where the spokes are from the empty spaces between the spokes—our perception running together the separate places and times.[25]

McGuire concludes by reaffirming a three-level partition. On the one hand, there is the realm of the actual, which is strictly discrete: "The actual cannot be continuous as it is simple and indivisible." It is neither resolvable nor composable. Second, there is the realm of phenomena, which are neither truly continuous nor actual. They are *resolvable* into units of substance, *divisible* into actual parts, and *composed* of these parts: "Being composable, resolvable and divisible the perceptual continuum cannot be truly continuous. Yet it is not actual, since these notions [i.e. composability, resolvability, and

[25] GP VII 564; English translation by Hartz and Cover (1988, 501).

divisibility] do not apply to what is truly simple . . ." (311). Thirdly, there is the realm of abstracta, which are truly continuous, but ideal.

Yet if this is indeed Leibniz's solution, then, as McGuire admits, "it bristles with difficulties" (311), some of which he proceeds to outline. In the first place, contrary to Leibniz's claim that his *law of continuity* applies everywhere, on this model it seems properly applicable only to space, time, and motion (311). Indeed, Leibniz seems to contradict himself on this score in three distinct contexts. For he claims (i) that "continuity is found in . . . extension . . . and in fact in all natural changes" (GM VII 25/L 671); but this seems incompatible with what he said to De Volder about matter and change being "not truly continuous" (GP II 278/LDV 327). Leibniz also asserts (ii) that "the change is continuous in each created monad" (*Monadology*, §10: GP VI 608); and (iii) that there is a continuity of kinds of monad, each differing infinitesimally from the next (to De Volder, 3 April 1699: GP II 168/LDV 71; *New Essays*, A VI 6, 307, 473)—assertions that seem impossible to reconcile with his stipulation that the actual cannot be continuous, if "the actual" refers only to simple substances. For on McGuire's interpretation, this stipulation would rule out any "continuity of forms"; the difference between different kinds of monads would always be discrete. It would also entail that a monad could not be regarded as a continuous temporal whole, so that there could be no question of continuous monadic activity. Further, if it were such a continuous whole, then it would be divisible temporally into *indeterminate parts,* which is quite impossible for anything actual.[26]

On McGuire's interpretation, then, Leibniz's introduction of monads seems to constitute not so much a solution to the difficulties of the continuum as a source of new ones. Indeed, on further reflection there are problems with its adequacy to deal even with the problems it does appear to resolve. For if, as McGuire says, and Hartz and Cover endorse, it is only "the *perception* of continuity" (312, my italics) that is created by "the repetition of discrete but simultaneous states" (312) or the aggregation of an infinity of discrete substances, then presumably this would be all there is to Leibniz's solution: actuals, monads and their states, are discrete, but they give rise to the appearance of continuity. As Hartz and Cover express it, "Along both spatial and temporal dimensions, then, bodies appear continuous only because we perceptually smear out the divisions which are actually in nature" (1988, 508). Thus when Leibniz said that extension and change are continuous, he meant only an *approximate* continuity, and not a true one.

This last claim seems correct; it is difficult to see how else to interpret passages such as those quoted above. But how are we to understand the approximation here? One can imagine a many-sided regular polygon appearing as a continuous circle if

[26] McGuire also claims to find a number of difficulties concerning the application of *time* to what is actual and real, stemming from the unreality of relations (1976, 312, 313–18). I believe these difficulties to be spurious, as I have argued in my (1985).

there were sufficiently many discrete and very small sides.[27] But monads are not discrete in this sense: this is precisely the sense of monad as an indivisible of matter that we saw to be wrong in considering the interpretation of Euler above. Thus the appearance of continuity must be an effect created in the percipient by the action of the monad. But then why shouldn't the created appearance be truly continuous? This, as we have seen, was how Wolff conceived the matter. It is because "we represent co-existents to ourselves in such an order that other things cannot be placed among them in another order" that "we must perceive any aggregate of elements as continuous" (Wolff 1737, §222, note). The continuity is a facet of our representation, of the confused perception by which extension is constituted as a phenomenon. But if this is also Leibniz's meaning, then why does he need to claim that phenomenal wholes are made up of discrete *parts* at all—why not claim simply that they are continuous appearances produced by discrete substances?

Furthermore, there is the whole question of the applicability of the mathematics of the continuous to the real world. If the actual is really discrete, then surely continuous geometry would not be applicable to it without error? In answer to this difficulty, McGuire tells us how "Leibniz believed that there was no inconsistency between coherent notions and the actual determination of phenomena", that ideal notions such as continuity are "applicable to phenomena in so far as they are consistent, and lead to correct empirical results" (1976, 312). But how can the application of the continuous to the discrete be consistent? Again, this seems little more than a verbal solution. Faced with the same question, Hartz and Cover deny that continuity is applicable to bodies as they really are: "*body* is not in metaphysical strictness geometrically characterizable" (1988, 507). Neither answer seems to do justice to Leibniz's own explanations of how continuity applies to the actual, which invokes the same wording he uses in justifying the infinitesimals of his differential calculus. For instance, in the continuation of the above quoted passage from his letter to De Volder, Leibniz says:

> But the science of continua, i.e. of possibles, contains eternal truths, which are never violated by actual phenomena, since the difference is always less than any assignable given difference.
>
> (to De Volder, 19 January 1706: GP II 282/LDV 333)

We will return to set about a proper resolution of these difficulties concerning continuity in the remaining chapters, especially Chapter 7. For now let us return to the particular difficulty raised by Russell's conundrum, and in particular the whole question of the actual parts of matter.

[27] As we shall see in Chapter 7, this is very close to Leibniz's meaning. But it would appear to be impossible on the interpretation of Hartz and Cover, according to whom "neither monads nor composite bodies are in metaphysical strictness geometrically characterizable" (1988, 507). As Samuel Levey has argued (1999), Leibniz's construal of the shapes of phenomena is as fractals *avant la lettre*, approximating arbitrarily closely to continuous curves, surfaces, and solids. Thus the phenomena are not the continuous entities of geometry, but they are nonetheless accurately describable using geometry.

There is a clue to unravelling this difficulty in the wording of the above passage. This is Leibniz's reference there to *actual phenomena*, an expression that violates McGuire's strict trichotomy of Leibniz's ontology into the actual, the phenomenal, and the ideal.[28] Indeed, Rescher himself had recognized that not only monads could be actual in Leibniz's philosophy when he wrote: "Leibniz splits the realm of the actual into two domains: the realm of monads, the real world . . . and the realm of the things of our everyday experience, the phenomenal world . . ." (1979, 65). Here the actual phenomena are being contrasted with the merely possible phenomena, ones that might have existed, but do not in fact exist. But the recognition of this other sense of 'actual' immediately opens up the possibility that this is the sense of 'actual' in the expression "actual parts": not parts that are substances, but actually existing parts as opposed to parts into which phenomena might have been divided. That this is the correct interpretation of Leibniz's "actual parts" can be confirmed by further inspection of the passages in which the phrase occurs. The two passages quoted above are cases in point. For in each of them, the actual parts are mentioned in the context of an *actual division.* In the letter to De Volder of 19 January 1706, Leibniz writes "in actuals there is nothing indefinite—indeed, in them any division that can be made, is made" (GP II 282/LDV 333). And in his Remarks of 1695, the points marking the possible divisions of an abstract line are contrasted with "the divisions actually made, which designate these points in an entirely different manner" (GP IV 49). Now since only phenomenal bodies can be divided (simple substances are indivisible), this means that Leibniz's "actual parts" must be parts of actually divided phenomenal bodies; and these parts will again be bodies. This is confirmed more explicitly in the following passages:

> But in real things, that is, bodies, the parts are not indefinite (as they are in space, a mental thing), but are actually assigned in a certain way, as nature actually institutes the divisions and subdivisions according to the varieties of motion, and . . . these divisions proceed to infinity . . .
>
> (to De Volder, 30 June 1704; GP II 268/LDV 303)

> No body is so very small that it is not in turn actually divided into parts excited by different motions; and therefore in every body there are actually bodies infinite in number.
>
> (*A Specimen of Discoveries* [*c.*1686]; A VI iv 1626/LLC 323)

Admittedly, this discovery does not by itself resolve Russell's conundrum. For if the actual parts of matter are phenomenal bodies, it is still not clear what role monads have in the resolution of the problem of the continuum. Nevertheless, the recognition that Leibniz's "actual parts" are phenomenal bodies resulting from repeated internal divisions will turn out to be one of the Ariadnean threads we need to lead us out of Leibniz's labyrinth. For it embodies a notion of actually infinite division as distinct from mere divisibility that is crucial for a proper understanding of Leibniz's philosophy of matter, space, and time. As we shall see below, insofar as matter, space, and time are manifested

[28] Although they do not elaborate, one finds the same criticism of McGuire in Hartz and Cover (1988, 519, n. 2). On the other hand, they refrain from discussing whether Leibniz's "'solution' to the problem of the continuum as applied to extended, enduring bodies is successful" (508), deferring to McGuire.

as existing phenomena, they are all actually infinitely divided; whereas insofar as they are regarded as arbitrarily divisible, matter, space, and time are ideal, continuous entities to which the phenomena conform.[29]

In order to get any further, however, we will have to go beyond a mere textual analysis of Leibniz's mature pronouncements and delve into the historical origins of his views. If we are to discover the basis for the above assertions, we have to ask some more pointed questions. In particular, (i) what is the origin of Leibniz's claim that matter is "actually divided"?; (ii) what is the basis for the claim that this division proceeds to infinity?; (iii) how does this make bodies infinite aggregates of substances, according to Leibniz?; and (iv) how, and in what sense, does their being infinite aggregates make them phenomenal?

1.3 Actually Infinite Division

The short answer to the first of these questions—what is the origin of Leibniz's claim that matter is actually divided?—may again be found in Leibniz's wording, this time in the two passages just quoted: "nature actually institutes the divisions and subdivisions according to the varieties of motions"; every body is "actually divided into parts which are excited by different motions". The implication is clear: it is *motion* that is responsible for the actual divisions of matter. That is, different actual parts of matter are distinguished by their differing motions; adjoining parts not in mutual relative motion are not actually divided from each other, and are thus (potential) parts of the same actual part.

Although this view may seem strange to us today, in the latter part of the seventeenth century it represented the orthodox Cartesian position. Leibniz knew this well. Indeed, in 1669 when he was still optimistic that Aristotle's physics could be completely reconciled with the new mechanistic philosophy of Descartes and Hobbes, he saw this construal of the actual division of matter as a key to their reconciliation. This was to be achieved by reinterpreting the principles of Aristotelian physics solely in terms of magnitude, figure, and motion, the one qualification to this otherwise pure mechanism being that mind is understood to be the principle of all motion.[30] Thus Leibniz identifies Aristotle's *primary matter* with Descartes' *subtle matter*, since each

[29] I already suggested such a solution to Leibniz's occasionally calling space and time phenomena in my (1985), (1989), and (1998); a solution that is, unfortunately, ignored by Timothy Crockett in his (2008).

[30] This way of reconciling Aristotle with the moderns through an identification of primary matter as indeterminately extended is not so far-fetched as some commentators have assumed. As we'll see in Chapter 4, Leibniz is here following a well-established interpretation of Aristotle, namely that of the Latin Pluralists, who followed Duns Scotus in insisting on the actuality of matter. Perhaps the most influential of the pluralists in Leibniz's time was Jacopo Zabarella, whom Leibniz certainly read and referred to often. According to Zabarella, primary matter, as the constant subject of change, must exist with extension in length, breadth, and depth. He followed Averroës in characterizing this extension as "interminate", and it is to this tradition that Leibniz is referring in his letter to Jakob Thomasius of April 1669 (GP I 15–27/ L 93–104; GP IV 162–74), when he endorses this way of characterizing Aristotle's primary matter.

is continuous and homogeneous, and has no divisions in it prior to motion.[31] That is, matter in itself is undifferentiated, and has only an indefinite quantity: "For so long as it is continuous, it is not cut into parts, and therefore does not actually have boundaries in it" (A VI ii 435/L 95). Form, on the other hand, being "nothing but figure", is the boundary of a body, and in order for there to be a variety of such boundaries in matter "a discontinuity of parts is necessary". The operative notion of continuity here is explicitly Aristotelian:

> For by the very fact that the parts are discontinuous, each of them will have separate boundaries (for Aristotle defines continuous things as ὧν τὰ ἔσχατα ἕν, those whose boundaries are one). (A VI ii 435/L 95–6)

Now it is crucial to realize that on this account of continuity, as Leibniz points out, there can be *two different kinds of discontinuity*: the first kind arises when parts are actually pulled apart, leaving a vacuum; and the second when the parts are displaced relative to each other, but remain contiguous: "For example, two spheres, one included in the other, can be moved in different directions and yet remain contiguous, though they cease to be continuous" (435/96). Leibniz argues that, since vacua cannot be created by the "supernatural" annihilation of parts of the plenum, matter could only be discontinuous in the first sense if it were actually created this way. "But if it is continuous in the beginning"—the view he obviously favours—"forms must necessarily arise through motion" (435/96).

Thus here we can see the origins of Leibniz's determinate/indeterminate parts distinction, and his view that mass or secondary matter is discontinuous. For whereas *primary matter*—that is, matter as it is in itself, devoid of form—is not divided into determinate parts, and is therefore *continuous*, this is not true of *secondary matter*[32] or *mass*, which is actually divided into parts by its various motions. These parts are fully determinate, each having its own boundary. But consequently they are merely *contiguous* with each other. Thus "mass is not truly continuous", but is rather *discontinuous* in the second sense above. Only a homogeneous, undifferentiated whole such as primary matter can be truly continuous.

This brings us to the second question posed above: what is the basis for Leibniz's claim that the actual division of matter proceeds to infinity?

Most commentators seem to have assumed that by this claim Leibniz simply means that matter, like any continuum, is infinitely *divisible*, and that it is from this infinite divisibility that he derives the infinite plurality of its parts. Thus Russell: "owing to

[31] Cf. *On Primary Matter* (GP VII 259–60): "Aristotle's primary matter is the same as Descartes' subtle matter. Each is divisible to infinity. Each lacks form and motion in itself, each acquires forms as a result of motion. Each receives its motion from a mind."

[32] This distinction between primary and secondary matter is Scholastic in origin, as Daniel Garber points out in his (1985). There he quotes Eustacius: "Primary [matter] is said to be that which, before all else, we conceive as entering into the composition of any natural thing; regarded as lacking all forms…Secondary [matter] is said to be that very primary [matter], not, however, bare, but endowed with physical actuality [i.e. forms]. (Eustacius a S. Paulo, *Summa Philosophiae Quadripartita*…, Cambridge, England, 1648: p. 119)."

infinite *divisibility*, the parts of the extended are always extended", "if what appears as matter is a plurality, it must be an infinite plurality. For whatever is extended, *can be* divided ad infinitum" (1900, 110, 108); Nicholas Rescher: "an actual whole, though *divisible* into actual parts, cannot be resolved into actual ultimate constituents" (1967, 108); McGuire: "plurality is actually infinite, as there is no possible or actual limit to the *divisibility* of the extended" (1976, 307); and Rutherford: "[Leibniz] agrees with Descartes that extended matter is *divisible* into parts *in infinitum*. Bodies, therefore, are necessarily 'pluralities' of material parts, and not 'true unities' or substances" (1990a, 528).[33] But although it is true that Leibniz holds matter to be infinitely divisible, this cannot be the way Leibniz derives the infinite plurality of matter's actual parts. To claim so is to run roughshod over the distinction between the determinate parts into which matter is actually divided and the indeterminate (or merely possible) parts into which it could be divided. For the point of his contrast between contiguity and true continuity is that whereas in a continuum all divisions are possible, in reals there is some one particular division. Of course, anything that is actually divided is *a fortiori* divisible. But the converse does not hold: infinite divisibility does not entail infinite division. Infinite divisibility connotes that the parts into which anything may be divided may themselves be divided further, but it does not entail that any of them are so divided.

This distinction, of course, is precisely the one employed by Aristotle in his treatment of the continuum, by means of which he is able to deny the actual infinite, and so avoid the paradoxes of the infinite first raised by Zeno of Elea.[34] An abstract line, on his account, is *potentially* infinitely divisible, but is actually divided only into a finite number of determinate parts. Thus there is never anything but finite number in actuality: the only infinite is the potential infinite, which pertains to the possibility of division of the continuum, and the infinity of potential parts into which it can be divided; there is no actual infinite. At least, that is the standard interpretation of Aristotle. But in conscious opposition to this, Leibniz asserts even in his earliest writings that matter is divided into an *actual infinity of parts*.[35]

[33] Emphases mine. I should add that although Rutherford here derives the plurality of material parts from the divisibility of bodies, he later correctly notes that "matter is not only infinitely divisible, but in fact infinitely *divided*" (1990a, 529). Indeed, as he concludes in this excellent article, "Leibniz leaves no doubt that what is at stake in the relation of body and substance is not the conventional part–whole relation. Substance is meant to provide a foundation for body that is absolute and irreducible, as no composition of parts can be" (544).

[34] The relevant passages of Aristotle's writings on the continuum have been collected together in translation in Appendix A of Kretzmann (1982, 309–21); many of the articles in this book should also be consulted, as should Richard Sorabji's excellent and extended account of the progress Aristotle made in his treatment of the continuum, its shortcomings, and its historical importance (1983). There are also two extremely stimulating accounts of its contemporary significance: a book by José Benardete which deserves to be much better known (Benardete 1964, esp. 18–27); and a provocative article by Paul Feyerabend (1983).

[35] Thus in Axiom 4 of Leibniz's *Dissertatio de Arte Combinatoria* is "Each body has infinite parts, ôr, as is commonly said, the Continuum is divisible to infinity" (A VI i 169). As we'll see in Chapter 2, Philip Beeley (1996, 56–7) gives an argument as to why this infinity of parts has to be an actual infinity, but he still argues that the case is inconclusive.

Thus despite the obviously Aristotelian pedigree of his distinction between determinate and indeterminate parts, Leibniz's espousal of the actual infinite is in conflict with the standard (Thomist) interpretation of Aristotle in the Schools. How then does Leibniz justify it? Apart from theological arguments that appeal to the unseemly niggardliness of a God who would stop the division when he could have taken it further (i.e. arguments from the Principle of Plenitude), the one argument Leibniz regularly offers depends on premises of Cartesian provenance: (i) each body or part of matter, being acted on by all others in the plenum, is agitated by its own motion; and (ii) matter is at each moment actually divided by the differing motions of its parts.

Descartes' own argument for actually infinite division is given by him in his *Principles of Philosophy* (1644) as a corollary to his argument for the possibility of the circulation of matter through unequal spaces in a plenum. Such circulation can occur without the creation of a vacuum, he argues, so long as the matter travels proportionately faster through the narrower space, and vice versa. This cannot happen, however, if all the corpuscles of matter are of a fixed shape and size. Some corpuscles may be so; but if circulation is to occur, then at least some part of the fluid matter in which they are floating must be able to adjust its shape by infinitely gradual degrees; "and for this to happen", Descartes reasons, "all imaginable parts of this piece of matter—in fact, innumerable parts—must be to some degree displaced from their positions relative to each other; and this displacement is actual division" (*Principles*, II, 34: 1644, 60). Consequently:

> There is an infinite or indefinite division of matter into small parts; and the number of these is so great that, however small a part of matter we may imagine, we must conceive it as undergoing actual division into still smaller parts. (60)

Leibniz seldom misses a chance to praise this argument.[36] In his published critique of the *Principles* he calls it "most beautiful and worthy of his genius" (GP IV 370/L 393).[37] But there he regrets that Descartes "does not seem to have sufficiently pondered the importance of this last conclusion", namely, the actually infinite division itself. For whereas Descartes had allowed that some bodies might be undivided, and that it is only necessary for the fluid matter between them to be *indefinitely* divided in order to preserve the continuity of matter flowing through unequal spaces, Leibniz concluded

[36] A recondite illustration of how Leibniz perceived himself indebted to Descartes in this context is provided by this wonderful piece of Latino-Deutsch Leibniz wrote to Erhard Weigel on 20 May 1694: "ich zuerst durch den neuen calculum differentialem ad analysin bringe was Cartesius selbst davon als Mechanisch ausgeschloßen gehabt, aber de infinito Concreto in ipsis rebus habe nicht weniger viel admiranda, unter andern die demonstration, daß in quavis particula materiae sey eine welt von unzahlbaren substanzen und also infinitum actu". A rough translation: "Through the new differential calculus I bring to analysis what Descartes himself had concluded mechanically, but concerning the concrete infinite in things themselves I have [found] quite a few more things worth admiring, amongst others the demonstration that in any particle of matter there is a world of innumerable substances, and thus an actual infinite" (A II 2B, 800).

[37] Elsewhere I have argued that it is very likely that Leibniz's estimation of the importance of this argument derives from Spinoza's treatment of it in his *Principles of Descartes' Philosophy*, Part II, Proposition IX (1905, 77–8), since there is good circumstantial evidence that Leibniz had read this work (prior to a serious study of Descartes himself). See my (LLC li, 372, 407), and Loptson and Arthur (2006, 39–40).

that, because any part of matter is internally divided by motions within it, every part of matter is actually divided to infinity, and is therefore an infinite aggregate of parts. The argument is given most explicitly in a fragment dating from the late 1670s or early 1680s, "Created things are actually infinite":

> Created things are actually infinite. For any body whatever is actually divided into several parts, since any body whatever is acted upon by other bodies. And any part whatever of a body is a body by the very definition of body. So bodies are actually infinite, i.e. more bodies can be found than there are unities in any given number. (A VI iv 1393/LLC 235)

As Leibniz goes on to explain in the remainder of the above fragment, the conclusion can be seen to follow because even if each body is divided into only two parts, and only one of these parts is further divided, a new body will be produced by each division. So there will be at least as many parts in the aggregate as there are unities in any number, no matter how great. That is, because of the recursive nature of the division, the number of parts will exceed any given natural number. This recursive character of actual infinite division is crucial, and we will return to it in Chapter 2.

In this formulation of the argument it is perhaps not clear why a body being acted upon by other bodies should therefore be divided. Why, one might ask, shouldn't a body acted on by others simply deform and compress through its own elasticity?[38] Leibniz would respond, I believe, by saying that this is exactly what does happen;[39] but in order for the body to suffer the effects of such action, its internal parts must be displaced relative to one another, and this relative displacement resulting from different internal motions is an actual division.[40] Thus in a manuscript written at the same time (whose seminal importance is not reflected in the dull title his editors have given it: *Metaphysical Definitions and Reflections* dating from probably late 1678 or early 1679), Leibniz writes "Every portion of matter however small is actually divided into smaller parts which are agitated by different motions" (A VI iv 1400/LLC 249). That these motions are in fact instantaneous motions or endeavours (*conatus*) is made clear by his reformulation: "Every body acts on every other body, and is acted upon by it. For since everything is a plenum [*omnia plena sunt*], every endeavour is propagated to infinity. But every endeavour has some effect, even if the effect of a weaker endeavour is smaller" (1400/249).

[38] Cf. Samuel Levey (1998, 52): "What the Cartesian demonstration shows is only that a portion of matter circulating through unequal spaces in a plenum must 'adjust its shape', that is, has to suffer a *deformation*, and this fact does not support the inference to actual division or discontinuity. For while deformations can be topologically discontinuous, they can also be topologically *continuous*…"

[39] Cf. what Leibniz wrote to Damaris Masham in 1704: "Matter is plastic or organic throughout, even in those portions that are as small as can be conceived" (GP VI 544).

[40] As Leibniz wrote to Bayle (27 December 1698): "there are, so to speak, worlds within the smallest bodies, since every body however small has elasticity, and consequently is surrounded by and penetrated by a fluid as subtle with respect to it as that which makes the elasticity of sensible bodies able to be with respect to us, and thus there are no first elements, since it is necessary to say as much about the least portion of the most subtle fluid one can suppose" (GP III 57).

Now it may be thought that this conclusion could be resisted simply by positing the existence of a limit to this division: bodies would be divided down into tiny parts, but these would be finite atoms. The relation of Leibniz's thought to atomism is a complex matter, and we will come back to it in Chapter 3. He will often object to atoms on the grounds of the lack of a sufficient reason for God to introduce a limit or bound to the division at one scale rather than another. This is the obverse of the argument from the Principle of Plenitude mentioned earlier, that since each division introduces greater variety, the maximization of variety for minimum outlay would dictate an unlimited division. But let us bracket these arguments, and suppose that there are undivided parts of matter, as posited, for instance, by Cordemoy. Leibniz argues that there are no resources within the mechanical philosophy that will even allow for such an atom to be acted upon. The only way for a purely material body to be acted upon is for the parts at its boundary to be set in motion, and for these to agitate other more internal parts, and so on. Since this action cannot be propagated infinitely fast, it means that there will be differential motion inside the atom, so that the atom will be actually divided. A body is acted upon, experiences a passion, by being divided. Thus in order for a body to respond to actions upon it, it must be actually divided.

> And since every case of being acted upon [*omnis passio*] has some effect, it is necessary for the particles of this matter to be set in motion in different directions, and thus for the mass to be subdivided. (A VI iv 1623/LLC 317)

But in April 1676 Leibniz had already reasoned that a body's "resist[ing] what endeavours to divide it . . . is sensation" so that "sensation is a kind of reaction" (A VI 3, 510/LLC 117–99). In *Metaphysical Definitions and Reflections* he reasons the same way, equating a body's being acted upon with its ability to *sense* or to *perceive other bodies*. He argues:

> Every body is organic, ôr is actually divided into smaller parts endowed with their own particular motions, and thus there are no atoms. For every finite substance is actually acted upon [*actu ipso patitur*] . . . while every body is acted upon by being divided [*omnis passio corporis est cum divisione*]. (A VI iv 1398/LLC 245)
>
> For those who do not well enough understand the principles of metaphysics easily believe in the vacuum and atoms, i.e. unbreakable bodies, when in fact it is absurd for there to be a body which cannot be acted upon ôr have sensation. (A VI iv 1399/LLC 245–7)
>
> Every body acts on all others and is acted upon by all others, i.e. perceives all others. (A VI iv 1400/LLC 247)

This construal of sensation as equivalent to being acted upon is intriguing, and clearly some explanation is called for as to why Leibniz was led to advocate such a view. As Daniel Garber has cogently argued, it seems to have its origins in Leibniz's studies of Thomas Hobbes' *De corpore*.[41] "Sense", argued Hobbes, "in the sentient, can be nothing

[41] See Garber's discussion in his (2009), particularly pp. 29–40.

else but motion in some of the internal parts of the sentient" (*De corpore* 25.2; quoted from Garber 2009, 33), namely the reactions of various organs to bodies endeavouring to impel them. The appearance of a body external to the eye, for example, is produced as a reaction to endeavour of the light from the external body incident upon the eye; the body's being perceived as external is then a consequence of the fact that the reactive endeavour, being equal and opposite to the incoming one, is outwards from the eye. In order to forestall the objection that this equating of sensing with reacting would make "everything that reacteth have sense", Hobbes argued that although a phantasm would be produced by such a reaction in an inanimate body,

> it would nevertheless cease as soon as ever the object were removed. For unless those bodies had organs, as living creatures have, fit for the retaining of such motion as is made in them, their sense would be such, as that they should never remember the same.
>
> (Hobbes, *De corpore* 25.5; quoted from Garber 2009, 34)

As Garber observes, Hobbes' admission of the need for his bodies to have memory gave Leibniz just the opening he needed to make his case that the mechanical philosophy needed supplementing by minds, since, as he urged Hobbes to recognize, "there is no truly enduring reaction in the nature of mere corporeal things".[42] As a consequence, whereas in 1670 Leibniz took the Cartesian position that even beasts, since they lack a rational mind, do not have true sensation,[43] by April 1676, he is already using the necessity of memory to distinguish otherwise indiscernible (because homogeneous) bits of extension to argue for minds as principles of individuation internal to bodies,[44] an argument that in the late 1670s and early 1680s will reappear as an argument against Cordemoy's atoms.[45] (We will investigate the turbulent course of Leibniz's developing thought on atoms in Chapter 3.) Crucially, though, throughout the changes in his views from 1670 onwards, Leibniz retains Hobbes' thesis that in order to have sensation, a body has to have organs. Thus we have the argument that memory is essential for the individuation of actual bodies; but this requires each of these bodies not only to have some mind-like principle, but also to be a body capable of sensing, which means a body with (physical organs), an organic body.[46]

[42] Leibniz to Hobbes, July 1670 (A II iB, 93–4/L 107; Garber 2009, 34). Cf. also my footnote 9 in LLC 391: "Building on Hobbes's idea of the mind as a kind of storehouse of endeavours, Leibniz had proposed that the distinction between body and mind lay in mind's being able to conserve endeavours (hence memory) without breaking out into motion."

[43] Leibniz to Hobbes, July 1670 (A II iB, 93–4/L 107; Garber 2009, 35).

[44] *Meditatio de principio individui* (1 April 1676; A VI iii 490–1; DSR 51).

[45] "There is no such thing as One Body" (date uncertain: anywhere from 1678 to 1685—see LLC 416); (A VI iv 1464–5/LLC 256–9); and "Annotated Excerpts from Cordemoy's *Treatise*" [1685] (A VI iv 1798–1801/LLC 274–83). See Cordemoy (1668).

[46] The necessity for any true substance to have an organic body will become a central plank of Leibniz's metaphysics, up to and including the *Monadology*: it's all very well for a substance to be characterized by its having appetite and perception, but it will not perceive anything unless it has a body with organs, so that the internal representations have correlates in the external mechanisms of sense. (This perhaps has an analogue in Leibniz's view that thought is impossible without sensible characters.) So an organic body,

That consideration makes the fragment *Metaphysical Definitions and Reflections* all the more interesting, as it is one of the first places in which Leibniz insists on the necessity of every body's containing within it "sensation and appetite".[47] Each body must contain within it "as much appetite as there is a force of acting, and as much sensation as there is in it a force of being acted upon". His explicit argument for there being a non-material "principle of unity and duration" in addition to matter—which is itself characterized as the "principle of multiplicity and change"—is based on the actually infinite division of matter:

> For since we have said that body is actually divided into parts, each of which is agitated with a different motion, and since for the same reason each part is again divided, then certainly if we consider matter alone, no point will be assignable that will remain together with another, nor a moment at which a body will remain identical with itself; and there will never be a reason for saying that a body is a unity over and above a point, and the same for longer than a moment. And since points and moments themselves are not things, but bounds, i.e. modes, of things, it follows that if there were only matter in body, there would be no reality or perfection in it. But if there were only form in body, there would be nothing changeable and imperfect in it. (A VI iv 1399/LLC 245)

Again this links with the criticism of the mechanical philosophy mentioned above: a body conceived as mere bulk can have no enduring reaction, and requires an enduring principle of individuation in order to remain identical to itself. Matter defined as pure extension contains no such principle of individuation, but is continuously changing from moment to moment.

We may summarize Leibniz's argument up to this point schematically as follows. From the premises

(1) *Every body is acted upon by all others, and this produces differential motions within the body*, and

(2) *Each part of a body moving with its own particular motion is an actual part of the body*,

it follows that

(3) *Every body is actually divided into smaller parts endowed with their own particular motions.*

which also means a body with organs, is a necessary concomitant of every created monad: there are no disembodied substances in Leibniz's metaphysics, save God.

[47] The manuscript *Metaphysical Definitions and Reflections* is on the same paper as his *Conspectus for a Little Book on the Elements of Physics* written in the months between the summer of 1678 and the following winter. In that piece Leibniz writes "Here…the soul must be treated, and it must be shown that all things are animated. Unless there were a soul ôr a kind of form, body would not be a particular entity [*ens aliquod*], since no part of it could be assigned which would not again be made up of a plurality of others, and so nothing could be assigned in body which could be called *this something*, ôr *some one thing* [*unum quiddam*]" (A VI iv 1988/LLC 233–5). It looks to me very much as though the *Metaphysical Definitions and Reflections* is in fact a series of drafts for the "Little Book on the Elements of Physics".

Here we may note in passing that from the definition of an atom,

(4) *An atom is a body that is not actually divided*

it then follows that

(5) *There are no such things as atoms.*

Now at any given moment a body is the aggregate of all its parts:

(6) *A body divided into parts is at any moment the aggregate of all the parts into which it is divided.*

But on any plausible understanding of the complexity of the internal motions described in (3), this will result in different actual parts at different moments. It follows that a body is a different aggregate of parts at each moment, and therefore

(7) *No body remains identically the same thing for longer than a moment.*

This delivers Leibniz's conclusion above: without some principle or form by which it can be identified as the same thing through time, a body does not remain identical with itself for longer than a moment. It therefore cannot be a substance.

In two other texts from the same period (1678–9), Leibniz offers similar arguments against the Cartesian conception of corporeal substance. If we put aside the Scholastics' conception of body as a composite of "matter and a certain intelligible form", he writes in a fragment titled *Body is Not a Substance* and instead consider what the "Democriteans" call "bulk [*molem*]" as a substance, "we will fall into contradiction as a result of the labyrinth of the continuum" (A VI iv 1637/LLC 259). First, there cannot be atoms (as we just saw), and second, "bodies are really divided into infinite parts, but not into points. So it is in no way possible for one body to be assigned. Rather any portion of matter whatever is an accidental being [*ens per accidens*], and, indeed, is in perpetual flux" (1637/261).

In the second argument, "There is no such thing as One Body", he again supposes that body is defined as pure bulk or extension, together with movability, as by Descartes: "I suppose that nothing is intelligible in body other than extension, i.e. what has parts beyond parts" (A VI iv 1464/LLC 259):

(8) *A Cartesian body consists solely in (movable) extension or bulk.*

He also supposes that "every body is actually divided into several parts, which are also bodies" (A VI iv 1464/LLC 259). This follows from (3) given that these are Cartesian bodies, as in (8).

But as his first supposition, Leibniz introduces a strongly nominalistic principle about aggregates (which we will return to and consider in detail in Chapter 2), namely that an aggregate "is not properly one being but rather beings, although one name can be supposed for them all" (1464/257). That is,

(9) *Nothing that is an aggregate can be a true unity.*

But from (3), (8), and (6) it follows that every body will be an aggregate of nothing but other bodies. Since none of these aggregates can be a unity, it follows that

(10) *No body is a true unity*; or "There is no such thing as one body" (1464/259)

Second, Leibniz concludes, it would follow from these suppositions that "there exist no bodies either, these being nothing but one body after another". Bodies nevertheless certainly appear to the senses. "Hence", Leibniz concludes, "either bodies are mere phenomena, and not real beings, or there is something other than extension in bodies" (1464/259).

The second disjunct, of course, is the option Leibniz favours, that bodies are aggregates of *substances*, but we have not established it yet. What we have established is only that a body is an infinite aggregate of parts that are themselves divided, and that, unless it is more than mere extension, it is precisely not an infinite aggregate of substantial unities. The argument so far yields only an infinite plurality of parts, not substances. We still have to answer the third question posed above: how does this make bodies infinite aggregates of *substances*? And we now also have a further question: granted that Cartesian bodies are mere phenomena, what about bodies that are aggregates of further bodies that do *not* consist solely in extension or bulk? Should aggregates of such bodies be considered phenomena, and if so why, and in what sense?

We will treat these questions in Chapter 2.

2

Aggregation, Body, and Substance

> "A monad alone is a substance, body is substances, not a substance: nor can one escape the difficulties concerning the composition of the continuum, and other things of that sort, in any other way."
>
> (to De Volder, 21 January 1704; GP II 262)

At this juncture we seem to be face-to-face with the problem of consistency pointed out by Russell. Bodies are infinitely divided into parts that are themselves bodies, and so any body is an infinite aggregate of other, progressively smaller bodies; but these are not *substances*, because substances are not parts. Yet, Leibniz claims, "if there are aggregations of substances, then necessarily there must also be true substances from which all those aggregations result" (to Arnauld, 30 April 1687; A II iiB 185/WFT 123). Now, if we assume that an aggregate has the same ontological status as what it is aggregated from, and that 'real' and 'phenomenal' are mutually exclusive, then we are faced with the mereological dilemma that Glenn Hartz has described: if bodies are aggregates of real unities, then the bodies themselves should be real and not phenomenal (this is Hartz's "realist Leibniz"); on the other hand, if bodies are in fact phenomenal, they cannot be aggregates of real substances, but must merely result from them as possibly unconscious mental representations (the "idealist or phenomenalist Leibniz").[1]

If we interpret aggregation as *mereological aggregation*, so that the constituents of an aggregate would compose to form it as a whole, then the aggregate should indeed have the same ontic status as its parts. As we have seen, though, Leibniz holds that bodies are phenomena, but that monads are not their actual parts; rather bodies *presuppose* simple

[1] Thus Hartz distinguishes the "real, mind-independent universe whose denizens include, in addition to monads, aggregates and animals" (Hartz 2007, 96) from the idealist world where a body consists in a mind's representing an "an infinity of actual monads" in an "intentional state as being so related that they are (possibly unconsciously) judged to form a unified object" (83). Similarly he distinguishes the "mental phenomena" of his idealist Leibniz from the "derivative phenomena" of his realist Leibniz: "Mental phenomena are thought of as real because of something going on 'in the head'; derivative phenomena seem real because of the reality emanating forth 'outside the head' from their metaphysically more basic parts." Hartz's own solution is to construe Leibniz as a "theory pluralist": the incompatibility among the various views Leibniz proposes shows that they are not meant as descriptions of the truth, but are mere theories about what is.

substances: "any real aggregate presupposes simple substances or *real unities*" (A VI vi 378/RB 378). What this indicates is that the relation of an aggregate to the things it presupposes is more general than that of a whole to its parts: a whole is the aggregate of its parts, but other things may be aggregated from entities that they presuppose and that are not their parts.

But *how can a body be an aggregate of the immaterial substances it presupposes*? This is the Ariadnean thread we shall be following in this chapter. We need to know what it means to say that aggregates *presuppose* monads as their constituents, or that monads "are in" bodies. We will also examine why, if they have such substantial constituents, Leibniz insists that aggregates are phenomena. We also need to see how Leibniz can sustain a belief in corporeal substances while maintaining, sometimes in the same breath, that all that exist are simple substances and the aggregates resulting from them.

2.1 Bodies as Aggregates of Substances

Leibniz's argument for unities being presupposed by bodies goes as follows. Since every body is further divided into parts which are themselves bodies, every body is a plurality of parts. From this it follows that bodies can be neither substances nor unities, as we saw above. For, as he wrote in a fragment from mid-1685, "no being that is truly one is composed of a plurality of parts; and every substance is indivisible, and those things that have parts are not beings, but merely phenomena" (A VI iv 627/LLC 271). More accurately, bodies are beings, but mere *entia per aggregationem*, "beings by aggregation". The contrast here is between beings by aggregation and *entia per se*, beings per se or substances, a distinction that was widely accepted in Leibniz's time. For the atomists (as we'll see in Chapter 3), atoms are the indivisible substances, and everything else mere aggregates of atoms. For scholastic philosophers, it is a combination of matter with a substantial form that constitutes a corporeal substance. Moreover, they subscribed to the axiom that *being* and *one* are convertible terms, so that whatever substances exist must be substantial *unities*. As Leibniz commented in the continuation of the above fragment, "For this reason the ancient philosophers rightly attributed substantial forms, such as minds, souls or first entelechies, to those things they said make a unity per se, and denied that matter per se is one being" (627/271). Things lacking such forms "are no more one being than a woodpile".

Leibniz repeats this argument in his correspondence with the famous Port-Royal logician and philosopher Antoine Arnauld. Now Arnauld was sufficiently convinced by Cartesian philosophy that he believed in neither atoms nor substantial forms. So when Leibniz argues that bodies cannot qualify as substances because they lack unity, Arnauld does not see the difficulty, suggesting that it might just be the nature of corporeal substances to lack such unity. To this Leibniz rejoins that it is impossible for every body to be a plurality of parts, and these in turn pluralities, and so on to infinity,

without ever reaching any unities from which the pluralities could be aggregated. For something cannot be a plurality if there are no unities:

> I believe that where there are only beings by aggregation, there will not in fact be any real beings; for any being by aggregation presupposes beings endowed with a true unity, because it derives its reality only from that of its constituents. It will therefore have no reality at all if each constituent being is still a being by aggregation, for whose reality we have to find some further basis, which in the same way, if we have to go on searching for it, we will never find.
>
> (to Arnauld, 30 April 1687; A II iiB 185/WFT 123)

Leibniz's crucial premise here is the principle that *the reality of an aggregate derives only from the reality of its constituents*, which I shall dub the Aggregate Reality Principle.[2] For given that bodies are real aggregates, this means that they must have real constituents. There could not be "only aggregations of substances", as Arnauld had suggested, without there being substances from which the aggregates result. And given his commitment to the scholastic principle that "*one* and *being* are reciprocal things", as he tells Arnauld, he "cannot conceive of any reality without a true unity" (185/124), which aggregates lack. From these premises it follows that "where there are only beings by aggregation, there will not in fact be any real beings" (185/123). Given that conclusion, he argues, there are only four alternatives that he can conceive:

> [I]f there are aggregates there must also be some true substances from which all those aggregates result. So we must necessarily end up with mathematical points, which some authors hold extension to be made up of; or with atoms, like Epicurus and M. Cordemoy—which you, like me, have already rejected; or we will have to say there is no reality in bodies; or, finally, we will have to accept that there are in bodies substances which possess a genuine unity. (185/123)

Interestingly, Leibniz had himself earlier explored the first two of these options quite vigorously and this helps to explain his confidence in this Aggregate Reality Principle. For it is not obvious why we should accept that an aggregate has no reality beyond that of its constituents. As Russell observes, Leibniz puts this principle to "a very bold use" in his arguments about the reality of bodies (Russell 1900, 115). But why should we accept it? We can perhaps accept that a pile of logs is only a "one" in the weak sense that they are resting on one another. But Leibniz wants us to accept that the woodpile has no more unity than a pair of diamonds existing far apart, for example "the diamond of the Grand Duke and that of the Great Mogul" (to Arnauld, 8 December 1686; A II iiB 120/WFT 117), and further, that a log or a diamond itself has no more unity than a woodpile. Why, one might ask, couldn't one give an account of the cohesion of a body's parts into a system? Couldn't a body be constituted by an infinity of indivisible points held together by some mechanical principle, such as motion in common? Or why couldn't a body just be impenetrable, as the atomists assumed their atoms were?

[2] Peter Loptson suggested I should call this principle concerning the unity of aggregates the *Atomistic Aggregate Principle*. Certainly, there are strong connections with Democritus that are acknowledged by Leibniz, as we shall see below.

The second of these last two alternatives, atomism, was popular among Leibniz's contemporaries, as we shall see in Chapter 3. Jean Chrysostôme Magnen, Pierre Gassendi, and many others had revived the classical atomist explanation that the cohesion of macroscopic bodies is due to the tangling together of the constituent atoms, which hold onto each other "by hooks, crooks, ringlets, projections" and so forth (A VI i 492). Atom-and-plenum physicists like Christiaan Huygens, on the other hand, had preferred to update Galileo's explanation of cohesion in terms of nature's abhorrence of the vacuum. Galileo had attributed a liquid's cohesion to a repugnance to an external vacuum, and the greater cohesion of solids to a repugnance on the part of their constituent indivisibles to the indivisible voids separating them—a kind of interstitial suction. But in the wake of Torricelli, Pascal, and Boyle, explanations appealing to the repugnance to an external vacuum had been replaced by mechanical explanations in terms of the pressure exerted by the weight of the atmosphere; so Huygens, applying parity of reasoning, attributed the primary cohesion of solid bodies to the pressure of a fluid more subtle than air forcing their constituent atoms together. But here Leibniz saw an important lacuna, which he continued to stress well into his maturity and his dispute with Hartsoeker: in all such atomist explanations, the cohesion of the atoms themselves remains unexplained, so that one has only really succeeded in pushing the problem further down, exposing oneself to the threat of an infinite regress.[3] He first advances this as an objection in his *Confession of Nature Against the Atheists* of 1668, where he urges it as demonstrating the need for a primary cause of cohesion (God) lying outside the regress, in reasoning evoking Aristotle's argument for the prime mover.[4] Within a couple of years such arguments are dismissed as bringing in God as a *Deus ex machina*, and Leibniz manages, under the inspiration of Hobbes and with debts to Aristotle, Scaliger, and Galileo, to find his own mechanist explanation for primary cohesion, the binding together of the primary constituents of solid bodies.

Leibniz's explanation of primary cohesion, however, appeals to a version of the first alternative he suggested to Arnauld: that a *body is constituted by an infinity of points*. Without going into details, the idea is that a continuous extension is formed from indivisible unextended elements, each of which is not a mere minimum, but proportional to an endeavour. The notion of endeavour here is crucial to the ingenious account of cohesion, which goes as follows. If one body impels another, i.e. endeavours to move it, it has already begun to penetrate it. This is because at the moment of contact, the

[3] The same infinite regress argument is repeated as a criticism of standard accounts of cohesion in the *Hypothesis Physica Nova* of 1671 (A VI ii 250–1, 365), in "On the Cohesiveness of Bodies" of 1672 (A VI iii 96/LLC 23), in "Motion is Something Relative" of 1677 (A VI iv 1971/LLC 229), and in the Note on Firmness and Fluidity tucked into his *Specimen of Discoveries* of around 1686 (A VI iv 1629/LLC329), and again in his letter to Des Bosses concerning Hartsoeker of 7 November 1710 (LDB 189).

[4] See the discussion in my introduction to (LLC xxviii). In the *Confessio* Leibniz writes: "Thus in providing a reason for atoms, it is right that we should have recourse to God, who is responsible for the firmness in these ultimate foundations of things. And I'm surprised that neither *Gassendi* nor anyone else among the very acute philosophers of our age has noticed this splendid occasion for demonstrating Divine Existence" (A VI i 492).

boundary point of the impinging body occupies a space that is not a minimum, but proportional to the body's endeavour to move. Therefore the two bodies overlap at the point of impact and thus share an extremity. But according to the Aristotelian definition of continuity (discussed in Chapter 1), this means that the bodies in question are "not only contiguous but continuous"; according to Leibniz, this makes them "truly one body, movable in one motion" (to Hobbes, 23 July 1670; A II 1, 57). Thus "whatever things move in such a way that one endeavours to enter the other's place, cohere together while the endeavour lasts" (to Oldenburg, 28 September 1670; A II i 64).

We will consider this theory further in Chapter 3, but for present purposes the important point is that in 1676 Leibniz comes to reject the idea that the continuum can be composed out of infinitely many infinitely small actual parts—whether these parts are the indivisibles of his *Theoria Motus Abstracti* or the divisible actually infinitely small parts that succeed them in his favour. It is not just that he rejects indivisible points as containing substances when he rejects mathematical indivisibles in late 1671. Indeed, if anything this rejection of indivisibles initially seems to strengthen his conviction that there are infinitely small constituents in the physical continuum—they are "beginnings" of line segments, *presupposed* in any finite line segment, that are proportional to their endeavours. Thus in the intervening period his endeavour theory of cohesion remains intact: spinning bodies (*bullae*) are held together by bands of overlapping infinitely small elements, where each element of the band is spinning with the same endeavour as the others at any given instant. When Leibniz comes to reject the actually infinitely small in early 1676, however, this account of original cohesion in terms of overlapping points collapses, and with it his early account of the unity of primitive bodies.

Still, one might argue, what is there to prevent an infinity of points from constituting body even if they do not overlap? Even if one rejected Galileo's idea that body consists in an infinity of indivisible points held together by the infinite vacua between them, one might still suppose bodies to be composed of points and account for their cohesion in terms of some external pressure. Perhaps the continuum is an infinite collection of infinitely small points, as some of the Zenonians had proposed. (Such Zenonian views had been advocated by Marin Mersenne, Pierre Gassendi, and Pierre Bayle, and were seriously treated by Christian Wolff, as we saw in Chapter 1.) This consideration takes us right into the heart of the paradoxes of the infinite. Leibniz had read the weighty tome of refutations of such views by Libert Froidmont (1631), but it has not been generally appreciated how relevant his own subtle position on the actual infinite is to his theory of matter.[5] After the collapse of his endeavour theory in the spring of 1676, Leibniz continued to hold that matter is actually infinitely divided. But he denied that the resulting parts form a collection or whole, except insofar as they can be viewed

[5] As Carla Rita Palmerino has shown in her excellent article (2016), Leibniz returned to Froidmont's book in the 1690s, taking copious notes and worrying about whether time might be composed from instants—see Chapter 7 below.

as a whole by the mind: "I doubt whether what is really divided, that is, an aggregate, can be called one. It seems to be so because names are invented for it." What remains when something changes "can be mind itself, understanding a certain relation" (A VI iii 503/LLC 99). This reasoning occurs in an unpublished tract of April 1676, *Numeri infiniti*, in which Leibniz is exploring the consequences of his new philosophy of the infinite. According to this new understanding, a circle, viewed as the limit of a certain sequence of polygons of increasing numbers of ever smaller sides, is a *fictive entity*, as is the putative smallest of such sides, or the last term of an infinite series. There are expressions for such things, but they are *compendia loquendi*, abbreviations of speech. Similarly, Leibniz concludes, "it must be said that an infinity of things is not one whole, i.e. that there is not one aggregate of them" (503/101).

This is perhaps the first explicit statement of what I have termed the Aggregate Reality Principle. But here it is given a strongly nominalistic interpretation, according to which *the only unity applicable to an aggregate is supplied by a mind in considering it as one*. One could perhaps subscribe to the principle that the reality of an aggregate derives from the reality of its constituents and still call the resulting unity of aggregates a derivative or physical unity. But this interpretation goes further in claiming that the only unity possessed by an aggregate is added by its being considered as one, a clearly nominalist thesis. I shall call this the Aggregate Unity Principle. Leibniz had already displayed a partiality towards nominalism in his earliest writings,[6] but the above considerations indicate that he was persuaded to apply this nominalist interpretation to the unity of aggregates by his meditations about the philosophy of the infinite. He seems to have been pushed in this direction by the collapse of his former account of cohesion in terms of an infinity of infinitely small endeavours: in the writings of 1676 we find him changing his mind over whether matter is united into a continuum by motion, or remains a discrete multiplicity of points "united by some mind".

But, as Russell sagely observes (Russell 1900, 116), even if this nominalist interpretation of the unity of aggregates first emerges in connection with infinite aggregates, Leibniz understands it to apply to all aggregates, finite as well as infinite: "I doubt whether what is really divided, that is, an aggregate, can be called one, although it seems to be because names are invented for it" (A VI iii 503/LLC 99). This nominalist understanding of the unity of aggregates is at the basis of his construal of them as phenomena. By 1678–9 (as we saw at the end of Chapter 1) Leibniz was already arguing that "what has no greater unity than the logs in a bundle of firewood or woodpile, or bricks placed one on top of the other, is not properly one being, but rather beings,

[6] See in particular Leibniz's *Preface to an Edition of Nizolius* of 1670 (GP IV 131–62): "*In philosophizing accurately, only concrete terms should be used.*... concretes are really things; abstractions are not things but modes of things. But modes are usually nothing but the relations of a thing to the understanding, or capacities for appearing" (GP IV 147/L 126). A nominalist approach to aggregates also appears in *De minimo et maximo* of 1673: "it is known from experience that everything is not sensed any the less by others because I am absent, and the same is true of each individual. Therefore this will also be the case in the aggregate of them all, which combines them only by considering them together" (A VI iii 100–1/LLC 17).

although one name can be supposed for them all" (A VI iii 1464/LLC 257). The connection with the phenomenality of aggregates is clearly expressed in the *New Essays* of 1704: "So the only perfect unity that these 'beings by aggregation' have is a mental one, and consequently their being also is in some way mental or phenomenal, like that of the rainbow" (Ch. xii, §6; A VI 6, 146). More on this analogy with the rainbow in a moment.

The third of the four alternatives Leibniz suggested to Arnauld is: "or we will have to say there is no reality in bodies". This, again, is a live option, since he knows very well this is the option favoured by Academic Sceptics like his friend Simon Foucher.[7] As was noted in the introduction above, the Sceptics concluded from the difficulties of the composition of the continuum that extension and motion have no substantial reality, since the continuum can be composed neither of partless points, nor of atoms or physical points, since they too will be extended, leading to a vicious regress, just as Leibniz had argued. Thus they inferred that "the foundations of extension could never really exist".

Not so Leibniz, who, as we'll see in detail in Chapter 5, inverted this Zenonian reasoning in the case of motion to argue that, since motion does indeed exist, it must have real foundations. If these cannot exist in the continuum, this is evidence of the ideal nature of the continuum, not of body. Likewise, the reality of body is another of Leibniz's premises, rather than something he is seeking to prove. For what Leibniz's argument entitles him to conclude is that, *granted there exist bodies that are aggregates*, they must have real constituents. And as we saw in Chapter 1, if there is nothing more to body than the usual defining properties, namely, extension, motion, shape, magnitude—in short, if body is taken as mere *bulk*—then it does not contain any indivisible unities that could be those real constituents.

But Leibniz certainly does not believe that there are no unities in bodies. He himself is a unity whose principle of unity (he assumes without argument) is the soul, and so by analogy are other thinking things. And why would God endow only humans with a true unity if he could endow other kinds of beings with an analogous principle of unity too, thereby increasing the amount of perfection in the world? As he wrote in the 1678 manuscript *Metaphysical Definitions and Reflections* discussed above, "To attribute a soul only to man and a few other bodies is as inapt as believing that everything is for the sake of man alone."[8] Thus Leibniz thinks it probable that we are not the only corporeal substances, or bodies containing a principle of unity. Yet he knows that he has

[7] See Maia Neto (1997) for an analysis of Foucher and Academic Scepticism. Foucher's influence on Leibniz can perhaps be seen in the insistence that primary qualities such as motion and shape are no less phenomenal than the secondary ones. See the lucid discussion in Garber (2009, ch. 7).

[8] (A VI iv 139/LLC 245). Cf. also what Leibniz wrote in the *Conspectus libelli elementorum physicae* of summer 1678–winter 1678/9 (A VI iv 2009–10; L 289; see LLC 412 for the dating): "I believe that there is in every body a kind of sense and appetite, or a soul, and furthermore, that to ascribe a substantial form and perception, or soul, to man alone is as ridiculous as to believe that everything has been made for man alone and that the earth is the centre of the universe."

no means to prove this to the sceptic. Nor can he prove from the appearances whether any particular body, such as a sheep, contains a soul or some other organizing principle, or is only an accidental unity. Hence the customary hypothetical formulations: "Unless there were a soul, ôr a form of some kind, a body would not be an entity, because no part of it could be assigned which would not again be made up of a plurality of others, and so nothing could be assigned in body which could be called *this something*, ôr *some one thing* [*unum quiddam*]" ([*c.*1678–9]; A VI iv 1988/LLC 233–5); "if beasts are not mere machines, it is necessary for them to have substantial forms, and these are called *souls*" (*On the Present World, c.*1685; A VI iv 1508/LLC 287); "if there are no corporeal substances such as I claim, it follows that bodies would only be true phenomena, like the rainbow" (to Arnauld, 8 December 1686; A II iiB 122/WFT 118); "It also follows either that there are no corporeal substances and bodies are only true or mutually consistent phenomena, such as a rainbow or a perfectly coherent dream; or that in all corporeal substances there is something analogous to the soul, which the ancients called form or species" (*A Specimen of Discoveries*, *c.*1686–7, A VI iv 1622/LLC 315). Nevertheless, Leibniz believes there is a strong presumption—one that he expects his correspondents to share—that bodies are not mere phenomena, and, given this and his other premises, it follows that there must ultimately be substances of which they are aggregates.[9]

Thus the fourth option Leibniz suggested to Arnauld is the only one remaining: "we will have to accept that there are in bodies substances which possess a genuine unity" (A II iiB 185/WFT 123). This option, it must be stressed, is the one that enables him to avoid the sceptics' conclusion that bodies are *mere* phenomena. Notice, however, that the fourth option is not that the *bodies* possess genuine unity, but that they *contain substances that possess such unity*. What, then, is the status of such bodies? Leibniz's answer is that such bodies *are* phenomena, but *real phenomena*, with their reality deriving from that of their constituent unities.

This also follows from the same premises, provided they are supplemented with a definition of phenomenon along the following lines: a *phenomenon*, in the sense in which Leibniz intends the word, is something appearing to the senses that is not itself a substance; or, is something that exists as a unity only in relation to us.[10] Thus bodies, which really do appear as unities to the senses but are not themselves substances, will be phenomena in this sense.

[9] Here I agree with Garber, who notes that Leibniz "never takes seriously the possibility that the world of bodies is unreal" (1985, 32; 2009, 281–2—although his position in Garber 2009 is somewhat more nuanced (see especially ch. 7))—and also with Levey, that this is a "concession to skepticism" on Leibniz's part, "though not to Cartesian worries about the very existence of any external world at all" (Levey 2003a, 247). Russell had also correctly noted Leibniz's (moral) commitment to the external world (Russell 1900, 74).

[10] Cf. "And just as colour and sound are phenomena, rather than true attributes of things containing a certain absolute nature without relation to us, so too are extension and motion" (*Mira de natura substantiae corporeae*, March 1683, A VI iv 1465/LLC 263). There is an extensive literature on the ambiguities in Leibniz's use of the term "phenomenon". For a thorough analysis, see Rutherford (1990b) and the references contained therein. See also Garber 2009 (ch. 7).

Such a reading is supported by what Leibniz says about phenomena using the illustration of the rainbow (his most frequently used example of a phenomenon) in the *Notationes Generales*, a manuscript dated 1683–5:

> I hold that a rainbow, a parhelion, and other phenomena of this kind, can be called *beings by aggregation*, like a pile of logs or an army, for a rainbow is an aggregate of raindrops which, when joined together, produce the particular colours appearing to us. Qualities are apparent which are not absolutely in things, but only insofar as they act on us. Thus the same water will seem cold or warm or hot according to the ways my hand is disposed. That, however, is really in it, when it comes about in a way appropriate for this sensation to be produced in me when so disposed. Hence the rainbow is of diminished reality under two heads, for it is both a being by aggregation from raindrops, and also the qualities by which it arises are apparent, or at least derive from the kind of real things that are relative (*respectivae*) to our senses. (A VI iv 555)

The fact that a rainbow is phenomenal in two ways is significant for interpreting Leibniz's various remarks about the phenomenality of rainbows. For on some occasions they are dismissed as *mere phenomena* or *appearances*. This is the sense in which they are just the appearance of a spectrum of colours to someone observing them, the sensations produced in me when I am facing the rain with my back to the sun. But there is something really there in the atmosphere that produces these sensations in me, namely the raindrops in which the sun's light is reflected and refracted. In this sense the rainbow is a *real phenomenon*, "a being by aggregation from raindrops". It is real, its reality being constituted by the drops from which it is aggregated; but it is one being only insofar as it is perceived as such, and as one being it is therefore a phenomenon. In sum, a phenomenon will be a *real phenomenon* if there are things existing outside of us from which it results; otherwise it is a *mere phenomenon*. A mere phenomenon, in fact, will correspond to what Wolff said the idealists understood by a phenomenon, namely "that which only appears to exist, but has no reality outside the mind" (Wolff 1737, §226).[11]

This distinction between the two ways in which something can be called phenomenal is of crucial importance to understanding Leibniz's views on aggregates and their connection with the problem of the continuum. For a Cartesian body, by the above argument, will be a mere phenomenon. It appears to the senses, but has no constituent unities, so that its unity will reduce to its being considered as such. This is because, without an animating form or similar principle, it will have nothing to ground its being the same aggregate of parts through time. Given the mutual convertibility of unity and

[11] The claim that Leibniz uses the term 'phenomenon' in two different senses is also clearly expressed by Rutherford. "On the one hand, 'phenomenon' may refer to what is merely an object of thought or perception, an appearance. In this sense, a phenomenon is a mental content that by itself makes no claim on an extramental existence. We have seen, however, that 'phenomenon' is also used by Leibniz to describe whatever is a 'being by aggregation', the existence of which depends upon its being apprehended as one by some mind. In the case of phenomena that are aggregates of substances, we cannot say that they are merely objects of thought or perception" (Rutherford 2008, 181).

being, it will therefore have a merely nominal reality, as Leibniz explains in the continuation of the above passage from the *Notationes Generales*:

> Moreover I will show in its place that all bodies in which there is no soul or substantial form are only appearances, like dreams, nor do they have any definite and determinate nature; and all attributes of bodies of this sort are nothing but phenomena which lack a subject. Whence it follows either that bodies are not real beings, or that all bodies are animated in some way. (A VI iv 555)

In contrast with phenomena that are mere appearances, there are beings that are aggregated from real unities, such as an army or crowd of people. The unity and reality of such beings by aggregation "differs from the unity and reality of a person", and this difference is most appropriately seen, Leibniz tells us, in their "attributes or operations" (556). An army, for instance, can have the attributes of being "thirty thousand strong", or being "arranged in a lunular battle-array". But "even if the army is not regarded as one" (556), Leibniz insists, these attributes can still be expressed. One can say that "thirty thousand soldiers are present", and the lunular battle array can be described by saying "that one soldier is so situated with respect to another, just as the above-mentioned form of array requires, that the others are such and such a distance from some one fixed point" (556). These attributes, evidently, are all relations between individuals, such as relations of situation, and these may change from one moment to another. In a person, by contrast, what makes the parts constitute a unity is an attribute which cannot be expressed without "a faculty of sensing and appetite". Thus

> an army cannot accurately be regarded as the same for even a moment, for there is nothing real in it that does not result from the reality of the parts it is aggregated from; and since all of its nature consists in number, figure, arrangement, and similar things, when these are changed it is not the same. But the human soul has its own reality, to the extent that it cannot cease to exist whatever parts of the body are changed. (556)

In sum, an aggregate, such as a body, is not a real whole or unity, but appears to be so when its constituent unities are either conceived together or perceived together. Its unity is therefore phenomenal. Its reality is conferred by (indeed, reduces to) the reality of its constituents; its unity is the result of these being perceived or conceived together.[12] Moreover, whatever might be taken to give it a physical unity at any instant—the arrangement or shape of its parts—stems from a relation among the individual substances constituting it. These change from one instant to another, making the body

[12] Cf. Rutherford: "The existence of bodies themselves, as beings through aggregation, is mind-dependent. This does not imply, however, that the *reality* of bodies is wholly mind-dependent; on the contrary, insofar as bodies are essentially pluralities of true unities, they derivatively possess the reality of the beings from which they are aggregated" (1990a, 532); and "An aggregate exists as a distinct entity over and above its components only insofar as they are represented as one by some mind; consequently, any such entity is, in Leibniz's technical vocabulary, a *phaenomenon*" (2008, 175).

phenomenal in a Platonic sense.[13] Beings by aggregation such as bodies are therefore phenomenal in two senses, as Leibniz duly explains to Arnauld. As composites whose unity depends on their being considered together, they exist by convention, "as Democritus rightly said, namely *Esse opinione, lege,* νομῷ" (A II iiB 191/WFT 127). "And Plato is of the same opinion regarding everything that is purely material", namely that "our mind observes or conceives some true substances which possess certain modes; those modes contain within them certain relations to other substances, as a result of which the mind has occasion to join them together in thought, and make one name stand for all those things together" (191/127).[14] But these are not truly real beings; "they are transitory beings that never subsist longer than a moment" (GP VI 586/L 623). Thus there are two senses in which an aggregate is phenomenal: (i) Democritean—it is a plurality that exists as one only through being considered as one; and (ii) Platonic—due to its changing constituents, it is always becoming something different. This constitutes the answer to our fourth question posed at the end of Chapter 1: namely, how, and in what sense, does their being aggregates make bodies phenomenal?

With all this in place, we can now return to Russell's conundrum. Leibniz's argument was stated by him as follows:

> The general premiss is: Since matter has parts, there are many reals. Now the parts of matter are extended, and owing to infinite divisibility, the parts of the extended are always extended. But since extension means repetition, what is repeated is ultimately not extended. Hence the parts of matter are ultimately not extended. Therefore it is self-contradictory to suppose that matter has parts. Hence the many reals are not parts of matter. (The argument is stated almost exactly in this form in GP VII 552.) (Russell 1900, 110, n. 1)

"It is evident", he remarks, "that this argument, in obtaining many reals, assumes that these are parts of matter—a premiss which it is compelled to deny in order to show that the reals are not material" (110, n. 1). But Leibniz nowhere denies that matter has parts—indeed it is a crucial premise in the argument for monads; and Leibniz does not identify the actual parts with monads in his premise, only to deny it in his conclusion. The argument is not that matter's parts *are* the true and pure unities, but that "every

[13] Cf. Nachtomy: "The ancient notion of 'phenomenal', which is grounded in the distinction between the variable and the invariable, should be clearly distinguished from a modern notion of 'phenomenal', which is grounded in the opposition between mind-dependence and mind-independence. It seems to me that confusion between these two senses infects the debate over Leibniz's phenomenalism" (2007, 206).

[14] As other commentators have argued, this does not make the truth of the relations perceived purely subjective: insofar as they are truly perceived, they reflect relations among the modes as constituted in the mind of God. "Relations have their proper foundation *in mente Dei* insofar as God, by creating or thinking single individuals together in a determined world, connects them and articulates their reciprocal relationship. The resulting relations are not the fruit of divine arbitrariness, but are a consequence of the intrinsic modifications of the individual substances" (Mugnai 1992, 111). See also Lodge (2001), Phemister (2005, 123), and Nachtomy (2007, 189ff.).

multiplicity *presupposes* true unities". In this respect the passage from Leibniz's reply to Foucher cited by Russell is no exception:

> Everybody agrees that matter has parts, and is consequently a multiplicity of many substances, as would be a flock of sheep. But since every multiplicity presupposes true unities, it is evident that these unities cannot be matter, otherwise they would in turn be multiplicities, and by no means true and pure unities, such as are finally required to make a multiplicity. Thus the unities are properly substances apart, which are not divisible, nor consequently perishable. For whatever is divisible has parts, which can be distinguished even before their separation.
>
> (GP VII 552/Russell 1900, 248)

To be charitable, one can understand how Russell might have been misled by this wording, where the "parts of matter" referred to in the first leg of the argument are compared to corporeal substances like sheep, whereas the unities that are "properly substances apart" cannot have any distinguishable parts, and therefore cannot be material. Still, the fact remains that for Leibniz the unities are immaterial things presupposed by any actual part, not the actual parts of matter themselves. This is much clearer in some (unpublished) remarks Leibniz made concerning the same example of a flock of sheep, in drafting a reply to Foucher's objections to his *New System*:

> In realities, where only divisions actually made enter, the whole is only a result or assemblage, like a flock of sheep. It is true that the number of simple substances in any mass, however small, is infinite; for besides the soul, which makes the real unity of the animal, the body of the sheep, for example, is actually divided, i.e. is an assemblage of invisible animals or plants, similarly composite except for what makes their real unity; and though this goes on to infinity, it is plain that all in the end depends on these unities, the rest, or the results, being only well-grounded phenomena. (GP IV 492/WFT 185)

So far, so good. But this analysis still leaves us with some perplexing difficulties, including one that has become a stumbling block for all perceptive interpreters of Leibniz. This is to see how Leibniz is entitled to say both that there are organic bodies together with their principles of unity—i.e. corporeal substances like the sheep—all the way down; and also that "in the end" everything depends on principles of unity. In a similar passage from 1712, also invoking the same "in-the-end" motif, Leibniz concludes that "there are simple substances alone":

> For even though every simple substance has an organic body which corresponds to it—for otherwise it would not have any kind of orderly relation to other things in the universe, nor would it act or be acted upon in an orderly way—yet by itself it is without parts. And because an organic body, or any other body whatsoever, can again be resolved into substances endowed with organic bodies, it is evident that in the end there are simple substances alone, and that in them are the sources of all things and of the modifications that come to things.
>
> *Metaphysical Consequences of the Principle of Reason* [*c.* 1712]; C 14/MP 175)

But if "in the end there are simple substances alone", this would appear to mean that ultimately there are no corporeal substances, but only immaterial substances. That is

certainly how most commentators have interpreted it. Let us now turn to a discussion of this question.

2.2 The Problem of Corporeal Substances

According to an influential interpretation of Leibniz's views, there was a profound change in his metaphysics between the writings of the 1680s and those of the last dozen years or so of his life. In his *Discourse on Metaphysics* of 1686 and the correspondence with Arnauld that ensues, and in the *Specimen of Discoveries* and related texts from that period, Leibniz explicitly upholds the reality of *corporeal substances* as the ultimate constituents of matter; these are understood as body–form composites, with the consequence that Leibniz appears as an Aristotelian realist. A good example would be this statement from his *Supplement to the Explanation of the New System* [1696?]: "Secondary matter or the mass which makes up our body, contains parts throughout, all of which are themselves complete substances because they are other animals, or organic substances which are individually animated or active" (G IV 572–3). In his later writings, however, we find explicit statements that the ultimate constituents of reality are *simple substances* or monads, and this is all that is real in things, such as the famous statement to De Volder in 1704 quoted in the introduction: "there is nothing in things except simple substances, and in them, perception and appetite" (GP II 270/L 537). Consequently many commentators have attributed a change of position to Leibniz, from a realism about corporeal substances to a substance-idealism in his later writings. This interpretation was initiated by Charlie Dunbar Broad (1975, 83), and has been vigorously promoted by Daniel Garber (1985, 29ff.), who defends it at book length (2009).[15] A clear statement of it is given by Donald Rutherford: "While the status of corporeal substance remains a central concern until the very end of his life, I think it is fair to say that Leibniz failed in his efforts to articulate a coherent version of such a theory, and that as a consequence, by about 1700 he leans fairly definitely towards the view that only mind-like 'monads' count as true substances" (1990a, 553).[16]

That, at any rate, is the picture in broad strokes. But there are many difficulties with this thesis that Leibniz's metaphysics underwent such a change that have been noted by other commentators. I won't go into all of them here. Suffice to say, first, that no one has

[15] Another major proponent of this "change of view" interpretation is Catherine Wilson: "For a time in Leibniz's thinking corporeal substances appear to coexist with monads. Later his hand is forced and only monads are said to be real. For the Leibniz of the Arnauld correspondence, corporeal substances serve as a hedge against a pure phenomenalism which in the end, despite a good deal of resistance, he is no longer able to avoid" (Wilson 1989, 158).

[16] Cf. Garber: "We may never be able to mark with certainty the moment at which the doctrine of the monadology emerges from the earlier corporeal substance view. But even though we don't know when exactly it emerges, and when exactly Leibniz first signs on to it, by 1700 it is definitely there, and Leibniz seems definitely committed to it" (2009, 341). "By 1700 or so, Leibniz had clearly committed himself to the new metaphysics of simple substances, substances without parts, what he had come to call monads" (2009, 344).

been able to point to a single statement by Leibniz that he made such a profound change in his ontology, as opposed to pointing to passages that they claim exemplify it; secondly, that one can find him talking of minds as substances in the 1680s,[17] and can still find favourable references to corporeal or composite substances in writings up until the last year of his life;[18] and, thirdly, that there are no signs that Leibniz recognizes that his upholding of corporeal substances is in conflict with the claim that all that exist are monads and their states and modifications,[19] since throughout his life, whether writing to princesses or to just himself, he often maintained both views in the very same passage, as in the two passages just quoted above.[20] So, I believe, what is undeniable is that Leibniz never did acknowledge a discrepancy between the two, and that it is his lack of recognition of any discrepancy that requires explaining.[21]

It seems to me, then, that we are obliged to take seriously the idea that corporeal substances are not in conflict with the thesis that things can be resolved into monads or

[17] In his letter to Arnauld of 23 March 1690, Leibniz writes "everywhere in bodies there are substances, indivisible, ungenerable, and incorruptible… [which] have always been and always will be united to organic bodies"—it is of course, only substantial forms that are united to bodies, so these are here being described as substances, as Adams notes (Adams 1994, 268). In the summary Leibniz had sent to Arnauld earlier, he mentions "simple substances", although "simple" is an addition that may have been made later: "35) Excellence des Esprits; que Dieu les considere preferablement aux autres creatures; que les Esprits expriment plustost Dieu que le monde, et que les autres substances simples expriment plustost le monde que Dieu" (A II iiB 7; 11 February, 1686). See also his letter of 9 October 1687 (A II iiB 253), where he refers to "substances corporelles simples". Certainly he is referring to simple substances in the sense they will have in his mature philosophy in 1692/3: "Je parle d'un simple qui est une veritable unité. Or il est manifeste que les composés ne sçauroient estre sans les simples, ny les pluralités sans les unités, ny enfin les estres d'imagination, sans les estres veritables à la rigueur" (to Electress Sophie, 29 December 1692/8 January, 1693; A II iiB 639).

[18] Thus it is hard to see any substantial change of position between what Leibniz tells Johann Bernoulli in 1698, "What I call a complete monad or individual substance is not so much the soul as it is the animal itself, or something analogous to it, endowed with a soul or form and an organic body" (GM III 542/AG 177, L 530), and what he tells Friedrich Wilhelm Bierling in 1711, "You ask for definitions of Matter, body, spirit.… *Body* is either a corporeal substance or a mass made up of corporeal substances. I call *corporeal substance* that which consists in a simple substance ôr monad (that is, the soul or something analogous to the soul) and an organic body united with it" (GP VII 501). There is terminological variance, in that the soul (or soul-analogue) united with its organic body is called a monad in the first, and a corporeal substance in the second; but that is consistent with the bivalent way of identifying substances that Leibniz shares with Aristotle, as I shall argue below. Hartz (1998) contains a catalogue of statements by Leibniz supposing or asserting the reality of corporeal substance; see also his (2007). Phemister (2005) gives an extended defence of their reality.

[19] Again, I must exempt the later stages (1712–16) of the correspondence with Des Bosses, in which, I maintain, Leibniz uses the term "corporeal substance" to denote a substance involving "something real over and above monads", namely a kind of substantial bond unifying the subordinate monads in a body independently of the dominant monad (to Des Bosses, 15 February 1712/LDB 225). This will be discussed in Chapter 6 below.

[20] Robert Adams concedes that "Leibniz seems to have regarded the two accounts as consistent" (Adams 1994, 260); Glenn Hartz demurs, arguing that "the appearance of the two accounts together is perfectly in order even if Leibniz deemed them inconsistent" (Hartz 2007, 151). This is the "theory pluralism" that he ascribes to Leibniz.

[21] Likewise, the allegation that Leibniz was duplicitous can only be taken so far. In the manuscripts that were mere notes for himself, who was he trying to deceive? This consideration also undermines the view advanced by Russell (1900, x), Adams (1994, 307), Rutherford (1995, 269, 281–2), and others, that the discrepancies are explained by the fact that Leibniz suited his views to his different audiences. Even granting this, if the audience were himself, would one not expect his real views? Why would there still be such discrepancies?

simple substances alone, and the modifications that result from them. As a preliminary clarification, it should be noted that, just as the conception of body that Leibniz wishes to defend is not the Cartesian one, so the conception of corporeal substance he wishes to defend is not simply a combination of a Cartesian soul with a Cartesian body.[22] A Cartesian body, as we saw above, would be a mere phenomenon; if all bodies were like this there would be no argument to monads.

Second, as we saw, no purely material body stays the same from one instant to the next. So insofar as it is the body of the same thing, again there must be some immaterial principle that accounts for this. This is its principle of activity or principle of duration. What is substantial in a corporeal substance, then, is a principle which takes it through its states according to an internal law. This is what Leibniz refers to severally as the entelechy united to the organic body, its form, its primitive active force, its principle of activity, or soul. Each of these states represents the infinity of bodies acting on it in one confused perception (this relates to the principle of passivity or primitive passive force), and the entelechy is what accounts for there being successive such perceptions which belong to the same thing. The entelechy is what is substantial about a given corporeal substance, and this is what, according to Leibniz, can neither be created nor destroyed for the duration of the world.

Thus when Arnauld suggests that obviously a corporeal substance like a silkworm could not survive a fire, Leibniz does not accept that its substance could be destroyed: "I believe I have shown that there must be entelechies if there are corporeal substances, and if we accept these entelechies or souls, we have to recognize their ungenerability and indestructibility…" (to Arnauld, 9 October 1687; A II iiB 256/WFT 133). What is material about a body, on the other hand, is its very changeability, its potential for being differently divided, and therefore being a different aggregate of parts and of constituent substances from one instant to another. But Leibniz is very clear that both matter and form are equally necessary. As he writes in a fragment from the later 1670s that we will return to in Chapter 6, "if there were only matter in body, there would be no reality or perfection in it. But if there were only form in body, there would be nothing changeable and imperfect in it" (A VI iv 1399/LLC 245).[23]

The idea that form and matter are equally necessary to substance is, of course, straight Aristotle, and Leibniz's discussion of substance is replete with Aristotelian terminology. Thus Leibniz's reference in his 1698 *On Nature Itself* to "the indwelling

[22] Garber recognizes this in his recent book, when he writes: "It may look here as if Leibniz's solution to the problem of unity in Cartesian bodies is simply to add forms to Cartesian matter…But this is not quite right.…when Leibniz revives Aristotelian forms, he also means to revive an Aristotelian conception of matter" (2009, 97). As we shall see in detail in Chapters 3 and 4, it is arguably an Aristotelian account of matter, but *not* a Thomist account, where the matter of a corporeal substance is a pure potentiality made actual by the substantial form. This makes for a picture of the development of Leibniz's metaphysics, I argue, in which there is much more continuity than in Garber's rendition, where Leibniz is supposed to switch from a neo-Hobbesian account of body, to a neo-Thomist one, to a frankly phenomenalist one.

[23] This is admittedly an early paper (dated as between Summer 1678 and Winter 1680–1). But one can find similar statements in his mature work, for instance: "Although God could, by his absolute power, deprive a created substance of *materia secunda*, yet he cannot deprive it of *materia prima*; for he would thus make it a pure act [*Actum purum*], such as he alone is" (to Des Bosses, 16 October 1706; GP II 325/LDB 79).

monads [*monadum inexistentium*]" (GP IV 514/WFT 220) recalls Aristotle's claim in his *Metaphysics* that "the substance is the indwelling form, from which along with the matter the so-called concrete substance is derived" (Bk VII, 1,1037[a] 29/BA 2, 1637). Leibniz explicitly cites Aristotle in this connection.[24] Thus, with regard to the thesis that Leibniz's differing referents for the term 'substance' signify a change of position, it is telling that Aristotle himself is quite explicit that 'substance' is an equivocal term: "Substance is of two kinds, the concrete thing and the formula…" (Bk VII, 15,1039[b] 20/BA 2, 1641):

> We must not forget that sometimes it is not clear whether a name means the composite substance, or the actuality [*entelechy*] or form…For soul is the substance or actuality of some body, but animal might be applied to both.…For soul and to be soul are the same, but to be man and man are not the same, unless indeed the soul is to be called man; and thus on one interpretation the thing is the same as its essence, and on another it is not.
>
> (Bk VIII, 3,1043[a] 29–1043[b] 4/BA 2, 1647)

Substance taken in the sense of the form, formula, entelechy, or essence is indivisible, and incapable of generation and destruction; by contrast, it is substance in the sense of the concrete thing, "the complex of form and matter" that is capable of generation and destruction (1043[b] 17/BA 2, 1647). In the case of animals, it is not the substance in the sense of the soul that is divided into parts, but the animal's matter: "And since the soul of animals (for this is the substance of living beings) is their substance according to the formula, i.e. the form and essence of a body of a certain kind,…the body and its parts are posterior to this its substance, and it is not the substance but the concrete thing that is divided into these parts as its matter" (Bk VII, 10,1035[b] 14–21/BA 2, 1635).

Leibniz agrees that it is not the substance but the concrete thing whose body is divided into parts, and that it is the concrete thing, the complex of form and matter, that is actually what changes, and also that the substance that remains the same thing can be identified by reference to the form. He puts more stress than does Aristotle on the fact that the concrete thing is *continuously* changing, since its matter is continuously changing: "if we consider matter alone, no point will be assignable that will remain together with another, nor a moment at which a body will remain identical with itself".[25] The main difference, though, is his insistence that forms are indestructible. Thus whereas Aristotle envisages a composite thing coming into existence when its matter takes on a certain form, enduring for a time, and then being destroyed when it loses its form, for Leibniz the form, being indivisible and incapable of generation and destruction, endures for the duration of the created

[24] "Aristotle (who in my view is more profound than many think)…saw the necessity of alteration over and above change of place…[This] diversity of qualities and *alliosis* or alteration, which Aristotle did not properly explain, results from the different degrees and directions of endeavours [*nisuum*], and so from the modifications of the indwelling [*inexistentium*] monads" (*On Nature Itself* §13; GP IV 514/WFT 220).

[25] *Metaphysical Definitions* (A VI iv 1399/LLC 245). Cf. Leibniz to Des Bosses, 15 February 1712 (LDB 225): "in fact no point can be designated in matter that preserves the same place for more than a moment and does not move away from neighbouring points, however close".

world, as does its organic body, even though it does not remain precisely the same body for longer than a moment. "For matter changes like a river, with the entelechy remaining as long as the machine persists" (to Des Bosses, 11 March 1707/LDB 35). The machines that persist, his "organic machines of nature", are identified as persisting as the same machines not by the sameness of their constituents, but by the indestructible form or monad, which he therefore calls a substance. Thus, since these monads are always associated with the organic body of which they are the form, the body–form composites may also be referred to as *corporeal substances*. As Ernst Cassirer was perhaps the first to suggest, a Leibnizian corporeal substance can therefore be identified with the monad itself "insofar as it is endowed with a particular organic body, according to which it represents and desires".[26] Indeed, Leibniz does speak of animals and plants as monads, not only in the letters to Bernoulli, but also (as noted in the introduction) in writing to Des Bosses.[27] Thus even though for Leibniz no form–matter complex remains precisely the same thing for however small a duration, one can still call any embodied substance a corporeal substance by reference to the form or soul that individuates it.[28]

Thus the equivocation involved in Leibniz's using the same word 'substance' to refer to both the immaterial form or soul and the form–body composite is no different than in Aristotle. For Aristotle, the soul is "the first actuality [*entelechy*] of a natural body which has organs" (*De Anima*, 412^{b} 3–4; Ackrill 166),[29] so that a soul is always the form of an organic body; and yet, "soul . . . is substance, that corresponding to the principle of a thing" (*De Anima*, 412^{b} 10–11). On my reading, it is the same for Leibniz: "simple substance" is the term he uses for the soul, entelechy, or principle of unity of an organic body; and "corporeal substance" is his term for the same substance taken together with its organic body. As for "monad", this usually means simple substance, but can also just mean substance, so that sometimes (as in the Bernoulli correspondence) the monad is embodied.

It should be noted that this reading gives a completely different perspective on the passage from 1712 quoted in section 2.1, with which it is thoroughly compatible: "every simple substance has an organic body which corresponds to it"

[26] Cassirer (1902, 408). See n. 9 of the Introduction above. As I pointed out there, Cassirer's interpretation is neo-Kantian and idealistic: the body only exists, according to him, as a representation in the perceptions of the monad.

[27] "When I say 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 animals, any of whose solid and fluid parts in turn contain in themselves other animals and plants" (to Des Bosses, 11 March 1707; LDB 35).

[28] This reading appears to be supported by one of the last words that Leibniz has on the topic of corporeal substances to his correspondent, the Jesuit Des Bosses: "I do not believe I depart from the Scholastic doctrine of corporeal substances except in this one thing, that I do away with the generation and corruption of true substances, whether simple or composite, since I find it to be neither necessary nor explicable . . . But in this way I restrict composite or corporeal substance to living things alone, that is, only to the organic machines of nature" (29 May 1716; G II 517; LDB 375–7).

[29] Cf. Leibniz in *On Nature Itself*: "Primary matter . . . is not a complete substance; and so there needs to be added to it a soul, or form analogous to a soul, ôr first entelechy *ἐντελέχειαν τὴν πρώτεν*" (GP IV 512/WFT 218).

is not in contradiction with "in the end there are simple substances alone", since the latter statement is said to follow from the fact that "any body whatsoever can again be resolved into substances endowed with organic bodies". That is, each of the "simple substances alone" is endowed with an organic body, even though by itself—i.e. insofar as it is a substance—it is without parts.[30]

Now it may be doubted whether this resolves all difficulty concerning corporeal substance in Leibniz's metaphysics. In particular, some interpreters have stressed that the problem remains of how corporeal substances, or indeed their organic bodies, are supposed to be *constructed* from simple substances. Samuel Levey has presented the difficulty based on a version of a kind of Leibnizian "characteristic" I had proposed previously.[31] Suppose a *corporeal substance CS* is comprised of both secondary matter *M* and an immaterial form *F*. We may represent this hylomorphic unification schematically as

$$CS = F(M) \tag{1}$$

Here we may suppose that the secondary matter *M* is "itself an aggregate of a number of corporeal substances that are included in the body of the encompassing one" (Levey 2007, 77), so that if we represent this aggregation of constituent substances by '+', we have:

$$M = (CS + CS + CS + CS + \ldots) \tag{2}$$

Combining (1) and (2) we obtain

$$\begin{aligned} CS &= F(CS + CS + CS + CS + \ldots) \\ &= F(F(M) + F(M) + F(M) + F(M) + \ldots) \end{aligned} \tag{3}$$

In this way, if we systematically substitute every occurrence of *CS* on the right by *F*(*M*) by (1), and every occurrence of *M* on the right according to (2), we obtain:

$$CS = F(F(F(F\ldots) + F(\ldots) + F(\ldots) + \ldots) + F(F(\ldots) + F(\ldots) + F(\ldots) + \ldots) + \ldots) \tag{4}$$

So it appears that, if we imagine this recursive process taken to a completion, corporeal substance itself is constructed from immaterial unities alone, in keeping with Leibniz's claim that "in the end there are simple substances alone". As Daniel Garber comments in his (2009), "And here we are in quite a different place from where we began: '. . . in the end there are simple substances alone . . . ,' suggesting that what began as composite substances are not substances at all" (2009, 372). This echoes Levey's comment:

[30] I am indebted to Pauline Phemister (private communication) for suggesting this interpretation of the 1712 passage.

[31] Levey's schematism is based (with my permission) on a version of a "characteristic" I gave in a paper for a conference in Florence in 2000 (the conference volume never saw the light of day, but the paper has since had a certain life on the internet); he cites also my (1998). See Levey (2007, 77, and 104, n. 31).

And thus it appears, tantalizingly, that in the end corporeal substances are resolved into forms alone. . . . Since forms themselves have no parts, however, if they are substances in their own right, they must be simple substances. On this resolution of things into forms, therefore, we find that forms are simple substances—simple, incorporeal substances and the elements of things. Thus a monadology. (2007, 77–8)

Levey argues that such a result is perplexing and ultimately not convincing. For it takes the necessity for matter to have forms—i.e. for there to be corporeal substances—as a premise, but issues (reminiscently of "Russell's conundrum"!) in a conclusion that is incompatible with this. In fact, since no substance can be composed out of other substances, it is impossible for a corporeal substance to be composed of unities. Levey has dubbed this the "Construction Problem":

the doctrine of simple substances directly implies that there are no corporeal substances, for everything that it is not a simple substance must be a construction out of simples, but no construction out of simples could itself be a substance for Leibniz. (2007, 63)

We need to be careful, however, with this idea of the "construction" of corporeal substances. The use of the addition sign '+' above may suggest some sort of composition, but Leibniz's official position, as noted by Levey, is that substances cannot be composed. The '+' stands for aggregation, and this is not the same as composition. Nevertheless, Leibniz's conclusion in the passage quoted above (from *Metaphysical Consequences of the Principle of Reason*) that "in the end there are simple substances alone" seems to suggest some kind of synthesis corresponding to the resolution into simple substances. The force of the Construction Problem is thus to throw doubt on the compatibility of this idea of a synthesis of simple substances into a genuine unity.

This is in fact what Levey suggests. He notes that Robert Adams formulated what he calls the Construction Problem as "a powerful reason for accepting the premiss that composites are nothing but aggregates" (Levey 2007, 87). If, at any instant, there is nothing in composites over and above the monads mutually representing one another, and the perceptions constituting these mutual representations, then what resources are there in Leibniz's system for an entelechy to unify an aggregate? As Adams has expressed the difficulty:

There is no way for the unity of a corporeal substance to be anything over and above the system of relations among perceptions of simple substances. But aggregates, too, are united by relations among the perceptions of substances, according to Leibniz. [. . .] so on this line of thought it might seem that the unity of a corporeal substance is of the same kind as the merely accidental unity of an aggregate. (Adams 1994, 293)[32]

I think there are three distinguishable issues here. There is the problem of how the body of a corporeal substance can be *constructed* or synthesized from the monads of

[32] Earlier in his book Adams writes of the same problem: "This is a serious problem, and arguably fatal to any attempt to domesticate composite corporeal substances into the framework of the monadology" (Adams 1994, 119).

which it is an aggregate; I shall call *this* the Construction Problem. Then there is the problem of what constitutes the *unity* of a corporeal substance. But there are two ways to interpret this. One is, how its constituent simple substances might at any instant be rendered into a unity as distinct from a mere aggregate; let us call this the Synchronic Unity Problem. The other is the problem of how the corporeal substance is to be identified as the same thing over time, which I shall call the Diachronic Unity Problem.

The motivation for making the latter distinction stems from what we quoted Leibniz saying about the phenomenality of aggregates above. As we saw, aggregates are phenomenal in two senses: the only unity bodies have at any given time is an accidental one—they are Democritean phenomena. But Leibniz gives us no reason to suppose that their possession of a form provides a synchronic unity of the kind that Adams and Levey are supposing he intends. What he contrasts with a being by aggregation such as an army is not a corporeal being whose constituents are welded into a substantial unity, but the human soul. This is something that is identified by its "attributes and operations", such as its ability to act and to perceive, both of which take time. What is needed for this is a principle by which the thing can be said to be the same thing through time. Thus in *On the Present World* (*c.*1685), Leibniz writes:

> Every real being is either a unity per se, or an accidental being. A *being (unity) per se* is, for instance, a man; an *accidental being* (*unity*)—for instance, a woodpile, a machine—which is not a unity except by aggregation, and there is no real union in it other than a connection or contact, or even a running together into the same thing, or at least an agreement observed by a mind grasping it as one thing. But in a being per se some real union is required, consisting not in the situation and motion of its parts, as in a chain, a house or a ship, but in some unique individual principle and subject of its attributes and operations, which in us is called a soul, and in every body a substantial form, provided it is a unity per se. (A VI iv 1506/LLC 283)

After quoting this passage, Levey comments that "it is clear that the doctrine of substantial forms is introduced by Leibniz in order to solve the problem of unity for corporeal beings—a solution that is supposed to guarantee the existence of corporeal beings, that is, corporeal beings which *are* real beings, unities *per se*" (2007, 74). But the unity Leibniz says is necessary is not a corporeal being; it is a "unique individual principle and subject of its attributes and operations", like our soul.

This reiterates the point I already made in the introduction. In most discussions, it is assumed that Leibniz's commitment to corporeal substance means that he is committed to certain organic bodies *being* unities at a given instant: that is, that he is committed to the idea that there is a principle that acts as a *unifier*, a dominant monad or form that makes the aggregate constituting the body into a true unity at each moment.[33] Leibniz's

[33] I too have been guilty of this misapprehension, especially in my exchange with Gregory Brown in the *Leibniz Review* (Arthur 1999b, 2001b; Brown 2000), where I ascribed to Leibniz the view that "A corporeal substance, on the other hand, has a non-material unifying principle internal to it, organizing its constituent parts into one in a similar way to which the law of a converging series allows its infinite multiplicity of terms to be summed into a finite quantity" (1999b, 111). Partly as a result of the penetrating criticisms of

argument does not actually commit him to this, and he is careful to say only that bodies *presuppose* unities. What he needs is a principle of *diachronic unity*—a principle that constitutes a substance as the same substance through time despite the fact that its body is not precisely the same body from one moment to another, and which can serve as a foundation for incipient motion at an instant (*conatus*), and which thereby accounts for the differentiation and actuality of the parts of matter. So on my reading there is no synchronic substantial unity of the kind that Adams and Levey are presupposing.

As for the Construction Problem, corporeal substances can be "resolved into" simple substances if, for example, all the relations among the parts of the body—for instance, relations of situation—are relations among the modes (or states) of the substances. Given the simple substances and their modes, the relations will 'result' or supervene. All created substances will then still be embodied, even if their material structures do not remain precisely the same from one moment to another. At a given instant the "construction" of a body as a physical unity will depend on such relations; but the unity referred to in calling an animal a substance will be a unity of function through time, not something cementing immaterial monads into a substantial material composite. And it is this unity of function that delivers it as the same, enduring organic body, despite its infinite complexity and changing relations.[34]

We can throw further light on how aggregation differs from composition by a closer analysis of Leibniz's notions of aggregation, presupposition, and 'being in', the subject of section 2.3.

2.3 'Being in', Presupposition, and Aggregation

Leibniz claims that an aggregate of substances, such as a flock of sheep, is only a phenomenon. Since a body is an infinite aggregate of substances, as we have seen, this is often taken as evidence that matter—and indeed any plurality—is a mere phenomenon, and has no reality except insofar as it is perceived. Bertrand Russell was the first to argue this explicitly. He took Leibniz's claim that infinite aggregates are represented as unities only in perception—which Leibniz defined as the representation of an infinite

Adam Harmer, I now reject this claim. An infinite series of parts of geometrically decreasing size does indeed sum into a finite quantity, but their aggregate is a pure phenomenon; there is no unifying principle turning such an aggregate into a synchronically unified whole. The monad constitutes a particular temporal sequence of representations, each representation corresponding to a different aggregate of subordinate monads, which thereby constitute the organic body over time.

[34] On both of these last points my analysis is in close agreement with that of Ohad Nachtomy (2007). See his analysis of relations and aggregates (chapter 8): "the relations supervene on and presuppose the individuals" (197); "since relations derive from the relata, they are well-founded in the nature of the individuals" (198). And regarding unity being provided by function see his chapter 9 on Nested Individuals: "While an organism is definable through its unique program of action, an aggregate lacks such an intrinsic and unique program" (247); "Since the program functionally organizes the constituents of an organism, it may be seen as its source of unity and identity through time" (247).

plurality in a unity—to mean that there is no plurality independent of perception. So he confronted Leibniz with a dilemma:

> If the plurality lies only in the percipient, there cannot be many percipients, and thus the whole doctrine of monads collapses. If the plurality lies not only in the percipient, then there is a proposition not reducible to the subject-predicate form, the basis for the use of substance has fallen through, and the assertion of infinite aggregates, with all its contradictions, becomes quite inevitable for Leibniz. (Russell 1900, 117)

The basis for this dilemma, of course, is Russell's belief that Leibniz derived his doctrine of substance from a "denial of relations" inferred from the impossibility of expressing relations in a subject-predicate logic. That interpretation has been debunked elsewhere, and I will not recapitulate all of that here. For a start, though, we may note the oddness of Russell's belief. Subject-predicate logic held sway in philosophy until the late nineteenth century, but this did not prevent a huge diversity of beliefs about the reality of relations, even among the schoolmen prior to Leibniz.[35] And, as Leibniz's own attempts to parse relations illustrate, he did not accept that it was impossible to express them using subject-predicate logic, so this could not have been his motivation for his doctrine of substance in any case. But the underlying problem with Russell's understanding of Leibniz lies deeper than this. It is a failure to distinguish *the representation of a plurality as a unity*—which Leibniz held to be achieved by a kind of synthesis of apperception, as Russell rightly alleges (1900, 116)—from *the plurality itself*. It is only the *unity* of the plurality—the plurality's being perceived as one thing—that lies in perception, not the *plurality* (the existence of many things) itself. As I have already argued above, Leibniz's position is a nominalist one, not a phenomenalist one. According to him, it is the unity of the aggregate that consists in its being recognized as one thing; the reality of the aggregate consists only in the reality of the unities from which it is aggregated. We may summarize this position in the following two principles:

The Aggregate Reality Principle:

the reality of an aggregate consists only in the reality of its constituents.

The aggregate itself, however, is a plurality, and being many, it cannot be one. More precisely, it can be represented as one, but this adds no further substantial reality. It is simply the representation of a plurality as a unity. Hence the second principle:

The Aggregate Unity Principle:

the unity of an aggregate derives only from its representation as such (i.e. if it is a sensible aggregate, from perception).

[35] For a detailed analysis of Leibniz on relations, especially in the context of his scholastic precedents and contemporaries, Mugnai (1992) is authoritative. I am also indebted to Mugnai for the recognition that Leibniz's nominalism about aggregation is of a piece with his nominalism about relations. See Mugnai (2012) for further references, and Mugnai's own "last word" on Leibniz on relations.

If this is a purely conceptual representation, then the unity is purely conceptual. Thus to use one of Leibniz's own examples, one can represent all the Roman emperors as a totality: <Augustus, Nero, Tiberius, Claudius, Marcus Aurelius, Caligula, Trajan, Hadrian, etc.>. This is a plurality, consisting in all the emperors taken severally. Note, however, that it is not the *set* of all Roman emperors. Although it agrees with Cantor's notion of a set as any multiplicity that can be thought of as one,[36] the difference is that for Leibniz, if there are no elements to be aggregated, then there is no aggregate. There is therefore nothing corresponding to the null set. Again, there are infinite pluralities, but these are not collections, and therefore not sets.

In the case of sensible things such as bodies, they are represented as one thing by being perceived as one. Their unity is therefore perceptual, and the aggregates in question are phenomenal wholes. A good example of a phenomenal whole is provided by the case of the flock of sheep: its reality consists in the reality of the individual sheep. But the individual sheep are not phenomenal: they are living beings, substances, as I have argued above. It is the representation of the sheep as a flock that is phenomenal. The fact that other perceivers (under normal viewing conditions) also perceive the same flock is due to the spatial relations among the sheep. The sheep, as embodied substances, will have relations of situation to one another through their bodies.[37] These relations may change from one moment to another, but they are not therefore illusory: they are well founded. The flock, in that case, is a well-founded phenomenon.[38]

On this reading each individual sheep, a corporeal substance, is a real unity. The unity consists in the substantial form of the sheep, which remains the same despite changes in the aggregate constituting its body at different times. The body of a given sheep, considered independently of its entelechy, will at any instant be a phenomenon in the same sense as the flock, an aggregate of its constituent unities whose reality reduces to the reality of those unities.

A different reading of Leibniz on the reality of bodies is provided by Donald Rutherford, one that is at once very close, and yet also in sharp contrast to the reading

[36] "By a 'set' we understand every collection into a whole *M* of determinate, well-differentiated objects *m* of our intuition or our thought (which are known as the 'elements' of *M*)" (Cantor, "Beiträge", 1895, *GA* 282). See Levey (2011) for an insightful analysis of Leibniz's logic in relation to plural quantification.

[37] Cf. Anne-Lise Rey (2011, 164), who quotes Leibniz's letter to De Volder of 20 June 1703, where he claims that monads "have a certain kind of situation in extension . . . through the machine over which they preside . . . Extended things contain [*involvunt*] within themselves many things that are endowed with a situation, but which are simple" (LDV 269; my translation). Also in agreement is Justin Smith, who summarizes Rey's analysis succinctly: "Monads are situated precisely to the extent that they are implicated in the organic body or natural machine, and it is through this situatedness that they may be said not just to exist but to coexist" (Smith 2011, 104).

[38] Cf. the analysis of Ohad Nachtomy in chapter 8 of his (2007). Like me, he takes issue with Rutherford's charge that relations are "merely ideal" (Rutherford 1995, 222). Even though relations are mind-dependent, this "does not threaten (or even affect) their status as truths" (Nachtomy 2007, 198–9), since, insofar as they are veridical, they reflect relations between concepts and possibilities in God's mind. Consequently, "Well-founded phenomena are distinct from mere phenomena. The logical unification of elements, which is required for an aggregate, does not render a material body a fiction" (199).

I am proposing here. For (in agreement with what I argued above) he depicts Leibniz as deriving the reality of body from the reality of the units of which it is an aggregate, but still insists that this is compatible with what he takes to be Leibniz's late substance-idealism. That is, he denies the reality of corporeal substance in Leibniz's mature philosophy. He claims that to resolve bodies into immaterial principles of unity is to advocate a fundamentally idealist position, although not a phenomenalist one: what are represented in a monad's perceptions are other monads really external to it. But these monads are immaterial substances, not corporeal substances. Rutherford maintains that this substance-idealism is compatible with Leibniz's being a realist about matter, provided the latter is understood in the right way. To assert the reality of matter, he proposes, is to assert that insofar as it is real it presupposes a plurality of monads that constitute that reality: "matter derives its reality, or the possibility of its existence, from the prior existence of monads" (Rutherford 2008, 173). This interpretation depends on the crucial notion of presupposition, which I have so far left unanalysed, and on which Rutherford has thrown a great deal of light. It is a subject that deserves an extended discussion in its own right.

As Rutherford observes, for Leibniz *inesse* ('being in' or 'being contained in') is a technical term used in a wide variety of contexts. It applies not only to spatial inclusion but also to concept-containment, as when he maintains that every predicate pertaining to an individual substance *is in* its complete individual concept. Rutherford quotes Leibniz from a logical paper, "*Specimen Calculi Coincidentium et Inexistentium*", now dated by the Akademie editors as Spring 1686 to the beginning of 1687:

> We say that the concept [*notio*] of the genus *is in* [*inesse*] the concept of the species, the individuals of the species in the individuals of the genus; a part in the whole, but also the indivisible in the continuum, just as a point is in a line, even though a point is not a part of a line. Thus the concept of an affection or predicate is in the concept of the subject. And in general, this consideration extends very widely. (A VI iv 832/L 379)[39]

The notion of *being in*, in turn, is equivalent to *being an ingredient of*, or *being presupposed by*. If *A* is in *B*, this means that once *B* is posited, *A* is immediately posited too: it is presupposed by *B*. Rutherford quotes the following passage from the *Initia rerum mathematicarum metaphysica* (April 1715) in support of the same view:

> We say that an entity *is in* [*inesse*] or is an *ingredient* of something, if, when we posit the latter, we must also be understood, by this very fact and immediately, without the necessity of any inference, to have posited the former as well. (GM VII 19/Mates 1986, 60–1; L 667)

As Rutherford summarizes this, "in general, we may say that an entity A 'is in' an entity B if, when we posit the existence of a B, we must thereby be understood, without need of inference, to have posited the existence of an A" (1990a, 539). Applying these considerations to the case of constitutive unities being in matter, Rutherford concludes

[39] Parkinson translated this as "A Study in the Calculus of Real Addition", and dated it as "after 1690" (GP VII 244–5/Leibniz 1969, 141); cf. Rutherford (1990a, 541).

that from the fact the unities are said by Leibniz to be in matter, we should no more conclude that they are *spatially contained* in matter than that the concept of the predicate is *spatially contained* in the concept of the subject. What is meant by an aggregate presupposing constitutive unities, Rutherford argues, "is just to say that the latter derives its reality, or the possibility of its existence, from the former by virtue of a relation of essence" (548): "unless these prior *entia* should exist, it is conceptually impossible that the *entia* which they 'are in' should exist" (544). He quotes a passage from the 1680s in support of this reading:

> And it seems, therefore, that that *is in* [*inesse*] a subject whose reality is a part of the reality of the subject itself; or, as I should say, in a way better suited to forming and demonstrating propositions, *A is in B*, if every thing that is immediately required for *A* is also immediately required for *B*. But what is immediately required for something, such that nothing more is immediately, nor therefore mediately, required for it, can be called its *reality*.
>
> (*De Abstracto et Concreto*, A VI iv 990)

Thus for Rutherford, "the thesis that bodies are aggregates of monads is at bottom a thesis about the nature or essence of material things" (1990a, 551). Instead of thinking of monads as "atomic entities which are located *within* an extended being, we should instead think of the metaphysical requisites . . . [as] the things without which it would be impossible for us to conceive distinctly of a genuine plurality" (546). Thus, Rutherford feels entitled to conclude, "When we say with Leibniz that a body is an aggregate of monads, we assert that its appearance is grounded in some specific plurality of monads" (549). The monads are related to one another in such a way as to produce in another monad the appearance of a body, whose reality is constituted by the fact that "any veridical perception of a body is necessarily the perception of a plurality of monads" (551). But the reality of the body is not constituted by the agreement among these perceptions alone, as it is on Adams' reading, but by the plurality of real substances presupposed by any body. Where Rutherford's reading differs from the one I have outlined, however, is his insistence that (i) Leibniz's substances are not "in" bodies in the sense of being spatially contained in them; and (ii) that "the presupposition arguments sketched above make no claim about the existence of particular bodies" (Rutherford 2008, 172).

It will repay us to look at Rutherford's argument in greater detail, beginning with his denial that monads are spatially contained in their bodies. As we have seen, Leibniz's notion of 'being in', 'being an ingredient of', or 'being presupposed by' has the broadest application: the notion of the subject contains or presupposes the notions of the predicates that are in it, without any connotation of spatial containment. We should, therefore, distinguish a very general sense of aggregation corresponding to the most general connotation of 'being in' from the mereological aggregation involved in the part–whole relation, where all the parts taken together comprise or compose the whole.

I will retain Leibniz's term 'aggregate' for the most general sense of the word, with no connotation of spatial togetherness, nor wholeness. In this sense, (1) the concept

of the subject is an *aggregate* of the concepts of the predicates that are in it, (2) the pair constituted by "the diamond of the Grand Duke and that of the Great Mogul" is an *aggregate* of the two diamonds "even though they are a long way apart from one another"(to Arnauld, 8 December 1686; A II iiB 120/WFT 117–18), (3) a flock of sheep is an *aggregate* of individual sheep, (4) a line is an *aggregate* of the finite line segments into which it has been divided, and (5) an abstract line is an *aggregate* of the endpoints of all such segments into which it can be divided. It is important to see, however, that with respect to spatial containment the relation of the constituents to the aggregate in each of these five examples is different. In case (1) neither the concept of the subject nor the concept of the predicate exists in space; in (2) the pair of diamonds is only a "being of reason", an aggregate by conception, since they are conceived together and one collective noun is used to describe them: the diamonds have spatial locations, the pair only does in a very derivative sense; in (3), however, the flock of sheep must exist where the sheep are: the sheep and the flock are contained in the same region of space, even if the flock, as something superadded by the perceiving mind, has no mind-independent reality apart from the sheep that are its constituents; in case (4), the line segments that are parts of the line compose to form the whole line, and are spatially contained in it; in case (5), there is no part–whole relationship between the points and the line, but the points are nevertheless spatially contained in the line.

Now what this means is that when Leibniz tells us that simple substances "are in" matter everywhere, the relation "is in" does not by itself determine the kind of spatial containment that might or might not be involved. I doubt that the five cases I have enumerated exhaust all the senses of 'being in', but these are the ones that typically come up in Leibniz's examples. Rutherford concentrates on case (5), since the analogy with points in a line is one Leibniz often makes.[40] It features prominently in his exchange with the Italian philosopher Michel Angelo Fardella in March 1690, which Rutherford quotes (2008, 168):

> There are infinite simple substances or created things in any particle of matter; and matter is composed from these, not as from parts, but as from constitutive principles ôr immediate requisites, just as points enter into the essence of a continuum and yet not as parts, for nothing is a part unless it is homogeneous with a whole, but substance is not homogeneous with matter or body any more than a point is with a line. (A VI iv 1673)

Here the emphasis is on points entering into the *essence* of the continuum which leads Rutherford to conclude that "points are 'in' a line in the sense that they are necessary for the line to be and to be conceived, but they do not *constitute* the line" (Rutherford 2008, 170). They are the units presupposed by the line, but neither the abstract line nor the points are concrete existents: "This is because a mathematical continuum is not

[40] "Leibniz clearly aims to model the matter–monad relation on the line–point relation" (Rutherford 2008, 169).

a real entity that is constituted from prior existing things" (170). By analogy, then, monads are in matter only insofar as matter, as a plurality, presupposes unities out of which it is aggregated. But in the case of matter, more is required than mere unities: the existence of real unities requires that matter really exist: "Nothing can exist as a plurality or composite unless its existence can be explained in terms of the prior existence of unities" (172). Thus "matter derives its reality, or the possibility of its existence, from the prior existence of monads" (173).

Possibility of existence, however, is not the same as actuality. As Rutherford concedes, his argument makes no claim for the existence of particular bodies, and consequently it cannot establish the actual existence of the simple substances or monads. All it establishes is their *possible existence*, or rather the impossibility of matter's being real without their being real. But as Leibniz wrote to Jacques-Benigne Bossuet in 1693, "Possibility by itself produces nothing if it is not put into actuality": "to clarify the nature of body, it is not enough to attribute to it a mere possibility, which tells us only what it could have; one must also attribute to it something effective, namely power", that is, a primitive power or entelechy.[41] As I will argue further below, Leibniz's argument is that every actual part of matter presupposes something that makes it actual, namely, an *entelechy*: an entelechy that is either the body's substantial form or the forms of the organic bodies within it.

Contrary to what Rutherford maintains, therefore, the substances actually have to be in a body in a more robust sense than merely being presupposed as constituting its essence. Each of these entelechies is specific to the organic body it actuates, and informs that body. Although the soul or entelechy is not spatially contained in the body, nevertheless it is specific to the body in that it is the principle that informs or makes actual that part of matter. The soul does not exist at a point inside the part, but nevertheless it is in that volume in the sense that it is where the activity resulting from it has its effect. As we shall see in the ensuing chapters, it is these entelechies and the distinct endeavours that result from them that produce the actual divisions in existing, secondary matter. They are the principles of motion: without them, matter at a moment would not differ from matter at any other moment, and the resulting pure extension would be an abstraction, and not an existing thing. (This is the crux of Leibniz's rejoinder to Sturm, as we will see in Chapter 6.) This consideration is tightly connected with the difference between matter's mere divisibility and its actually infinite division that I stressed above: if matter were not divided into actual parts, but merely potential ones, its being a plurality would only prove that some unities—perhaps the same finite

[41] "Mais la force d'agir est une *entelechie*, ou bien un acte positiv, et c'est ce qu'on demande. La seule Possibilité ne produit rien, si on ne la met en acte; mais la force produit tout" (A II iiB 753; 5 December 1693); "Cependant il n'est pas assez pour éclaircir la nature du corps, qu'on luy attribue une simple possibilité, qui ne dit que ce qu'il pourroit avoir, il faut luy attribuer quelque chose d'effectif, sçavoir la puissance, qui est un estat dont l'effect suit, pourveu que rien ne l'empeche. Cette puissance quand elle est primitive est proprement la Nature du corps, c'est à dire selon la definition d'Aristote, le principe du mouvement et du repos ou plustost de la resistence au mouvement" (A II iiB 745; 23 October 1693).

aggregate of unities—are presupposed by each part, not that there is an infinity of organic bodies, and thus an infinity of substances, in any part of matter however small. I shall call this "the *distinct actual parts objection*".

There must, moreover, be more to the elements of an aggregate's being *constitutive unities* than their merely being *presupposed* by it. For a given line divided into segments presupposes those segments as its parts, in that, if it did not exist, neither would they. But the segments are not constituent *unities*, since they are divisible. The points, on the other hand, are unities presupposed by every part of a line, and are not themselves parts. This seems to be the point of Leibniz's analogy between points and monads in his explanation for Fardella:

> Although the aggregate of these substances constitutes body, they do not constitute it as parts, just as points are not parts of lines, since a part is always homogeneous with the whole. However, the organic bodies of substances included in any mass of matter are parts of that mass. (A VI iv 1671)

As I read this, the analogy between the real unities in matter and points is that the points, while not being parts of the line, nevertheless *constitute* the line. This agrees with the conclusions of Vincenzo De Risi in his study of Leibniz's Analysis Situs (De Risi 2007, 173–5). According to De Risi, abstract space (and a fortiori, a continuous line) is constituted by all situational points related to a given point by relations of congruence, and yet is not composed of these points, which are not homogeneous with the line or space.[42] The points are thus constituents of the line. Leibniz's analogy then suggests that, similarly, matter is not composed of monads, which are not parts; but it is constituted by them.

Rutherford, as we have seen, objects to the idea of points constituting a line on the grounds that "a mathematical continuum is not a real entity that is constituted from prior existing things" (2008, 170). He rightly points out that such a continuum "is ideal because it has no determinate parts from which it is composed", in contrast to actual things, where the parts are determinate. As Leibniz tells De Volder, "In fact, the continuum involves indeterminate parts, whereas in actuals nothing is indefinite: indeed, in actuals any division that can be made, is made" (19 January 1706; GP II 282/LDV 333). But this does not entail that points cannot constitute a continuum, only that they cannot constitute it as an actually existing entity. Matter, on the other hand, insofar as it really exists, must be constituted by entities that actually exist, and composed of determinate parts at each instant. These parts compose the body in a straightforward mereological sense, but each actual part presupposes an entelechy making it actual. Rutherford

[42] De Risi quotes Leibniz: "*constitui, dico, non componi*", transposing this remark from the context of Leibniz's discussion in *Dynamica* (IV, i, prop. 5; GM VI 370) about three-dimensional bodies being constituted by two-dimensional surfaces through motion: "every moving body is constituted by infinitely many surfaces, each of which moves with an equally distributed motion. *Constituted*, I say, not composed." But, De Risi maintains, the transposition holds good for Leibniz's situational points: space is constituted by all such points related to a given point by the relation of congruence, and yet is not composed of them. See Arthur (2011a) for further discussion.

resists this on the grounds that since the monads themselves are not spatially extended, matter itself cannot be extended either.[43] Space, being ideal, has no determinate parts.

In fact, one of the mainsprings of resistance to the idea that monads are in matter is the conviction that this would be incompatible with Leibniz's claims that space is ideal.[44] I think this is mistaken. As I have argued elsewhere (Arthur 1994; 2013b), it is only space in the abstract, encompassing all possible divisions, that is ideal. This is perfectly compatible with the idea that matter, and therefore space, is at any given instant actually divided (into "all the divisions that can be made"), forming a specific partition of actually divided parts whose boundaries are demarcated by lines and planes. Such an infinitely partitioned space is an instance of abstract space, which involves all possible divisions. But abstract space is a conceptual entity, not an enduring thing, and the boundaries of the bodies partitioning instantaneous space are the result of the entelechies in a given mass individuating its different parts. Leibniz is quite explicit that these entelechies or monads are situated through their bodies, designated through the boundaries of these actual parts of space. As he tells Des Bosses:

> Although the places of monads may be designated through modifications or boundaries of parts of space, nevertheless monads themselves are not modifications of a continuous thing. Mass and its diffusion result from monads, but not space. For space, like time, is a certain order,… which includes not only actual things but also possibles.… If there were in the nature of things other subdivisions of organic bodies into organic bodies, there would be other monads, other mass, and yet the space filled would be the same. For space is something continuous, but ideal… (to Des Bosses, 31 July 1709/LDB 141)

Let us return to the issue of constitutive unities not being the same as mere ingredients. Here I find some inconsistency in Leibniz's definitions. In some texts he equates the constituents or "inexistents" of any aggregate with those entities which *are in* the aggregate, and gives this relation the widest possible connotation. So, as Rutherford notes, Leibniz gives as examples of constituents the parts of a continuous whole or the points in a line, as in the *Specimen Calculi* of 1686 quoted above. In other texts of the same period, however, he identifies these inexistents as the aggregate's *immediate requisites*, stating some exacting conditions for being an immediate requisite, one of which would rule out parts of the continuum from qualifying as such. In the *Analysis particularum* of 1685–6 Leibniz defines this notion as follows:

> If A is an immediate requisite of B, A is said to be *in* B, that is, A must not be posterior by nature to B, and if A is supposed not to exist, it follows that B also must not exist; and this consequence must be immediate, independent of any change, action or passion. (A VI iv 650).

[43] "Leibniz interprets matter as constituted by substances that are essentially non-spatial: in themselves, monads are neither spatially extended nor spatially located", so that "as an infinity of monads, matter is not spatially extended" (Rutherford 2008, 154).

[44] Thus Hartz: "Outside the divine intellect, [space and time] are eliminatively reduced to mere conceptual structures in rational minds.… In Leibniz's system, space and time are safely tucked away in reason" (2007, 61); Adams: "There are no spatial facts on the ground floor level of Leibniz's metaphysics…It is only by a mental construction that substances and aggregates of substances receive spatial properties" (1994, 255).

As Rutherford explains, there are thus three criteria that must be met for something to be an immediate requisite (1990a, 540). The first is that of being prior by nature, and the second, that of being a necessary condition. Together these define a *requisite*, as Leibniz explains in another draft of the same period: "A *requisite* is a *condition* which is by nature simpler, or, as is commonly said, 'prior by nature' ", and "A *condition* is that which, when removed, a certain thing is destroyed" (A VI iv 627/LLC 271).[45] A requisite is *immediate*, finally, if it does not depend on any intermediate reasoning from *B* to *A*, and is "independent of any change, action or passion". Whereas mediate requisites, "such as causes, must be investigated through reasoning", immediate requisites are, "for instance, parts, endpoints, and in general those things which are in a thing" (A VI iv 627/LLC 271). Thus, as Rutherford observes, the " 'immediate requisites' of an entity *B* cannot be identified as *B*'s 'causes', since causes pertain to 'the mode of existing by which a thing in fact exists', and 'must be investigated through reasoning' " (1990a, 540). This is why he insists that immediate requisites have nothing to do with existence. As immediate requisites of a continuum, Rutherford argues, points do not constitute it as an existing thing; and similarly monads are only conceptually necessary for the reality of bodies, not for their actual existence.

It is the first criterion for immediate requisites, however, that connects up to what Leibniz says about unities and the continuum. Although he has some difficulty in defining the idea of priority by nature to his own satisfaction, Leibniz is adamant throughout his writings that the difference between the parts of a continuous whole and the constituents of actual beings is that while the latter are prior to what they constitute, the former are *not*. For instance, as he writes to De Volder, "there are no divisions in [a continuum] except those that the mind makes, and the part is posterior to the whole. In real things, on the contrary, unities are prior to the multitude, and multitudes do not exist except through unities" (to De Volder, 11 October 1705; GP II 278/LDV 327). According to Leibniz's definitions, then, while the parts of a continuum may be necessary conditions for the whole, and immediate ones at that, they are not prior by nature to the whole they are parts of, and therefore *not* requisites, and *a fortiori*, not immediate requisites. They are in the continuum in the broad sense of 'being in' that is the inverse of Leibnizian aggregation, but they are not in it in the sense that 'being in' is equivalent to 'being an immediate requisite'.

Now it is possible that *being prior to* is not precisely synonymous with *being prior by nature to*. But it is still the case that Leibniz claims that monads, being *simple* substances, are "constitutive principles or immediate requisites" and are *not* parts of matter, and that this is what they have in common with the points that are in a line. Like the situational points constituting a line, they are simpler than their aggregates in the sense that the aggregates can be explained in terms of the unities, and not the other way around. *They are presupposed in every part, while not themselves parts.* The parts of a

[45] (Note the corrections to my translations in LLC in these quotations.) Cf. also *Definitiones. Notiones. Characteres.* of 1686, "Let it be the case that if A is not, B is not: then A will be the *condition*, B the *conditioned*." "Let it be the case that if A is not, B is not, and let A be prior in nature to B: then A will be the *requisite*, B the *required*."

continuum, on the other hand, being similar to the whole, are not simpler than it. That the broad notion of aggregation fails to make this discrimination, I shall call "the *priority by nature objection*".

We can put these objections in more formal dress by using some of Leibniz's own concepts and notation. We have seen that he proposed a very general notion of aggregation, extending not just to parts composing into a whole, but to any constituents being put together into an aggregate. This is the notion he works with in the *Specimen Calculi* of 1686. The constituents *A* are then said to *be in* the aggregate *B* iff, once *B* is posited, *A* is immediately posited too: it is presupposed by *B*. (This corresponds only to the second and third criteria for a primitive requisite as defined above.) In the *Specimen Calculi* Leibniz calls this *real addition*, for which he provides the symbol '⊕'. Thus we may distinguish it from general mereological aggregation as follows:

'+' denotes *mereological aggregation*, or simple composition. If $C = A + B$, and *A* and *B* are homogeneous with *C*, then *A* and *B* are *parts* of *C*, and *C* is a *whole* composed of *A* and *B*.

'⊕' denotes *Leibnizian aggregation*, or *real addition*. If $C = A \oplus B$, then *A* and *B* are *in*, are *constituents* of, or are *presupposed* by *C*, in the sense that when we posit *C*, we must thereby be understood, without need of inference, to have posited *A* and *B* as well.[46]

Thus mereological aggregation is appropriate to *homogeneous* entities, that is, to parts that are of the same kind as the whole they compose. Leibnizian aggregation is more general, and applies to *heterogeneous* constituents as well. In this latter sense, a line can be regarded as an aggregate of points without this implying that it is composed from them.

On this basis we can construct a kind of characteristic similar to the one discussed in section 2.2. As we have seen, Leibniz maintained that every body is divided into parts, which are themselves bodies. We can represent that schematically by

$$B = B + B + \ldots + B \tag{1}$$

This represents the fact that a material body can be regarded as a mereological aggregate of further material bodies that are its parts.

Now on Rutherford's interpretation, the fact that "a real body must be the body of something possessing real unity, or a collection of such" is interpreted to mean that each body presupposes "a specific plurality" of monads or simple substances as its constitutive unities. Thus

$$B = (\mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S}) \tag{2}$$

(The parentheses here serve to distinguish the parts for visual convenience.) Substituting this resolution into (1) gives us that a body is a mereological aggregate, each of whose parts presupposes simple substances:

$$B = (\mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S}) + (\mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S}) \ldots + (\mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S}) \tag{3}$$

[46] Cf. Leibniz's own definition in the *Specimen Calculi* of 1686: "$B \oplus N \infty L$ signifies that *B* is in *L*, ôr *L* contains *B*. But *B* and *N* together constitute or compose *L*, and it is the same with many [constituents]" (A VI iv 832).

But mereological addition is a species of real addition: what is a part is a constituent, since if the body did not exist, then we can immediately infer that none of its parts would. Thus each part is an aggregate of simple substances, and so is the body as a whole:

$$B = \mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S} \oplus \mathrm{S} \oplus \mathrm{S} \oplus \mathrm{S} \oplus \ldots \oplus \mathrm{S} \oplus \mathrm{S} \oplus \mathrm{S} \oplus \mathrm{S} \oplus \ldots \mathrm{S} \tag{4}$$

This accords with Rutherford's claim that "matter derives its reality, or the possibility of its existence, from the prior existence of monads" (2008, 23) or simple substances. Since the reality of an aggregate consists in the reality of its constituents, body presupposes simple substances.

But there is nothing in this construction to give us an *infinity* of monads. According to (2), a body presupposes a specific plurality of monads. But (a) this plurality could well be finite, and (b) it could be the same specific plurality of monads that is presupposed by each part of the body in (3). The upshot is that the simple substances into which a given body is resolved (i.e. those on the RHS of (3)), could be the same specific finite aggregate of monads. In such a representation, therefore, the infinitude of monads is posited rather than derived, nothing about the actual existence of bodies is entailed, and the connection with the problem of the continuum is lost. This is the *distinct actual parts objection*.

The second objection identified above is the *priority by nature objection*. If mereological addition is a species of real addition, then it would be equally valid to infer from (1) that

$$B = B \oplus B \oplus \ldots \oplus B \tag{5}$$

Body would then be constituted by other bodies, and there would be no need to presuppose unities. Clearly this contravenes Leibniz's insistence that bodies, being extended, are pluralities, and not unities. Rutherford assumes, rightly, that the constituents of bodies are simple substances, because these, and not bodies, are unities. But it would be more satisfactory to have this follow from the definition of the immediate requisites to which they are supposed to be equivalent.

So let us see if we can give a construction that avoids these objections. To represent the connection with the problem of the continuum we must take into account that the actual division results in any body being an organic body or an aggregate of organic bodies. Now, "the organic bodies of substances included in any mass of matter are parts of that mass". So an actual body $B(t)$—that is, a particular body actually existing at some given time t—will be a mereological aggregate of distinct actual parts, each one an organic body O_i. We may render this schematically as follows:

$$B(t) = O_1 + O_2 + O_3 + O_4 + O_5 + O_6 + \ldots \tag{6}$$

Here the '+' denotes mereological aggregation of the actual parts of the body existing at a given time. Now, every organic body O_i is itself a body B_i made actual by its

containing its own entelechy E_i. It therefore presupposes both E_i and B_i as immediately inferred necessary conditions for its actual existence:

$$O_i = E_i \oplus B_i \tag{7}$$

Together, (6) and (7) give us that every existing body is an aggregate of organic bodies, each of which presupposes a specific entelechy making actual its own body:

$$B(t) = (E_1 \oplus B_1) + (E_2 \oplus B_2) + (E_3 \oplus B_3) + (E_4 \oplus B_4) + \ldots \tag{8}$$

This says that an actual body is divided into actual parts, each corresponding to the entelechy that it presupposes. Note, however, that the body is a mereological aggregate of homogeneous parts. Each part of the body *B(t)* is an organic body, and they aggregate to a whole by mereological aggregation '+'.

Now the process of substitution may be repeated, as before, so that

$$\begin{aligned} B(t) = (E_1 \oplus \{(E_{11} \oplus B_{11}) + (E_{12} \oplus B_{12}) + \ldots\}) + (E_2 \oplus \{(E_{21} \oplus B_{21}) + \\ (E_{22} \oplus B_{22}) + \ldots\}) + \ldots \end{aligned} \tag{9}$$

and so on. The same process may be repeated indefinitely, given the recursive definition of organic body. After any finite number of substitutions, we will always have an aggregate of organic bodies, each of which presupposes the matter of its own body *B* and entelechy *E*. These organic bodies compose mereologically into the original body.

Now, since *every* body is actually divided, we should take this process to infinity. But this is an actually infinite process in the syncategorematic sense: each part of the body is actually divided, but there is no collection of all the parts. We can nevertheless speak of the aggregate of *all* the parts in the distributive sense: each part is so divided.[47] Here I see an analogy with Leibniz's conception of infinite analysis, which also involves the notion of an actual distributive infinity of constituents with no last term. A contingent proposition, Leibniz claims, contains no contradiction, although it is impossible to prove this in a finite number of steps. Nevertheless, God is able to make the infinite substitution of equivalences constituting such a proof in one flash of intuition, without having to proceed through these steps in succession, which would presuppose a collection. Assuming such an infinite substitution, we would have an actual infinite, although not an infinite collection.[48]

[47] In the *Specimen Calculi* of 1686, Leibniz is explicit that real addition applies to aggregates distributively: "Thus our demonstrations apply even to those things which compose something distributively, as all species together compose a genus" (A VI iv 833/L 379).

[48] Here I am profoundly indebted to the perceptive comments of Samuel Levey, who revealed himself as one of the anonymous reviewers of the manuscript for Oxford University Press. In a first draft, as in previous publications, I had equated an infinite's being completed with its being a collective infinite. But these are not necessarily the same: Leibniz's rejection of the "categorematic" or collective infinite does not commit him to denying that an infinite series of terms can be completed. In fact, in order for his account of contingency to succeed, there must be a completed actual infinity of requisites for every state despite the fact that there is no last requisite. See my (2014) for an account of Leibniz's theory of contingency.

There is therefore an actual infinity of actual parts or organic bodies in any given existing body at any instant. Each organic body, moreover, has its own entelechy or monad that renders it a distinct actual part of the body. So there is a 1–1 correspondence between the distinct actual parts into which an actual body is divided and monads, thus circumventing the "distinct actual parts" objection. There is an actually infinite multiplicity of monads in any existing body; and insofar as they are embodied, these monads are spatially contained in the body.

Turning now to the "priority-by-nature" objection, we have seen that for Leibniz an immediate requisite, insofar as it can be identified with a constitutive unity, cannot be a part, even though it is presupposed by every part. We can capture this in a definition:

Constitutive Unities:

X is a constitutive unity *of Y iff it is an immediate requisite of (i.e. presupposed by and prior by nature to) every part of Y, and is not itself a part of Y.*

Thus each organic body *B*, insofar as it is extended, is not a constitutive unity. Even though it is in or presupposed by each part of the body, it is not prior by nature to the aggregate of which it is a part. The entelechies that are in each part, however, are prior to them, and therefore constitutive unities. A body's being extended is explained in terms of the entelechies *E* in each of its actual parts that are simultaneously diffused or repeated, but no occurrence of *E* is itself further resolved. The entelechies therefore count as the body's constitutive unities. They are immediate requisites in the strict sense, since they are prior to the organic bodies of which they are constituents. A body is therefore resolved into monads or simple substances as its constitutive unities, but it is not composed of them as parts. This resolves the "priority-by-nature" objection.

Points are likewise constitutive unities for a line. They are in every line segment, since they bound it, but unlike the segments, they are not parts of the line. If they were mere endpoints, though, it would be hard to see how they could be said to constitute a line: the continuum is not composed of them. De Risi's analysis suggests that they are able to do this because they are situational points bearing relations of congruence to one another.[49] Analogously, we have seen that bodies have structure because of the relations existing among their constituents, whose "modes contain within them certain relations to other substances", and allow the mind to perceive them as constituting one body (A II iiB 191/WFT 127). Thus monads constitute a body by virtue of the relations to other substances contained in their modes, which result in the structure that we perceive bodies to have. This, I have suggested, resolves the Construction Problem identified above.

[49] Analyzing Leibniz's parallel argument about the resolution of motion (the topic of Chapter 5 below), Samuel Levey argues that, "viewed from the outside", as it were, "where *all* the scales and *all* the divisions are given at once, a resolution of motion into a powder of points (or leaps) seems to be inevitable—for having cut back every finite interval into finer and finer parts without end, what extended intervals could now remain?" (Levey 2003b, 402). On the contrary, I maintain that if "every" is taken in the distributive sense, then every subinterval is extended, and there are none that are not; but no subinterval is a constitutive unity.

But what about corporeal substances? If the reality of an organic body at any time reduces to that of its constitutive unities, does a corporeal substance have any more reality than its body? By the above analysis, a corporeal substance presupposes an entelechy and its own organic body as constituents:

$$C(t) = (E_0 \oplus B_0(t)) \qquad (10)$$
$$= (E_0 \oplus (E_1 \oplus \{(E_{11} \oplus B_{11}) + \ldots\}) + (E_2 \oplus \{(E_{21} \oplus B_{21}) + \ldots\}) + \ldots)$$

Again the bodies, being extended, are always further resolvable into other bodies with their entelechies, whereas the entelechies presupposed in each part are not; they are therefore constitutive unities. So the corporeal substance is also resolvable into simple substances as its constitutive unities, just like its body. The difference, however, is as follows. A corporeal substance is the same thing through time by virtue of its entelechy E_0. This is what differentiates it from a mere aggregate. Its body $B_0(t)$, on the other hand, is an aggregate constituted by a different plurality of parts at each instant t. Its being the body of the same substance through time is explained in terms of its functioning as the body of that unity. A corporeal substance is not a mereological aggregate of those instantaneously existing organic bodies, but the belonging of the various $B_0(t)$s existing at different times to the same substance E_0 is explained in terms of their functioning as its body through time. This resolves the Unity Problem identified above.

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To summarize the conclusions of this chapter: a pure phenomenon is an aggregate (appearing to the senses) that has only a mental unity and no reality, whereas a well-founded phenomenon is an aggregate (appearing to the senses) that has both unity and reality. The unity of a body, being provided in perception, is what makes it phenomenal; the reality derives from that of its constituents. But by the above argument, each of these constituents, although in itself a simple substance (one not further resolvable), has its own corresponding organic body. Since on this reading, Leibniz does not deny the reality of body, this is not incompatible with his holding that there are only simple substances constituting the reality of each body ad infinitum. The reality of body reduces to the reality of the simple substances that are its constituent unities, but "in them are the sources of all things and of the modifications that come to things" (C 14/MP 175).

In Chapters 3–7, we will see a similar kind of reasoning underlying Leibniz's views on motion and on extension, whose reality reduces to the reality of certain constituent unities, but which is nevertheless phenomenal when taken as an entity. The reality of motion derives from irreducible states of change or active force presupposed by every interval of motion, however small; its phenomenality has two sources (like the rainbow analysed above). On the one hand, it is an infinite aggregate of these states of change; on the other, motion is not an absolute attribute of things, but only relative to a point of view: something moves only in relation to the standpoint of a given perceiver. The reality of extension presupposes a diffusion of centres of active and passive

force in any extended thing, however small; again, its phenomenality derives firstly from the fact that it is an infinite aggregate of these diffused sources, and second from the fact that its appearance as something extended is provided in perception. The continuity of matter, motion, time, and space, on the other hand, involves an abstraction from the underlying substantial unities. As I shall argue in Chapter 7, continuity is something that is constructed in perception, but in such a way that it corresponds to the diffusion of the real constituents throughout intervals of arbitrary smallness.

Thus corporeal substances, insofar as they are substances, are not composed of any parts, but are indivisible. Although they can be resolved into an organic body and an entelechy or dominant monad, only the monad is not resolvable into further immediate requisites. The body on the other hand, is not a mereological aggregate of monads or simple substances, but presupposes them as constitutive principles. It results from them in the sense that its reality derives from them. But also the actual division of matter into determinate parts is effected by the monadic entelechies in them, and is not simply constructed in the perception of a perceiving monad. In this sense bodies are well-founded phenomena, whose sources are the simple substances they contain. That everything is resolvable into simple substances alone is not a statement of idealism, if only because these substances are the "the sources of all things and of the modifications that come to things", including derivative forces, bodies, and the relations of situation among them.

Moreover, a dominant monad functions as the principle of unity of a body not by binding together the constituents of a body into a synchronic whole, but by accounting for why the differing aggregates of subsidiary monads existing at various times constitute instances of the same organic body of the dominant monad. A corporeal substance is a monad together with an organic body, where the latter is a series of differing aggregates of monads which are given a unity of form or function through time by the dominant monad, and is thereby distinguished from a mere aggregate, which is unified only by a perceiving mind.

If the preceding account is successful, it makes clear Leibniz's analytic argument for the necessity of non-extended unities. But much remains to be explained about how he reached these conclusions. This will be the goal of subsequent chapters. As an obvious first step, we need to establish the nature of the constitutive unities in matter, and how Leibniz was led to postulate them. A good place to start is with his views on atoms, obvious candidates for enduring unities that are constituents of bodies.

3

Atoms and Souls

> "Although when I became a geometer I relinquished these opinions, atoms and the vacuum held out for a long time, like certain relics in my mind rebelling against the idea of infinity…"
>
> (*Phoranomus*, 1689; Leibniz 1991, 803)

> "In my view there are no *material atoms* in nature, since even the smallest piece of matter still has parts."
>
> (Reply to Bayle, 1702; GP iv 561)

Why should atoms play any role in Leibniz's philosophy, in particular, in his solution to the problem of the composition of matter? After all, one of his favourite arguments against atoms in his maturity is that their existence is contrary to the actually infinite division of matter. Given that he seems always to have upheld the actual division of matter to infinity, why, then, would he ever have espoused atomism? Again, he often appeals to the analogy with atoms in defence of his positing of indivisible substances as the ultimate constituents of matter. Yet if atoms are purely passive, indivisible portions of matter, they would seem to have little in common with his monads, which are in themselves immaterial and essentially active. These enigmas would seem to suggest that atoms have only a negative role in Leibniz's natural philosophy, as a failed natural philosophy which he was once seduced by, but came to reject. In fact, however, as I shall argue here, the real story is much more interesting. Once we understand what type of atoms Leibniz once espoused, and what his motivations were in proposing them, we will at the same time have identified a good part of his motivation for his "atoms of substance". This examination of the context in which Leibniz's views were formulated will require some serious historical scholarship, in contrast with the more analytical approach we took in Chapter 2. In this chapter we will attempt to get straight on his early views on atoms, up until about 1676, and in Chapter 4 will follow this development to his rehabilitation of substantial forms two or three years later.

3.1 The Enigma of Leibniz's Atomism

In one of his reminiscences about his early views on the continuum penned in 1689,[1] Leibniz recalled the period in his youth when he had enthusiastically subscribed to the "New Philosophy". The character Lubinianus, Leibniz's spokesman in the dialogue, recalls how he had embraced the doctrines that the continuum is composed of points and that "a slower motion is one interrupted by small intervals of rest".[2] "And", he continues,

> I indulged other dogmas of this kind, to which people are prone when they are willing to entertain every imagination, and do not notice the infinity lurking everywhere in things. But although when I became a geometer I relinquished these opinions, atoms and the vacuum held out for a long time, like certain relics in my mind rebelling against the idea of infinity; for although I conceded that every continuum could be divided to infinity in thought, I still did not grasp that in reality there were parts in things exceeding every number, as a consequence of motion in a plenum. (Leibniz 1991 [1689], 803)

That "atoms and the vacuum held out for a long time" among Leibniz's cherished views is readily confirmed by an examination of his manuscripts. One may find papers containing some commitment to atomism intermittently throughout the period from 1666 to 1676. Moreover, according to his later recollections, he first "gave himself over to" atomism as early as 1661. Thus in a letter to Nicolas Rémond of July 1714, Leibniz recalls:

> As for Gassendi,…I am not as content with his meditations at present as I was when I was starting to abandon the opinions of the school, while still myself a schoolboy. Since the doctrine of atoms is satisfying to the imagination, I gave myself over to it completely, and the void of Democritus or Epicurus, together with the impregnable corpuscles of these authors, appeared to me to relieve all difficulties… (GP III 620)[3]

As for his reasons for rejecting atoms, Leibniz's mature objections based on the actually infinite division of matter are well known. This passage from the correspondence with Clarke is representative:

> The least corpuscle is actually divided *ad infinitum* and contains a world of new created things, which the universe would lack if this corpuscle were an atom, that is, a body all of a piece and not subdivided…What reason can be assigned for limiting nature in the process of subdivision?[4]

[1] From the second dialogue of Leibniz's *Phoranomus* (Leibniz 1991 [1689], 803).

[2] Both views are characteristic of the "Zenonist" faction of Jesuit philosophers of the early seventeenth century, particularly Rodrigo Arriaga in his *Cursus Philosophicus* (1632, 490ff.). The second view is also endorsed by Pierre Gassendi in his *Animadversiones* (1649, 455–6). It is discussed and criticized by Libert Froidmont in his *Labyrinthus sive de compositione continui* (1631, 62ff.). See Philip Beeley's discussion of this doctrine in his 1996 (298–300); see also Arthur (2009) and Palmerino (2016).

[3] In a letter to Rémond the previous January, he described himself as having begun to deliberate whether to opt for the moderns over the scholastics "at the age of 15" (GP III 606), which fits with a decision to adopt atoms before he went to university in 1661. We know that he had already encountered Gassendi and Hobbes by 1663. See Antognazza (2009, 52); Moll (1978–96).

[4] Postscript to Leibniz's fourth paper (GP VII 377–8/MP 220, 221).

According to this scenario, then, one would expect to find some definitive text or texts from the 1670s in which Leibniz discovers his mature objection to atoms, and presents it accordingly. This is the line taken by the French scholar André Robinet, for example, who locates the crucial change in Leibniz's thinking as his rejection of indivisibles in the fragment *De Minimo et Maximo* (Nov. 1672–mid-Jan. 1673).[5] He then identifies the text in which Leibniz gives a definitive statement of the resulting position as the dialogue *Pacidius Philalethi*,[6] a detailed investigation of the problems of the continuum which Leibniz wrote in November 1676[7] on board a ship from England to Holland (where he would visit Spinoza and other leading Dutch scholars on his way back to Hanover). For in that dialogue Leibniz's spokesman Pacidius eloquently presents the position that has become familiar to us in his mature works:

> I myself admit neither Gassendi's atoms, ôr a body that is perfectly solid, nor Descartes' subtle matter, ôr a body that is perfectly fluid… (A VI iii 554/LLC 185)
>
> But there is no reason why these miraculous leaps should be ascribed to this rather than that grade of corpuscles—unless, of course, we admit atoms, ôr bodies so firm that they do not suffer any subdivision or bending…But I do not think that there are such bodies in the nature of things…since there is no reason why God should have put a stop to his handiwork at this point and left only these creatures without a variety of other creatures inside them, as if they were paralyzed or dead… (A VI iii 561/LLC 199)
>
> Accordingly I am of the following opinion: there is no portion of matter which is not actually divided into further parts, so that there is no body so small that there is not a world of infinitary creatures in it. (A VI iii 565/LLC 209)[8]

There is little doubt that the view Leibniz articulates here represents his mature position, even if, awkwardly, barely a month later one can find him serenely proposing spherical atoms, without so much as a hint of acknowledgement of the arguments of the *Pacidius* that he later found so conclusive.[9] But we might be prepared to discount this on the

[5] Robinet (1986, 186–7). This fragment is edited by the Akademie as "*De Minimo et Maximo. De Corporibus et Mentibus*", A VI iii N5, and translated as "On Minimum and Maximum; on Bodies and Minds" in LLC 9–19. Robinet cites it by its *incipit* (opening words) *Nullum datur Minimum…*, rather than by the Akademie title.

[6] Robinet (1986, 187–9, esp. p. 188): "[Dans le *Pacidius Philalethi*] les points ne sont pas des indivisibles, les points sont des extrémités, des limites…Il s'ensuit que la conception de la matière ne peut plus reposer sur l'indivisible-point puisqu'elle est infiniment divisible en acte, passant sous le modèle de la poursuite de la division vers l'infiniment petit…Et remarquons ensuite que l'éviction du vide et de l'atome s'ensuite."

[7] Leibniz wrote the *Pacidius* during the last ten days of October (OS) on board a ship bound for Holland, whilst waiting in the Thames estuary for cargo and optimal sailing conditions. I give all dates here New Style (NS), which makes its composition the first ten days or so of November.

[8] He has the interlocutor Gallutius respond: "This is an admirable idea of reality you are presenting us with, since so much would have to be missing in order for there to be atoms; whereas the idea that there should rather be a kind of world of infinitary things in any corpuscle you please is something which, as far as I know, has not been adequately considered before now" (A VI iii 566/LLC 211).

[9] In the *Catena* ("A Chain of Wonderful Demonstrations about the Universe", A VI iii 585), dated by the Akademie editors as 12 December 1676 (NS), Leibniz claims that "*atoms* are demonstrated" by supposing the plenum, or even "from the mere consideration that every flexible body is divided into points". We will return to this later.

grounds that it took Leibniz a while to convince himself that the infinite division of the continuum was not merely theoretical, and that "there really were parts in things exceeding every number". Nevertheless, we are faced with a genuine enigma. For this thesis, that the continuum is not just potentially but actually divided into an infinity of parts, is one he seems to have held from as early as 1666, and consistently from then on. So if atoms are disproved by the actually infinite division of matter, then Leibniz had no business entertaining them at all during the decade 1666–76. Let me now detail his early pronouncements on atoms, so we can see what we are up against.

In his *Dissertatio de Arte Combinatoria* of March 1666, Leibniz advocates a combinatoric of atoms as "the only way of penetrating into the secrets of nature—if it is indeed true that large things are composed of small ones, whether you call these atoms or molecules" (A VI i 187), citing Johannes Kepler's *Harmonice* as well as Pierre Gassendi's *Animadversiones* (1649), Chrysostôme Magnen's *Democritus Reviviscens* (1648), and the classical atomists (A VI i 216). Yet in the fourth axiom of the dissertation he had proposed that "Each body has infinite parts, ôr, as is commonly said, the Continuum is divisible to infinity" (A VI i 169). Granted, at first sight this seems to fit the description Leibniz gave in the *Phoranomus* of his early views. Atoms still have a certain claim on his thought, but he has only conceded that the continuum is infinitely divisible. The mention of infinite parts in the first clause of axiom 4 seems dubious as evidence for his subscribing to an infinity of parts in things in reality, an actually infinite division. For as we have seen, on the standard Aristotelian interpretation, a body has infinite parts only potentially, i.e. in the sense that any parts into which it is actually divided are susceptible of further division. However, as Philip Beeley has suggested, Leibniz can be read as using this axiom to prove that the force of motion of a body must be infinite, on the grounds that the motion of the body as a whole presupposes the coming-into-motion of every single part, and thus a moving principle in each one. But the infinitude of the force follows from this only if the parts of the bodies are actually infinite, and not merely potential. Therefore a body must have an actual infinity of parts in reality.[10]

Five years later Leibniz is unequivocally committed to actually infinite division, but now sees it as refuting atomism, just as in his mature work. In the fragment *On Primary Matter* of 1671, he writes:

Matter is actually divided into infinite parts. There is in any body whatever an infinity of creatures. All bodies cohere with one another. Yet every body separates from every other, although not without resistance. There are no atoms, ôr bodies whose parts never separate.[11]

[10] See Beeley (1996, 57). The suggestion that this axiom does concern actual parts had been made previously by Daniel Garber in his (1982, 168).

[11] Leibniz also claims in this piece that without minds in bodies, the persistence of motion in the world would be inexplicable. As Garber notes (2009, 37), this idea does not appear in his published work of this period. But both the necessity of minds for the continuance of motion and the connection between minds and vortical motion are very evident in Leibniz's unpublished writings of 1676.

Yet later in 1671, in the *Hypothesis de Systemate Mundi*, he describes the world as "a space full of globes, touching each other only at points", with voids in the gaps between them. All bodies are either "naturally dissoluble, or they are indissoluble, i.e. atoms". Although atoms are "the only integral bodies", "it suffices for a body to be integral only at its surface", and to be "again composed of infinite globes inside" (A VI ii 294). Similarly in his Paris manuscripts of 1676 one may find Leibniz explicitly upholding both the reality of atoms and the actually infinite division of the continuum, sometimes even in the same passage, as we shall see.

Thus the enigma of Leibniz's atomism is this: if we take atoms in the orthodox sense of Democritus—i.e. as strictly indivisible elements of fixed shape and finite extension—then Leibniz's thesis that matter is actually infinitely divided *directly precludes them*, as he himself urges in his mature writings. Yet this thesis of the actually infinite division of matter is one he had maintained throughout the period in which he had subscribed to atomism.

At first blush this difficulty seems intractable. Although it has perhaps not usually been pointed out in quite so stark a fashion, several commentators have shown some awareness of the problematic nature of Leibniz's dalliance with atoms in his youth, and in the remainder of this section I consider some of the different approaches that have been taken. This will introduce us economically to many of the central features of Leibniz's early atomism, as well as motivate my own resolution of the enigma in the following sections. The three main approaches are these: (i) Leibniz's atoms have been identified with the indivisibles he once thought composed the physical continuum, so that, being the end result of an infinite division, they are of course compatible with it; (ii) it is denied that his toying with a conception of atoms was ever a serious commitment to them; and (iii) it is proposed that the atoms were not indivisible material atoms, but instead atoms of substance, early versions of the corporeal substances he later advocated. Although there is some merit in each of these claims, I shall argue that none can be regarded as providing a wholly satisfactory resolution to the enigma.

First, regarding the claim that Leibniz's atoms were simply the indivisibles making up the physical continuum: certainly, there was ample precedent for identifying atoms with points, including a Platonic tradition for identifying *atomoi* as the rudiments of lines.[12] This can be seen in the *Democritus Reviviscens* of Descartes' contemporary Magnen (cited by Leibniz in his *Dissertatio*), who declared that "The continuum is composed of atoms…", and that "Simple atoms are the indivisible particles of the elements, and the roots of physical lines."[13] And Leibniz was aware of the theories of the Zenonists, who had urged the composition of the line from atoms as the only viable

[12] The Platonic origin of this doctrine is reported by Aristotle: "[Plato] called indivisible (atomoi) lines the origin of the line, and this he often postulated" (*Metaphysics* I 9, 992a19–22).

[13] Cf. Magnen (1648, 160): "*Atomi simplices, sunt elementorum indivisibiles particulæ, & linearum physicarum radices*. [Simple atoms are the indivisible particles of the elements, and the roots of physical lines.]."

solution to Zeno's paradoxes of motion.[14] Indeed the reference by "Lubinianus" to the young Leibniz's having composed the continuum out of points in the same breath as the doctrine that the motion is interrupted by *quietulae* (little periods of rest) could well be taken to refer to his having upheld the theories of the Zenonists, Arriaga, and Oviedo. Paolo Rossi, in his note "Leibniz e gli Zenonisti" (2001), has hinted at such a Zenonist origin for Leibniz's atoms of substance through the intermediary of these Zenonian points.[15]

But whatever the influence of the Zenonists on Leibniz's earlier views, he is not appealing to their account of the continuum in the *Dissertatio* of 1666. For they claimed that Zeno "denied that the continuum is divisible to infinity", so that there are only finitely many points in any continuum,[16] contrary to Leibniz's claims in 1666 and in all his subsequent work. Neither are Leibniz's atoms the same as Magnen's, despite the fact that Magnen, after roundly criticizing Arriaga for trying to compose the continuum from mathematical points, distinguishes his "atoms of material extension" constituting a physical line from such mathematical abstractions. For Magnen nevertheless agreed with Arriaga and Gassendi that "the continuum is composed of atoms or corpuscles finite in number."[17]

If Leibniz's atoms are points, then, they must be identified, not with finite parts of matter, but with the infinitely small parts or *indivisibles* he had posited in his *Theoria motus abstracti* (*TMA*), composed in 1670, and sent to the Royal Society and the Académie des sciences in 1671. This is the reading of Robinet already mentioned above. On the one hand, the indivisibles of the *TMA* are inferred from the fact that continuous matter is actually infinitely divided, not just indefinitely divided, as Descartes had proposed. On the other hand, indivisibles of a line (identified with the indivisibles of Cavalieri's geometry) are justified in terms of motion: an indivisible line is the space traversed by a body with a definite endeavour (*conatus*) at an instant: the greater the endeavour, the greater the indivisible space traversed. One of the main results that Leibniz derives from this theory is that "bodies are momentaneous minds" (A VI ii 266).

[14] According to Arriaga, "the famous opinion of Zeno, Pythagoras, Leucippus, and all the Stoic teachers" that the continuum is composed of indivisibles "is defended by many important and more recent members of our Society [sc. the Jesuits]."

[15] Leibniz refers to the Zenonists in his *Theodicée*: he comments on Descartes's being unable to find an answer to the difficulties concerning the division of matter to infinity, "which he nevertheless recognizes as actual. Arriaga and the schoolmen make well-nigh the same confession; but if they took the trouble to give their objections the form these ought to have, they would see that there are faults in the reasoning, and sometimes false assumptions which cause the trouble" (Prelim. Diss. §70, GP VI 90/H 112). I take issue with Rossi's suggestion that the Zenonisti were a major source for Leibniz's monads in Arthur (2003a); Rossi defends his position in a reply immediately following (Rossi 2003).

[16] Thus, according to Arriaga the Zenonian view is that "a finite continuum is composed of finite indivisibles" (Arriaga 1632, 460). Francisco de Oviedo, apparently conflating the two famous Zenos, writes "that the continuum is made up of indivisible parts is consistently defended by Zeno, the Head of the Stoics, who was followed by the philosophers Democritus and Leucippus" (Oviedo 1651, 334). See Beeley (1996, 299ff.), for discussion and quotations.

[17] See Magnen (1648, 167–8) for his criticisms of Arriaga; and Propositio XIX: "Continuum componitur ex atomis, sive corpusculis finitis numero…" (1648, 174).

This Robinet interprets to mean that the body itself is the point that is proportional to endeavour: "the 'conatus-body' which is a point and not a line, does not endure longer than a moment".[18] But at the same time, Robinet contends, this "conatus-body" is a "conatus-mind", a mind lasting no longer than a moment.[19]

As Robinet acknowledges, however, within two years of devising this novel theory of indivisibles, Leibniz has rejected them. In his *De minimo et maximo* written in the winter of 1672–3, Leibniz now identifies indivisibles with the minima he had hitherto eschewed, and rejects both—indeed, as Philip Beeley has observed, he had already abandoned indivisibles in late 1671.[20] He still upholds the existence of "infinitely small things in the continuum, that is, things smaller than any given sensible thing". But these infinitely small things cannot be indivisibles, he now recognizes in 1672–3, on pain of the same contradictions as arise from trying to compose a line from points.[21]

On Robinet's reading, this still gives a neat explanation of Leibniz's adoption and subsequent rejection of atomism. For since atoms traditionally *are* the indivisibles that are inferred from the division of matter, it would seem redundant for Leibniz to have two kinds of physical indivisibles. Moreover, Leibniz does refer to mind as "consisting in a point", so that it would seem to follow from his description of bodies as "momentary minds" that they would be momentary points.[22] Thus on this reading, as long as Leibniz upholds his early theory of the continuum, he supports atoms as the indivisible constituents of the material continuum, the indivisible parts into which it is infinitely divided.[23] Once he abandons indivisibles, he is bound to reject atoms too.

Neat though this reading may be, however, it doesn't tally well with the detailed development of Leibniz's thought. First, it is chronologically awkward: Leibniz's theory of indivisibles, which he first formulated in 1670, is abandoned by him in November 1671, whereas the text in which Leibniz articulates clearly his mature rejection of atoms, the dialogue *Pacidius Philalethi*, was written five years later in November 1676. There is also the awkward fact that Leibniz entertains atoms on various occasions in the interim. Second, the indivisibles in the *TMA* derive from Hobbes' reinterpretation of Cavalieri, who in turn had seen himself to be building on Galileo's foundation.

[18] "Ainsi le 'conatus-corps' qui est point et non pas ligne, ne dure pas plus d'un moment: il reste 'intra-punctum' " (Robinet 1986, 162).

[19] " . . . les structures de la *TMA* et de son environment métaphysique postulant . . . un concept du 'conatus-corps' qui est un esprit momentané, un concept du 'conatus-esprit' qui practique l'auto-conservation . . . " (Robinet 1986, 162).

[20] In a letter to Arnauld dated November 1671, Leibniz wrote: "there are no indivisibles, but there are unextended things" (A II i 172). See Beeley's discussion in his 1996 (esp. 258–59). See also (A VI 2, 165).

[21] Since "every indivisible point can be understood as the boundary of a line" (A VI iii 97), one can show that the number of such indivisibles in the diagonal of a square is both equal to and greater than the number in the side, thus yielding a contradiction.

[22] On the other hand, though, in the *TMA* Leibniz describes a point as corresponding to a single endeavour, i.e. a thought, not a mind. In order to constitute a "harmony" or "storehouse of endeavours", it seems that a mind needs a structure in which more than one endeavour can be conserved, and thus a plurality of such points.

[23] "Le corps et l'âme sont ponctualisés, rendus indivisibles par l'essence même du modèle de Cavalieri" (Robinet 1986, 160).

But although in his *Two New Sciences* Galileo had resolved the continuum into infinitely many atoms separated by indivisible voids, Cavalieri did not identify his geometrical indivisibles as physical atoms. Hobbes, on the other hand, does advocate atoms, as we shall see; but his atoms are spinning corpuscles with a finite extension, and are not the same as the indivisibles that compose a line. Here Leibniz follows Hobbes. His indivisibles cannot simply be identified with Hobbes', though, since Hobbes' indivisibles are finite (like those of Gassendi and Magnen), whereas Leibniz's indivisibles are actually infinitely small.

But the important point to note here is that Leibniz *does* follow Hobbes in distinguishing his indivisibles from atoms of matter. For both philosophers, although these indivisibles make up the physical continuum and there are always some smaller than others, they are not themselves bodies. Instead, Leibniz describes them as the unextended boundaries or "beginnings" of bodies.[24] Thus in the very period (1670–1) he is supposed by Robinet to be still upholding atoms because of his theory of indivisibles, he explicitly disassociates himself from the atomism of his contemporaries. In the *Hypothesis physica nova* (*HPN*) or "concrete theory of motion", the companion piece to the *TMA* that Leibniz sent to London and Paris in 1671, he writes:

> I have always believed that whatever may be said about atoms with various figures, about vortices, shavings and branches, about hooks, claws, globules and so much other apparatus belonging to the game of the learned, is too remote from the simplicity of nature and from any experiments, and too naïve to be connected in any obvious way with the phenomena. (A VI 2, 248)

He proposes instead a theory of the constitution of matter from *bullae*, tiny hollow balls which were formed shortly after Creation by the rectilinear action of the sun's rays on the rotating matter of the Earth, like the beads in glassmakers' workshops.[25] From then on they are "the seeds of things, the warps of species" (*HPN*, §§6–11). The great advantage of his theory, he claims, is that with it he can explain the cohesion of these ultimate constituents in terms of the overlapping of indivisibles, whereas the atomists and corpuscularians alike have to take the cohesion of their basic particles as an "$\alpha\rho\rho\epsilon\tau o\nu$" or unexplained given.[26]

[24] Thus Leibniz writes to Oldenburg: "for indivisibles are boundaries of things…therefore the two points or extremities of body, that of the one pushing and that of the one pushed, penetrate one another (for there is such a thing as a penetration of points, although not of bodies)" (A II i 64).

[25] "For whenever subtle things endeavour to break through dense ones, and there is some obstruction, the dense things are formed into certain hollow bubbles, and an internal motion of parts, and thus a consistency or cohesion, is produced…The same thing is established in the workshops of glassmakers, where, by a circular motion of fire and a straight one of spirit, glasses, the simplest artificial kind, are produced; similarly, by a circular motion of the earth and a straight one of light, bubbles are produced" (A VI ii 226).

[26] In a letter to Oldenburg in September 1670, Leibniz writes "Hobbes himself assumes a consistency ôr cohesion in things as a kind of arreton" (A II i 63–4). As Beeley reminds us (1996, 71), this objection, that explanations of cohesion in terms of particles already assumed to be cohering would lead to an infinite regress, had been made by many opponents of atomism such as Froidmont, White, Glanville, and Hobbes himself.

Leibniz's theory of cohesion is of great interest in its own right, although rather too complex to explain in detail here.[27] The basic idea is that the indivisibles of a body are not minima, or partless points, but have an infinitely small quantity that is proportional to the body's endeavour to move at a given instant. The endpoint of a body in motion therefore occupies a greater (yet still infinitely small) space than one at rest. Consequently, when one body impels another, or endeavours to move it, it has already begun to penetrate it. This is because at the moment of contact, the extreme point of the impinging body occupies a space that is greater than the extreme point of the body at rest, so that they overlap. Therefore "whatever things move in such a way that one endeavours to enter the other's place, cohere together while the endeavour lasts."[28] As he writes to Pierre de Carcavy in June 1671, it is by means of "my theory of abstract motion that I explain the original cohesion by means of which certain insensible bodies, as if fornicating, obtain their *primary hardness* (which cause suffices for those of us of intelligence to suppose, for otherwise nothing will prohibit there from being a progression to infinity . . .)" (A II i 126–7). This done, he can explain the "*secondary hardness*" of his *bullae*, "how they are made firm by a motion returning on itself around their own centres," so that, with the infinite regress thus broken, he has "explained the elements of sensible things by the origin of *bullae*" (127). These spinning hollow balls (*bullae*), together with the solid globules which he also assumes in the early 1670s, are then Leibniz's "atoms" of this period, although he prefers the collective term *terrellae* (literally, "earthlets").

Of course, even if Leibniz's atoms are not the indivisibles themselves, but the *bullae* composed from them, Robinet could still be correct in his claim that Leibniz's rejection of atoms is a consequence of his "*éviction de l'indivisible*" in 1672. But we are now in a position to see that this does not follow. For nothing in Leibniz's theory of cohesion depends on the points being indivisible, but only on their proportionality to the infinitely small elements of motion, or endeavours. This construal of points in terms of endeavours is strengthened rather than weakened by the rejection of indivisibles, and Leibniz continues to promote his endeavour theory of cohesion from this time onwards.

To summarize: Robinet's identification of atoms with indivisibles fails because in the *TMA* indivisibles are the *geometrical points* from the union of which indissoluble bodies are formed, rather than being those atomic bodies themselves; and because Leibniz offers his theory of *bullae* in the *HPN* as a preferable alternative to atomism in that, unlike the latter, it gives an explanation of the cohesion of its elementary particles.

[27] More extended discussions are given in Arthur (1999a, 113–18), and LLC, Introduction, xxxvii–xliii.

[28] Leibniz to Oldenburg of 28 September 1670 (A II i 64). He gives a similar account in late 1672: "Hence it follows that whatever endeavours to move into another's place already at its boundary begins to exist in the other's place, i.e. their boundaries are one, i.e. penetrate each other; and consequently one cannot be impelled without the other. And consequently these bodies are continuous" (A VI iii 96/LLC 21–3).

Thus even though he occasionally refers to atoms as *physical points*,[29] he does not begin by supposing bodies that are physically indivisible, but explains their firmness in terms of his endeavour theory of mutually cohering, unextended points. Moreover, since his rejection of indivisibles in 1671–2 is only a reinterpretation of his theory of points in terms of endeavours, it is not in itself inimical to his endeavour theory of cohesion, or to the *bullae* or globules whose cohesion is explained in terms of this theory. It is therefore insufficient to explain any change of attitude towards atoms between 1671 and 1676, or why, by his own testimony in the *Phoranomus*, "atoms and the vacuum held out for a long time" after he had "become a geometer" and abandoned his earlier views on the continuum.

A second tack is to take Leibniz's negative attitude to atoms in the *HPN* to represent his real view on atomism, and to dismiss other unpublished papers where Leibniz refers to atoms as simply "work-shop drafts", but not representative of his considered position. This is the line taken by Philip Beeley, who objects in particular to the idea that Leibniz can be seen as "committed to atomism" during the Paris period. Granting that Leibniz "does at this time in numerous philosophical drafts refer to atoms", he argues that the mere mention of atoms or physical indivisibles is not enough to warrant a claim that Leibniz is committed to atomism. The idea that for a time in Paris he embraced atomism is "a mistake" resulting in part "from over-interpretation of work-shop drafts". The various manuscripts involving atoms should properly be regarded, he claims, as further experiments in "Leibniz's workshop of ideas", hypotheses studied for the sake of theoretical exploration.[30] These are what Catherine Wilson has called "momentarily adopted trial positions" (Wilson 1997b, 61), and what Robinet has likewise aptly referred to as "a series of ephemeral hypotheses … in the style of '*videndum est*' [i.e. 'It must be seen whether … ']".[31] In a similar vein, Beeley has observed that Leibniz was surprisingly open to exploring hypotheses with which he did not entirely agree for the sake of a cooperative pursuit of knowledge (Beeley 2001, 86–92). Although in his interchanges with other scholars Leibniz holds fast to certain ideas deeply entrenched in his metaphysics (what we might call, following Lakatos, the "hard core of his research programme"), such as in this case the actual division of matter to infinity and the consequent rejection of atoms, Leibniz nevertheless "finds it perfectly acceptable that the physicist set a certain limit to the analysis of matter" in his scientific practice.[32]

[29] Physical points are thus always extended for Leibniz (in contrast with the unextended indivisibles of 1671), which is why he sometimes refers to them as atoms: thus in his letter to Duke Johann Friedrich of May 1671 Leibniz refers to "physical points" as atoms (A II i 115), and in February 1676 he refers to "points, i.e. bodies smaller than any that can be assigned" (A VI iii 473–4/LLC 47).

[30] All of these quotations are from Beeley (1997, 65–82, esp. 74, 82).

[31] "Ce reclassement des structures est obtenu à suite d'hypothèses éphémères, toutes ces pièces restant sur le style du 'videndum est' " (Robinet 1986, 189).

[32] Beeley quotes Leibniz's letter to Des Billettes of March 1697, which I translate: "… thus there are no atoms, nor perfectly fluid matter, nor perfect globes, and I believe I have a demonstration of that. But just as architects only need to push the analysis of materials down to a certain point, I believe that physicists likewise can arrive at a certain analysis of sensible bodies which serves their practical needs" (A I xiii 656/Beeley 2001, 87).

Beeley's point here about Leibniz's lack of dogmatism must, I believe, be granted without reservation, especially with regard to the heady and inspired manuscripts penned in Mainz and Paris. In these Leibniz seems prepared to let the logical current of his reasoning carry him into uncharted waters, and even to relish this, despite the heretical shores he sometimes reaches in his conclusions. An explanation in terms of his lack of dogmatism, then, might well explain Leibniz's apparent commitment to atomism in certain cases. Perhaps it explains the atomism of the draft *Hypothesis de systemate mundi*, which is explicitly based on hypotheses (such as the non-existence of the plenum) which contradict those of the *HPN*, in which it is mentioned as a separate project lying outside the scope of that work.[33]

But it does not fit well with Leibniz's attitude to atoms in the Paris manuscripts of 1676. Leibniz broaches the issue of atomism undogmatically enough, when he asks in *On the Secrets of the Sublime* (dated 11 February 1676): "Does it seem in accord with reason for there to be atoms?" But his answer is in the affirmative:

> If an atom once exists it will always exist. For the liquid matter of the surrounding plenum will immediately endeavour to dissipate it, since it disturbs its motion, as can easily be shown. If some large body that to some extent resists dissipation moves in a liquid, it will at once form a kind of terrella, and a vortex. (A VI iii 473/LLC 47)

This seems to be an endorsement of the coherency of the idea of atoms' existence. And in manuscripts written in the succeeding months, Leibniz's tone grows progressively more assertive:

> Since, therefore, I have established on other grounds that there is some portion of matter that is solid and unbreakable—for no adhesive can be allowed in the primary origins of things, as I judge to be easily demonstrable—and since, moreover, connection cannot be explained in terms of matter and motion alone, as I believe I have shown satisfactorily elsewhere, it follows that thought enters into the formation of this portion, and that, whatever its size, it becomes a body that is single and indissectible, i.e. an atom, whenever it has a single mind. (A VI iii 393/LLC 57)

> I am more and more persuaded of indissectible bodies; and since these did not originate through motion, they must be the simplest, and therefore spherical, for all other shapes are subject to variety. So it seems indubitable that there are infinitely many spherical atoms. (A VI iii 524/LLC 61)

Although Leibniz certainly changes his mind about whether he has indeed "satisfactorily shown" that connection cannot be explained in terms of matter and motion, the talk of "indubitability" and "demonstration" shows him writing in a decidedly affirmatory mode; that is, even if the existence of atoms is a hypothesis, it is one that at this time he regards himself as having demonstrated.

Beeley also buttresses his case for a consistent anti-atomism on Leibniz's part by a subtle reinterpretation of the doctrine of indivisibles in the *TMA*. On his reading, Leibniz, like Ockham, understands points in terms of lines, though not as their

[33] See A VI ii 225; A VI ii 20–2.

endpoints: they are not minima, or smallest assignable parts, but lines smaller than any that can be assigned.[34] According to Beeley, this means there is an "ontological relativization of the concept of a point" (1996, 243). Points, as lines smaller than any assignable, are indivisible relative to the division of the original continuum, for there are none smaller in relation to the line; but they themselves may be infinite in comparison with other points, and so on down. As for Leibniz's rejection of indivisibles in 1671–2, Beeley claims that his abandoning of this feature is not a major change of position, but merely a making explicit of something already implicit in the nature of point, the fact that it is not partless. This is therefore not so much a change of doctrine as Leibniz's finally recognizing the inconsistency of construing points both as indivisible and as infinitely small lines. Points, therefore, were never really indivisible for Leibniz; and after 1671–2 indivisibles are only endpoints of lines, absolute minima, distinct from the actually infinitely small actuals. Thus, in keeping with his anti-atomism, Leibniz was never committed to physical indivisibles in any absolute sense.

The problem is that in de-emphasizing the importance of this change, Beeley makes it harder to see how Leibniz could ever have invested his talk of "indivisibles" in the *TMA* with any philosophical significance.[35] Yet he certainly did, going so far as to explain the indestructibility of minds as due to the indivisibility of the points in which they inhere. In a short treatise "On the Use and Necessity for Demonstrations of the Immortality of the Soul" [*De usu et necessitate demonstrationum immortalitatis animæ*], written for Duke Johann Friedrich and enclosed in a letter to Oldenburg in May of 1671, Leibniz wrote:

> For I shall demonstrate that mind consists in a point… Whence it will follow that mind can no more be destroyed than a point. For a point is indivisible, and therefore cannot be destroyed. Therefore body is obliterated, and dispersed to all corners of the earth. Mind endures forever, safe and sound in its point. For who can obliterate a point? (A II i 113)

Now with his rejection of the indivisibility of points, this warrant for the non-dissolution of minds is lost. On Beeley's interpretation, however, it was only ever an illusion, which Leibniz recognized as such in late 1671, after which he consistently distinguished infinitely small actuals from indivisible elements in matter, which latter he rejected from then on. But then this will not explain why in 1676 he should have begun to experiment in earnest with atoms that are strictly indissectible and perfectly solid, whose "solidity ôr unity… is due to mind" (A VI iii 509/LLC 117), arguing that "If there were no atoms, everything would be dissolved, given the plenum" (A VI iii 525/LLC 61).

[34] Such a point may therefore be understood as containing parts, as Leibniz explains to Oldenburg in 1671: "especially admirable is the nature of points: for although a point is not divisible into parts supposed *extra partes*, it is still divisible into parts… previously penetrating one another" (A II i 64).

[35] Cf. O. Bradley Bassler's criticisms of Beeley's interpretation in Bassler (1998): "Since Beeley takes the identification of the point with an infinitely small (divisible?) line in the *TMA* as an indication that points are homogeneous with lines, Beeley's reaction is understandably to see this [rejection of indivisibles] as 'Bedeutungswandel ohne inhaltiche Konsequenz' (1996, 258)" (19). Bassler charges that Beeley "fail[s] to take Leibniz's declared position—in particular the indivisibility of points—seriously from the outset" (21).

Beeley claims that in these drafts Leibniz was not embracing atomism; rather, in his opinion, "what he was really trying to do was to solve the fundamental problem with which the *Theoria motus abstracti* and *Hypothesis physica nova* had left him: how to integrate minds into the system". But granting that in 1676 his atoms perform this function, they would seem to be something more substantial than an arbitrary limitation of the physicist's analysis of the division of matter; and granting that this function was previously performed by indivisible points, it would seem that the idea of physical indivisibles of some kind is more than a "momentarily adopted trial position". Nor is it clear how the fact that atoms contain minds is supposed to detract from Leibniz's being committed to them.

This last feature of Leibniz's thought on atoms, their connection with minds and metaphysical unity, prompts consideration of the third main line of interpretation, according to which they are simply early versions of his later atoms of substance, metaphysical rather than physical indivisibles. This is the interpretation offered by Christia Mercer, first in concert with Robert Sleigh (1995) and subsequently in her book, *Leibniz's Metaphysics* (2001). In this connection we may note that in Leibniz's early metaphysics it is the union of matter with a concurrent mind that constitutes *corporeal substance*; in the *TMA* and associated manuscripts "the door is opened for pursuing the true distinction between bodies and minds" by means of the Hobbesian identification of thoughts as endeavours (*conatus*), with Hobbes' materialist intent inverted so that minds are more basic; in the Paris writings thought is described as "entering into the formation" of a portion of matter, so that "whatever its size, it becomes a body that is single and indissectible, ôr an atom, whenever it has a single mind" ("Notes on Science and Metaphysics", 18 March 1676; A VI iii 393/LLC 57); and finally, in the 1680s, corporeal substances, explicitly identified as *substantial atoms*, are described as containing indestructible minds, souls, or substantial forms, making it "probable that they have always existed from the beginning of things" (*Wonders concerning the Nature of Corporeal Substance* [1683]; A VI iv 1466/LLC 265).

Such considerations have led Mercer to propose a continuity thesis even more pronounced than Beeley's, but in a way its obverse: Leibniz *always* upheld atoms, from 1668 onwards, although these are to be conceived of as *atoms of substance* or corporeal substances, *not* the purely material atoms of Democritus and Epicurus, which (she agrees with Beeley) Leibniz rejects. The origins of this position, according to Mercer, are to be found in Leibniz's theological project of 1668 where he gives his first theory of substance, with mind functioning as an active, organizing principle for body, playing the role of an Aristotelian substantial form. "A mind makes the body substantial by constituting its principle of activity", says Mercer (2001, 75), quoting Leibniz's "the substance of the body is union with a sustaining mind" (A VI i 508–9).[36] In the first

[36] Here I shall follow the account Mercer gives in her part of the article with Sleigh (1995), which is more explicit than her recent book about her views on Leibniz's atoms. Her position in the latter, however, seems essentially the same: Leibniz was committed to substantial atoms from 1669 onwards, despite his fluctuating views on cohesion, continuity, and motion. See e.g. Mercer (2001, 282, 293). (Page number references in the text are to the article, unless otherwise stated.)

version of this theory, the substance of each human body is provided by union with its human mind, whereas non-human bodies are made substantial by union with the "universal mind" or God. Moreover, this union is not merely metaphysical but physical. In the *Confession of Nature Against the Atheists* of 1668 Leibniz offers the necessity of a divine origin for the firmness or cohesion of atoms as an opportunity for proving the existence of God:

> Thus in providing a reason for atoms, it is right that we should have recourse to God, who is responsible for the firmness in these ultimate foundations of things. And I'm surprised that neither *Gassendi* nor anyone else among the very acute philosophers of our age has noticed this splendid occasion for demonstrating Divine Existence. (A VI i 492)

But by 1671 a different conception has emerged, in which every body contains its own principle of activity (Mercer 2001, 84). In the letter accompanying the treatise on immortality of the soul written for Duke Johann Friedrich of May 1671, Leibniz asserts that every substance has a "kernel of substance" that can either "spread throughout the body" or "draw itself back into an invisible centre". Mercer identifies this "kernel" with the mind or principle of activity, claiming that "the mind or kernel of every corporeal substance causes and maintains its organization, . . . an organization of matter that can be more or less 'spread out' " (82). This combination of variable matter with constant substantial form, claims Mercer, is what Leibniz means by his references in 1676 to "indissectible bodies":

> Mind takes some portion of matter, acts as the "cement" of the parts of matter, and thereby produces a "naturally indestructible" atom [A VI iii 474ff.]. Nor should the term *atom* mislead us: for Leibniz an atom is indestructible, but it is not invariable; it is the fundamental unit of the physical world, but it is constituted of mind and matter. Mind functions as the metaphysical glue or "cement" of an atom or corporeal substance by persistently producing an organization with some chunk of matter; exactly which chunk it organizes is unimportant. (88)

Thus for Mercer there is a perfect continuity from Leibniz's speculations of 1671 concerning the "kernel of substance" to his mature theory of corporeal substance. The natural indivisibility of atoms or corporeal substances, i.e. "the indestructibility of the union formed between mind and matter", is a consequence of the fact that "whatever acts cannot be destroyed" (A VI iii 521/LLC 121), and that mind "will organize some matter as long as it acts" (88).[37] Moreover, in addition to acting as the "metaphysical cement" or organizational principle, "mind constitutes both the identity of the substance whose cement it is and the source of its individuation" (88). Although there is an important modification in 1678 or shortly thereafter, when Leibniz declares that

[37] In her book, Christia Mercer separates out the problem of cohesion from the problem of metaphysical unity, arguing that in the *TMA* and letters to Hobbes and Oldenburg of 1670, a body consists in "an infinity of substantial atoms which have momentary minds, and whose momentary endeavors constitute the cohesion among the atoms" (Mercer 2001, 282).

he has rehabilitated the notion of a substantial form,[38] and distinguishes minds as a privileged subclass of such forms or souls, the basic idea is the same. It is the mind's (or mind-like substantial form's) ability to retain memories of its past actions that distinguishes it from a merely material body, which would by itself be incapable of action and passion.

Again, this interpretation has much to recommend it. Most obviously, it explains how Leibniz could simultaneously countenance both "atoms" and the actually infinite division of matter: the atoms are indestructible by virtue of the mind they contain, even while their matter varies and is divided infinitely within. Moreover, the commonality Mercer identifies between many of the themes and ideas from Leibniz's first writings about substance and those of his mature metaphysics seems incontrovertible. There can be little doubt that the same concern with the inadequacy of a purely materialist account of body that informed his earliest writings also informs his later ones: throughout he saw it as necessary for body to contain certain unities, whose principles are immaterial. Unless somewhere in matter there are such perduring substantial unities, he never tired of arguing, there would be nothing substantial at all in matter, which would long ago have dissolved into a powder of points. As Leibniz mentions on numerous occasions, this is the very argument that Cordemoy had used to promote his own version of atomism.[39]

Undeniable also is the theological connection to which Mercer draws our attention. As she points out, it was certainly part of the context of Leibniz's early atomism that he was trying to solve traditional problems such as the resurrection of the body, the topic of the essay on the immortality of the soul he appended to his letter to Duke Johann Friedrich in 1671. "Because substantial identity depends wholly on the mind, as long as the mind remains the same so will the body or corporeal substance" (Mercer and Sleigh 1995, 89). Thus despite the dramatic change at death, where the volume of matter organized by the soul shrinks to some minute portion, at resurrection the kernel of substance can diffuse itself through a quantity of matter equal to what it did before death, and thus reconstitute the same individual. This prefigures Leibniz's later doctrine of *transformationism*, according to which death is merely a transformation of the

[38] According to Mercer, though, although Robinet and others date Leibniz's restoration of substantial forms to 1679 or later, they are wrong: "In fact, as we will see, this reformation begins in 1668" (Mercer 2001, 67). I shall argue in Chapter 4, however, that the story is more complicated than this. Leibniz is disposed from the beginning to posit substantial forms (equated with minds) as principles of individuation of bodies, and also their principles of motion and rest. But as his understanding of such principles changes, from his simple concurrent minds, through the endeavour theory to its abandonment, so does his commitment to these principles. It is only when he has arrived at his new theory of force in 1678 that he is in a position to announce the rehabilitation of substantial forms with confidence in its compatibility with a fully mechanistic natural philosophy.

[39] "Yet if there were no true substantial unities there would be nothing substantial or real in such a collection. It was this that forced M. Cordemoy to abandon Descartes and adopt Democritus' doctrine of atoms" (*New System of the Nature of Substances* [1695]; GP IV 482/WFT 148–9). See also Leibniz's letter to Arnauld, 8 December 1686 (A II 2B, 123/WFT 119).

organism in such a way that the domain of influence of its dominant monad shrinks to a physical point—i.e. an insensibly small volume.[40]

But although Mercer has identified several important continuities in Leibniz's thought, in accentuating them she has perhaps glossed over some real discontinuities. Chief among these is the difficulty that the atoms Leibniz entertains in 1676 are explicitly described as "indissectible" (*insecabilis*), as "simplest bodies" which lack variety in all respects but size, and which (unlike his *bullae*) "did not originate through motion" (A VI iii 524/LLC 61). They are "perfect solids", moving in a perfect fluid constituted by infinitely small physical points lacking any original cohesion. That is, like classical atoms, these spherical atoms are maximally hard. And although a mind is indissolubly planted in the matter of each, "this matter is of a definite magnitude (*esse certae magnitudinis*)" (A VI iii 477/LLC 51), unlike that of his earlier corporeal substances, or indeed his later ones, of which he writes in 1683: "A corporeal substance has no definite extension (*nullam habet extensionem definitam*)" (A VI iv 1466/LLC 265). Granted, the atoms of 1676 differ from classical atoms in that each contains a mind which organizes matter as a kind of accretion that may vary over time. But this matter is described as organized not around the mind, but around the atomic body itself: "Body is as incorruptible as mind, but the various organs around it are changed in various ways" (A VI iii 510/LLC 119).[41] This suggests that *the atoms of 1676 are not to be directly identified with corporeal substances, but are instead their indestructible cores or centres*.[42]

This in turn invites a similar re-reading of the theory Leibniz proposed for Duke Johann Friedrich in his letter and accompanying essays in May of 1671. Here, too, mind or soul is encased in an indestructible centre, and matter is organized around this central core. In the treatise on resurrection he wrote for Duke Johann Friedrich (21 May 1671), he writes: "Even the Jews relate the story that in a certain little bone they call the *Luz*, the soul survives intact in all cases together with the flower of substance" (116). Only, at this juncture Leibniz considered the central core or kernel to be a "physical point", containing the soul at a mathematical point inside it: "this kernel of substance, consisting in a physical point (the proximate instrument and as it were

[40] A representative statement of this is given in Leibniz's *Specimen Inventorum* of *c*. 1686: "Indeed, just as some people have proposed that every generation of an animal is a mere transformation of the same animal now living, and a kind of accretion that renders it sensible, so by parity of reason it seems defensible to hold that every death is a transformation of the living animal into another smaller animal, and is a kind of diminution by which it is rendered insensible" (A VI iv 1623–4/LLC 317). Cf. Leibniz's letter to Arnauld of 9 October 1687, where he cites both Leeuwenhoek and Swammerdam in support of his belief in transformation (A II 2B, 254–5/WFT 133).

[41] This description of the body of a living being as having an unchanging core, but with organs around the core changing during the animal's development, is again highly evocative of Zabarella. See Blank (2015).

[42] The mind-containing atoms are also the centres of the associated vortices, as Catherine Wilson has observed (in her unpublished paper "VORTEX: The Significance of Inertial Circular Motions in Leibniz's Paris Notes, with Reference to Aristotle, Hobbes, and Descartes"). She suggests that Leibniz's strong association of mind with vortical motion in this period is connected with his identification of the latter with the eternal circular motion of Aristotle's fifth element. Mind occupies a singularity, as it were, at the centre of the vortex, encased in an indivisible material kernel. Wilson suggests that this way of conceiving mind comes to an end with Leibniz's *Thought is Not Motion* at the end of the Paris period (A VI iii 586–7/DSR 111).

vehicle of the soul constituted in a mathematical point) remains always,…" (A II i 109); "Mind endures forever, safe and sound in its point" (A II i 113). Thus the *corporeal substance* would be the whole complex of mind together with an organized portion of matter of varying magnitude, as Mercer has observed: but this would not be the *atom*, which would instead be the indestructible core. Leibniz says as much in his *De resurrectione corporum*, which he appended to the essay that he sent to Duke Johann Friedrich. For in his discussion of cannibalism *the mind is implanted in the indestructible point*, even if that is all that is left of the atom: "…even if not even an atom (other than that point in which the mind is implanted) is now left of me…" (A II i 115).[43]

In a recent article Andreas Blank has presented considerations that appear to provide strong support for this interpretation. He draws attention to Leibniz's comments in his Master's thesis for Leipzig, the *Specimen quaestionum philosophicarum* of 1664,[44] on the controversy about how substantial forms are related to growth in living beings. Leibniz approves the position taken by Jacopo Zabarella in his *De accretione*, with the remark that he (along with Averroës and Angelo Mercenario) "have more closely seen the mind of Aristotle and also have elegantly declared how a living being remains one".[45] This refers to Zabarella's rejection of Duns Scotus' position that both the matter and the substantial form of a living being change during its growth and development, and his endorsement of the view that there is some part of the body of a living being to which the soul is more closely attached that remains the same during its life.[46] Leibniz writes:

> It also has to be denied that it ever happens that a human being loses all of its parts, and it is certainly probable that the soul is, as it were, more firmly implanted in some parts, so that in one place there is the source of life and in other parts the little streams of life, and that the former parts always remain. The Rabbis of the Jews have delightfully built a dwelling place of the soul in a certain body part, which cannot be separated by any force, any hammer, and they decreed that the soul reigns in this hall even after the death of the human being. (A VI i 91)

Thus Leibniz's view that the seat of the soul is in a hard part of the body, analogous to the chymists' *caput mortuum* and the Rabbi's *luz*, is a constant in his thought from 1664 to 1676. But there is also a strong correspondence with the views of Zabarella in

[43] As noted above, this seems to accord with Robinet's interpretation of points as atoms. But Leibniz distinguishes the (concrete) physical point from an (abstract) mathematical point, or indivisible, in much the same way as he does much later in the *New System*: "when a corporeal substance is contracted, all its organs together make what to us is only a *physical point*… *mathematical points* are their *points of view* for expressing the universe" (G IV 483/WFT 149).

[44] *Specimen quaestionum philosophicarum ex jure collectarum* (*An Essay of Collected Philosophical Problems of Right*) (G IV 483/WFT 149).

[45] (A VI i 90–1/Blank 2015, 2). Zabarella's *De accretione* is in his 1590 (col. 718): the passage in question is given by Blank (2015, n. 15).

[46] As Blank notes, Leibniz repeats this endorsement of Zabarella's interpretation of Aristotle's substantial forms in his *De transsubstantiatione* of 1668/9, where he claims that Aristotle equated substantial form with a thing's nature or principle of motion and rest, and that, in agreement with this, "Averroes, Angelo Mercenario and Jacopo Zabarella also claim that substantial form is the principle of individuation" (A VI i 510/Blank 2015, 2).

Leibniz's belief that the soul or form is always attached to some part of matter, a point we will return to later.

Nevertheless, despite this clear continuity in Leibniz's thought concerning the interpretation of the soul or form as an immaterial principle necessary for the individuation of a living being, and its being implanted in an atomic core from which it extends its influence by means of circulating fluids or spirits, the precise way in which mind is supposed to organize matter seems to have been an open problem for Leibniz in this period, and one on which he changed his views more than once. Indeed his thinking throughout the whole ten years from 1668 onwards is characterized by constantly changing views on how mind is relevant to the cohesion of matter. We have already noted how the young Leibniz was elated to be able to explain what the atomists could not, the cohesion of their primary particles, in terms of his endeavour theory of original cohesion. Cohesion around the equator and latitudinal lines of his *bullae* is explained by the spin of the particle, forming a closed chain of overlapping points. To be sure there is a continuity between the atoms of 1676 and the *bullae* or *terrellae* that preceded them, for in each case the particle is immersed in a fluid at the centre of a vortex, and each such particle-vortex is associated with a mind. But whereas in 1671 the *bulla* is actually created by the action of light on the aether causing a vortex, and its cohesion is explained in terms of this spinning about its own axis, in 1676 the atom is a perfectly solid body whose solidity is perhaps explained by mind and whose firmness is the cause of the associated vortex: "It is necessary that as many vortices are stirred up as there are firm bodies in nature, solely by the motion of the firm bodies. And there are in the world as many minds, ôr little worlds, as there are vortices."[47] So we see that, on the one hand, Leibniz does not in 1676 separate the problems of metaphysical unity of a body from its physical cohesion, as he later would, after he has finally rejected atomism; and on the other, the idea that mind or soul accounts for body's cohesion and unity is more a statement of an ongoing research programme than a solution to a problem that remains constant.

3.2 Leibniz and the Chymical Tradition

At this point it may seem that all we have done is to muddy the waters. For apart from still having to explain how Leibniz could uphold infinite division and atoms simultaneously, we are now also faced with elements seemingly extraneous to atomism as normally understood: the individuation of substances; the indestructibility of minds or souls; and the biological theory of transformation. In addition we have the problem of why in 1676 Leibniz should have reverted to atoms lacking all variety except size, and subsequently replaced them with his theory of corporeal substance.

[47] (A VI iii 393/LLC 59). Cf. also "There are as many vortices . . . as there are indissectible bodies" (A VI iii 525/LLC 63), "there are as many minds as vortices, and as many vortices as solid bodies" (A VI iii 509/LLC 117).

In what follows I shall argue that not only the original enigma, but also the seemingly extraneous elements of Leibniz's atomism, are all resolvable once the traditions of atomism on which Leibniz is drawing are properly identified. For the resistance on the part of his modern interpreters to ascribing atoms to Leibniz is directed at atoms conceived as *absolutely indivisible, purely passive chunks of extension, devoid of any qualities, forces, or internal complexity*, notions in evident conflict with the hard core of Leibniz's metaphysics. This is indeed one notion of atom that became prevalent after the advent of the "Mechanical Philosophy" associated with Descartes and Mersenne, where matter is held to be essentially passive, and fully characterizable in terms of extension, magnitude, shape, and motion alone. But it is not the conception of atom that was most prevalent in the first half of the seventeenth century, where many authors proposed atoms that were regarded not only as in principle physically divisible, but also as possessing a variety of qualities, powers, and inner complexity.[48] This is worth elaborating on in some detail.

Classically, atoms were posited as homogeneous lumps of unchanging "being" moving around in the "non-being" or void. In contrast, the Stoics posited a plenum of matter which was indefinitely divisible. Accordingly we are wont to assume that there could hardly be a more clear-cut alternative than that open to a mid-seventeenth-century matter theorist: either, on the one hand, infinitely hard atoms and the void, as advocated by Democritus and Epicurus and revived by Gassendi, or, on the other, the infinitely divisible corpuscles moving in a plenum advocated by Descartes in his Stoic-inspired cosmology. But the starkness of this opposition does not seem to have been evident to many of the historical actors themselves. Robert Boyle's refusal to commit himself one way or the other is well documented, although this is usually attributed to a distrust of metaphysical reasoning. Yet the lack of acknowledgement of any such polar opposition between atomism and plenism seems to have been widespread. Hobbes, for instance, was unequivocally opposed to the vacuum even in the face of Boyle's experiments.[49] Nevertheless, despite opting for a plenist metaphysics and the actually infinite divisibility of body,[50] Hobbes was quite happy to talk of *atoms* in his physics:

Since we already supposed earlier that innumerable atoms, some harder than others and having several simple motions of their own, are intermingled with the aethereal substance; from

[48] The discussion that follows largely duplicates Arthur (2003b). But substantially the same points had been made earlier and in great detail by various authors in Lüthy, Murdoch, and Newman (2001). See these authors' introduction, as well as the various papers in the collection, which I have referenced where appropriate.

[49] For a thorough, if somewhat contentious, discussion of this episode and its significance, see Shapin and Schaffer (1986).

[50] "*There is no minimum divisible thing*: whatever is divided, is divided into parts that are further divisible; ôr, there is no minimum divisible thing; ôr, as most geometers express it, for any given quantity, a smaller one can be assumed" (*De Corpore*, II, ch. 7, §13; *LW* I 386). "Therefore there is no tininess of a body that is impossible…For we know there to be certain animalcules so tiny that their whole bodies can scarcely be discerned; yet these too have their embryos, their little veins and other vessels, and their eyes perceptible by no microscope…" (*De Corpore*, IV, ch. 27, §1; *LW* I 363).

this it necessarily follows that… some of these atoms on colliding with others, and to the extent that their motions and mutual contact demand, will attach to one another and cohere together; and that, seeing as there is no vacuum, it will not be possible for them to be pulled apart, except by as much force as is necessary to overcome their hardness.[51]

Nor is this mix of atoms and the plenum some Hobbesian oddity; rather, it is a feature of much seventeenth-century thought. Hobbes had been preceded in this by his compatriots Sir Kenelm Digby, who had also asserted divisible atoms and denied the void, and earlier by Sir Francis Bacon, who had advocated atoms or *semina rerum* (seeds of things) whose *virtutes* enabled them to assume any shape by folding and unfolding so as to fill any space. This made the vacuum redundant, and Bacon denied that there was one in nature, whether aggregated or interstitial.[52] Likewise the early seventeenth-century German atomist Daniel Sennert (1572–1637) had made no appeal to the void as a principle in his influential work, and even later atomists such as Huygens and Newton speculated freely about subtle fluids penetrating all apparent vacua. In this vein Leibniz himself introduces his *New Physical Hypothesis* with the disclaimer that "It is all the same whether you affirm or deny the *vacuum*, since I freely acknowledge that whatever is exhausted of air is filled up with aether; in short, whether little empty spaces are left is irrelevant to the gist of our hypothesis" (*HPN*; A VI ii 246). Similarly, the French atomist Sébastien Basson (*c*.1560–1626?), whilst urging the merits of classical atomism, had rejected the interstitial vacuum, appealing instead to the Stoics' all-pervading aether, "an extremely tenuous corporeal substance, which in the rarefaction of air, for example, insinuates itself among the particles of air", and which produces all material changes, including the arrangement of the atoms.[53]

In fact, Basson's *Philosophiæ naturalis* (1621) is an interesting example of the vigour and non-conformism of early seventeenth-century natural philosophy, forging elements of Stoicism, Democritean atomism, and alchemical theory into a bold rejection of Aristotle. It is worth a short digression for the context it can provide for understanding Leibniz's own atomism. According to Basson, atoms were created by God (Basson 1621, 14); they "originated after the first creation, and are free from all

[51] *De Corpore*, IV, ch. 28, §8: *LW* I 386. Cf. also: "In the first place, therefore, I suppose that the immense space we call the world is an aggregate of bodies: both of those that are consistent and visible, [*viz.*] the earth and the stars; and of those that are invisible, [*viz.*] the minutest atoms which are scattered in the gaps between the earth and the stars; and finally, of a very fluid aether, occupying every remaining place, wherever it is in the universe, in such a way that no place is left empty" (*De Corpore*, IV, ch. 26, §5; *LW* I 347–8).

[52] For a good survey of the atomisms of this period, see Antonio Clericuzio's *Elements, Principles and Corpuscles* (2000, esp. p. 82). I am indebted to Dan Garber for bringing this valuable resource to my attention.

[53] Basson (1621, 335). The full title of Basson's book is: *PHILOSOPHIAE NATVRALIS aduersos Aristotelem Libri XII. IN QVIBUS ABSTRVSA Veterum Physiologia restauratur, & Aristotelis errores solidis rationibus refelluntur A Sebastiano Bassone*, i.e. "Twelve Books of NATURAL PHILOSOPHY against Aristotle in which the abstruse physiology of the ancients is restored, and Aristotle's errors are refuted by solid reasons". See also Partington (1970, 388).

destruction" (126). There are atoms not only of the four elements, air, water, fire, and earth, but also of the three Paracelsian principles (the alchemists' *tria prima*), sulphur, mercury, and salt, and, in addition, atoms of phlegm. These are the primary particles. But Basson also held—and this appears to be original with him[54]—that there are compound particles (*mixts*) of various orders, formed through composition, that remain intact through chemical reactions (*mistiones*): "From these primary particles secondary ones are composed, and from the secondary ones tertiary ones, and from the tertiary, particles of fourth, fifth and sixth degree, etc." The primary atoms "conserve their own nature in a mixt, and act otherwise than through the force of some form" (126), the form of a mixt itself being explained entirely in terms of addition or subtraction of particles and change of their mutual situation:

> Furthermore, parts varying to infinity can be forged in this way from those very different prime particles; and through either the subtraction or addition of some particles, or the variation of the situation of parts, it is not difficult to understand that some pass over into the nature of others…[55]

But this description perhaps makes Basson sound more of a Democritean than he was. In fact, for him atoms do not combine by pure chance, as in materialist atomism, but through appetite, attractions, and sympathies, with which they are endowed by the universal spirit or world soul, depending ultimately on the will of God:

> We have said that that universal spirit endows those elements with an appetite doubly conjoined…[It] excites two motions, the primary one being that by which like attracts like…the secondary motion being that by which there is a connection among them, insofar as like has an appetite for like.[56]

Nevertheless, despite appealing to such non-mechanistic causes of combination, Basson's explanation of the natural phenomena produced by them is entirely in terms of corpuscular combination, dissociation, and rearrangement of the elements. The forms are mechanistically explained, and the only teleology resides in the actions of the universal spirit, acting under God's direction.

These views of Basson are evocative of some of the views that Leibniz himself enthusiastically urged on his correspondents in 1671. To Pierre de Carcavy, for example, he writes in June 1671 concerning his *New Physical Hypothesis* and *Theory of Abstract Motion*: "it is not possible to reconcile the Phenomena of the World with the abstract laws of motion, or Experience with Reason, unless a certain Universal Spirit is admitted",

[54] According to Christoph Meinel, Basson "was probably the first to introduce a clear concept of secondary, tertiary, quaternary, and so on, aggregates which, in chemical reactions, behave as if they were stable particles" (Meinel 1988, 73).

[55] Translated from the quotation given in Clericuzio (2000, 40); Clericuzio cites it as p. 72 in the Amsterdam edition of *Philosophiæ naturalis*.

[56] Again, this is translated from the quotation given by Clericuzio (2000, 40, n. 21), cited as p. 391 in the Amsterdam edition of *Philosophiæ naturalis*.

equating this spirit with "the World Soul or subtle matter" (A II i 122).[57] Leibniz invokes Plato and the Stoics, and compares the Spirit to "an invisible fire that permeates all the things in our world", and also to the Holy Spirit. In the *New Physical Hypothesis* itself he describes the subtle matter or aether as "the *Spirit of the Lord*" which "will penetrate inside everything, and everywhere will be cut out into hollow balls [*bullae*]" (A VI 2, 225/Mercer 2001, 279–80). Despite his comparison of the aether with the Holy Spirit, Leibniz's explicit equating of it with subtle matter and with the Stoics' invisible fire seems to make it a material substance, analogous to Bacon's "spirits or pneumaticals", which are very active, highly rarefied bodies.[58]

If this non-classical mixing of atoms and plenum is an indication that seventeenth-century atomism is no straightforward revival of ancient atomism, this is even more evident in the way atoms themselves were conceived at the time. For few natural philosophers of the seventeenth century thought of atoms as passive, rigid, and strictly indivisible units of matter, and this is of the greatest relevance for understanding Leibniz's own views on atomism. Of first importance are the subtle innovations of Julius Caesar Scaliger (1484–1558), and their adoption by Sennert and his disciple Johann Sperling.[59] One of these innovations was Scaliger's reconceptualization of the notion of *minima naturalia*. In orthodox Aristotelianism this term signified the idea that below a certain spatial lower limit, a piece of matter is unable to sustain a substantial form. But Scaliger reinterpreted such *minima* as actually existing least particles of individual natural kinds, out of which every natural body is composed:

> But are there natural minima? No sane person will deny it. For natural bodies are finite: therefore they are made of finite things. . . . For indivisibles exist actually and according to sense; and not by the power of mathematical intellection. (Scaliger 1557, 35)

Interpreting minima as particles allowed Scaliger to give explanations of various physical and chemical phenomena of the kind traditionally associated with classical atomism—for instance, of rarefaction and condensation. Scaliger's minimal corpuscles are the smallest particles of which each element is composed, and therefore exhibit the form and qualities of these elements. They are therefore quite different from the infinitely hard atoms of the philosophical tradition, which lacked any qualitative variety and were

[57] See Christia Mercer's discussion of Leibniz's espousal of this universal spirit in 1671 (Mercer 2001, 273–80), which contains these and other quotations. See also Lærke (2008) for a lucid discussion of Leibniz's commitment to an Averroist universal spirit in this period, and Blank (2015) for some insightful corrections.

[58] Mercer takes issue with Philip Beeley's interpretation of this aether as material, interpreting it instead as an original, immaterial "undifferentiated vitality" which is then "spread throughout everything" (2001, 275). But she also notes Leibniz's familiarity with Francis Bacon's writings (Bacon, *Works*, vol. 2, 380–1), and quotes him to the effect that "spirits or pneumaticals" "are the most active bodies" and "are nothing else but a natural body, rarified to a proportion, and included in the tangible parts of bodies" (Mercer 2001, 274–5). This seems to me to be Leibniz's own view of the aether too.

[59] In his letter to Thomasius of April 1669 Leibniz specifically mentions Scaliger as having "paved the way" for the reconciliation of Aristotle with modern philosophy, and "in our own times Kenelm Digby and his follower Thomas White…have dealt explicitly with the same thing" (GP I 20/L 97–8). He also shows knowledge of the work of Scaliger and Sennert, attributing to them and Sperling ("who claims to be a disciple of the latter") the view that "forms are produced…from the active power of an efficient cause", namely God (15/94).

incapable (in themselves) of acting or being acted upon. But this did not prevent other thinkers from enthusiastically adopting Scaliger's *minima naturalia* and calling them atoms. For example, in 1611 the Dutch theology student David van Goorle (Gorlaeus) (1591–1612) wrote two tracts proposing a radical atomism in which Aristotelian forms were dispensed with.[60] Van Goorle depicted all physical bodies as either indestructible atoms (*entia per se*) or as accidental conglomerations of them (*entia per accidens*). (The correspondence with Leibniz's later distinction between beings per se and beings by aggregation is no coincidence; both authors are availing themselves of a traditional distinction in scholastic philosophy.[61]) Yet Van Goorle's only reference to recent works is to Scaliger's not-so-recent *De subtilitate* of 1557.[62] Likewise in his (1621) Sébastien Basson appeals to Scaliger for his atoms, conceived as "very minute particles of various kinds, . . . whether of the four elements, fire, air, water, earth, or some other prior thing from which these elements are composed".[63]

The most influential expositor of Scaligerian "atoms", though, was the above-mentioned professor of medicine at the University of Wittenberg, Daniel Sennert.[64] Like Van Goorle, Sennert identified his atoms with *minima naturalia*, enabling him to claim a further classical precedent in Galen.[65] Accordingly, for him atoms were not indivisible in an absolute sense, but rather minimal particles of various natural kinds of bodies:

It seems, however, that the doctrine of atoms can be expounded in the following way. In natural things, which are liable to generation and corruption, because there is a perpetual alternation

[60] Van Goorle died in 1612 aged only twenty-one, so his philosophy was published posthumously (Gorlaeus 1620).

[61] Van Goorle's adaptation of this scholastic distinction to atomism follows on his identification of atoms with Scaliger's *minima naturalia*, and his adoption of Scaliger's theory of mixtion—roughly contemporary with Daniel Sennert's own conversion to atomism on this basis in 1619: see below. See Christoph Lüthy (2001) for a fascinating treatment of this link between Van Goorle's atomism and Northern Italian metaphysics. See also Lüthy (2005).

[62] See Lüthy (2001, 268; 2005, 101).

[63] Basson (1621, 55, 125). One should also add the Dutch atomist, Isaac Beeckman (Descartes' mentor), who advocated atoms that are physically indivisible, but still mathematically divisible. He shows himself very familiar with Scaliger in a diary entry of 7–19 August 1620: "Quale minimum naturale SCALIGER (de Subt. Exercitat. 16, 4) requirit, non videtur necessarium in motu et tempore", i.e. "A natural minimum of the kind Scaliger requires does not seem necessary in time and motion" (Beeckman 1939–53, I, 102).

[64] Sennert's mature statement of his doctrine is his *Hypomnemata Physica* (Physical Memoirs) of 1636: see *Hypomnema* III, chapter 1, "On Atoms and Mixtion". For my own original research I consulted the Venice edition (Francis Baba, 1651) in the Fisher Rare Book Library at the University of Toronto; but I have referenced it to the pagination of the 1650 Huguetan and Ravaud edition of his works—thus *Hypomnema* III, chapter 1, is (*HP* 3.1, 157–63), where the pages are keyed to Sennert (1650, vol. 1)—and also, where I can, to the contemporary English translation by Nicholas Culpeper, *Thirteen Books of Natural Philosophy* (Sennert 1659), of which the last five are the five *Hypomnemata*. The translation is excellent, although unfortunately Culpeper does not include the Preface. Thanks to Hiro Hirai and Roger Ariew, resp., for drawing my attention to available on-line versions of these (1650) and (1659).

[65] "As, indeed, the elements cannot be increased to infinity, so also they cannot be divided to infinity, but are mixed with one another in omnicrètata mo‹pa, as Galen [writes] (*De Elem. last chapter*). He teaches, that is, that they are reduced to minimal particles in such a way that they cannot naturally be further divided into smaller bodies, which the Ancients for this reason called Atoms" (Sennert 1650, vol. 1, 17). Quoted from Michael (2001, 333).

of generations and corruptions, it is necessary that there be certain simple bodies of their own kind, from which composites are generated and into which they pass away again . . . these minimal natural bodies are called atoms, atomic corpuscles, sèmata ¢diareta, indivisible bodies; and they are called this because of the fact that in a natural resolution no further progress can be made to smaller ones, and vice versa; and from them natural bodies have their origin. And these indeed really are in their nature so small as to be inaccessible to the senses.

(*HP* 3.1, 158/1659, 446)

William R. Newman has argued in 2006 that Sennert's atomism was also informed by a tradition extending back to the very beginnings of alchemy, in the works attributed to Geber (Jâbir ibn Hayyân), active in the eighth century. In the *Summa perfectionis* attributed to him, there occurs an account of mixtion (the formation of a chemical compound) that is at odds with the orthodox Aristotelian account, precisely in that the mixts are not regarded as thoroughly homogeneous, but as homogeneous only down to their least parts.[66] This is of prime importance to alchemy, where the properties of any mixt are explained by its containing proportions of certain intermediate principles, the *tria prima* (salt, sulphur, and mercury). But this is not in keeping with orthodox Aristotelianism, according to which, when a mixt is generated, the forms of its constituents disappear, and the mixt takes on its own form. Consequently, alchemy is at odds with orthodox Aristotelianism in its very roots—a fact which was exploited by Thomas Erastus in his trenchant attacks on the cogency of alchemy.[67] For on the orthodox account of mixtion there cannot be any intermediate principles, such as the *tria prima*, nor would there be any possibility of resolving a metal, for example, into anything other than primary matter. On the Geberian account, by contrast, "identical particles of a metal [are] composed of principles that are themselves made of smaller corpuscles lodged within the larger ones and held together by a 'very strong composition'" (Newman 2006, 43). The least particles of silver, for example, would be complex corpuscles formed from the minima of the four elements by this "very strong composition".[68]

[66] Geber's account depended heavily on an interpretation of Aristotle's *Meteorology IV*, in which Aristotle used the terms *synkrisis* and *diakrisis* (or their verbal and participial forms) to explain such phenomena as the concentration of matter to form clouds and comets, and human generation. The authenticity of this book was dismissed by twentieth-century scholars such as Hammer-Jensen, Ross, and Jaeger precisely because of its frequent use of atomistic-style explanations in terms of pores and corpuscles. But its Aristotelian origin is now generally acknowledged. See Newman (2006, 67) for discussion and references.

[67] See Newman's discussion (2006, 45–65) of Thomas Erastus' late sixteenth-century critique of alchemy. The main weapon wielded by Erastus was what Newman has dubbed "the *reditus* principle"; in Erastus' words: "*Non datur a privatione reditus ad habitum in naturalium generationibus*", i.e. "In the generation of natural things, there is no return to a habit [or form] from a privation": once a form (such as that of mercury or silver) has been lost, it can only be regenerated through a process that begins again from the four elements.

[68] Newman supports his case by establishing a precedent for the *reductio ad statum pristinum* in the *Theorica et practica* by Paul of Taranto, an obscure thirteenth-century Franciscan from Southern Italy. Even though Sennert had not read *Theorica et practica*, this fact gains in significance on account of Newman's identification of Paul of Taranto as the probable author of the *Summa* itself, which is now known to have been written at the end of the thirteenth century, and not in the eighth, when Geber is supposed to have lived. See Newman (2006, 26ff.).

Sennert depends heavily on such chymical considerations in arguing for atomism: "the action of chemicals proves atoms", he wrote in his *Hypomnemata Physica* of 1636 (*HP* 3.1, 161). His chief argument, as Newman has stressed, was by appeal to the process of *reductio in pristinum statum*, the reduction of dissolved metals into their original or pristine state (to which we will return in Chapter 4). This is easiest to understand in terms of Sennert's example involving the treatment of the alloy electrum, made by fusing gold and silver together. When *aqua fortis* (nitric acid) is applied to this alloy, it dissolves the silver while the gold remains in the form of a powder. The powder can be fused into pure gold. Meanwhile, from the acid mix one can precipitate out a *calx* (silver carbonate), and then by heating and fusing this, reconstitute the silver. The fact that "purest gold and silver" can be recovered by this process, Sennert claimed, is evidence that their constituent atoms remain unchanged in the process.[69]

But Sennert also used atoms to explain a wide range of other natural phenomena, including the action of magnetism, poisons, contagion, and natural generation.[70] In this he was followed by Kenelm Digby, who asserted that:

> it is evident that the Elements must remaine pure in every compounded body in such extreme small parts as we use to call atomes: for if they did not, the variety of bodies would be nothing else, but…so many pure homogeneall Elements, and not bodies composed of heterogeneall parts:…nor could produce the complicated effects which proceed from them.[71]

And while Digby denied that there were any strictly indivisible particles of matter at all, Sennert characterized his atoms as merely physically but not mathematically indivisible. As we have seen, they are "so small as to be inaccessible to the senses"; similarly Basson's atoms are "so minute that, unless very many of them come together into one mass, they do not affect the senses" (Basson 1621, 126). As has been established in detail by Newman (1996, 2006), Sennert's works were the most important source for Robert Boyle, who "plundered" them for proofs of his corpuscularian hypothesis (Newman 1996, 580). In an early unpublished manuscript summarizing this tradition, Boyle wrote that the assertors of atoms do not understand them to be

> indivisible or Mathematicall points which are so void of quantity that the subtle rasor of Imagination it selfe cannot dissect them, but *minima Naturalia* or the smallest particles of bodyes, which they call Atomes not because they cannot be suppos'd to be divided into yet smaller parts…but because tho they may be further subdivided by the Imagination, yet they cannot by Nature, which not being able in her resolutions of Naturall bodyes to proceed *ad infinitum* must necessarily stop somewhere.[72]

[69] See Sennert (1659, 452). See also Clericuzio (2000, 28–9), and the references contained therein; Michael (2001); and above all Newman (2006) for a thorough treatment.

[70] Sennert, *De Chymicorum* (1619, 356). Sennert's most elaborate presentation of atomism, though, is in his *Hypomnemata Physica* (Sennert 1636) mentioned above. See also Partington (1970, 273).

[71] Digby, *Two Treatise*s (1644), ch. xvi, 143; (1645), 178; cf. Clericuzio (2000, 82).

[72] Robert Boyle, 'Of the Atomicall Philosophy', BP 26, fols 161v–162r (dated as 1651–3); 227–35 in Boyle (2000, Vol. 13); also quoted in Clericuzio (2000, 117). Cf. Digby: "By which word *Atome*, no body will imagine we intend to expresse a perfect indivisible, but onely, the least sort of natural bodies" (*Two Treatises*, 1644 edition, 38; 1645, 48).

These atomist conceptions of Bacon, Van Goorle, Basson, Sennert, Digby, and Hobbes should be compared to Descartes' comment in his *Principles of Philosophy*: "No one ever rejected Democritus' atomic theory because it admitted particles that are so small that they elude the senses, . . . but [*inter alia*] because it supposed the atoms to be indivisible" (Descartes 1644, (IV) 202; AT VIII 1, 325). It is interesting to note that shortly after Descartes wrote this, his compatriot Magnen (teaching in Pavia, Italy) had advocated "simple atoms" which, though physically indivisible and insensible, were not only infinitely divisible in the mathematical sense but able to undergo radical changes of shape, just like Descartes' particles of the third element. No wonder, then, that Descartes' corpuscles were often assimilated by his contemporaries to atoms,[73] since seventeenth-century atoms were regarded not as absolutely indivisible—beyond God's power of dividing them—but as beyond ours.[74] Leibniz himself drew attention to this point in his reading notes on Descartes' *Principia* in 1675. To the latter's claim that "There cannot be atoms, since they could at least be divided by God", he adds laconically: "this Gassendi would not have denied" (A VI iii 215/LLC 25).

This hardly makes the atoms of Sennert and company indistinguishable from Cartesian corpuscles, however. The latter, whose parts cohere only by virtue of their being mutually at rest, would eventually be divided and dissolved by the jostling of other particles in the plenum. An atom, on the other hand, is naturally indissoluble, indivisible by natural means, so that atoms of various kinds form the building blocks of all matter (Van Goorle, Basson, Sennert), even if they do not maintain the same shape or size (Bacon, Hobbes, Magnen). Their different properties are posited above all to explain the different natures of chymical elements or principles. And the idea that a metal could have an entirely different form from a substance compounded from it, and yet be reconstituted from that compound in its original form by further chymical processes, seemed to cry out for an atomist explanation. As Lüthy remarks, "someone wishing to explain how table salt (NaCl) can possibly be the result of the mixing of a metal with a gas will have little help from a Cartesian who accepts only extension and motion as properties of particles and denies the existence of mixtures and higher compounds" (Lüthy 2005, 115–16).

Thus in assessing Leibniz's atomism it is vital to recognize that there was a flourishing tradition of atomism in the seventeenth century deriving from chymical,[75] biological, and medical sources, rather than directly from the classical metaphysical tradition of Leucippus, Democritus, and the Epicureans. The term 'atom' did not

[73] Famously, Gerauld de Cordemoy (1668) will substitute atoms for divisible Cartesian corporeal substances. Henri LeRoy (Regius), in his *Philosophia naturalis* (Regius 1661), and Adriaan Heereboord were other prominent Cartesians to advocate atomism; see Clericuzio (2000, 185–6).

[74] Cf. Descartes to More, 5 February 1649: "It implies a contradiction for there to be atoms, . . . since although God could have made things so that they are not divided by any created being, we certainly cannot understand him as having been able to deprive himself of the faculty of dividing them" (AT V 273).

[75] Following current custom (initiated by Newman and Principe in their 1998, q.v.), I use the term "chymical" to denote chemical and alchemical matters without distinction, as was the practice in the early modern period.

necessarily, or even usually, carry the connotation of a corpuscle that is absolutely indivisible, homogeneous, and perfectly hard, possessing the same shape and size for all eternity, movable, but wholly passive, incapable of sustaining any activity or reactivity; these we may agree to call *classical atoms*. In the chymical tradition represented by Sennert, the basic meaning of "atom" is a least particle of a given kind, with no particular connotation of sameness of shape or rigidity, nor of inner homogeneity or inactivity. Thus an atom is rather a corpuscle of matter of a particular kind that remains intact through relevant changes. In this tradition, there can be not only atoms of the elements (air, fire, water, and earth) and principles (sulphur, salt, mercury, phlegm), but also atoms of gold and silver, of minerals, and even of biological kinds. Such an atom is the irreducible building block of that substance; for example, any pure sample of gold is composed of gold atoms, and these atoms remain intact even in compounds of gold, from which they can be precipitated again in a chemical reaction. These we will call *chymical atoms*.

But by calling the former "classical atoms" I do not mean to suggest that the mechanical philosophers' interpretation of them as homogeneous and inert should be regarded as historically accurate.[76] Lucretius construed atoms as biological seeds, Epicurus' atoms were endowed with an innate tendency to action or *energeia*, and there was a strong tradition of regarding Plato's atoms not simply as geometrical shapes, but as being attracted to atoms of the same kind by a force of sympathy. Thus the division between classical and chymical atoms is by no means a strict dichotomy. It was certainly possible, for example, to maintain that atoms are absolutely indivisible and perfectly hard, yet still possess active powers of various kinds. Indeed, Gassendi himself not only strove to correct the interpretation of classical atoms as purely passive, but was no stranger to the chymical tradition, as recent scholarship has established.[77] He did not, as we shall see, subscribe to the narrow mechanist programme of reducing the whole of nature to the motions of a purely passive matter, but allowed activity, forces, and even formative powers in his atoms and molecules.[78] For although he agreed that all phenomena or effects should be explained in terms of matter in motion, this did not for him entail that all *causes* were so reducible. And contrariwise, just as Gassendi was influenced by the chymical tradition, so authors in that tradition were not shy of claiming Democritus, Epicurus, Lucretius, Apollodorus, and Plato as precedents for their views. Indeed, many

[76] Here I am thinking of the neo- or post-Cartesian atomists, Cordemoy, Huygens, and Hartsoeker.

[77] As Olivier Bloch notes in his (1971), Gassendi had explicitly responded to Campanella's imputation of an inert matter to Epicurus, objecting that "Epicurus dreams of nothing less than passive matter, unmitigatedly assigning a restless motion to his atoms, from which he also deduces the actions of all concrete things" (B. N. Nouv. acq. lat. 2643, fols. 49v–50r) (Bloch 1971, 212, n. 39). See also Gassendi's comment in Tours (709 folio 185r): "Epicurus believes all atoms to be endowed with a certain internal energy, ôr inborn vigor, by which they set themselves in motion" (ibid., n. 55). Bloch gives a good account of Gassendi's views in relation to the chymical tradition. On this, see also Clericuzio (2000, 63–74).

[78] Cf. Clericuzio: "Gassendi's theory of *semina* and spirits . . . are to be understood as part of a theory of matter which does not dispense with forces, activities and powers" (2000, 63).

authors appealed to Plato's authority as a counterbalance to the authority of Aristotle, in spite of the fact that their own atoms had little in common with his geometrical atoms.

In any case, taking into account this well-established alternative tradition which justified atoms through chymical and medical arguments enables us to relieve the apparent inconsistency in most of Leibniz's statements about atoms in the 1670s. We may grant that, having opted for the moderns, Leibniz would not have accepted, say, "sympathies" and "attractions" as original properties of atoms.[79] Nevertheless, the properties Leibniz singles out in his rejections of atoms—their absolute indivisibility, their rigidity, and their inability, given their inner homogeneity, to provide a basis for actions or reaction—are all properties of classical atoms interpreted according to a neo-Cartesian mechanical philosophy, as advocated, for instance, by Cordemoy, Huygens, and Hartsoeker. The atoms he rejects are "bodies whose parts never separate" (A VI ii 280/LLC 344), "perfect solids" or "bodies so firm that they do not suffer any subdivision or bending" (A VI iii 561/LLC 199), or bodies containing nothing but extension (A VI iv 1799/LLC 279). On the other hand, the "atoms" he upholds are very small, very hard corpuscles which are "naturally indissoluble", yet still divisible, and which have an internal complexity—all of which are properties of chymical atoms, and for which there were also precedents in Bacon, Hill, Gassendi, Hobbes, Digby, and others not usually thought of as chymical atomists. Certainly, Leibniz's own primary corpuscles in the *HPN*, the *bullae*, are of this kind: although not perfectly hard, they will endure for the duration of the present world. In fact, Leibniz's *Hypothesis physica nova* is replete with references to the chymical literature, and his theory of *bullae* may be seen as a reinterpretation of Sennertian chymical atoms along acceptable mechanical lines.[80]

In this regard a second Scaligerian innovation adopted by Sennert is of decisive significance. This is Scaliger's novel theory of mixtion (*mistio*, or the forming of a chemical compound or "mixt").[81] Aristotle's definition was *mistio est miscibilium alteratorum*

[79] More accurately, Leibniz accepted the idea of bodies sympathizing with one another, but tried to give it a reductive interpretation, first in terms of motion in common (see A VI iii 80, 104/LLC 4–5) and later in terms of his doctrine of expression (A VI iv 1618/LLC 309). He takes this kind of rational reduction a step farther with his later rehabilitation of the atomists' *appetitus* in the guise of an instantaneous tendency to change state. Given the other correspondences (though not necessarily influences) of Basson's views and Leibniz's in the *HPN*, particularly the predominant role of aether, the relationship between these thinkers is probably deserving of further study.

[80] See Beeley (1996, *Kapitel*). See also his (1997), in which he writes "Leibniz also provides an [ingenious] model of the chemical atom, composed of cortex and nucleus, which he is able to adapt without difficulty to his theory of the infinite dividedness of matter, while at the same time serving to explain the chemical processes of decomposition and synthesis" (75).

[81] As Newman explains very clearly in his *Atoms and Alchemy* (2006), the terms 'mixture' and 'composition' have almost the exact opposite meaning now to what they did classically. Whereas in the Aristotelian and alchemical tradition a composition (*compositio*) of two substances is a mere juxtaposition of their small parts in such a way that the substances may easily separate out again, in a mixt (*mixtum*) the original substances fuse together in such a way that the mixt has its own form, different from that of each of the original substances.

unio (*De Generatione et corruptione* I.10 328b 22)—roughly, that mixtion is a union of miscible bodies that are altered in the process. On this Scaliger writes:

> The definition commonly trotted out, which is taken from the Philosopher [sc. Aristotle], is worthless. For it is not subtle to say: "Mixtion is a union of miscibles". I understand the union, but I ask, what is a "miscible"? For how do I know what it is, when I do not know what mixing is? Here something is explained in terms of the same thing. A better definition is this: mixtion is the motion of minimal bodies toward mutual contact so that a union is made. For our corpuscles do not come into contact the way Epicurean atoms do, but do so in such a way that a continuous body, and a unity, is made. For it becomes one by a making continuous of the boundaries, and this [process] is common to all mixts. (*Exercitatio* 101, §1; Scaliger 1557, 143)

Although Sennert relied very much on Scaliger's *Exercitationes* in his earlier work, he did not adopt Scaliger's *minima naturales* until the *De Chymicorum* of 1619, published when he was forty-seven.[82] The cause of this "sea change" in Sennert's thought is a matter of current scholarly dispute. But whatever his precise motivation, it had much to do with his belated recognition of the advantages of Scaliger's theory of mixtion, which he endorsed with enthusiasm in chapter xii of his *De Chymicorum*: "I confess I am now won over by the opinion of Scaliger, who defines mixtion to be the motion of minimal bodies towards mutual contact so that a union is made" (Sennert 1619, 356). Under the influence of Sennert this theory became widely accepted in the seventeenth century. It was adopted by Robert Boyle, according to whom the concretions of particles that form the basis of chymical processes (what Basson had called "secondary" particles, Gassendi had termed "molecules", and Boyle calls "corpuscles of the second order") are formed by a close union of *minima naturalia*.[83] In his early work Boyle identifies these *minima* as Sennertian atoms. But in his published works he reinterprets them as corpuscles possessing only mechanical properties.[84]

Now, it does not seem too fanciful to regard Leibniz as extending this kind of rationalization of Sennert's theory in terms of the mechanical philosophy that had been begun by Gassendi and Boyle.[85] Indeed, the theory of cohesion of his *bullae* offered by Leibniz bears a close affinity to Scaliger's theory of mixtion, with which Leibniz would probably have been familiar.[86] As we have seen, Scaliger had written of corpuscles or "minimal bodies" moving towards one another in such a way that on contact they form

[82] The reason for Sennert's "sea change" is a matter of dispute among historians: see Michael (2001), Stolberg (2003), Lüthy (2005), Newman (2006), and Hirai (2012). I am persuaded by Hirai's explanation that the decisive factor in Sennert's adopting atomism in 1619 was his reading of Liceti's (1618).

[83] See Clericuzio (2000, 122–3).

[84] On Sennert as the source of Boyle's early atomism, see Newman (1996, 567–85), as well as his extended treatment in his (2006). See also Clericuzio (1990) and Clericuzio (2000, 103–48, esp. 117, 123).

[85] In his letter to Thomasius (30 April 1669), Leibniz criticizes Scaliger for ascribing to bodies "appetite and natural instinct from which natural knowledge arises", "whereas in fact there is no wisdom in nature and no appetite". He admits form, but interprets it as a body's "principle of motion", a form that "is really abstracted from matter (and at the same time an efficient cause), namely mind" (GP I 25/L 99).

[86] For an account of Leibniz's early work on cohesion see references cited in n. 27.

a union "by a making continuous of the boundaries", as opposed to being merely juxtaposed, like Epicurean atoms.[87] In Leibniz's *TMA*, when one body impinges on another, the indivisible constituting the boundary of the impelling body is greater than that of the body with which it is colliding in proportion to the endeavours of their motions; they therefore overlap, so that the bodies are truly continuous and cohering, as opposed to being merely contiguous.

The difference in Leibniz's case is that, unlike Scaliger, Sennert, and Boyle, he did not have to presuppose primary particles whose original cohesion is attributed to a form or simply left unexplained: where they had assumed *minima naturalia* or corpuscles of each natural kind to come together to form concretions of atoms that were the principles of most chymical processes, for Leibniz such minimal cohering bodies are formed from an actual infinity of overlapping points, as exist in the circles of latitude around the axes of the spinning *bullae*. This accounts for original cohesion. As we have seen, for the making firm of such bodies Leibniz follows Hobbes in appealing to the spin of the *bullae*.[88] On the one hand, their rotating motion allows for a continuous band of matter as opposed to a momentary cohesion at one boundary; on the other, an appeal to a principle of minimization of disturbance accounts for the tendency of these concentric bands towards the meridian, and thus the formation of a spherical surface, the hard crust of these bubbles (*bullae*) or little worlds (*terrellae*).[89]

There is, however, a second difference in Leibniz's understanding of the internal composition of atomic particles that is crucial to the resolution of our enigma. We have seen that his *bullae* are held together by the cohering bands of overlapping points in their surfaces, and that they presuppose motions within. But for Leibniz the differing internal motions of the parts of a body are precisely what constitute these parts as individually different, *and therefore divide the body within*. As he wrote in an unpublished tract of 1672:

[87] Newman seems not to have understood this Scaligerian "making continuous of the boundaries", for he claims that Scaliger's "corpuscles, although they do not interpenetrate, can at least conform to one another's boundaries so that no other corpuscles can get between them" (Newman 2006, 101). But that would make them merely contiguous, not continuous, a juxtaposition and not a union. But Scaliger is arguing here that such a union of inanimate corpuscles, which he calls a *crama* (Greek κρᾶμα), "is not one by form, but by a making continuous (*continuatione*)". The parts are not mathematically distinct, "for they are not delimited and separated by borders", but they are present "in natural act", that is, they still retain their individual forms. As such, however, a *crama* would be, in Newman's words, a "collection of particles with their own forms united *per accidens*", as opposed to the body of a living creature like a lion, which is united by its own form (see Newman's further discussion and quotations on pp. 102–3). Ironically, though, this is not Scaliger's considered view, as Sennert took it to be. For, as Kuni Sakamoto has argued (2016, ch. 7), in the continuation of the passage Scaliger goes on to reject the idea that a *crama* has real as opposed to a merely accidental unity, insisting that every unity of substance must have a corresponding dominant form. See Chapter 4 below.

[88] From a modern perspective, this is all very ironic: Hobbes and Leibniz were on the right track in seeing spin as being fundamental. On a contemporary understanding, the cohesion of matter is due in part to the Coulomb force, which at its most fundamental is explained in terms of an exchange of particles. But this must be supplemented by an appeal to the Pauli exclusion principle, and even this does not explain everything about cohesion. And none of this explains how elementary particles, even those that are taken as point-like, can have a spin, which has to be taken as a fundamental property of such particles.

[89] For further discussion consult Arthur (1999a) and LLC, Introduction.

It is manifest that a body is constituted as definite, one, particular, distinct from others, by a certain motion or particular endeavour of its own, and if it is lacking this it will not be a separate body… And this is what I have said elsewhere, that cohesion comes from endeavour or motion, that those things which move with one motion should be understood to cohere with one another.[90]

The *bullae* themselves, however, are composite, divided within by the differing motions of their component parts. And it is the individual motions or endeavours of these parts that individuate them as actually differing parts, dividing them off from one another.[91]

As we saw in Chapter 1, this conception of parts being individuated by their differing motions is in fact Cartesian in origin, and forms the basis for Leibniz's argument for the actually infinite division of matter.[92] But the internal division of bodies does not detract from the spinning motion that gives them coherence. Whatever the individual endeavours of the points constituting the surface, the spinning body as a whole will move with its own endeavour, through which it can be individuated as one body. This privileged nature of circular motion for the formation of bodies is a recurring theme in 1671. Thus in *On Primary Matter*, Leibniz attributes the origins of bodies to "particular circulations" of matter, arguing that bodies have infinite parts and that "there are infinitely many creatures in any body whatever" (A VI ii 280/LLC 344). In the *Hypothesis de systemate mundi*, as we saw above, he describes space as "filled with globes" spinning on their axes, these being "the only integral bodies", the "naturally indissoluble" atoms. But he also says that "it suffices for a body to be integral only at its surface", and to be "again composed of infinite globes inside" (A VI ii 294/LLC 344–5). Vestiges of this can still be seen in 1676, with Leibniz's association of each atom with a vortex at whose centre it lies.

So there are two senses of division here: a body is actually divided *within* by the differing motions of its internal parts despite the fact that, if it is atomic (i.e. "integral" or "indissoluble"), it will not be divisible by any natural process from *without*. That is, an atom for Leibniz can quite literally be a *terrella* or little world, if it has an impenetrable crust. Beneath that crust, as if beneath the Empyrean, is a world of inner motion and activity that is in principle explicable in the same terms as our world but on a vastly smaller scale. Hence Leibniz's sustained commitment to the thesis of "worlds within worlds to infinity", often in the very same tracts in which he defends atoms.

To summarize: the solution I am offering to the enigma posed in section 3.1 is this. I had said that *if* we take Leibniz's atoms in the orthodox sense of finite parts of matter that are not further divided, then his thesis that matter is actually infinitely divided would indeed preclude them. But the point is that the atoms he upholds are not such orthodox atoms; rather they *are* further divided within. Like the chymical atoms

[90] Proposition 14, *Propositiones Quaedam Philosophicae* (A VI iii 28). Leibniz wrote this tract, probably intended for publication, in early-to-mid-1672.

[91] Indeed, without motion to give these parts their individuality, Leibniz argues on several occasions, matter, being undifferentiated, is nothing at all. See e.g. *On Primary Matter* (A VI ii 280/LLC 344).

[92] See the analysis given in Arthur (1989, esp. 182–9).

of Basson, Sennert, and the young Boyle, Leibniz's atoms are complex corpuscles that are naturally indivisible (physically unbreakable), even though they possess internal parts. But the very fact that they have internal parts with different motions entails that they are actually divided within; and the fact that each part is further divided by different internal motions means that the division is an actual division to infinity.

Thus we have an explanation of how it was that Leibniz was able to entertain atoms while maintaining the infinite division of matter, and also have some notion of why he was motivated to propose more Democritean atoms in 1676 when his theory of the cohesion of chymical atoms by the overlapping of indivisibles had collapsed. But we still have no insight into why he should insist on endowing his atoms with minds, nor with biological properties. For this we turn to a further comparison with the views of Sennert.

3.3 Atoms, Souls, and Traduction

Leibniz's neo-Hobbesian account of the cohesion of atoms or naturally indissoluble bodies was conceived by him in 1671 as part of a grander project for a theory of mind, on which he was intending to write a book, *Elementa de mente* (GP I 67, 73/A II i 114). We have already encountered some of the governing ideas of this project: thought is an endeavour (*conatus*), and "as body consists in a stretch of motions, so mind consists in a harmony of endeavours" (G I 73). These endeavours, momentary in bodies, are sustained in mind, where they are proto-thoughts or emotions that can be compared and contrasted.[93] A mind or soul is "constituted in a mathematical point", proportional to an endeavour at each instant. This punctual mind or soul is in turn encased within a physical point, "the proximate instrument and as it were vehicle of the soul", the indestructible atomic core, variously described as an atom, globule, or a *bulla*, the latter being a hollow but unbreakable bubble. Each mind is associated with its own vortex of matter, which can be construed as forming the impenetrable spherical shell of the globule or bubble by overlapping circles of motions, each consisting in a continuous string of overlapping indivisible points. The overlapping of the indivisibles forms a true continuity, and it is this that is responsible for the cohesion of the globules and *bullae* and their resistance to being broken up. Thus "Mind endures forever, safe and sound in its point" (A II i 113), that is, in the atomic core constituting its "kernel of substance".[94]

[93] As Leibniz writes to Oldenburg, 11 March 1671: "Every body is a momentaneous mind, and therefore without consciousness, sense, or recollection. Indeed, if two contrary endeavours could persevere in the same body for longer than a moment, every body would be a true mind. But wherever this does come about, minds are produced, and these are naturally indestructible, because, as I shall demonstrate in the appropriate place, once two contrary endeavours in the same point of a body are compatible beyond a moment, no other bodies can slip between them, nor can they be prised apart by any force for all eternity . . . " (A II i 90).

[94] My interpretation of the kernel of substance as material, the core of a chymical atom, is supported by what Leibniz says in the body of the letter accompanying the treatise on resurrection: "In particular, I hold fast to the opinion that every body—people as well as animals, herbal plants and minerals—has a kernel of its substance which, distinct from the *Caput Mortuum*, is understood to be just like what the chymists take 'from the damned and phlegmatic earth' " (letter to Duke Johann Friedrich, 21 May 1671;

A fascinating aspect of this early theory of mind is Leibniz's contention that the minds, though indestructible, *can multiply themselves*. In a fragment from that period he speculates that mind can be generated in the place where the actions of stars, and possibly suns, collide, something he thinks he can establish by means of a "Globular Hypothesis".[95] The fragment continues, enigmatically, with further speculation headed "An Essay on Traduction [*de traduce*]":

> What if congenital eggs or minds are determined in them? But what about ones that are not given birth to? Do these minds not then perish, and are they to be excluded from serving their time with the other things? Must we say that the mind alone is able to impress equally perfectly an equilateral triangle onto another body touching it in a certain way, and thereby produce a new mind? And this is to be explained by means of the establishment of globules. (A VI ii 282)

It would have been very difficult to make sense of these claims about minds "impressing triangles onto bodies" were it not for some remarks about his earlier views Leibniz prepared in a draft for Des Bosses some thirty-eight years later. "Many years ago", he confides,

> when my philosophy was not yet sufficiently mature, I located souls in points, and in this way thought that the multiplication of souls could be explained by traduction, where many points can be made out of a single point, just as the vertices of many triangles can be made by division of the vertex of one triangle. (to Des Bosses, 30 April 1709; LDB 129/L 599)

Earlier in the same letter he uses his old argument (with accompanying diagram in the margin) to show how, if a soul is assumed to exist in a point, "nothing prevents an infinity of points from continually arising and perishing (or at least from coinciding or being placed outside one another), without any increase or decrease in matter or extension" (LDB 125), using the example of the vertices made by successively bisecting the vertex of the triangle ABC (see Figure 3.1). "Any of these triangles could exist separately (by giving them a solidity so that they become bodies, or by assuming from the outset a solid triangle, i.e. a pyramid)" (LDB 125). The idea, then, is that if the mind is contained in a mathematical point at the extremity of a pointed body, a division of the body resulting in a division of the point could produce a multiplication of minds. The claim that one point, though unextended, could be larger than another is defended by Leibniz in the *HPN* using the same example of the vertices of geometrical figures, an argument he had found in Hobbes's *De Corpore*.

A II i 108). Kenelm Digby describes *Terra damnata* as "the more grosse and heavy earthy partes" which, when water is used to dissolve calx into salt, "do fall downe to the bottome, and settle under the water in dust. . . . Which ordinary Alchymistes looke not after: and therefore call it *Terra damnata* . . . " (Digby 1644, *Of Bodies*, ch. XVI, 136).

[95] Leibniz writes: "It is possible that a mind is born in the place of a rectilinear collision of all the actions of suns; certainly of all the actions of stars. It is not at all necessary that stars themselves should have minds. . . . These things [are inferred] from the establishment of a Globular Hypothesis." This is the fourth fragment of a set titled *De conatu et motu, sensu et cogitatione* (A VI ii 281–2). It continues with the paragraph entitled "An Essay on Traduction".

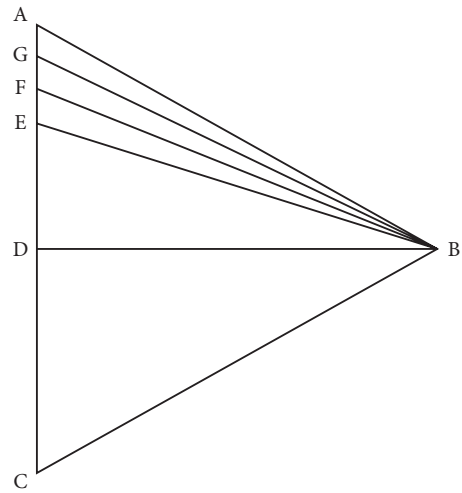

Figure 3.1 Leibniz's diagram for the multiplication of souls in vertices

But what of the talk of "congenital eggs or minds" and "traduction"? *Traduction* is the process of generation whereby the soul is transmitted to the offspring of the parents by a kind of budding of the parents' souls, just as its organic body is generated from the parent's organic body, in a process analogous to the grafting of trees. The alternative theory, called *eduction*, was that new souls are educed (drawn out) from the potency of matter. (This was usually applied to the case of vegetative and sensitive souls, with human rational souls thought to be specially created when the body was ready to receive them.) Traduction was extremely controversial, and indeed it still is, in that the notion of budding or division of the rational soul seems to entail the materiality of the soul. What Leibniz is proposing here, then, is a mathematical model for the possibility of traduction, whereby the soul or mind can be divided without its being extended: Leibniz's indivisibles were conceived by him as being immaterial on the very ground that they are not extended, and therefore not corporeal. In early May 1671 Leibniz wrote an enthusiastic letter to the Utrecht physician Lambert van Velthuysen extolling the virtues of his *HPN*, and drawing together some of these themes:

> I judge, however, that just as *corporalia* are to be explained by spaces and motions, so *mentalia* are to be explained by points and endeavours. I explain the way in which God could construct a body which is agitated by motions of such a kind that it would from then on be naturally indissoluble…; indeed, what is more, I explain by means of this body in which a mind is implanted, that mind can multiply itself, without new creation, by traduction (*per traducem*), with no mention of incorporeality, something which no one has hitherto been able to explain clearly and distinctly. Nor do I think Traduction (*Traducem*) is despised by certain theologians except insofar as it seems to imply corporeality and divisibility, and thus mortality. That it does not is shown by the very nature of indivisibles with as much clarity as sunshine. Once

this is supposed, it is at least more rational to concede human propagation to be natural than needlessly to invoke God to perform the perpetual miracle of new creation, not to speak of other difficulties. (A II i 97–8)

These themes are also evident in the short treatise on the immortality of the soul, written for Duke Johann Friedrich in 1671 only a couple of weeks after the letter to Van Velthuysen quoted above. Here Leibniz writes of "how mind can produce mind from its substance without being diminished, or, 'On Traduction' (for I do not see why it is necessary to posit a new creation of minds as often as a man is generated, by always calling on God for perpetual miracles, like a *Deus ex machine*…)". In another piece from the same period, perhaps connected with his project of reconciling Catholicism with Protestantism, Leibniz reveals a theological motivation for upholding traduction when he observes that Augustine inclined towards traduction since he could not otherwise explain original sin.[96] Moreover, whereas in his letter to Van Velthuysen Leibniz had referred to "the nature of indivisibles", without specifying what kind, in his discussion of cannibalism in the treatise for Johann Friedrich (as we already saw above), Leibniz explicitly calls the physical point that contains the soul or mind an *atom*: "…even if not even an atom (other than that point in which the mind is implanted) is now left of me…" (A II i 115).[97]

Thus Leibniz is defending a theory in which the mind or soul is implanted in an atomic body (an atom with internal structure and properties, but which is naturally indissoluble), where the body–soul composite is able to multiply itself *per traducem*, without the soul being thereby rendered material.

In situating these views about atoms and traduction proposed by Leibniz in the early 1670s, the views of Sennert again provide an illuminating point of comparison. For Sennert adopts his atoms to explain not only chymical phenomena such as sublimation and distillation, but also explicitly biological phenomena such as the action of contagion and natural generation. And central to his account of generation is the idea of *soul-containing atoms*:

Atoms of Animate Bodies: Indeed, there are atoms not only of inanimate bodies, but of certain animate bodies too: and meanwhile the soul itself can remain whole in such minimal bodies and conserve itself: as will be said afterwards, *concerning mixtion and the spontaneous birth of living creatures*: and the Very Learned Fortunio Liceti built upon this doctrine of atoms almost the whole of his opinion on the spontaneous birth of living creatures. (*HP* 3.1, 162/1659, 453)

[96] "Concerning traduction. Augustine approved inclining towards a certain causal Traduction, as he called it, since he could not explain the propagation of Original Sin if the soul were not an offshoot of Adam's (*decisa ab Adamo*)" (A VI 2, 144). The Akademie editors date this 1670–beg. 1672 (?). Leibniz refers to Augustine's commitment to traduction "the better to explain original sin" in the same context in his discussion in the *Theodicy* (§86; GP VI 149/H 169).

[97] Concerning the uniting of the soul with an atom Parkinson observes (DSR 130), that Leibniz had stated in an earlier paper of 1669–70 (A VI i 533) that the soul is substantially united, not with all the corpuscles of the body, but with one in the centre of the cerebellum.

As Sennert goes on to argue in *Hypomnema* 5, the apparent phenomenon of spontaneous generation is in fact a transformation of matter due to putrefaction, and the new forms of life are produced by *semina* (seeds; but also semen) latent in the rotting matter, each of which comes to be animated by a soul. This is in keeping with his whole philosophy of generation, for which he argues clearly and methodically, beginning with the generation of plants.[98]

A plant produces a seed, which contains a vegetative soul, and this can only be an emanation from the mother plant. Likewise each animal seed, male and female alike, contains a sentient soul which emanates from the soul of the father or mother. As Jacques Roger explains, "the two souls are united at the moment of conception as easily as they propagate themselves, and despite its double origin, the soul of the embryo is simple: 'a fire which burns with different flames is not called composite' (*Hypomnemata* 287)."[99] This soul, moreover, is the only soul the animal has; Sennert rejects the Aristotelian orthodoxy of vegetative, animal, and rational souls, all existing as entities or essences in the same being: "In truth, it is denied that the vegetative, sensitive and rational are three different entities (*Esse*) that are produced from different forms; rather, they are powers of the same soul" (*HP* 4.13, 203/Roger 1963, 110). Rather, "since there is only one soul in man, having a vegetative, sensitive and rational faculty, . . . and the human soul not only understands and reasons, but also forms the human body, feeds it, grows it, and conserves it, and as it senses and moves, and yet is human, it does this in a different way from a beast" (*HP* 4.14, 206).

Sennert is explicit about where this leads in connection with the controversial matter of the propagation or origin of the human soul. Concerning plants and animals he takes himself to "have demonstrated on firm grounds, I believe, that plants and brute animals are generated from seed (*semen*), that the seed contains a soul communicated from the thing generating, which, lying hidden in the seed, makes a home for itself suitable for a plant or animal of the same species from which it was split off" (*HP* 4.10, 197/1659, 509). He then argues that it is only reasonable to suggest that the same account applies to human generation, and declares himself on three counts:

> First, it is more probable and more consonant with the truth that the soul propagates from the parents into the offspring by dint of a divine blessing. Second, whatever else is established, whether it is the soul's creation and infusion or its propagation and traduction, it must nevertheless be held that the soul is present in the seed at first conception, when the seed of the father and mother are conjoined in the womb and retained, and as soon as the work of formation of the human body begins; nor can there be any other efficient cause which could accomplish the

[98] (Sennert, *HP* 4.8–10, 189–200). Jacques Roger has already charted this progression in his *Les sciences de la vie* (Roger 1963, 108).

[99] (*HP* 4.9, 192/1659, 501)—Roger is using a different edition of the *HP*. As Sakamoto explains (2016, 121ff.), the image of lighting one lamp from another derives from Augustine in his rejection of Tertullian's explanation of the traduction of the human soul as materialistic and incompatible with Christianity. Scaliger used a similar image of lighting one flame from another to explain the transmission of the immaterial soul from the parent to the offspring in animals and plants, but not humans. Sennert boldly applies the same explanation to human souls.

work of conformation than the human soul itself. Third, even though I know great men disagree here, still, if their reasons alone are considered in isolation from their authority, I will show that scarcely any solid reason can be brought against the propagation of the human soul through the seed. (197/509)

Thus, according to Sennert, the human soul already exists in a preformed seed that derives from the conjoining of the parents' seeds at conception. This opposes the traditional account of Aquinas and others, where the rational soul is introduced to replace the sensible soul, which in turn had formed from the vegetative soul.[100] In opposition to this, Sennert insists on traduction: "The truth is namely that the seed (I mean the body of the seed) is the vehicle by which the soul is communicated from the parents to the offspring:[101] which action is called traduction, by a word taken from plants" (Sennert 1651, 54, c. 2). The analogy, as he explains, is with the grafting of trees, where the form of a pear tree, for example, is communicated to the apple tree into which the shoot is grafted, thus producing pears.[102] Perhaps recognizing that this seems rather to debase the human soul, Sennert insists that traduction does not derogate from the nobility of the rational soul:

> Nor does the nobility of the intellect, with respect to both essence and operations, show anything else. For it pleases the Creator thus to associate the noblest substance with the body. And so if the immortal rational soul can spend a long time in the mortal body, why may it not also be propagated with the seed? . . . The nobility of the human soul is consistent with traduction. (*HP* 4.11, 201/1659, 515; the last sentence added in Sennert 1651, 57, c. 2)[103]

Sennert justifies his theory of traduction by appeal to his axiom that *omnis forma est sui multiplicativa*, i.e. that every form multiplies itself (*HP* 4.1, 169/1659, 465, and *HP* 1.3, 143/1959, 424); in particular, in the generation of living things, every soul multiplies itself. Leibniz discusses Sennert's theory of traduction in his *Theodicy*, without ever admitting to having subscribed to the doctrine himself. Nevertheless his advocacy in 1671 of the "multiplication of souls", and of mind that can "multiply itself, without new creation, by traduction", is certainly suggestive of a Sennertian influence, even if mediated by other authors. His mathematical modelling of the

[100] See Hirai (2012, 88).

[101] We may note in passing that Sennert's talk here of the seed being the "vehicle of the soul" is echoed in Leibniz's characterization of his physical point as "the proximate instrument and as it were vehicle of the soul" in his letter to Johann Friedrich.

[102] "For example, in trees, in which the seminal force is diffused throughout the whole body, if some part is cut off, and that of some other tree is inserted, the soul of the tree from which the shoot was cut is communicated into the other tree: in the same way, when the soul is conveyed with the semen of animals into the feminine uterus, so finally from this semen endowed with its own soul the complete animal emerges" (Sennert 1651, 54, c. 1).

[103] In Arthur (2006, 171) I misinterpreted this passage, reading Sennert as asserting that the Creator "associates the noblest substance" with such fertilized seeds at the moment of conception, thus anticipating Leibniz's talk of the "elevation" of certain immaterial souls to the "elect" or "society of minds". But as Kuni Sakamoto sagely pointed out to me in Toyama (February 2016), God's having so to intervene would defeat the point of traducianism.

process of the multiplication of souls by the division of vertices of bodies can thus be seen as an attempt to make traduction conformable to the principles of the New Philosophy. In particular, it seems likely that, through his neo-Hobbesian characterization of minds and thoughts in terms of endeavours and his localization of them in points, Leibniz thought he could avoid one of the serious charges with which traduction was faced: that such multiplication by division would entail the materiality of the human soul.

For the doctrine of traduction (Traducianism) was a controversial view for this reason, despite Augustine's attitude to it. Indeed, it is still regarded as a heresy in today's Catholic Church.[104] As Leibniz documents in his *Theodicy*, the alternative doctrine of Creation (of souls anew, as in eduction) "is taught in the majority of Christian schools", despite its difficulty in accounting for original sin.[105] Traduction, on the other hand, was taught by "the great majority of the theologians of the Augsburg confession", the primary confession of faith of the Lutheran Church, and the fact that it was widely accepted in Lutheran circles in the seventeenth century is perhaps sufficient to explain why both Sennert and the young Leibniz advocated the view. But Sennert's defence of it stirred up quite a hornet's nest in his own day. After the publication of the *Hypomnemata*, Sennert was accused of impiety in a barrage of attacks by Johan Freytag (1581–1641), who denounced him "to the Academies of the Christian world".[106] The nub of Freytag's denunciations is precisely "the doctrine of the transmission of souls from the parents *per traducem*, which", according to Freytag, "would imply the transmigration of souls as well as the immortality of the souls of beasts" (Clericuzio 2001, 32).

The transmigration of souls would follow from the fact that, according to Sennert's theory, all souls were created by God *ex nihilo* in the Creation, and since then have simply propagated from one generation to the next, budding at each conception, thus transferring from parent to offspring. Sennert's answer to Freytag's objection to this

[104] The *Catholic Encyclopedia* on the web comes out firmly against Traducianism, claiming that "the organic process of generation cannot give rise to a spiritual substance, and to say that the soul is transmitted in the corporeal semen is to make it intrinsically dependent on matter… Since the soul is immaterial and indivisible, no spiritual germ can be detached from the parental soul… Theologically, corporeal Traducianism is heretical because it goes directly against the spirituality of the soul." (See <http://www.newadvent.org/cathen/15014a.htm>; accessed 18 April 2011.) These criticisms are apparently made in ignorance of Sennert's position.

[105] "*Traduction*… is taught also by most of the theologians of the Augsburg confession. Nevertheless it is not completely established among them, since the universities of Jena and Helmstedt, and others besides, have long been opposed to it. The third opinion, and that most widely accepted today, is that of *Creation*: it is taught in the majority of Christian schools, but it is fraught with the greatest difficulty in respect of original sin" (*Theodicy* §90/H 172).

[106] See Clericuzio (2000, 31) for a listing of the various works by Freytag attacking Sennert, published in 1630, 1632, 1632, 1633, 1633, and 1636. In the Preface to his *Hypomnemata*, Sennert reports Freytag as describing him as "substituting [for Aristotelian principles] his truly absurd, false, rancid, heretical and blasphemous paradoxes,… and putting forward as principles his truly inept, colder than January, impious, false, heretical paradoxes and dogmas brimming with contradictions that have either been previously condemned or recently hatched in the brains of sycophants"! See Michael (2001, 350).

is that the alternative—having souls created *ex nihilo* at each generation, as in the doctrine of eduction—contradicts what is implicit in God's command in Genesis: "Increase and multiply!"[107] For, "since man consists of a body and soul, if the soul does not emanate from the parents, man would not engender man" (*HP* 4.10 197/1659, 509–10). We will return to that issue, as well as that justification, in Chapter 4.

Concerning Freytag's second charge, Sennert responds by denying that "the immortality of the souls of beasts" does in fact follow from his premises. The fact that the soul remains intact in its atom or minimal corpuscle through certain processes does not entail that it remains intact forever:

> Sometimes, however, this seminal force completely dies and perishes. For the things I have said so far, and will say later, about the souls and seminal force [residing] in atoms and minimal corpuscles, are not such that someone should mock them and make me out to hold that such souls, since they remain intact during so many changes, are immortal.[108]

As Andreas Blank has explained, Sennert's commitment to the doctrine of *minima naturalia* means 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 [that] minimal size" (Blank 2011, 117). This makes for a crucial difference between Sennert's theory and the account of traduction that Leibniz was proposing in the early 1670s when he claimed that he could prove the immortality of souls from the fact they were indestructible, being contained in an indivisible point, or in the nucleus of an atom surrounded by an impenetrable cortex.[109] But since he also maintained that such minds are everywhere in matter, this left his theory vulnerable to Freytag's second charge that it would make animal souls immortal—not to mention all the lesser minds in bodies!—as no doubt someone pointed out to him.

At any rate, by 1678 Leibniz had clearly recognized this difficulty, and repaired it by distinguishing the souls that are immortal, namely minds, from those that are merely inextinguishable:

> All souls are inextinguishable, but precisely those are immortal which are citizens in the Republic of the Universe, i.e. those for which God is not only Author but King. For joined to

[107] Sennert quotes this passage from Genesis 1 many times: "And God blessed the fishes and the birds he had created, saying: increase and multiply; and fill the water of the seas, and let the birds be multiplied upon the earth" (*HP* 1.3, 142/1659, 421); again, noting how a single tobacco seed can engender 300,000 in one year, so that by the third year it will produce "100,000 myriads" (i.e. 10^9), he comments: "so powerful was that Divine Blessing: Increase and multiply" (*HP* 4.8, 190/1659, 498). Cf. also (*HP* 4.6, 184–5/1659, 489), (*HP* 4.4, 174/1659, 510).

[108] (Sennert, *HP* 5.3, 221/1659, 181); my translation of the Latin given by Hirai (2011, 168); cf. Clericuzio (2000, 31–2).

[109] Thus the two give differing accounts of the reported phenomenon of palingenesis, where whole plants were said (by Du Chesne) to be regenerated from ashes: Leibniz posits that the soul of the plant survives in its ashes in a "core of substance" that "is so subtle that it remains in the ashes of burnt things and is able, as it were, to contract itself into an invisible centre" (A II i 108–9), thus explaining the possibility of its regeneration; whereas for Sennert this is explicable in terms of a spirit, but does "not involve the agency of a soul-like entity". For a perceptive and illuminating discussion of this issue, see Blank (2011, 118–21).

these is a certain reason peculiar to them, these souls are called minds, these never forget themselves, these alone think of God; these have distinct conceptions of things.

(*Conspectus for a Little Book on the Elements of Physics*, A VI iv 1989/LLC 235)[110]

Indeed, after the early 1670s there is no longer any talk of the soul being "constituted in a mathematical point" or of the "multiplication of souls". In his note for Des Bosses Leibniz alludes to "innumerable difficulties" into which the theory leads, without going into specifics. One such difficulty would presumably be that if minds can continually *arise* by dividing their points in this way, they can continually *perish* too by a fusion of such points, by his own admission to both Van Velthuysen and Des Bosses (LDB 125). But this contradicts his boast to Oldenburg in 1671 that he could "demonstrate" the indestructibility of mind from the fact that "once two contrary endeavours in the same point of a body are compatible beyond a moment, no other bodies can slip between them, nor can they be prized apart by any force for all eternity" (A II i 90).

We can assume that the latter demonstration came to naught. In any case, by 1676, Leibniz had "become a geometer", and had abandoned his earlier theory of continuous bodies being composed of overlapping points. For once he has rejected his previous interpretation of the infinitely small as actual infinitesimal points, this explanation of original cohesion, and with it his theory of neo-Scaligerian mixtion, is in ruins. But he does not for this reason abandon atoms. Indeed, as we have seen, in numerous fragments he gives voice to a theory of spherical atoms whose solidity is now attributed directly to its containing a mind: "the solidity ôr unity of the body comes from mind" (16 April 1676; A VI iii 509/LLC 117). "No mind", he writes, "can be dissolved naturally. For if it could, it would have been dissolved long ago, since the whole of nature perpetually endeavours to dissolve it" (18 March 1676; A VI iii 393/LLC 59).

This is, of course, a negative argument; but there is a corresponding constructive argument. This is that once a substance begins to act, it necessarily must go on acting:

When anything that has a place is destroyed, so is its place, but the soul which proportionately corresponds to it cannot be destroyed. Whatever acts cannot be destroyed, for it at least endures as long as it acts, and therefore it will endure forever.... There seem to be elements ôr indestructible bodies precisely because there is a mind in them. (April 1676; A VI iii 521/LLC 121)

As Christia Mercer has observed, Leibniz has been committed since his *Catholic Demonstrations* of 1668 to the view that a substance, or being per se, is one that "has a principle of action within itself" (A VI i 508/L 115), a thesis she dubs Leibniz's "Principle of Substantial Activity" (Mercer 2001, 85). But here we have something

[110] See also the passages quoted above from May 1676, as well as Leibniz's little tract *On the Origin of Souls and Minds*, written in 1681: "Minds arise when God considers the whole universe not merely as a system of things but as a community of which he is King. So minds differ from other souls not merely in perfection, but also in their whole genus or nature. God granted minds that they should think about themselves, which gives rise to memory, which brings it about that the mind always remembers itself to be the same thing as before. From this immortality also follows, for the mind cannot begin to forget itself, and one thought always attracts another" (A VI iv 1461/LLC 261).

much stronger, an interpretation of the principle of activity as a principle of resistance to annihilation—reminiscent of Francis Bacon's *antitypia*, from which he derived his atoms' attributes of emanation, eternity, and immutability.[111] So Leibniz presents us with an interesting inversion: instead of the indestructibility of mind being explained in terms of its being contained in an atom, the indestructibility of the atom is explained in terms of its having an indestructible mind. But Leibniz perceives that the argument for the indestructibility of minds is symmetrical with respect to future and past. As he writes on 15 April 1676:

> If mind could have begun, it would be extinguishable; and just as it was made from God, it would return into God. This would be consistent with the Aristotelian view, and with those who speak of a universal intellect.[112] To me, however, it seems that no soul has ever begun, nor can any soul cease to exist. (A VI iii 512/DSR 65)

This doctrine that the mind or soul associated with an atom lasts from creation until the end of the universe is clearly ancestral to Leibniz's mature theory of monads. It marks a definite break from his earlier espousal of the multiplication of souls by traduction. With the demise of the theory of indivisibles of the *TMA* there is no longer any mention of the mind being located in a mathematical point. Instead, Leibniz regards each of his innumerable minds not only as "indissolubly implanted in a certain matter, that matter having a definite magnitude", but as "of unbounded duration", as he writes in *On the Secrets of the Sublime* on 11 February of the same year (A VI iii 476–7/LLC 51). "There are innumerable minds everywhere," he writes. "There are minds in the human ovum even before conception, and they do not perish, even if conception does not follow" (477/51).

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To conclude: in this chapter we have examined the complex issue of Leibniz's attitude to atoms in his writings up to the year 1676, and his conflicting statements about them. We have seen that his espousal of atoms during this period is explicable in the context of the various views about atoms entertained by his contemporaries, in particular, the chymists or those influenced by them. Like them, he used the term 'atom' for a least particle of a given natural kind that remains intact through relevant changes, for example, chemical reactions or biological reproduction, with no particular connotation of sameness of shape or rigidity, nor of inner homogeneity or inactivity. Leibniz's atoms or *bullae* are integral bodies, but it suffices for such an atomic body to be integral only in its crust or surface: "For inside it is again composed of infinitely many globes, and new worlds can be contained in it without end" (A VI 2, N44/LLC 345).

[111] According to Silvia Manzo's analysis in her (2001), Bacon should not be interpreted as moving from an embracing of atoms in his early work to a more "pneumatical" or semi-Paracelsian matter theory in his maturity. Rather he moves from a conception of atoms as minimal particles moving in interstitial vacua in his *Cogitationes de natura rerum* of 1604 (215–16) to one in which (in his *De principiis* of *c.*1612) they are identified with a *vis vel virtus*. This, she argues, is the same principle of *anitypia* described in the *Novum Organon* of 1620, whereby "matter must always continue to move in order to conserve its identity" (231). It is in the latter work that Bacon rejects the vacuum, and replaces it with his philosophy of folds (*plicae*) of matter.

[112] Here Leibniz refers to Averroës and his followers, such as Paul of Venice. See Michael (1997, 284–5).

Leibniz's criticisms of atoms in this period, on the other hand, are of a piece with his mature criticisms: they are directed at atoms of the kind conceived by Cordemoy, Huygens, and Hartsoeker, perfectly hard (or firm) portions of extended matter that are absolutely indivisible, retain the same shape and size, and lack any inner principle of activity. Indeed, by the end of 1676 most of his mature criticisms of atoms have already been articulated. Thus the argument Leibniz gives against atoms in the postscript to his fourth paper to Clarke based on plenitude and sufficient reason—namely, that the world of new creatures contained in the least corpuscle would be lacking "if this corpuscle were an atom, that is, a body all of a piece and not subdivided", and that no reason can be assigned for limiting the subdivision of matter (GP VII 377–8/MP 220, 221)—had already been formulated by him in the *Pacidius Philalethi* of November 1676 (A VI iii 561/LLC 199). A second argument that Leibniz often gives in his mature writings is the argument from elasticity: "There is no body so small that it does not have elasticity, so that is permeated by an even more subtle fluid; and consequently *there are no elements of bodies*, there is no perfectly fluid matter, and there are no solid globes of some supposed second element, of fixed and unchanging shape; rather, the analysis continues to infinity."[113] Again, as early as 1671 Leibniz was writing "*There are no Atoms*, i.e. bodies whose parts never separate" (A VI 2, 280/LLC 344); and it is amplified in the *Pacidius*: there are no "perfect solids" or "bodies so firm that they do not suffer any subdivision or bending" (A VI iii 561/LLC 199); indeed, "every body is everywhere flexible" (554/185). The basis of this argument is that "if a perfectly fluid body is assumed, a finest division, i.e. a division into minima, cannot be denied". Since the latter conclusion is absurd, bodies must be capable of all degrees of flexibility short of perfect fluidity, always retaining a certain resistance to penetration, or *antitypia*.

There is one last sting in the tail, though. Although by November 1676 Leibniz has already articulated the main arguments against atoms that will appear in his mature work, in a manuscript bearing the date "2 X^{br} 1676" (i.e. 12 December NS), he calmly returns to his spherical atoms of earlier in the year—and this despite his explicit disavowal of indissectible corpuscles in a letter to Fabry of the same month (A II i 289).[114] The arguments he gives are those he gave earlier in April: "Supposing the plenum, *atoms* are demonstrated" (A VI iii 585/DSR 109), which presumably alludes to the argument that the action of the surrounding bodies on any given solid body will reduce it to a "powder of points". "Indeed, they are even demonstrated without assuming the plenum, from the mere consideration that everything flexible will be divided into points" (585/109). These claims perhaps indicate that Leibniz still does not have

[113] (*Specimen Dynamicum*, GM VI 249/WFT 171). Leibniz wrote the same thing to Bayle on 27 December 1698: "there are, so to speak, worlds within the smallest bodies, since every body however small has elasticity, and consequently is surrounded by and penetrated by a fluid as subtle with respect to it as that which makes the elasticity of sensible bodies able to be with respect to us, and thus there are no first elements, since it is necessary to say as much about the least portion of the most subtle fluid one can suppose" (GP III 57).

[114] The simplest explanation for this would be that Leibniz later added the wrong date, but the Akademie edition editors have assured me that the dating of this piece is correct.

any way of characterizing flexibility in terms other than internal division. He has no temporal continuants which can remain the same even while undergoing changes of shape and size. Perhaps, then, this is a case of Leibniz's finding the hypothesis of atoms indispensable for his physics, as suggested by Beeley. In order to give explanations in physics in terms of flexible bodies, he is compelled to assume perfectly hard, spherical atoms moving in a perfectly fluid plenum as a necessary fiction for this purpose. This is consistent with Leibniz's writing of its "sufficing" to reduce everything to globes "even if they were not the most basic elements".[115] At any rate, it is this fictionalist interpretation of atoms that we find him advocating a few years later in his *Specimen of Discoveries* from the late 1680s, which we may take as his final word:

> Even if there is nothing in the universe of the utmost fluidity, nor of the utmost firmness, one may still imagine for purposes of explanation that everything consists of globules of any desired smallness and infinite firmness, and of a fluid running between them of infinite fluidity, just as in geometry we imagine lines that are infinite and infinitely small. (A VI iv 1628/LLC 327–9)

Thus there is a sense in which the movement of Leibniz's thought on atoms recapitulates Francis Bacon's. Both begin with atoms conceived as extremely small and very hard ultimate parts of matter, although they both often lean towards regarding the hypothesis as a "heuristic tool" for uncovering truths about matter in terms of combinatorics, rather than as literally true. On the other hand, though, both conceive each atom as containing an active principle from which its motions would emanate, a *vis* responsible for the inherent activity of matter. Both, finally, adopt the position that the force alone is sufficient to explain what is indestructible in matter, while matter itself is divided into *plicae*, an elastic contiguum of folding and unfolding bodies of differing degrees of solidity and fluidity. Clearly the relationship between Leibniz's early natural philosophy and Bacon's (particularly the *Novum Organon*) is deserving of much more detailed study.[116]

But as we have seen here, there are considerations outside physics propelling Leibniz towards indestructible principles in things, even if these principles are not physical

[115] "These firm bodies may for all intents and purposes be reduced to a globular shape of whatever size, because in this way they offer as little obstruction as possible to those surrounding them, and because this can be done without their being broken up. Hence all things are made from globes, and even if globes were not the most basic elements, there would still always be a reduction to globes; therefore it would be useless for there to be a variety of shapes among atoms, so that it suffices for atoms all to be globular" (A VI iii N85: 585). Similarly Nicolas Hartsoeker advocated hard corpuscles of various shapes and sizes floating in a continuous fluid, stressing that one could formulate hypotheses about their shapes and sizes for the sake of plausible explanations, even if it were impossible to verify them (Clericuzio 2000, 190).

[116] See Silvia Manzo (2001) for an illuminating exposition of Bacon's changing views about atomism. In this connection, it should be motioned that there are many features of Leibniz's views which might suggest an influence from Giordano Bruno. For Bruno was perhaps the first to propose atoms as endowed with an indivisible vital force, conceived his atoms as spherical (since a variety of shapes is not necessary to produce the variety of structures in the phenomena), and as moving in an infinite plenum of aether: see Gatti (2001) for details. Maria Rosa Antognazza, however, reports in her (2009, 352) that Leibniz did not study Bruno till much later in life, so that any instances of Brunonian themes were presumably mediated through Bacon and other thinkers. Again this deserves more study than it has heretofore received.

atoms. Leibniz's early theory of traduction, where the soul is located in a point, has already alerted us to the importance of theological concerns, and these issues in turn are deeply entangled with biological theories of generation. Both sets of concerns, theological and biological, require a proper accounting of the status of forms and their relation to bodies. In order to understand the full movement of Leibniz's thought, we need to investigate these matters in detail.

4

Forms and the Scholastic Tradition

> "Not only was there an organic body already there before conception, but there was also a soul in that body: in a word, there was the animal itself. Through the process of conception that animal was merely committed to a great transformation so as to become an animal of a different kind…
>
> Thus we can say that not only is the soul—the mirror of an indestructible universe—indestructible, but so too is the animal itself."
>
> (*Monadology*, 1714, §§74, 77; GP VI 619, 620)

In Chapter 3 we examined Leibniz's atomism against the backdrop of the chymical atomist tradition. The comparison with Sennert, in particular, helped to clarify Leibniz's early views on traduction, as well as providing a precedent for his soul-containing atoms and thus setting the stage for his later atoms of substance. But by 1676, as we have seen, although Leibniz no longer supported Sennertian multiplication of souls, he was still espousing spherical atoms, and not the corporeal substances that he was to promote after his rehabilitation of substantial forms little more than two years later. In fact, there is much still to be explained about this transition to his mature philosophy of substance. Putting aside considerations about force and the subject of motion for Chapter 5, in this chapter we will be concerned with what appear to be the non-mechanical elements of Leibniz's new philosophy of substance: why does he abandon his physical atoms of 1676 for a natural philosophy in which "every body is animate" or at least a collection of such animate bodies?[1] Given his strong commitment to the mechanical philosophy, what prompts him to rehabilitate the substantial forms of scholastic philosophy, widely regarded as discredited? Why does he feel the need to solve the traditional "problem of the origin of forms"? And, finally, what explains his endorsement of teleology?

We can gain some insight into these issues by setting Leibniz's natural philosophy in its historical context. To this end, a comparison of his youthful views with those of Gassendi, Sennert, and Boyle will prove most instructive. Gassendi, I argue, can

[1] In the drafts *Metaphysical Definitions and Reflections* (1678–9), Leibniz writes: "Every body is animate, ôr has sensation and appetite" (A VI iv 1398/LLC 245); but his more considered opinion is that "all organic bodies are animate, and all bodies are either organic or collections of organic bodies" (Notes on Cordemoy, [1685]; A VI iv 1798/LLC 277).

be seen as providing a mechanistic reinterpretation of the views on forms and generation of his predecessors, among them Liceti, Severinus, Du Chesne, De Boodt, and Sennert,[2] a process of reinterpretation continued by Boyle and also by the young Leibniz. As we have seen, Sennert anticipated Leibniz in rehabilitating substantial forms fifty years before him in explicit opposition to the rejection of such forms by his fellow atomist Sébastien Basson; and it is largely Sennert's views on forms that Boyle criticizes in his *Origine of Formes and Qualities*, since he considers Scaliger's and Sennert's arguments for them among the most intelligible of scholastic accounts. Moreover, I shall argue, it seems plausible that these very criticisms of forms by Boyle were instrumental in provoking Leibniz in the late 1670s to argue for their rehabilitation in a guise that was not susceptible to the Anglo-Irish philosopher's criticisms, and to formulate conceptions of organic body and its end-directed actions that were compatible with the mechanical philosophy. For Leibniz was, if anything, even more committed to the mechanical explanation of natural phenomena than were either Gassendi or Boyle themselves, and yet his metaphysics of a hierarchy of active forms animating bodies dispersed throughout nature can be seen to be profoundly indebted to Scaliger and Sennert.

4.1 Preformation, Seeds, and Material Souls

> I agree entirely with the followers of those excellent gentlemen, *Descartes* and *Gassendi*, and with whomever else teaches that in the end all variety in bodies is to be explained in terms of *size*, *shape* and *motion*.[3]

Modern scholars have been sceptical about the possibility that Leibniz could ever have been much influenced by Gassendi's largely materialist philosophy,[4] despite Leibniz's favourable references to him, as well as to a period where "he gave himself over completely" to atoms and the void.[5] From his earliest writings, they point out, Leibniz was concerned to argue the insufficiency of a purely mechanical account of body, in

[2] See the Glossary of Scholastics and Atomists for more information on the views on forms and generation of these thinkers. For a thorough examination of their views, as well as those of Marsilio Ficino, Jean Fernel, Georg Agricola, Jérôme Cardan, and many others, consult Hiro Hirai 2005 and 2011.

[3] Leibniz (*HPN* §57; A VI ii 248); cf. Garber (1995, 275). Leibniz continues the passage by saying that he nevertheless finds that the hypotheses of Epicurean atoms and Cartesian globules are "rather remote from the simplicity of nature and from any experiments", and that his hypothesis of *bullae* is much to be preferred.

[4] Thus Christia Mercer, after describing how the youthful Leibniz tackles Anaxagoras' "black snow" paradox using Gassendian principles, writes that "there is little reason to believe that Leibniz was particularly wedded to Gassendi's views on perception, or to Gassendi's philosophy for that matter" (Mercer 2001, 40). Although the tide has now turned, Gassendi's reputation among a previous generation of historians of science is represented by Marie Boas Hall's opinion that "No scientist could take seriously Gassendi's elaborate, turgid and prolix attempt to introduce Democritean atoms into the physics of the mid-seventeenth century" (Boas Hall, 346); quoted from Clericuzio (2001, 467–8).

[5] See Leibniz's frank assessment of Gassendi's philosophy in his July 1714 letter to Remond: "ses meditations me contentent moins à présent qu'elles ne faisoient quand je commençois à quitter les sentimens de l'École, écolier encore moy même. Comme la Doctrine des Atomes satisfait à l'imagination, je donnay fort là dedans . . ." (GP III 620).

keeping with his firm opposition to materialism in his mature philosophy. Thus as early as 1668, Leibniz argued in his *Catholic Demonstrations* that Descartes' *extended substance* could not contain the basis for the activity of a body, and that being purely passive and unable to act, it would not qualify as a substance. He claimed to have demonstrated in this work that "no body taken apart from a concurrent mind [*praecisa mente concurrente*] has a principle of motion within itself", so that since a substance must have a principle of action, and a body's action is its motion, it follows that "no body taken apart from a concurrent mind is a substance" (A VI i 508–9).

But these criticisms of Descartes by Leibniz echo those made by Gassendi of his French rival in his *Disquisitio metaphysica*, the large tome he wrote in response to Descartes's *Meditations*:

> Concerning body, I note only this, that if its whole nature consists in the fact that it is *res extensa*, then every action and the faculty of every acting thing is outside corporeal nature, since extension is purely passive, and whoever says a thing is only extension says, among other things, that it is not active. Therefore there will be no action, and no faculty of acting, in bodies.[6]

In order to account for the activity of bodies, Gassendi insisted, it is necessary for there to be a principle of action in them, a principle that cannot be derived from matter conceived merely as extension or bulk. Leibniz acknowledges his agreement with this criticism of Descartes' passive matter even while rejecting Gassendi's materialism concerning substance. In December 1676, in the context of an indignant response to Honoré Fabry's accusation that he favoured Democritus and Gassendi over Aristotle, he avers:

> Truly, I hold for certain that there are incorporeal substances, that motion does not come from body but from outside; that there are no corpuscles indissectible by nature . . . Nonetheless I agree with Gassendi rather than Descartes that the essence of body does not consist in extension . . . (A II i 289)

The respects in which Leibniz dissents from Gassendi here are also interesting. He has by December 1676 rejected indissectible atoms, as we saw in Chapter 3. His insistence that there are incorporeal substances[7] opposes Gassendi's construal of substances as conglomerations of material atoms, albeit ones containing principles of action; and his avowal that motion comes from outside signals that, at this stage of his philosophy (at the end of 1676), Leibniz does not believe that these principles of action are internal principles of motion. This is evidenced in his unpublished writings of that year, where he writes of motion occurring by a "transproduction", where

[6] Gassendi, *Disquisitio Metaphysica*, 1658 (GO III 305b); quoted by Bloch (1971, 207).

[7] As Christia Mercer has observed, this metaphysics of incorporeal substances is evidenced elsewhere. For instance, in the fragment *On Existence* of the same month (December 1676) Leibniz writes: "The harmony of things requires that there should be in bodies beings that act on themselves. . . . Thought ôr the sensation of oneself, ôr action on oneself, is necessarily continued, but I do not yet see that the action of an agent on itself is necessarily continued in the body; what is continued, rather, arises from the harmony of things" (A VI iii 588/DSR 113; Mercer 2001, 413).

matter is annihilated and then resuscitated, while what endures is "mind itself, understanding a certain relation" (A VI iii 503/LLC 99). But, in contrast to the mature theory, the mind that remains intact to "assist matter" through its transproduction is "a certain universal intellect"—i.e. God.[8] As we'll see in what follows, in this period Leibniz's views are rather unsettled: although he continues to be persuaded that there must be principles of individuation within bodies, their action is understood to depend directly on God. But this will change within a scant two years as a result of his reconstrual of substantial form as force. For by the winter of 1678–9 the "incorporeals" are not only "in body"; they are souls or forms animating bodies, principles responsible for the self-identity of body through time, possessing a kind of perception and appetite; substance is defined as "that which can act"; and the actions of a body, its forces, are "estimated from the quantity of the effect" (A VI iv 1988/LLC 233–5; A VI iv 1398/LLC 245). As Leibniz explains in his *Theodicy*, this involves a reinterpretation of Aristotelian substantial form or entelechy as a force or endeavour "from which action itself must follow if nothing prevents it" (§87; GP VI 150/H 170). Form is thus an unextended principle of activity whose phenomenal effect is the activity of otherwise passive extended bodies.

This advocacy of agents and principles of action in matter is quite evocative of what Gassendi had written in his posthumous *Syntagma*, where he even equates the principle of activity with *form*:

> [I]n natural things there is an Agent operating inside them, which is indeed distinguished from matter in part, but not from matter as a whole… since in everything there is a principle of action and of motion,… and as it were the flower of the whole of the matter, which is also the very thing that is usually called Form.[9]

Leibniz's doctrine that there is a principle of activity inherent in every corporeal substance thus has an interesting correspondence with Gassendi's ascription of a principle of action or form to atoms. Lest I be misunderstood, however, I am not claiming here that Leibniz derived the idea of a principle of activity in bodies from Gassendi. It was a common interpretation of Aristotle's "principle of motion and rest", and as Leibniz himself notes, such a principle was interpreted as the substantial form of a body by Aristotle, and by Averroës and scholastics such as Jacopo Zabarella, who equated it with a body's principle of individuation (A VI i 510/L 117). Moreover, whether or not Leibniz was consciously emulating Gassendi on this point,[10] the latter was by no means the only representative of the "Mechanical Philosophy" to advocate

[8] See *On Motion and Matter* (A VI iii 493–4/LLC 77–9). See also *Pacidius Philalethi* of November 1676, especially (A VI iii 559, 567/LLC 195, 213).

[9] GO I 336a, 337a; cf. Bloch (1971, 216).

[10] Writing to Thomasius in 1668, Leibniz says "Aristotle himself agrees remarkably well with Galileo, Bacon, Gassendi, Hobbes, Descartes and Digby" (A II i 10/Mercer 2001, 91). A related matter on which he explicitly acknowledges agreement with Gassendi is the fact that he is among those "who, in forming a theory of corporeal nature, add to extension a certain resistance or impenetrability" (A VI iii 157–8/Mercer 2001, 83).

active principles in matter, as John Henry has argued.[11] First, there was an English tradition of assigning bodies a *vis radiativa* as the active principle in matter. This begins with Thomas Harriot and extends to the writings of the young Walter Charleton and the virtuoso Matthew Hale, but is represented above all by Walter Warner (1570–1642).[12] Secondly, there was the chymical tradition we discussed in Chapter 3 in which the atoms were regarded as fonts of activity; but where other active principles were also assumed, such as those responsible for magnetism and fermentation. And thirdly, thinkers asserting an original activity in matter were also inspired by the writings of Epicurus (as were Nicholas Hill, Isaac Beeckman, and Gassendi himself) or by Gassendi's elaborations thereof (as were Robert Hooke, William Petty, and Walter Charleton). Now Gassendi, in his influential *Animadversiones* of 1649 (which, as we saw, Leibniz had cited in his *Dissertatio* of 1666), not only attributed activity to matter, but assigned it a cause that was not in keeping with the mechanical philosophy as conceived by Descartes.[13] Atoms, he claimed there, following Epicurus, possess an *impetus* or *energeia* by which they spontaneously resume their motions after collisions: "Whence also the motive force which is in each concrete thing owes its origin to atoms; nor is it in fact distinct from their weight (*pondus)* or impetus" (Gassendi 1649, 309).[14]

This agreement with Epicurus about atoms' ability to spontaneously resume their motions was, of course, rather dangerous theologically, as it seems to make matter self-sufficient, to the advantage of the atheists. For if atoms have this impetus or *energeia* innately, they stand in need of no divine concurrence. In his posthumous *Syntagma Philosophicum* (1658), however, Gassendi distances himself from the idea that self-activity is innate or intrinsic to matter, in the sense that it has it independently of God. In this work, Gassendi merely imputes the innateness of the atoms' impetus to Epicurus, and then denies that it follows from their own nature. The thesis "that atoms have in themselves a motive force ôr impetus", he wrote there, "must be disapproved".[15]

[11] John Henry (1986), argues that many English philosophers regarded matter as endowed with activity, among them Petty, Glisson, and even Robert Boyle. Clericuzio disagrees (1990, 572), quoting passages showing Boyle's trenchant opposition to ascribing self-motion to matter. Nevertheless, Boyle certainly upheld the incessant motion of matter: see n. 15 below.

[12] For an informative account of the theories of matter entertained by members of the Northumberland Circle see Stephen Clucas (Clucas 2001).

[13] Newman (2006), takes issue (rightly, I believe) with conceptions of the mechanical philosophy as eschewing final causes or allowing only action by contact (177), and (under the influence of Descartes) as requiring explanations solely in terms of the size, shape, and motion of the *prima naturalia* or micro-corpuscles (178–89).

[14] In *On Nature Itself* (1698) Leibniz criticizes Sturm for denying that "there is any *energeia* in created things" (GP IV 504/WFT 210).

[15] Before disowning it, Gassendi had ascribed the innateness of impetus to Epicurus: "Supposing (as Democritus did not deny) that motion is ascribable to atoms, he judged it absurd not to attribute to them a special force by which such motion is initiated: of this kind is gravity ôr weight, ôr impulsion, and also the impetus by which whatever moves is made to act." Gassendi, *Syntagma Philosophicum* (GO I 280); see Clericuzio (2000, 64–5). As Clericuzio observes in his (2001), however, in the *Syntagma* Gassendi still advocated gravity as an innate force (*vis insita*) in atoms (472), so that his position was not free from ambiguity. This results in a significant difference between Gassendi's position and Boyle's, as Clericuzio stresses. For Gassendi followed Epicurus in attributing the same velocity to all atoms, with the velocity of macroscopic

Nevertheless, Gassendi continued to promote the idea of an active matter resulting from the incessant activity of atoms, even if the activity is not original with bodies but depends on divine concurrence.

A similar line is taken by Robert Boyle: bodies are active and in incessant motion, but they do not have an innate capacity to move themselves. In *The Origine of Formes and Qualities* of 1666, Boyle maintained that:

> according to our doctrine [viz., "the *Mechanical Hypothesis*"], the World we live in is not a Moveless or Indigested Mass of Matter, but an ἀυτόματον, or *Self-moving Engine*, wherein the greatest part of the common Matter of all Bodies is always (though not still the same parts of it) in Motion… (Boyle 1666, 92; 1667, 61)

And in his initial statement of the doctrine in this work, Boyle presents an argument for the incessant activity of matter that could easily be taken for the original of Leibniz's later argument that "there is never any true rest in bodies":

> And since we see not, how there could be any change in Matter, if all its (actual or designable) parts were perpetually at rest among themselves, it will follow, that to discriminate the Catholick Matter into variety of Natural Bodies, it must have Motion in some or all its designable Parts and that Motion must have various tendencies, that which is in this part of the Matter tending one way, and that, which is in that part tending another; as we plainly see in the Universe or general Mass of Matter there is really a great quantity of Motion, and that variously determin'd, and that yet diverse portions of Matter are at rest. (Boyle 1666, 3)

Boyle was careful to add that he does not agree with those ancients who, "not acknowledging an Author of the Universe", made motion "congenite to *Matter*, and consequently coëval with it" (4). Not being "wont to think a man the worse Naturalist for not being an Atheist", he agrees with Descartes that "the Origine of Motion in Matter is from God" (Boyle 1666, 5). He also considered and rejected the Epicurean thesis of the innateness of impetus in *An Essay of the Intestine Motions of the Particles of Quiescent Solids*, appended to the second edition of his *Certain Physiological Essays* (Boyle 1669). This is the book by Boyle that Leibniz cites in his *New Essays* in support of his views.[16] As we shall see when we come to examine Leibniz's views on continuous creation and divine concurrence in Chapter 7, Leibniz will agree with Gassendi and Boyle that to regard substances as entirely self-sufficient would be to deny their continuing dependence on God, yet he will nevertheless insist (in agreement with the Gassendi of the *Animadversiones*) that each substance has an inherent *energeia* and is the source of its own actions. For him the actions of a substance are produced by that substance, but the force or principle of activity which is its means to produce

bodies being a kind of group velocity resulting from these interior motions, whereas Boyle took the view that "God first impressed motion upon atoms and then continued to guide the motions of primary corpuscles in order to bring about various concretions of them" (Clericuzio 2001, 473).

[16] As a precedent for the incessant motion of matter, Leibniz mentions only Boyle, citing "Mr. Boyle's book attacking absolute rest" in support of his view that "there is never a body without movement", which "is one of my proofs that there are no atoms" (i.e. classical atoms) (A VI vi 53).

them still depends on divine concurrence: "all its actions come from its own depths, except for its dependence on God".[17]

There is a fundamental difference, of course, between the way Leibniz conceives principles of activity and the way Gassendi conceives them. In the same passages in the *Syntagma* where he advocates a principle of action in natural things, Gassendi attempts to account for this principle as "that most mobile and active part" of the matter. This is consistent with his materialism (excepting the rational soul), but difficult to square with the idea of agency. Confronted with the same problem, Sennert had distinguished between *spirit*, which he conceived as the material and efficient cause of corporeal changes, and *form*, which he denied could be understood as material. As we saw in Chapter 3, he adopted Scaliger's image of the soul as "a fire which burns with different flames".[18] This is echoed in Gassendi's description of the sentient soul (the *anima*) as a "sort of little flame":[19]

> It seems therefore that this soul is a sort of little flame [*quandam flammulam*] or very tenuous kind of fire, which thrives or keeps burning for as long as the animal lives, and when it no longer thrives but is extinguished, the animal dies.[20]

Thus for Gassendi the soul (*anima*) is a certain very tenuous body, so tenuous, in fact, that it is as if it were incorporeal:

> It seems to me therefore that the soul is rather a certain very tenuous substance, as it were a flower of matter [*flos materiæ*], with a special disposition or arrangement [*habitudine*] and symmetry of the parts passing within the denser mass itself; in fact, because of its mobility, it can be the principle of acting, just as is a substance (for we have deduced in its own place that the primary matter from which the substance of bodies comes is not something otiose, or devoid of motion and action)…. By this argument the soul is also a body, but it is very tenuous, and with respect to the rest of the mass it is as if it were incorporeal. (GO II 250b)

When we compare this passage with what Leibniz wrote in the 1670s, we see no great metaphysical gulf. In particular, even though chymical literature abounds with talk of the *flos* of one substance or another, it is hard not to perceive a commonality between Gassendi's *flos materiæ* ("flower of matter") and Leibniz's *flos substantiæ* ("flower of substance") in the 1671 treatise on resurrection discussed in Chapter 3. In February 1676, after reading Boyle's paper on the possibility of resurrection (1675), Leibniz wrote a short paper *On the Seat of the Soul* in which he recalls the treatise he sent to Duke Johann Friedrich. He again makes favourable references to the "'Luz' of

[17] The quotation is from a summary of his "pensées particulieres" that Leibniz sent Arnauld from Venice in March 1690 (GP II 136/WFT 136).

[18] Sennert: "For they are of the same species, and, just as when two flames are united, they are called one and give out an inseparable effect, so two souls joined together conspire to produce one effect" (*HP* 4.9, 192/1659, 501).

[19] Descartes, as Peter Anstey has reminded me, also took '*feu sans lumière*' as the principle of life. But there was a long tradition of identifying *spirit* with a flame—see, e.g., Sennert's remarking of this at (*HP* 4.7, 188).

[20] Gassendi, *Syntagma* (1658; GO II 262b); see Roger (1963, 139).

the Rabbis" and the flower-of-substance doctrine which he had sketched there, and rates the argument in the treatise for a flower of substance based on cannibals as "demonstrative" (A VI iii 479/DSR 35).[21] In this 1676 paper Leibniz argues that "the flower of substance persists through all the body's changes". He says that he thinks "the flower of substance is our body", and that he would "add only what was not observed by Boyle, that the soul seems to be firmly implanted in this flower of substance" (A VI iii 478–9; DSR 33).[22] The fact that Leibniz identifies the flower of substance as a body seems to imply, as Andreas Blank has also stressed, "that he understands it as something extended and material" (Blank 2015, 15). It is true that for Leibniz, as for Sennert, the soul must be immaterial. Nevertheless, as we have seen, in his early work he accounted for this immateriality in terms of the unextendedness of minds due to their being located in mathematical points, a fact which also accounted for their indestructibility. And in another paper of February 1676, *De unione animae et corpori*, Leibniz describes the soul as not only "implanted" in the flower of substance, but as "agitating" its own vortex, through which it has its perceptions:

> I have believed that there is some fluid or, if you like, an ethereal substance, diffused in the whole body, and continuous; by which the soul senses: which inflates the nerves, which contracts itself, and which expands itself. It is by no means credible that each part of this substance is animated, for since something always flies away, also the souls would be multiplied and divided. [...] Therefore I would think that in this liquid itself there is some fount of motion and expansion, as in a burning candle. In fact, it seems that in the cavities of the brain all circular motion takes place and that the soul preserves its vortex. And that [sensible] species themselves are nothing other than waves impressed upon the liquid, and that each wave is preserved eternally, even if through the composition with others it becomes imperceptible. But that the soul itself agitates a vortex, is a true wonder. Nevertheless, it does so, since we do not act as simple machines, but out of those reflections, that is, actions on ourselves. (A VI iii 480/DSR 35–7)

With minds so very much implanted in matter, and souls governing bodies by means of vortices, we can say that perhaps Leibniz was not after all exaggerating when he referred to this earlier phase of thought as "when I was more materialistic [*cum materialis magis essam*]" (*On the Radical Origination of Things* [1697]; GP VII 305/L 489). Indeed, it seems to me that once it is realized that Gassendi advocated a principle of action in every body, and indeed "forms" in matter whose effects would always be motions of parts of matter, and a "flower of matter" that would be a fast-moving subtle fluid, one can begin to appreciate that Leibniz's later remarks about his early sympathy for Gassendi's

[21] For discussions of Leibniz's "flower-of-substance" doctrine in relation to Boyle's, see Catherine Wilson (1997a, esp. 162–6); Stuart Brown (1998, esp. 582–4); and Blank (2011).

[22] Here he also gives chymical analogies, relating the case of how four different salts that have been dissolved in the same water can be precipitated out recombined in a crystal, as an example of how the same kind of recombination by crystallization could "occur in any human individual, in a more refined solution and in a quicker time". He also appeals to what the chymist "Glauber says about the regeneration of nitre" (A VI iii 479/DSR 35).

views may not have been exaggerations. Still, the fact that Leibniz advocated a flower of *substance*, in preference to one of *matter*, is, of course, significant, in that for him what is substantial, the soul itself, is immaterial.

But more light is shed on the development of Leibniz's thought by another point of consilience with Gassendi. This lies in the fact that Gassendi, having already followed Sennert in distinguishing atoms as the principles of most chemical reactions,[23] also agreed with him in holding that generation occurs in plants, animals, and humans alike by the passing down of invisibly small seeds (*semina*) which are indivisible—not atoms of the elements, but still indivisible molecules or certain concretions of them specific to the plant or animal in question:

> Nothing forbids our saying that atoms or corpuscles were created by God in the beginning and given a certain mass, shape and motion, and that as these move in various ways, meeting, interweaving, mingling, unrolling, uniting, and being fitted together, molecules—or small structures similar to molecules—are created, from which the actual seeds of plants are constructed and fashioned within the plant.[24]
>
> Of course the seed is woven together from several molecules, which are not all always broken down into atoms, nor into anything close to them in primary or subsequent generation…
>
> (GO II 285b)

The indivisibility of the molecules by natural processes accounts for the persistence of natural kinds from the beginning of time, even if the individual substances developing from the *semina* do not so persist. These seeds, created by God at the beginning of things, contain all the "genetic information", as it were, needed for the generation and development not only of biological substances, but also of minerals, stones, and gems. Moreover, still consistently with Sennert, each of these seeds contains a little soul that is an offshoot of its parents' souls, in accordance with traduction.

Gassendi's agreement with Sennert on these latter points, however, need not be ascribed to Sennert's direct influence. In his work on chymistry and mineralogy he owes a debt to the Lutheran scholar Anselm de Boodt and his notion of an "elaborator spirit" (*spiritus elaborator*). Crystals could not be formed, Gassendi thinks, without there being in the minerals a kind of seminal force (*vis seminalis*) operating through the actions of this elaborator spirit. "Such a regular distribution of parts and particles and the assembling of smaller particles in the formation of larger ones" would be impossible unless rocks were penetrated by such a spirit.[25] Even if minerals are not alive, he argues, there must be such an active force within them just as surely as in living things.

[23] For Gassendi's views, see Clericuzio (2000, 63–74). Boyle followed Gassendi's identification of primary concretions of particles with seminal principles. See Clericuzio (1990, 583).

[24] Gassendi (GO II 170b–171a); quoted in Fisher (2006, 109).

[25] Gassendi, *De lapidibus*, 1 (GO II 114 b): "Assuredly," Gassendi adds, "the seminal force is in a certain active substance which is not ignorant of its own operation; only the spirit can be a substance of this kind"; translated from the quotation given by Hirai (2003, 223), which should be consulted for a thorough discussion.

And in the case of spontaneous generation Gassendi explicitly admits a debt to Fortunio Liceti (1577–1657), Sennert's own acknowledged inspiration. He notes Liceti's solution, that there must be souls everywhere in living or dead matter where such generation occurs. But how could one believe "that there would be a form in matter without its informing the matter?" (GO II 261b/Roger 1963, 138). To resolve this problem, Gassendi asserts (as had Sennert before him) that "the cause of generation of animals of this kind is nothing other than the seed itself, or the little soul (*animula*) contained in it and prepared for its service" (GO II 262a). This in turn leads him to assert that these seeds must be already formed, and lying dormant in matter:

> Thus one can also say that even now the seeds of animals are formed, whether out of atoms or out of other principles, which God created in the beginning, and that he willed them to be endowed with forms and movements of such a kind that, on coming together, mixing, combining and remaining attached to one another in such a manner and in such order, they made such seeds, and such animals. But can one not say equally plausibly that seeds of this nature were made at the beginning of the world by the Supreme Creator of things, and dispersed variously through the Earth and the Water? (GO II 262b)

Thus Gassendi arrives at a view very like Sennert's, where seeds or *semina* are organic molecules containing an *animula* or little soul. As Saul Fisher has explained (2006), it is the life force contained in the *animulae* that "enables semen or seeds to direct ontogenesis simply on the basis of what they contain at the inception of the new individual, that is, without the benefit of interactions with any external matter" (Fisher 2006, 119). This is not a "classic" preformationism like Malebranche's, where "an actual miniature, the features of which are less developed versions of the features of the new individual, exists prior to conception" (114), since the *animulae* "bear, not the actual traits of the new individual, but the organizational information (in physical form) which gives rise to those traits" (114). But the effects of the action of the *animula* are all described in a way consistent with materialism. The task of the soul is to "apply the given parts to parts . . . by replacing them in the position and in the arrangement with respect to one another [so as to] form a complete diminutive body".[26]

There is substantial correspondence here with Leibniz's own views on generation, particularly in Gassendi's insistence that *the existence of living forms in matter implies preformation,* that is, the pre-existence of organic matter—matter containing organs adequate for its generation and organization. From this principle Gassendi inferred that everywhere in living or dead matter where generation occurs there must be matter that is already organized together with pre-existing souls or forms that can effect such organization. Leibniz concurs. As he writes in the *Theodicy* of 1710:

> Moreover, as the formation of animate organic bodies in the order of nature appears explicable only when one assumes a *preformation* already organic, I have thence inferred that what we call

[26] GO II 275b; quoted in Fisher (2006, 120). Similar views on animal generation were proposed by Sir Kenelm Digby, a close associate of Gassendi's. See Blank (2007).

generation of an animal is only a transformation and augmentation. Thus, since the same body was already furnished with organs, it is to be supposed that it was already animate, and that it had the same soul. (§90; GP VI 152/H 172)

This consilience between Leibniz and Gassendi concerning "a preformation already organic" is worth further discussion for what it reveals concerning Leibniz's conception of organic body.

An organic body is for Leibniz synonymous with a natural machine, which he also calls an organism. In fact, he was one of the first to write of "an organism", although this does not have quite its modern sense, since it is the *body* of a living being, rather than the living being itself. The word "organism", on the other hand, was widely used as a mass term denoting something like a systematic functional organization.[27] Thus both Leibniz and Lady Damaris Masham (1658–1708) use the word in this sense in their correspondence. When she objects to Leibniz that she does not see why bodies would need to be endowed with organs if the soul perceives independently of the body, or why Leibniz would insist that "Organisme" should be "Essential to matter" (to Leibniz, 3 June 1704; GP III 350), Leibniz responds that for him "*organism is essential*, not to matter taken absolutely, but *to matter arranged by a sovereign wisdom*" (GP III 356). Elaborating on this, he defines "*an* organism":

And this is also why I define an *organism*, or natural machine, as a machine each of whose parts is a machine. Consequently the subtlety of its artifice extends to infinity, nothing being so small as to be neglected, whereas the parts of our artificial machines are not machines. This is the essential difference between *Nature* and *Art* that our moderns have not considered sufficiently. (GP III 356)

Here Leibniz defines an organism as a machine, albeit one that is a machine in all its parts. On this basis Justin Smith contends that Leibniz's understanding of organic body is conceptually independent of the fact that it is the body of a corporeal substance or living being.[28] In the seventeenth century, he argues, the word 'organic' did not have its modern connotation of 'biological', but "was first and foremost a description of anything that has interrelated, working parts, whether physical or conceptual", thus making it more or less synonymous with 'mechanical' (Smith 2011, 106–7). He illustrates this with a quotation from Anne Conway's *Principles of the Most Ancient and Modern Philosophy* of 1690, where she refers to "a mere

[27] This point is made by both François Duchesneau and Justin Smith in their excellent recent studies. Duchesneau writes: "Leibniz est l'un des premiers penseurs modernes à avoir utilisé ce terme en lui conférant un sens technique, qui n'est d'ailleurs pas encore celui que la biologie a consacré au point d'en faire l'équivalent par excellence d''individualité vivante' " (Duchesneau 2010, 21). Both Duchesneau and Smith cite the study by Tobias Cheung (2006), documenting the shift in meaning of "organism" from an abstract noun (akin to "rationalism") to a count noun.

[28] "Organic body is not by definition unified by some immaterial principle, since it is conceptually possible to imagine a machine of nature that is not the body of a corporeal substance, even if there is no such thing.... [It is] conceptually possible but naturally impossible that there be organized body that is not unified by a simple substance into a corporeal substance" (Smith 2011, 121).

Organical body like a Clock, wherein there is not a vital Principle of Motion" (Conway 1996, 64; Smith 2011, 107). "In Leibniz's view," Smith concludes, "an organic body is distinct from a clock with respect to the complexity of its constitution, but Leibniz continues to agree with Conway that an organic body, considered in itself, lacks a single, dominant, vital principle."

In the above quotation from the *Theodicy*, however, Leibniz argues that it is because the generated body "was already furnished with organs" that one must suppose it to have been "already animate", so that it therefore "had the same soul". This replicates Gassendi's line of argument that matter cannot be "informed" without there already being a soul or *animula* in it that is doing the informing—by which, Gassendi means, producing the necessary arrangement of parts and organs to fulfil the functions of the generated being. When Gassendi refers to an organic body, he means a body that is "organized" in the sense that it is furnished with organs, these being the instruments by which it performs its functions; and in living things, as opposed to man-made machines, this presupposes an organizing principle, something pre-existing in them that provides for this organization and functionality. As we shall see, in this Gassendi simply follows the usage of predecessors such as Jacob Schegk, who refer to an organic body as being corporeally generated prior to its receiving an immaterial soul.

Thus before Leibniz there is already an established usage of the term 'organic body' to denote the body of a being that is animated, and not simply something systematically arranged; and he follows that tradition. Nor is it an innovation of his to insist that the vital actions of generation and development are corporeal and mechanical, i.e. effected through local motions, even though presupposing an active soul. As we have seen, this is characteristic of the material souls that Gassendi conceives in plants and animals; the case for the rational souls in humans is more difficult, Gassendi acknowledges, since they are immaterial. Still, he argues, the organic faculties that are "elicited" by such an incorporeal soul must nevertheless be assumed to be corporeal and vital:

> Since it is universally unclear how in the rational soul, an incorporeal subject, there can appear corporeal faculties which are organic, inasmuch as through them a corporeal action, internal and by its own nature vital, is elicited; or how there can be received in them (as the Philosophers claim) vital actions which are corporeal; . . . nothing prevents us from saying that corporeal faculties are received in the body, since the soul is the eliciting principle. (GO II 256)

Here Gassendi calls corporeal faculties organic "inasmuch as" the action they enable—namely the arranging of parts necessary for generation and development—"is internal and by its own nature vital". Implicit in this is the idea that these actions, though corporeal, are directed towards certain ends. Even if the way the ends are achieved is to be explained in terms of local motions, this telic quality is essential to their being organic. The same applies in Leibniz's philosophy. Explanations of particular phenomena are in terms of local motions, mechanical. But an organic body differs from an inorganic one not only in that (1) it has organs directed towards certain ends—an artificial machine may have this—but also in that (2) the organizing principle eliciting its generation and development

is internal to it, and that (3) the organic body together with this principle develop out of a pre-existing organic body.

The main point of difference is that where Gassendi believes that the organizational information necessary for such generation and development could be encoded in the structure of a finite organic molecule or seed, passed down by traduction, Leibniz believes that such a finite structure would be inadequate to contain the necessary information. This is connected, obviously, with his analysis of matter as actually infinitely divided, folds within folds to infinity. But in contrast to what an ingenious human (or even an angel[29]) might be able to achieve, God fashions organic bodies in such a way that each preserves a unity of function through time that harmonizes with the unities of function of any organic body of which it is a component, with this nesting of functionally dependent components reaching downwards without end. Such an infinitely ramified structure of each organic body, Leibniz held, is necessary for it to correspond to the infinite series of states of the dominant form corresponding to it, with each of these states itself infinitely ramified; and an organic body—a body with organs, and organs in all the organic bodies that are its parts—is equally necessary to every form in order for the organism to be able to perform these functions. We will return to these matters below.

At this point, though, we may usefully delve further into the origins of Gassendi's views. We have noted his debt to the likes of Liceti, De Boodt, and Sennert for the idea of seeds "dispersed variously" in the earth and water, containing their own active principles responsible for the later generation and development of living beings. But what explains the appeal to him of attributing forms and teleology to his seeds in defiance of a more Cartesian mechanist view? A major motivation is *theological*, as he makes evident in the continuation of the passage quoted above. For the doctrine of seeds immanent in matter from the Creation, he stresses, enables one to understand what is said in the Scriptures, that God created all things together. He quotes the passage from the Book of Genesis that Sennert had also quoted: "And God blessed the fishes and the birds he had created, saying: increase and multiply; and fill the water of the seas, and let the birds be multiplied upon the earth" (Genesis 1:11–12). "Insofar as God can have created the seeds of all things in the beginning", he concludes, "all things can be said to have been produced in that first primeval generation" (GO II 262b). The idea is that natural things contain in themselves active forms and powers through which God's providential plan can be achieved. This motivation is eloquently articulated by Sennert:

> We, therefore, knowing these things from the Sacred Scriptures [...], state that forms themselves, as also matter, were created at the beginning of the world together with the things themselves, so that all natural things should consist of them. Through forms not only do all

[29] That the construction of an organic body is beyond even an angel's powers is affirmed by Leibniz in his notes on Cordemoy of 1685: "Thus it is not possible for an angel to form a man or any true animal except from a seed, where it already pre-exists in some way" (A VI iv 1801/LLC 283).

natural things act according to their nature, that is, as has been established by the Creator, but they are also thereby governed, preserved and propagated. For God commanded that natural things should not only exist by their forms, but also propagate themselves by these, and when he commanded this, he at the same time gave to each of them the power to do what had been commanded. [. . .] Therefore, natural things obey the command of the creator, and all forms, by a power with which they were endowed in the first creation, generate by promotion and propagation of themselves.[30]

Similarly, for the Lutheran De Boodt the introduction of the fecundity of the Earth on the Third Day (Genesis 1:11–12) is "the principal motif of the doctrine of *spiritus*" (Hirai 2003, 17). Indeed, as Emily Michael has argued, the idea of the immanence in things of the powers necessary to carry out God's providential plan was a foundational plank of the Lutheran world view, and explains the appeal of the doctrine to Sennert, De Boodt, and other Lutheran thinkers such as Jacob Schegk and Andreas Libavius, as well as factoring into Sennert's adoption of Scaligerian active forms.

The network of influences here is complex. Although the notion of atoms as the seeds of things (*semina rerum*) can be found in Lucretius, there was also a longstanding interpretation of seeds as active principles (*semina rationales*) originating with the Stoics' *logoi spermatikoi*, to which Plotinus and Augustine had given an immaterialist interpretation. The main conduit for this Neoplatonist interpretation of *semina* from the ancients to the moderns was the influential Florentine metaphysician Marsilio Ficino (1433–99), for whom *seeds* were situated in the sphere of *nature*, corresponding to *reasons* in *souls* in the sphere above them, and *forms* in the sphere of *matter* below them, and again to *ideas* in the innermost realm, that of *intelligence*. This interpretation influenced a variety of thinkers, including the French physician Jean Fernel (1497–1558) and the Swiss iatrochemist Paracelsus (*c.* 1493–1541). Their views in turn were developed by the Danish chymist Peder Sørensen (1542–1602), known by his Latin name, Severinus, into an influential theory according to which invisible and spiritual seeds (*semina*), latent in the elements, are the source of all actions of bodies, while bodies themselves result from the *principia* they contain which are subject to the "reasons" (*rationes*, *scientiae*) existing in the seeds. Severinus' theory was adopted enthusiastically by a number of thinkers of the time, among them Joseph Du Chesne (known as Quercetanus), Libavius, Davisson, Jean-Baptiste van Helmont, and Leibniz's teacher Jacob Thomasius.

This web of influences is thus highly significant for understanding the genesis of Leibniz's views. Christia Mercer has argued that Leibniz inherits the doctrine of the immaterial *rationes seminales* of Plotinus and Ficino directly from his teacher Thomasius, a contention that forms part of her case for her immaterialist interpretation of Leibniz's atoms.[31] But the case of Severinus muddies any such straightforward polar opposition between the atomistic and Neoplatonic traditions: a form-containing

[30] Sennert (1618, 50–1); translated from the quoted passage in Michael (1997, 297, n. 88).
[31] See Mercer (2001, 200ff., 223ff.); Wilson (1999, 226).

atom could be thought of as a seed precisely because it contains a seminal reason or soul. In fact, this very idea is the basis of Gassendi's conception. For although, as Hirai has established, some of the consilience between the views of Gassendi and Sennert can be explained in terms of common sources—Du Chesne and De Boodt for the ideas of a *spiritus lapidificus* and *vis seminalis* in minerals, and Liceti for the idea that spontaneous generation requires seeds everywhere generation occurs—Gassendi himself explicitly acknowledges Severinus as the main source for this general conception of the *seminal forces* responsible for the generation and development of minerals, of living things, and for spontaneous generation alike.[32] So it is to Severinus that Gassendi is indebted for the idea that the "active substance" that is the principle of a body's actions, is an *elaborator spirit*, the vehicle for the seminal force that is latent in material receptacles everywhere in matter, having "the power to form the bodies of minerals, as well as of vegetables and animals, and also their parts": a spirit that is "mechanical", according to Severinus, yet still contains the knowledge prescribed by God for the development of the seeds.

But Gassendi immediately raises a doubt, which he expresses forcefully, perhaps even sarcastically, about the ability of a purely mechanical spirit such as envisioned by Severinus to do all the elaborating, planning, and execution that is required of it:

> And Severinus would say, what he wishes to be so, that these principles are mechanical spirits having the power of acting with knowledge and vigour; but when he has said this once, he will have said all he will ever say on the subject. For he will never hereafter show in general how anything spiritual, how a thing so tenuous, a thing so invisible and so intangible, could possess an idea and a knowledge of the work of elaborating; a consideration of the end to which it must obtain; an appreciation of the matter and necessary conditions by which it must conform to this end; the distinction of reason or of mode by which it needs to push, turn, return, mix, separate, fashion and perfect; nor how, likewise, it could possess a vigour and energy, sometimes making use of appropriate instruments, sometimes executing all that such a knowledge would prescribe. (GO II 559a/ Hirai 2003, 219, 225–6)

Of course, it is not at all clear that Gassendi himself has an answer to these doubts, given his materialist construal of the soul (*anima*). In discussing the generation of animals, he admits that "nothing has been done to create a genuine knowledge of this internal and occult economy, or to lay before the mind's eye that artifice, ôr as it were, worker, who knows how to use such refined little instruments to elaborate matter into so harmonious a work", and offers a "hymn to that divine and incomparable Architect who has created and established in the seeds of things these workers, so to speak, equipped with such foresight, industry, and facility" (GO II 267a/Hirai 2003, 218, 225).

[32] "One person who clearly recognized the truth", Gassendi writes in his *De Plantis*, "is the celebrated Severinus (as well as others like Du Chesne who have followed him), when he posited besides the four elements and three principles, innumerable invisible seeds, which are also worthy to be called principles and elements, of which the former grosser elements are only so to speak clothes, matrices or receptacles…" (GO II 558b–559a/Hirai 2003, 219, 225).

This issue of how such organic bodies might be formed "mechanically" was intimately bound up with the notion of a "plastic power" or generative faculty, responsible for the formation of organic bodies. According to Galen's original conception, this was a power emanating from the heavens, a view promulgated by Avicenna and Averroës, and taken up by various scholastics, among them the Parisian physician Jean Fernel.[33] On completion of its work in forming the body, Fernel had argued, this formative faculty becomes the soul of the living being. To this Scaliger had objected that this amounts to making the formative faculty and the vegetative soul two names for the same thing, an identification he favoured. That identification in turn was opposed by Jacob Schegk (1511–87), one of the most influential champions of plastic power, for whom it was a "plastic faculty [*facultas plastica*]" diffused everywhere in matter, operating independently of the soul. It is a "reason-principle [*logos*]" existing in matter, an "instrument for the generation of an animate body", even in cases of spontaneous generation where there is no soul. In non-human generation, the plastic power is responsible for the generation of the soul by "drawing it from the potentiality of matter", although it ceases to exist as soon as the soul is formed:

> For the plastic *logos* [πλαστικὸς λόγος] is in matter from which, as a result of its power, the organic body is generated; whereas the soul, as an entelechy [ἐντελέχεια], is in the already perfected organic body and, once the movement of generation ceases, the plastic *logos* itself ceases to exist. (Schegk 1580, 1, sig. B4r; translated from Hirai 2011, 98)

In human generation, though, the organic body is formed by the plastic power or sperm of the male parent, and with its assistance, the soul, created by God, enters the body from outside.

Schegk's account is vehemently opposed by Sennert. On the one hand, he objects that to posit both a soul and a plastic reason-principle is "to multiply entities without reason", and, on the other, he insists that the immaterial soul is immanent in matter, contrary to Schegk's claim that it is introduced from without directly by God.[34] Only the soul, "endowed with a formative force", is sufficiently divine to be the cause of generation, which it effects by means of the "semi-material" spirit that is its vehicle. In the strict sense, Sennert claims, the seed is

> a very simple substance, ôr a kind of spirit, in which the soul and the plastic force [*virtus* πλαστική] proximately reside, and contains within itself the Idea of the organic body from which it has descended, and thus possesses the potentiality both to form an organic body similar to that from which it has descended and to perfect itself into an individual of the same species as the parent. (*HP* 4.6, 177/Hirai 2011, 160)

[33] I refer the reader to Hiro Hirai's excellent (2011) for a full discussion of the debate and some of its wider philosophical implications. See also the same author's (2007) for the account of plastic force given by Athanasius Kircher (1602–80).

[34] "For since all the properties and operations of the soul apply to and are attributed to this plastic *logos*, why should it not be called the soul?" (Sennert, *HP* 4.5, 174–5; Hirai 2011, 158).

In his rejection of the idea that the formative power is distinct from the soul, Sennert was knowingly following the lead of Julius Scaliger. This was a point on which Scaliger was adamant, insisting with Themistius that "the soul is the architect of its own house", and citing Aristotle in support.[35] "It is not absurd that the soul shapes its house", he wrote in his *History of Animals*. "Rather, that [shaping] is part of the wisdom which was attributed to the soul by God."[36]

Leibniz was certainly aware of the tradition of *plastic forces* or *natures*, and also its roots in Scaliger's doctrine of the formative soul. For instance, in his *Considerations on Vital Principles and Plastic Natures* of 1705, he reiterates his own account according to which "there is machine in the parts of the natural machine to infinity", a plastic mechanism that "supports not only a continuous preformation, but also an original divine pre-establishment" (GP VI 544/L 589). This, he says, leaves him with "no need to resort, as does Cudworth, to certain immaterial *plastic natures*, though I recall that Julius Scaliger and other Peripatetics, as well as followers of the Helmontian doctrine of the Archeus, believed that the soul fashions its own body" (544/589).[37]

With this background we can now see Leibniz's philosophical predicament in 1676 more clearly. Like Severinus and Gassendi, he wishes to account for the development not only of life but of inorganic minerals too, by appealing to their containing invisible seminal principles, each such "mind" being "clothed" in a material casing, which, like Sennert and Gassendi, he regards as an atom. Just as Gassendi had supposed organic development to occur by a material soul or "flower of matter" diffused throughout a living body, so Leibniz posits a "flower of substance" "diffused throughout the whole body, and in a way contain[ing] only form". In his *Catholic Demonstrations* of 1668 he had written "in the human body, it should not be thought that the soul is hypostatically united with all the corpuscles that are in it, which are perpetually changing, but inheres in the centre of the brain itself to a fixed and inseparable flower of substance, which is mobile in a subtle way in the centre of the animal spirits, and is united with it substantially, so that it is not separated from it even by death" (A VI i 533/Blank 2011, 120). As noted, this prefigures Leibniz's later doctrine of *transformationism*, according to which death is merely a transformation of the organism in such a way that the domain of influence

[35] In the books of his *Metaphysics*, Scaliger asserts, "Aristotle repeatedly says that 'the material house arises from the immaterial house'" (Scaliger 1557, 32; *EE*, 6.7, 15v): quoted from Sakamoto (2016, 120).

[36] Scaliger, *Historia de animalibus* (1619), 595–6, quoted from Sakamoto (2016, 133). As Sakamoto points out (134), in the *Exercitationes* Scaliger describes the formative power as a soul distinct from the "less noble" soul that comes to occupy the "house", whereas in the *History* it is described as the same soul, the basic idea is that the house is created from within. Thus, commenting on Aristotle's comparison of the seed with an artisan in book 7, Scaliger writes: "An artisan has the form in his power.... Obviously, he imposes the form on matter. But [the seed] does not accept [the form] from the outside like a guest or leaseholder, but has it as something indigenous and self-grown [$\alpha\upsilon\tau o\varphi\upsilon\hat{\eta}$]" (Scaliger 1557, 32; *EE*, 6.7, 14v); quoted from Sakamoto (2016, 118), with my translation.

[37] See also Leibniz's remarks in his controversy with Stahl: "But they were mistaken who believed that here would be in the soul building its own body, or in I know not what other manufactory supervisor, such a wisdom and power that it could contrive and produce the divine machine of the animal. For the outcome of the artifice is owed to divine preformation" (Leibniz 2016, 27).

of its dominant monad shrinks to a physical point.[38] The difference is that in the earlier view the soul is still conceived as a kind of principle of motion that is able to activate a vortex and thereby unite a body.

But it is on just this shoal—namely, how an individual mind can function as the principle of motion of a body—that Leibniz's early efforts have become wrecked. As we have seen above, between his study of Hobbes in 1670 and the collapse of his *conatus* metaphysics in 1676, Leibniz had gone on a long detour with his *Elements of Mind* project, where bodies are minds lacking recollection and mind is a harmony of endeavours. In *On the Seat of the Soul* of February 1676, as he struggles to articulate the mind–body relation, he seeks support for the "flower-of-substance" doctrine in the notion of plastic force. He reminds himself to add what was said in a French journal by a certain anonymous Englishman who described plastic force as "an active substance of a certain shape" that exists in the seed before conception, and also to add what was said about plastic force by Schegk and the Scottish chymist William Davisson (1593–1669).[39] But even as he comes to reject the notions that the continuance of a body in motion could be explained mechanistically and that a created mind could act on its body through its associated vortex, Leibniz still retains the view that "there should be in bodies beings that act on themselves", i.e. minds (December 1676; A VI iii 588/DSR 112). And he is motivated to retain minds as principles of action because without them, on his understanding, bodies would be merely passive and lack a principle of individuation. In a fragment entitled *Meditatio de principio individui* from 1 April 1676, Leibniz argues that material bodies that are mathematically perfectly similar must differ by retaining the effects of their prior states, "from which it follows that there is present in any matter something which retains the effect of what precedes it, namely a mind" (A VI iii 491/DSR 51). Thus in 1676 mind is still the principle of action and individuation in bodies, but Leibniz's attempts to connect this with the body's mechanical properties have failed.

Consequently, in *On Motion and Matter* (April 1676), as in the *Pacidius* (November 1676), the letter to Fabry (December 1676), and in "Motion is Something Relative" (February 1677), Leibniz takes recourse to God as the efficient cause of motion. The reason he gives is that individual minds in bodies are not adequate to ground the conservation of motion.[40] On the one hand, an individual mind could not know to adjust its speed on colliding with another body in such a way that "magnitude

[38] A representative statement of this mature doctrine is given in Leibniz's *Specimen inventorum* of *c.* 1686: "Indeed, just as some people have proposed that every generation of an animal is a mere transformation of the same animal now living, and a kind of accretion that renders it sensible, so by parity of reason it seems defensible to hold that every death is a transformation of the living animal into another smaller animal, and is a kind of diminution by which it is rendered insensible" (A VI iv 1623–4/LLC 317). Cf. Leibniz's letter to Arnauld of 9 October 1687, where he cites both Leeuwenhoek and Swammerdam in support of his belief in transformation.

[39] In the same piece Leibniz also shows familiarity with what Libavius, Du Chesne, and Athanasius Kircher had written on the resurrection, and with Glauber's chymical experiments on the regeneration of nitre.

[40] See the account in Arthur (1999a).

compensates for speed", so that "it is clearly not the mind of each body that makes it follow the law of compensation, but rather the universal mind assisting both, or rather all, equally" (A VI iii 493/LLC 77). On the other, "since motion is something respective, its subject will not be any one particular body, but the whole world" (A VI iv 1970/LLC 229). As we shall see in Chapter 5, such considerations prompt Leibniz to revert to a version of the occasionalism he had advocated in 1669 prior to his composing the continuum out of indivisibles. In this theory, which he dubs "transcreation", bodies are annihilated and recreated across distances and times that are smaller than any that can be assigned, so that God is the direct cause of continuous motion.

Nevertheless, in 1676 Leibniz had not rejected the idea of incorporeal forms in bodies. As in his earliest theory of substance, outlined in his *Catholic Demonstrations*, each body depends on divine concurrence in order to continue its motion, but this does not mean (he explains there) "that there is one substantial form for all bodies, the concurrent divine mind" (A VI i 512). Each body rather contains its own form or idea, serving as its principle of individuation. The concurrent divine mind is different in different bodies, he continues, "for, as the disposition of bodies is varied, the form and idea are also varied; the motion and rest of a body derive from this fact" (A VI i 512). Similarly in 1676 Leibniz is no less committed to minds as substantial forms individuating bodies, despite having to appeal to God as the cause of continued motion. Thus in a draft for his perennial encyclopaedia, probably penned in the summer of 1676, he holds that all bodies contain souls: "On souls: all things are animate", he writes, "but only the immortal soul remembers itself" (A VI iii 527/DSR 89). And the claim we have already seen above in his December 1676 letter to Fabry, "I hold for certain that there are incorporeal substances", is matched by his declaration in notes made the same month that the "supposition [*fictio*] that a body could exist without a mind is impossible" (A VI iii 400/DSR 115). So all bodies contain souls or minds, although only minds that can act on themselves have memory and are immortal. Minds are beings which act, and, because of the necessary continuation of this action, they are consequently incapable of ceasing to act: "Whatever acts cannot be destroyed, for it at least endures as long as it acts, and therefore it will endure forever" (A VI iii 521/LLC 121). But although in March Leibniz recognizes that "a mind has a more special relation to one portion of matter than another" (A VI iii 394/DSR 47), by the end of the year he has still not been able to explain the link between the mind's thoughts—the actions of an agent on itself—and the continuation of motion in its body, except by recourse to divine action:

> The harmony of things requires that there should be in bodies beings that act on themselves. On the nature of a being that acts on itself: it acts by the simplest means; for there is harmony in this, that when it has once begun to exist, it is eternal.... Thought ôr the sensation of oneself, ôr action on oneself, is necessarily continued, but I do not yet see that the action of an agent on itself is necessarily continued in the body; the fact that it is continued, however, arises from the harmony of things; that is, by the will of God.... Certain minds are united individually with God, namely those to which is given a perfect action according to reason,

and to whose bodies is given so much force of motion that they cannot be overcome by those around them. (A VI iii 588/DSR 112–13)

It was during this time that Leibniz came to reject completely his earlier attempts to explain the soul's action on its body by its being located in a point in the body. In 1709, reminiscing about his earlier theories in an unsent note to Des Bosses, Leibniz reports that he came to see that it involved a kind of category mistake:

> After further reflection, I discovered . . . that there is also here a certain, as it were, category mistake [μετάβασιν εἰς ἄλλο γένος]. One should not attribute to souls the things that pertain to extension, and their unity and multiplicity should not be taken from the category of quantity, but rather from the category of substance, that is, not from points, but from a primitive force of operating. The operation proper to the soul, however, is perception, and the nexus of perceptions, according to which subsequent perceptions are derived from previous ones, makes the unity of the perceiver. (for Des Bosses, 30 April 1709/LDB 129)

Although it would be presumptuous to try to pinpoint exactly what factors led Leibniz to this realization, one influential event, by his own account, was his reading and translating in the summer of 1676 of Plato's *Phaedo*. There he was struck by Socrates' criticisms of Anaxagoras—so much so that ten years later he left a place in the *Discourse on Metaphysics* (L 316) where his translation of that passage (GP VII 335) was to be inserted. It is all very well to call upon mind to explain teleological development, but if a mind's action is then explained mechanically, it is not intelligible how minds are achieving what is attributed to them.[41] In his letter to Thomasius (1669) Leibniz had criticized Scaliger and others for attributing power and wisdom to the incorporeal substances they conceived in bodies, ascribing "to them appetite and a natural instinct from which natural cognition also arises" and thus reducing their substantial forms to "so many little gods" (A II i 35/L 101). This evokes Gassendi's criticism of Severinus, discussed above. But having himself ascribed minds to all his atoms as the active principles needed to account for the unity and teleological development of individuals, Leibniz had (by the end of his stay in Paris in late 1676) done no better than Gassendi to provide an intelligible account of how minds or souls were supposed to accomplish such teleological development in matter.

In sum, the comparison with Gassendi and his predecessors has illuminated many features of Leibniz's thinking in this period. Setting it in the context of the views on generation and divine providence of Severinus, De Boodt, Sennert, and others, enables us to see some of his motivation for ascribing minds or souls to bodies in opposition to the more Cartesian mechanical philosophy of his contemporaries. In line with that

[41] Cf. what Leibniz wrote to Malebranche in 1687: "Far from excluding final causes and the consideration of a being who acts with wisdom, it is from these that everything must be derived in physics. It is this that Socrates has already said most admirably in Plato's *Phaedo* in arguing against Anaxagoras and other philosophers who are too materialistic, and who, having first recognized an intelligent principle beneath matter, make no use of it when they come to philosophize about the universe, . . . and try to explain everything by the concourse of crude particles, thus confusing conditions and instruments with the true cause" (L 353).

tradition, he requires embodied souls for generation, and wishes to ground bodies' motions in a principle of activity that will provide the reasons for the unfolding of its states. There is no need to see his privileging of forms as committing him to a pure immaterialism, as does Mercer, nor to read the two domains of physics and theology as pulling him in different directions, as does Garber, who pictures Leibniz as providing a neo-Hobbesian "mechanist conception of body" sitting uncomfortably atop an orthodox Aristotelian metaphysics adequate to account for mysteries like transubstantiation.[42] The picture, as we shall see in detail in what follows, is much more integrated.

Of course, the doctrine of substantial forms had been subjected to devastating criticisms by the moderns, as Leibniz well knew. Apart from the unintelligibility of such forms and the complete obscurity of how they could act on matter, there was also the difficulty of how they could come into or go out of existence. Leibniz claimed to be able to avoid these difficulties. But in order to understand his solution we need to dig deeper into the scholastic background.

4.2 The Origin of Forms

Leibniz presents a detailed account of the controversy surrounding the Origin of Forms in §86 of his *Theodicy*. He notes how it was bound up with the theological difficulty of explaining original sin, and relates the three main alternative solutions on offer: (i) "the *pre-existence of human souls* in another world or in another life, where they had sinned", as subscribed to by Plato, Origen, and among his contemporaries, Henry More and Francis van Helmont; (ii) *traduction*, as discussed in Chapter 3; and (iii) the special *creation* of the human soul by God when the body was adequately prepared for it, as in, for example, Schegk's philosophy. This issue, of course, is deeply embroiled with the problem of the status of forms in scholastic philosophy. Aristotle had regarded the soul as the substantial form of living things. Leibniz's own solution is based on his understanding of an Aristotelian substantial form as "that which is a principle of action and is found in that which acts" (§88; GP VI 150/H 170), where "that which acts" is understood to be the substance. For, as we have already seen, on the one hand he held that that which acts must necessarily keep on acting, so that substance (together with its form or principle of action) is necessarily indestructible; and on the other, he also followed Zabarella in taking the substantial form to be the principle of individuation of substances, in opposition to Aristotle, for whom matter performed

[42] See Garber (2009, 40–3). Similarly, Smith sees his account, according to which organic bodies are wholly mechanical and unconnected with the doctrine of simple substance, as enabling him to avoid "entering into conflict with the immaterialist interpretation of Leibniz's deepest metaphysical convictions", according to which "whatever arises from the immaterial can at most appear to be material" (Smith 2011, 135). On the integrated view I am offering, no such separation is possible: substances are introduced precisely as the entelechies of organic bodies, and expressly to avoid bodies being constituted as mere appearances.

this role. The difficulty concerning substantial forms (aside from their compatibility with the mechanical philosophy) is to see how they could even arise or perish.

Now, as Leibniz observes in the *Theodicy*, that difficulty concerns the origin of *substantial* forms, as opposed to *accidental* ones, accidental form being what is "customarily termed 'Quality' ".[43] There is no particular problem in scholastic philosophy with the origin of accidental forms,

> since they are only modifications of the substance, and their origin may be explained by eduction, that is, by variation of limitations, in the same way as the origin of shapes [*figurae*]. But it is quite another matter when we are concerned with the origin of a substance, whose beginning and destruction are equally difficult to explain. (§89; GP VI 151/H 171)

This explanation has an interesting bearing on the position which Leibniz had outlined in his letter to Thomasius of 1669, and a brief consideration of that here will in turn throw further light on the development of his views. In that letter he does not contest the Zabarellan doctrine that the substantial form is the principle of individuation in body, "that by which the substance of one body differs from that of another" (A VI i 25/L 94).[44] One might infer, then, that it is *accidental form* that he conceives must be explained according to "the hypothesis of the moderns, which conceives no incorporeal entities within bodies but assumes nothing beyond magnitude, shape [*figura*] and motion" (26/95). On this view, as we saw in Chapter 1, the actual parts of matter, with their actual boundaries, are produced by motion:

> For division comes from motion, the bounding of parts comes from division, their figures come from this bounding, and forms from figures; therefore forms come from motion. From this it is very clear that every arrangement into form is motion, and the vexatious problem of the origin of forms is answered. (27/96)

Not quite, of course, for this solution would seem to apply only to the production of accidental forms, and Leibniz has said nothing here about how substantial forms are supposed to originate. Still, pleased with his solution, he notes parenthetically that "the distinguished Herman Conring could only answer to this problem, in a special

[43] Leibniz's discussion here follows Boyle's critique of the scholastic doctrine in his *Origine of Formes and Qualities*, as did his plan for his *Elements of Physics* in 1678. Loemker notes several signs of Boyle's influence in that writing, noting that Leibniz's use of the term 'Quality' to include both sensory and non-sensory properties of bodies, as well as his attempt to reconcile mechanical and teleological explanations, both indicate a debt to that work. See L 290, nn. 4, 19).

[44] This interpretation, as noted, is at odds with Aristotle's own interpretation, according to which a substance's matter is its principle of individuation. As a student, Leibniz had in 1663 written a thesis on the principle of individuation, in which he upheld a version of Suarez's interpretation, according to which "every individual is individuated by its whole entity" (A VI i 11). But five years later, in a piece on transubstantiation in the *Catholic Demonstrations* he would write: "For I demonstrate the numerical identity of a substance from the numerical identity of the substantial form, in agreement with the principles of the most noble among the Scholastic philosophers and the Aristotelians too, for whom the substantial form is the principle of individuation" (A VI i 511). For a discussion of Leibniz on individuation, see McCullough (1996); Cover and O'Leary-Hawthorne (1999); and Mugnai (2001).

dissertation, that forms arise from nothing" (27/96).[45] This leads to some embarrassment later, when in 1678 Conring accuses Leibniz of wrongly ascribing this view to him.[46] Leibniz rather disingenuously replies that he cannot remember where he had done that, after first repeating his assent to substantial forms. "Who would deny substantial forms", he asks rhetorically, "that is, essential differences among bodies?"[47] This echoes what he had written to Thomasius in 1669: "Who does not agree that substantial form is that by which the substance of one body differs from that of another?"[48] But although by 1678 Leibniz had arrived at the position that substantial forms arise only at the creation of the world (excepting miracles), Conring had not appreciated this change in his position, and (quite understandably) assumed from Leibniz's positive reference in 1669 to the "the hypothesis of the moderns, which conceives no incorporeal entities within bodies" that Leibniz was committed to giving a mechanical reduction of all forms. This misunderstanding was only reinforced by Leibniz's claim in his letter to Conring of 13/23 January 1678, that "*everything in nature happens mechanically*" (A II i 581). Conring, taking this for a Cartesian thesis, dismissed it as "most absurd" (A II i 596/L 189),[49] provoking a passionate defence by Leibniz. The thesis in question, of course, is the founding thesis of the mechanical philosophy formulated by Robert Boyle, which, Leibniz had told Conring, he regarded as "demonstrated":

> The reasonings of the chymists about these things are usually poor and change by the day, as for instance Glauber, having seen some new experiment, forges a new philosophy every year. More prudently, Boyle is content to recount experiments; on the other hand, the conclusions he draws from them are true rather than new. For what he professes in numerous places and strives with so much apparatus to prove, namely, that *everything in nature happens mechanically*, I regard as demonstrated.[50]

The exchange of correspondence with Conring concerned what principles should be appealed to in giving explanations in medical science. Leibniz's account here of the role of hypothesis in scientific method has been analysed very perceptively by François Duchesneau in his *Leibniz: le vivant et l'organisme* (2010). As Duchesneau points out,

[45] Leibniz had in fact later corrected his ascription of this view to Conring in the published 1670 edition of his letter, appending the marginal note: "Conring said the contrary" (L 103).

[46] Writes Conring: "I know you will not reject *substantial forms*, if you read the third chapter of *Natural Institutions*. Just as you will also gather when you have read the fourth chapter that you were wrong to attribute to me somewhere the dogma that forms arise from nothing" (Conring to Leibniz, 26 February 1678; GP I 191; A II 1, 595–6).

[47] "Who would deny substantial forms, that is, essential differences between bodies? You say that I have somewhere wrongly ascribed the view to you that forms originate out of nothing. I do not remember where I did this" (Leibniz to Conring, 19 March 1678; GP I 196, A VI i 604). Cf. also *Nouveaux essais* (A VI vi 455/RB 455).

[48] "*Formam quoque substantialem nempe, id quo substantia corporis unius a substantia alterius corporis differt, quis non admittat?*" (A VI i 25/L 94).

[49] "That *everything happens mechanically*, if indeed you want it to be understood in a Cartesian sense, for my part I do not hesitate to pronounce it the most absurd statement" (Conring to Leibniz, 26 February 1678; A VI i 596).

[50] Leibniz to Conring, 3 January 1678; GP I 186; A II 1, 581; partially quoted by Duchesneau (2010, 54); N.B. his "A II 1, 386" appears to be an error.

Leibniz concurs completely with Boyle that in the explanations of particular empirical phenomena the "recourse to substantial forms and the apparatus of scholastic faculties is deemed useless and questionable" (Duchesneau 2010, 55).

But this is not to claim that substantial forms should be rejected. As we have seen, Leibniz agrees with Conring that they are clearly needed as principles of individuation of bodies. But apart from their uselessness in explaining any particular phenomena, the difficulty with the scholastic accounts is to see how substantial forms—which are supposed to account for what is particular to each individual substance—could come into being or be extinguished. As Leibniz writes in the *Theodicy*:

> To say that the compound of form and matter is produced, and the form only *comproduced*, means nothing. The common opinion was that forms were derived from the potency of matter, this being called *Eduction*. That also in fact meant nothing, but it was explained by a comparison with shapes: for the shape of a statue is produced only by a removal of the superfluous marble. This comparison might be valid if form consisted in a mere limitation, as in the case of shape. (§88; GP VI 150/H 170)

Shapes can arise by eduction, since they are only limitations of what is shaped, namely matter. But to say that substantial forms are educed from the potency of matter is vacuous unless some account is given of how an immaterial form could be produced from something material. This echoes Boyle's criticism that "the Manner how forms are educed out of the Power of Matter, according to that part of the Doctrine of Forms wherein the Schools generally agree, is a thing so inexplicable, that I wonder not it hath put acute men upon several *Hypotheses* to make it out" (Boyle 1666, 147; 1667, 73–4). He has in mind, presumably, accounts like the following of Albert of Saxony, who writes in *Quaestio* 10 of his commentary on Aristotle's *Physics*:

> Forms of donkeys or some other heterogeneous [body] other than a human being are generated successively. . . . One part of the form of a donkey is first educed from one part of the matter and after that another part of the form from another part of the matter. It follows that the form of a donkey is generated successively, and this goes for any other heterogeneous body other than a human being.[51]

Faced with such accounts, Boyle objects that the Agent can only act as "a Physical and Finite Agent".

> And since tis confess'd on all sides, that no natural Agent can produce the least Atome of matter, tis strange [the Peripateticks] should in Generation allow every Physical Agent the power of producing a Form, which, according to them, is not onely a Substance, but a far nobler one then Matter, and thereby attribute to the meanest creatures that power of creating Substances, which the ancient Naturalists thought too great to be ascrib'd to God himself . . . (Boyle 1667, 77–8)[52]

[51] Albert of Saxony (1999, 152); translation quoted from Lagerlund (2015).

[52] Boulton epitomizes Boyle's argument nicely: "That the Agent can only act as a Physical Agent; and if the Form produced by it's [sic] Operation, be a Substance not preexistent in the Matter it works upon,

Those upholding eduction, Boyle argues, can't have it both ways. They claim that "these Forms are Substances, and yet at the same time they teach, that they depend upon Matter, both *in fieri* and *in esse*, as they speak, so that out of the Matter that supports them, they cannot so much as exist" (78). But that would make them accidents. So, Boyle concludes, "the production of Forms out of the power of Matter is for these reasons incomprehensible to me" (78). As we have seen, Leibniz says something similar: "that the forms were derived from the potency of matter . . . means nothing" (*Theodicy*, §88; GP VI 150/H 170).

As Leibniz explains in the same section of the *Theodicy*, it was this incomprehensibility of eduction that had led some scholastics to develop rival theories of the origin of forms. He relates Scaliger's suggestion that forms, rather than being sent from heaven or educed from the passive potency of matter, "were derived from the active potency of the efficient cause, that is to say, either from the active potency of God in the case of creation, or from that of other forms in the case of generation" (§88; GP VI 150–1/H 170–1). In the case of generation, Leibniz remarks, this set the stage for a return to Augustine's thesis of traduction (just as it had for Leibniz himself in 1670): "Daniel Sennert, a famous doctor and physicist at Wittenberg, cherished this opinion, especially in relation to animate bodies, which are multiplied through seed" (151/171).

Here Leibniz describes the attacks on Sennert's position by Johan Freytag discussed in Chapter 3, noting Johann Sperling's defence of Sennert, and the latter's conflict with Johann Zeisold, "a professor at Jena, who upheld the position that the human soul is created" (151/171). One of Freytag's accusations, as we saw, was that Sennert's endorsement of immaterial souls in plants and animals would make them immortal—a charge which Sennert and Sperling rejected on the grounds that they did not in fact hold any of these souls to be indestructible. Leibniz, on the other hand, upheld the indestructibility of such immaterial souls, but thought that his distinction of immortality from indestructibility exonerated him from this difficulty:

> Sennert and Sperling did not venture to admit the subsistence and indestructibility of the souls of beasts or of other primitive forms, although they allowed that they were indivisible and immaterial. But the fact is that they confused indestructibility with immortality [as had Leibniz himself earlier!], which in the case of man is taken to mean that not only the soul but the personality subsists. In saying that the soul of man is immortal one implies the subsistence of what makes the identity of the person, something which retains its moral qualities, conserving the *consciousness*, or the reflective inward feeling, of what is: thus it is rendered susceptible to chastisement or reward. But this conservation of personality does not occur in the souls of beasts . . . (151/171)

The Thomists likewise "recognized the immateriality or indivisibility of all souls, without being willing to admit their indestructibility, greatly to the prejudice of the immortality of the human soul" (151/171).

and which constitutes the Body, the Form must either be made of some Parts of that Matter, or created *de novo*" (Boyle 1699, 30–1).

Understandable as it is that Leibniz should situate his views in this way, it seriously understates the extent to which his views on forms share common ground with Scaliger and Sennert rather than the Thomists. For both Scaliger and Sennert subscribed to the so-called *Plurality of Forms*, or Latin Pluralism, an interpretation of forms that had been developed in opposition to the more orthodox Thomist view. This is worth a substantial digression, taking us back into recondite matters in chymistry, since the Scaliger–Sennert version of the plurality of forms is of the first importance for understanding Leibniz's metaphysics of dominant and subordinate monads.

According to the familiar "unicist"[53] interpretation of forms upheld by the Thomists, Toletus and the Coimbra commentators, and the Jesuits, a substance can have only one form. This is because a form is that which, when combined with the pure potentiality that is a substance's prime matter, makes the substance actual. Consequently, if a substance had two forms it would have two actualities, and thus be two substances. In opposition, the pluralists held that although each substance has its own (dominant) substantial form, its matter has its own actuality: it is not a pure potentiality, but is rather made actual by certain *subordinate forms*.

For example, according to the unicists, when a substance is generated, the substantial forms of the elements constituting its matter are all corrupted (i.e. cease to exist), in keeping with the Aristotelian axiom "*generatio unius est corruptio alterius*" (the generation of one form is the corruption of another). Similarly, when a person dies, since the rational soul has departed, it is replaced by a form of the corpse (*forma cadaveris*), which itself gradually undergoes decay as the body decomposes, until it loses this form. To this the pluralists objected that it would make little sense to regard the body of St Paul, for instance, as having a different form after death than it did before, for then it would not be Paul's body, but that of a wholly new substance (and one quite unworthy of veneration!). Paul's body must therefore have its own subordinate form (a form of corporeity, on some versions of pluralism) from which his soul could depart. In general, animate things must have at least one other form subordinate to the soul.

Now the plurality of forms has a long history, and comes in many versions. It was upheld by such luminaries as Duns Scotus (*c.* 1266–1308) and William of Ockham (*c.* 1285–1349). More importantly for our purposes, it was embraced by Julius Scaliger and the intellectual leader of the Lutheran Reformation, Philip Melanchthon (1497–1560), and developed by the Northern Italian philosophers Zabarella and Liceti, whose views were taken up with relish by philosophers in the Lutheran intellectual hub of Wittenberg, including Schegk, Sennert, and Sperling. A large part of its appeal to these thinkers, clearly, was that it made possible the immanence of forms in matter since the Third Day of Creation, something that would be impossible on Thomist

[53] 'Unicitist' is Emily Michael's preferred term (from unicity of forms); Newman coins the term "unitist" (2006, 36). I prefer 'unicist' for someone upholding that each substance contains one and only one (*unica*) substantial form.

accounts, where forms are either educed from matter (the doctrine of eduction) or introduced from the outside (the doctrine of creation).

For our purposes here, however, there are two main varieties of the plurality of forms to consider. The first is the doctrine of the Refraction of Forms of the twelfth-century Arabic philosopher Averröes (ibn-Rushd, 1126–98), subsequently adopted by Zabarella and Schegk, according to which the subordinate forms existing in a compound or "mixt" are "refracted" or broken; and a rival view, with roots in an interpretation of Averröes' predecessor, the great Persian philosopher Avicenna (Ibn-Sīnā, *c.* 970–1037), according to whom these subordinate forms remain integral and unbroken while in the mixt. The latter interpretation was advanced by Julius Scaliger, and adopted by Daniel Sennert in his mature philosophy.

Both versions opposed the unicist view that a compound substance or mixt has only one form, with its matter completely homogeneous, as Aristotle had proposed in his *De generatione et corruptione*. For the pluralists, the forms of component substances are not destroyed when they are combined in a mixt, but persist as subordinate forms in the mixt, despite the latter's possessing its own substantial form, the dominant form. On the Averroist version of pluralism propounded by Zabarella and Schegk, these forms are not complete forms, but "refracted" or broken. There emerges a new form of the mixt blended from the refracted forms of the elements entering into the mixtion. Sennert adopted this position in his earlier work: "For although the forms of the elements do not wholly perish in mixts, but some degrees of them remain," he asserted in 1600, "still they are not distinct from the form of the mixt." When these refracted forms are gathered together, "they make up the form of this mixt, so that nothing may be found beyond the form of the mixt and the prime matter in the mixed body".[54]

This doctrine enabled Sennert, following Zabarella, to solve the problem of the *forma cadaveris* (form of the corpse) described above.[55] The form of the dead body is simply the blending of all the subordinate, refracted forms that already existed within the living body, so that there is no need for any special creation of a new *forma cadaveris* when the creature dies. "In [substantial] change in animate beings", he wrote, "there is no resolution down to the prime matter, so that just as the form of the mixtion remains after the death of a living being, so in generation the form of the mixtion is produced before the soul."[56] According to this Zabarellan account, however, the situation is different

[54] Sennert, *Epitome* (1600), *Disputatio XIV, Thesis XIX*; quoted from Newman (2006, 110). Sennert maintained this Averroist account also in his *Institutiones medicinæ* of 1611 and his *Epitome Naturalis Scientiæ* of 1618. He reveals Zabarella and Schegk as his sources in his *Hypomnemata*: "Nor does it imply any absurdity that besides the specific form there should be still other subordinate forms", he wrote there, citing Zabarella's comment that "if there are two together, there is no reason why there should not be four or even a hundred together in the same thing", and Schegk's that "There is no absurdity in saying that in one substance there are many forms" (*HP* 5.2, 218/1659, 175).

[55] For discussion and quotations from Zabarella's *De rebus naturalibus* (1590) and Sennert's *Epitome* (1600), see Newman (2006, 108–10).

[56] Sennert (1600, *Disputatio XV, Thesis VII*); translated from the Latin quotation given in Newman (2006, 109). See also Newman's discussion on pp. 109–10. This contrasts with what Sennert would later write in his *Hypomnemata*: "And because from the cadavers of animals such more ignoble animals arise,

with inanimate mixts, where there would be a resolution down to prime matter before new mixts emerged, thus excluding atoms.[57] But this meant that it would preclude the existence of any intermediate principles, such as the *tria prima* (salt, sulphur, and mercury) advocated by the alchemists, as noted in Chapter 3. For they explained the properties of any mixt in terms of its containing proportions of these Paracelsian intermediate principles. The Averroist view of Zabarella and Schegk was therefore just as incompatible with the intermediate principles of the alchemists as was the unicists'.

Sennert had realized this by the time he wrote his *De chymicorum* of 1619. There the inadequacy of the Averroist account is demonstrated by the same argument he had used in favour of the existence of atoms, the appeal to the reduction to the pristine state:

> If gold and silver are melted together, they are mixed *per minima* so that gold can in no way be detected by sight; but if then *aqua fortis* is poured on, the silver is so thoroughly dissolved that no metal can be detected by sight in this water [i.e. acid solution]. But since it is really present in it, it can emerge from it in segregated form, and certainly in such a way that the gold and silver retain their own nature. And in this way it is rendered into a very subtle calx, which is nothing but a cluster of innumerable atoms, which is again reduced into the purest gold and silver by fusion.[58]

Now, on the Zabarellan account, Sennert explains, the process of mixtion or generation can occur only by "the resolution of the ingredients down to the elements, or even as some claim to happen, down to the prime matter, saying that no new mixt can be produced unless the elements are mixed anew".[59] But in that case, since the substantial forms of the silver, gold, and *aqua fortis* would all be lost, reduced to the forms of the elements that blend into the form of the mixt (the acid solution), there would be nothing to guarantee that silver or gold would be reconstituted at the end of the process. Whether the four elements remain "virtually" in the mixt, as on the Thomist view, or with refracted forms, as on the Zabarellan, it is impossible to see why, in Newman's words, "the elementary qualities or elements deriving from the acid-silver mixt [should] recombine in the same proportions that they had possessed in the original ingredients" (Newman 2006, 113). "Why", Newman asks, "should aardvarks or artichokes not emerge instead of a bright, heavy metal?" (114). But these things would be easily explained if the gold and silver had all the while been "really present in it", as Sennert concluded, only with their qualities undetectable because of the smallness of the atoms from which they were composed.

it does not happen that, with the same soul of the animal remaining, it is reduced to a more ignoble degree and produces worms, but that the latent subordinate form then exercises itself, as said above" (*HP* 5.7, 228).

[57] On a variant of the Zabarellan account, however, there would be atoms of the elements; but the forms of these atoms would remain refracted in each mixed body, their totality constituting the form of the mixt, and these forms would be mixed anew to produce new mixed bodies in every process of generation and dissolution of substances. Newman suggests that Sennert did not consider such an account tenable in 1619, because it is incompatible with the reduction to the pristine state (Newman 2006, 111).

[58] Sennert (1619, 352); translated from the Latin quotation given in Newman (2006, 99).

[59] Sennert (1619, 351); quoted from (Newman 2006, 106).

This is why Sennert adopts Scaliger's view of forms, according to which the forms of the gold and silver remain intact throughout the process. In fact, Scaliger had provided him with the argument for this, the reduction to the pristine state, illustrating it with the very same example of the gold–silver alloy. That the parts of a substance can be "preserved under their own pristine form", separated, and then recombined, Scaliger claimed,

> appears quite clearly in gold and silver that have been separated by the power [*facultate*] of that marvellous water [i.e. acid]. While they appear to our eyes as if under one form, this is effected by the subtlety of art, so that it is necessary to understand that there was not one natural body but two, as they are seen to be afterwards. Which would certainly not be possible unless the forms themselves were integral, and the parts themselves were by a natural act conserved under these forms. (Scaliger 1557, 145)

Here Scaliger is appealing to his theory of mixtion, where although the silver corpuscles would lose their boundaries when they were dissolved, combining like two drops of water, they would not lose their identity and blend into the form of the mixt, but preserve their own forms or natures.

According to Scaliger's account, however, the mixt only "appears to our eyes" to have one form, whereas in fact it is a plurality of substances, an *ens per aggregationem*, despite the fusion of the gold and silver in the mixt into one continuous liquid. While in this state, the forms of the gold and silver in the acid solution are merely latent, whereas on being precipitated out, these metals' forms would again become dominant and actual, displaying all the properties of gold and silver in their normal solid state. For Sennert, however, it seemed that even if the gold and silver had been given their own indissoluble forms by God in Creation, they would not become reconstituted in their pristine state by processes of dissolution and precipitation unless their forms were active in bringing about these effects. It seems probable that he was influenced in this, as Newman has argued, by his exposure to Libavius' views on atoms and the Geberian tradition of alchemy. For, like Libavius, Sennert adopted the Democritean notion of *diakrisis* and *synkrisis*, according to which like atoms attract one another, and repel atoms of unlike natures. In order for them to be able to do this, they must have species-specific forms, actual and activating, even while in the compound state. For how else could they be precipitated out, unless their natures or forms were actual and active, and thus able to possess an antipathy to whatever substance precipitates them, as well as an affinity for atoms of the same natural kind?

Thus Sennert followed Scaliger's lead in insisting that the forms of gold, silver, or other mixts, remained intact through these chemical processes, serving to preserve the identity of the substances while in the compound mixt. In this way Sennert could preserve all the detailed experimental knowledge of the chymists, explicated in terms of the Paracelsian principles, without subscribing to any of their more arcane theoretical explanations.[60] But in insisting that the forms of mixts remain actual even while

[60] See Michael (2001, 348) for an account of Sennert's criticisms of the extravagant Paracelsian explanatory apparatus.

subordinate, he was led to propose that they have remained intact since Creation. The forms of mixts would have been produced by God through his "active potency" on the Third Day, when he created all the natural kinds there were to be from the elements: "But when God the Best and Greatest created things by his Word, he mixed the elements, and endowed mixts with their own particular forms, and seminal reasons and essences analogous to Heaven" (Sennert 1619, 273/Newman 2006, 94).[61]

In this Sennert was deliberately departing from Scaliger, who held that only the forms of the mixts corresponding to living beings were made by God in Creation. In opposition, Sennert insisted that the generation of substantial forms should receive the same kind of explanation, whether they were the forms of living beings or minerals or mixts. By his own account he was persuaded by the arguments of Liceti to a view of animal generation that posited souls in seeds prior to their generation, and this seemed to have prompted him to seek an analogous explanation for the generation of mixts in chymical processes.[62] Emily Michael (1997) suggests that Sennert received further impetus for his adoption of integral and active forms from his empirical studies in embryology, where he had argued forcefully against the standard creationist view. On the creationist account upheld by Zabarella, the foetus would acquire a form of a yet-to-be-born baby when the matter in it was appropriately organized to receive the soul, just as a statue would acquire a form when the sculptor applied the last touches to his work. To this Sennert objected (as would Boyle later) that this is not intelligible: "For since nothing naturally comes from nothing, and yet there is a form in matter that was not there before, one may ask, where does it come from?"[63]

His answer, as we have seen, is that a form must already have been present in the seed at conception. Sennert's studies of aborted foetuses had convinced him that the form was a generative one, active in developing the foetus from conception onwards. Thus it appeared evident to him, by parity of reason, that atoms of gold or silver would not be reconstituted in their pristine state by processes of dissolution and precipitation unless their forms were active in bringing about these effects. Sennert applies a similar argument to mercury, which, no matter what processes of sublimation and precipitation it may be subjected to, "always retains its own essential form, is easily separated from the bodies with which it has been mixed, and returns to its pristine form of running mercury" (*HP* 3.1, 162/Michael 2001, 355). Another example Sennert gives of preservation of form through changing appearances, and one that will recur in Leibniz, is that of the metamorphosis of a caterpillar into a chrysalis and then into a butterfly, "where the same form fabricates diverse bodies at diverse times" (Sennert 1636, 450/Newman 2006, 149). Such examples, Michael argues, demonstrate Sennert's commitment to a strong principle of univocity of explanation, whereby

[61] Here the "analogous to Heaven" is probably an allusion to the theory of Fernel and others that "the soul comes from heaven". See Sennert's discussion in (*HP* 4.2, 169–71).

[62] On one occasion, as Hirai reports (2011, 169), Liceti even referred to these seeds as "atoms".

[63] Sennert, *Epitome Naturalis Scientiae* (1618), 47; translated from the Latin quoted by Michael (1997, 294).

principles of the same kind should be employed to explain processes of the same kind (Michael 1997, 294–5).

Thus Sennert develops Scaliger's notion of active subordinate forms into a full-blown hierarchical analysis of substances. As we have seen, he inherits the pluralist position of Zabarella and others that there are subordinate forms in living beings, whose dominant form is their soul:

> To me it seems more consonant with the truth that in living bodies there are many auxiliary and subordinate forms, yet such that one form is principal and mistress [*domina*] and informs the living thing, and is that from which the living thing gets its name. (*HP* 5.2, 218/1659, 175)

But he extends this idea to all substances. He rejects the Averroist idea of the refraction of forms upheld by Zabarella and Schegk, where the forms of the constituents of a mixt (such as the gold and silver in the experiment above) are lost in the mixtion. For this would imply that when the gold and silver were recovered at the end of the process the experimenter would have created their substantial forms, thus putting man on a par with God or nature as creator of forms. This would also violate the distinction between natural things, possessing their own internal principle of activity, and artefacts, which do not.[64] So he avers instead that they remain active, responsible for the actuality of the subordinate forms in the mixt, and the subsequent behaviours of the bodies they inform. Thus God initially creates the Aristotelian elements, earth, water, fire, and air, although they play no explanatory role for Sennert in matter theory. This role is performed rather by the atoms of mercury, sulphur, and salt that are formed from them by God on the Third Day, whose forms are in turn subordinate to those of the metals, such as gold and silver. On the same day, from these subordinate forms God also creates the atoms comprising the seeds of living matter (which Gassendi would call "molecules"), whose forms are active in generating new forms of the same kind: thus Sennert's axiom *omnis forma est sui multiplicativa*, the basis for his theory of traduction. Here, although Sennert appeals to spirits or innate heat as the material and efficient causes of generation, "natural things come about under the direction of a superior form".[65] Thus, as he wrote the *De chymicorum* of 1619:

> Today too in the generations of things, mixtion does not occur by the Elements running together of their own accord to constitute each thing, but every one is directed by a form. For forms are the divine and immutable principle that determines all the actions and passions of a natural thing; and they are, as it were, the instrument and hand of the most wise Creator and Workman God, who in creation freely bestowed this force and efficacy onto these his instruments, things than which nothing more marvellous can be thought. This is what J. C. Scaliger has rightly also taught, Exercise 307, sect 20. (Sennert 1619, 353)

In these doctrines of Scaliger and Sennert we can see many resonances with Leibniz's mature metaphysics. Active, immaterial forms are the "instruments" by which God

[64] Newman makes both these points (Newman 2006, 114).
[65] Sennert (1650, vol. III, 780); translated from Emily Michael's Latin quotation (2001, 357, n. 91).

brings about his providential plan.[66] They are everywhere in matter, each informing an organic body, although the body may be part of a larger body to whose (dominant) substantial form the form of the smaller creature is subordinate. There is a hierarchy of forms, so that the subordinate forms of one being dominate the forms of those beings constituting its own body. These subordinate forms are not always evident, but they are always active, and actuate the matter of any body. Moreover it is through the substantial form of a living thing that its generation, development, and behaviour is directed, and so may be explained teleologically. They are "the divine and immutable principle that determines all the actions and passions of a natural thing", through the "force and efficacy" bestowed upon them by God in Creation.[67] One point on which the mature Leibniz will follow Scaliger and not Sennert, however, is in refusing to assign forms to mixts, which for him are mere *entia per aggregationem*, not animate beings.[68] Nevertheless, he will agree with both of them that such compounds are natural things, so that all of their actions and passions must be determined by forms, even if these are subordinate forms and not their own substantial forms.

Returning to the problem of the origin of forms, however, it can be seen that Sennert's theory has not resolved all the difficulties besetting rival theories, and in fact has incurred some added ones of its own. All the natural kinds were created at the beginning of the world, and members of those kinds possess forms that enable them to propagate and multiply. But individuals of these kinds are not absolutely indissectible, and are destroyed when their bodies are diminished below the size of their natural minima. Thus the substantial forms of the various substances making up the body of a living thing are subordinate to it so long as it is alive, and these substances are the matter corresponding to the dominant form. But on death, says Sennert, here following Zabarella, the dominant form is extinguished, and the form of the body is reduced to the next lower grade, an aggregate of the forms of its subordinate substances (Blank 2011, 121). Thus immaterial forms, for Sennert, are not indestructible, and are dependent on the material integrity of the body they inform. Also, notwithstanding the fact that God created all the various forms on the Third Day, and that living beings are equipped with the power of generating beings of the same kind, this means that

[66] Newman attributes to Sennert an "operational atomism" (2006, 96, 97, 99), on the grounds that, like nineteenth-century atomism, it refused "to speculate about the microstructure of the undivided elements that made up its stock and trade"; the substantial form is unknowable, "a sort of 'black box' from which qualities emerge" (2006, 139). But this ignores the fact that, as the above quotation evinces, for Sennert the forms perform a crucial role as the indivisible "instruments" through whose actions God's providential plan for the world unfolds, a teleological function for forms that will be as important to Leibniz as it was to Sennert.

[67] Cf. the passage Sakamoto (2016, 178) quotes from Leibniz, "Consideration sur la doctrine d'un Esprit Universel Unique," "Besides God, there are numerous particular active beings, since there are numerous actions and passions which are particular and contrary and should not be ascribed to the same subject. And these active beings are none other than individual souls" (GP VI 537/L 559).

[68] There is some irony here, since Sennert had misread Scaliger as proposing that a *crama* was made into a substantial unity by the fusing of the boundaries of its constituents so that its body was rendered continuous; whereas, after considering this view, Scaliger had opted instead for the view that a *crama* should not be regarded as a substantial unity possessing its own form.

new *individual* beings of the same kind—even though not new *kinds* of being—are in fact created in traduction. Sennert's assertions that forms "may be said to be multiplied rather than made", and that "every form is self-multiplying" (*HP* 4.1, 169/1659, 465), mean that only the first forms of each given kind were created on the Third Day, whereas all the subsequent individual forms of each kind will be generated by multiplication. So there is not only destruction of individual immaterial forms (of plants and animals),[69] but also generation of immaterial forms,[70] again dependent on the material organization of the bodies involved in the generating.

None of this escaped the critical eye of Robert Boyle. In his "Free Considerations about Subordinate Formes, as they are wont to be maintain'd by divers Learned Modernes", added in the 1667 edition of his *Origine of Formes and Qualities* (Boyle 1667, 291–2), Boyle addresses Sennert's doctrine that in the parts of certain bodies, "besides the Specifick Form, as Sennertus calls it",

> certain other Formes proper to those parts, but nevertheless so subjected to the predominant Mistress Forme, if I may so call it, that they derive the Title but of subordinate Forms, and during the reign of the Specifick Form, are subservient to it, but in the capacity (as it were) of matter…

Boyle has no objection to the idea of subordinate forms as such, provided they are interpreted mechanically, a point to which we will return below. He allows that "though in living creatures we may often meet with subordinate Formes either properly or lesse improperly so call'd, yet…in bodies Inanimate this happens not so often" (347). The supervening form, he explains, is "often but accidental to the præexistent Form, and (then) does not at all destroy its nature but modifie its operations" (348). He discusses various examples, such as the needle of a compass receiving a magnetic faculty from a lodestone, and the spring of a watch, both of which retain all their mechanical properties. Such forms will be material. But if the form is regarded as distinct from matter, and yet dependent on how the relevant bodies are organized, Boyle sees only problems:

> for if a Form be a True Substance distinct from Matter, it must, as I lately noted, be able to exist of it self, without any other Substance to support it, as those I reason with confesse, that the Soul of Man survives the Body it did before death informe: whereas they will have it, that in Corruption the Form is quite abolish'd, and utterly perishes, as not being capable of existing, separated from the Matter, whereunto it was united; so that here again, what they call a Substance they make indeed an Accident… (Boyle 1667, 79)

The problem is only accentuated by Sennert's decision to ascribe immaterial souls to all living substances.[71] For if vegetable and animal souls are material, as in Gassendi's

[69] This is explicitly acknowledged by Sennert, who defends his views that the immaterial souls of plants and non-human animals die in the *Hypomnemata Physica*: "although the souls of plants and brutes perish as soon as the individual dies, God does not for that reason repent of his works" (*HP* 5.7, 233/1659, 201).

[70] "But that is said to be multiplied which, when before it was one [form] in one individual, now becomes multiple, and plural in number" (*HP* 4.1, 169/1659, 465).

[71] Of course, Scaliger and Sennert were not the only philosophers to propose immaterial forms. A particularly interesting case is that of Nicholaus Taurellus (1547–1606), who maintained atoms containing

philosophy, there is no problem in their losing their forms when their matter is dissolved into parts smaller than their natural minima. But if they are immaterial, as Sennert proposed, then it seems as hard to account for their origin and dissolution as it was through eduction.

Likewise, Leibniz cannot accept Sennert's position on the origins of souls or forms and their dissolution. If they are principles of action, they have to last forever: all substantial forms must be indestructible, even if they are not all immortal. Here he seems as committed as was Sennert to a principle of univocity of explanation: what holds for the generation of some kinds of substantial forms should hold for all. Thus it is just as unintelligible for the souls of living beings to be dissolved as for any other substantial forms; and also just as unintelligible for either to be created in natural processes. In fact, Leibniz will agree with the occasionalists, it is unintelligible how a mind or soul can act on or be acted upon by its body at all. This means that the same charge of unintelligibility that Sennert made to the generation of forms by eduction can and should apply equally to Sennert's own theory: the generation of forms from forms in traduction, and also their dissolution, are for Leibniz (after 1676) no more intelligible than on the unicist account.

4.3 Teleology and the Rehabilitation of Substantial Forms

We are now much better placed to understand Leibniz's insistence on the need to rehabilitate substantial forms, first announced by him in epistolary exchanges in 1679, but not made public until much later.[72] On the one hand, Leibniz is an enthusiastic "modern". He has read and understood Boyle's criticisms of substantial forms as conceived in the Schools, and agrees with him that the explanations given about the origin and dissolution of such forms are unintelligible. He is also fully committed to mechanism, precisely as conceived by Boyle: forms cannot be appealed to in the detailed explanation of phenomena, instead these phenomena should be understood wholly in terms of matter in motion. He is also completely persuaded by the arguments of the Cartesians—in particular, Malebranche—of the unintelligibility of mind–body interaction, and indeed, of any action of one substance on another. These objections would apply equally to Severinus' idea of an "elaborator spirit", to Schegk's δυνάμεως πλαστικῆς (plastic power) (A II i 35/L 101), to Scaliger's and Sennert's conception of the action of an immaterial soul or form on a body to guide its growth and development, and to his own speculations about the mind acting on its body through its associated vortex.

substantial forms; but his atoms were, according to Andreas Blank's analysis in his (2015, chapter 2), themselves immaterial atoms.

[72] The *Discourse on Metaphysics*, often taken as Leibniz's first announcement of his new system, was not published until 1846, and only the headings were seen by Arnauld in 1686.

On the other hand, however, Leibniz is as fully committed as the Lutheran intellectuals and Gassendi to the idea that the seminal principles or forms of all existing substances were created by God in the first days of Creation, and that there must exist in things the means to carry out God's providential plan. Here he finds a genuine weakness in the mechanical philosophy. If there are no natures in things, no continuants or principles of individuation, then there is nothing in them by means of which God's providential plan could be carried out. On the traditional view, as we have seen, accidental forms are not a difficulty, since they are modifications produced teleologically by substantial principles. But in the absence of such principles, there is nothing which can explain the generation of forms and qualities, nor anything substantial of which they can be regarded as modifications, and the origin of accidental forms becomes unintelligible. Moreover, those mechanical philosophers (like Descartes and Spinoza) who proscribed any final cause explanations in nature, rendered all goal-directed behaviour inexplicable, with dire consequences for understanding biological development, let alone human action.

These points can be seen in relief by a further comparison with Boyle's natural philosophy. Boyle, as we have noted, was particularly critical of Sennert for his appeal to forms as causal agents in nature. In painstaking detail, he works through a litany of examples from Sennert's natural philosophy that appealed to the action of forms on bodies to bring about certain effects, and in each case was able to come up with a plausible mechanical explanation. Crucially, these explanations extended to animate matter. Growth is increase of size, an effect brought about by motions in the parts of the plant or animal, and similarly all other observable effects in living substances will involve size, shape, and motion. Such changes require efficient causation, and this can be rendered intelligible by an analogy with man-made machines. Boyle writes:

> I may somewhat illustrate my meaning on this occasion, by making a comparison betwixt a living creature, and a Mill. For a Mill is capable of performing divers things onely when the water that passes through certain of its parts puts them, and by their intervention, others into motion through them: so there are divers things that are not performable by a Plant, unlesse when 'tis irrigated by a vital liquor… (Boyle 1667, 320)

Leibniz will, famously, adopt the same figure of the mill to make what might appear to be an anti-mechanist point in his *Monadology*.[73] But his argument is more subtle than that, as we will see. In the preface to his manuscript *Elementa physicae* dating from the summer of 1678 or not long afterwards—a somewhat unappreciated work whose importance has been stressed by François Duchesneau (2010, 66ff.)—he makes very

[73] "Imagine a machine which by its structure produced thought, feeling, and perception. We can imagine it as being enlarged while retaining the same relative proportions to the point where we could go inside it, as we would go into a mill. But if that were so, we would find nothing but pieces pushing against one another, and never anything to account for a perception" (§17, GP VI 609/L 644). Of course, such a "mill" might be a seventeenth-century factory, rather than the water mill of Boyle's example; but it is still an intriguing correspondence. As Duchesneau has noted, Malpighi (1967, 516) also used the analogy of an animal with a mill to support his mechanist programme (Duchesneau 2010, 44).

clear the extent of his agreement with Boyle's mechanical philosophy. All qualities and changes of bodies can be reduced to certain distinct concepts, he writes, "but in body, if it is viewed only as matter ôr that which fills space, nothing can be distinctly conceived but *magnitude* and *shape*, which are in it by reason of space, and *motion*, which is variation of space" (A VI iv 2007/L 287). Leibniz mentions how other learned men "consider qualities such as heat, light, elastic force, gravity and magnetic force, as certain absolute entities emanating from substantial forms" (2007/287). But, he insists, not even an angel could satisfactorily explain phenomena by an appeal to such things, since it would necessarily have to "present only such things as we perceive distinctly" (2007/288), and this means magnitude, shape and motion. For

> the way in which a body operates cannot be explained distinctly unless we also explain what its parts contribute. This cannot be understood, however, unless we understand their relation to each other and to the whole, that is, their figure and situation, and the change of this situation ôr motion, their magnitude, their pores, and other mechanical things of this kind, for these always vary their operation. (A VI iv 2008/L 288)

And not only plants are analogous to machines according to Boyle, who immediately extends the machinic conception to animals: "And even some Animals themselves are not so very unlike to these Plants, and consequently to Engines, as one would think" (Boyle 1667, 323).

Leibniz was fully on board with this mechanist programme, which he had also found elaborated in detail by Marcello Malpighi, who had especially emphasized the analogy of animals to plants in his *Anatome Plantarum* (1675) and other works.[74] Indeed, there are signs of Malpighi's influence in the introduction to the *Elementa physicae*. As Duchesneau has observed, the same fiction of the angel was used by Malpighi to the same effect, namely, "to challenge every form of explanation that supposes causal agents underlying phenomena that would act in a non-mechanical fashion and are not intelligible: souls, vital forces, faculties, occult qualities, which elude geometrical representation".[75] Particularly influential on Leibniz were Malpighi's depictions of the parts of a living organism as possessing parts that are themselves complex, interacting organic *machinulae*, in Duchesneau's words, "hypercomplex mechanical arrangements of micro-machines, interlinked and folded into one another", so that "practically, the machines of nature formed series of similar machines of nature 'to infinity'".[76]

[74] Leibniz alludes to Malpighi's work on embryology in 1676. To Arnauld he writes on 9 October 1687: "M. Malpighi, on the basis of very considerable anatomical analogies, has a great inclination to believe that plants can be included in the same genus as animals, and are in fact imperfect animals" (A II iiB 253/WFT 132).

[75] "À noter ici la fiction de l'ange dont Leibniz se sert, comme Malpighi ailleurs, pout récuser toute forme d'explication supposant des agents causaux sous-jacents aux phénomènes, qui agiraient de façon non mécanique et donc non intelligible: des âmes, forces vitales, facultés, qualités occultes, échappant à la représentation géométrique" (Duchesneau 2010, 60–1). Duchesneau references Malpighi, *Opere scelte* (1967, 516), quoting the relevant passage from the *Riposta del Dottor Marcello Malpighi* on p. 44.

[76] "On doit présumer avoir affaire à des agencements mécaniques hypercomplexes de micromachines inter-reliées et emboîtées les unes dans les autres. . . . Pratiquement, les machines de la nature seraient formés de machines de la nature 'à l'infini' " (Duchesneau 2010, 29).

As might be expected, Leibniz seized on this as further empirical confirmation of his thesis of "worlds within worlds to infinity". He had already rejected atoms in the *Pacidius Philalethi* of 1676 on the grounds that "there is no reason why God should have put a stop to his handiwork at this point and left only these creatures without a variety of other creatures inside them, as if they were paralysed or dead" (A VI iii 561/LLC 199). In the same dialogue he had adopted a Baconian interpretation of the division of bodies into elastic folds (*plicae*), so that the bodies "are everywhere flexible", divided into parts that cohere and resist being penetrated with varying degrees of resistance, "although variously opened up and folded together" (555/185). He writes:

> Accordingly, the division of the continuum must not be considered to be like the division of sand into grains, but like that of a sheet of paper or of a tunic into folds. And so although there occur some folds smaller than others to infinity, a body is never thereby dissolved into point ôr minima. On the contrary, every liquid has some tenacity, so that although it is torn into parts, not all the parts of the parts are so torn in their turn; instead they are merely take shape for a while, and are transformed . . . It is just as if we suppose a tunic to be scored with folds multiplied to infinity in such a way that there is no fold so small that it is not subdivided by a new fold; and yet in this way no point in the tunic will be assignable without its being moved in different ways by its neighbours, although it will not be torn apart by them. And the tunic cannot be said to be resolved all the way down into points; instead, although some folds are smaller than others to infinity, bodies are always extended, and points never become parts, but always remain mere extrema. (555/185–7)

After learning about Malpighi's microscopic observations (reinforced by what he had seen first hand in December 1676 on visiting Swammerdam in Amsterdam and Leeuwenhoek in Delft), Leibniz assimilated these elastic parts, "variously opened up and folded together" (555/185), to the bodies of living creatures seen under the microscope.

Pauline Phemister has perceptively noted that the analogy with the tunic presents a conception of the physical continuum as a whole characterized by folds, elasticity, and living creatures, in contrast with a conception of it as a geometrical continuum punctured by discontinuities. When the continuum is conceived in terms of folds, she writes, "No separate parts are created by the folding", and "All divisions remain within the whole" (2005, 116). On this reading, the physical continuum "is composed of indivisible living corporeal substances", "bodies whose substantial forms create, by motion, the divisions within matter" (116). "There are motions within the motions of larger bodies' motions, none of which destroy the unity of the original body" (116). In support of this reading Phemister quotes one of Leibniz's reflections in the seminal manuscript *Metaphysical Definitions and Reflections* of 1678–9, which begins "The parts of any body constitute one continuum." He continues:

> For a unity always lasts as long as it can without destroying multiplicity, and this happens if bodies are understood to be folded rather than divided. As, for example, a chord is one vibration, even though there is no part of it that does not have its own particular motion. Whoever

understands this proposition well enough will laugh at the vain questions concerning the seat of the soul. (A VI iv 1401/ LLC 251)

On Phemister's reading, each corporeal substance is a unified physical continuum, notwithstanding the divisions in its body. But what it is that makes for this unity is not explained: substantial forms "create" the divisions within matter "by motion", but if these divisions result in a multiplicity of actual parts, how does this not destroy the unity?

Actually, I think there are answers to these questions suggested in the continuation of this reflection. For what we see emerging in these reflections is a re-conception of the unity of an organic body in terms of a *conservation of power* distributed across its parts, rather than in terms of a conservation of their mass or bulk. There must be some lasting unity that goes along with a multiplicity of parts, Leibniz reasons, in order for them to be correctly identified as parts of the same thing:

Anyone seeking the primary sources of things must investigate how matter is divided into parts, and which of them is moving. This, so it seems to me, I have investigated. A unity must always be joined to a multiplicity to the extent that it may. So I say that matter is divided not even into parts of equal bulk, as some have supposed, nor into parts of equal speed, but into parts of equal power, but with bulk and speed unequal in such a way that the speeds are in inverse ratios to the magnitudes. For in this way all things will indeed be agitated [*turbata*], but with the utmost reason. For if they were not agitated, they would not be alive, and if they were not agitated in a certain ratio, they would not become known. (A VI iv 1401–2/251)

As I read Leibniz's meaning here, the unity that is added does not destroy the multiplicity: the internal motions that are producing the foldings still divide matter at any instant into distinct actual parts, even if the spatial partition of matter differs from one moment to the next. What accounts for the actual parts constituting a body that is self-identical through time, the unity that is joined to this multiplicity, is constituted by the conservation of power: even though the parts do not have equal bulk or spatial volume, and even though the internal motions producing the divisions conserve quantity of motion (bulk times speed) rather than bulk alone, it is constancy of power that constitutes the actual parts as parts of the self-same thing through time.

We will return to this idea of the machines of nature conserving their power in Chapter 5. For now we note that these texts give support to Phemister's claim that the machine of nature remains the same organic body through time despite the differing foldings it receives from its roiling internal motions. This is an important point. For otherwise there is a discordance between Leibniz's claim that a body does not remain the same for longer than an instant, and his repeated claims that an organic body is as indestructible as the form to which it belongs, despite incessant changes of its constituent parts. What, in fact, is Leibniz's argument for the indestructibility of organic body?[77]

[77] I am indebted to Michael Detlefsen for raising this question in a talk I gave in Paris, and for the scepticism I read in his face when I suggested in reply that it is impossible to destroy an infinitely folded organic body by breaking it down or dissolving it into constituent parts simply because there is no last portion: there are always smaller parts.

In the *Nouveau système* of 1695, Leibniz introduces organic bodies as "machines of nature":

> It must be recognized that the machines of nature have an infinity of organs, and are so well apportioned and resistant to all accidents that it is impossible to destroy them. A natural machine remains a machine in its least parts, and what is more, it remains the same machine that it always was, being merely transformed by the different folds it receives, now extended, now contracted, and as it were concentrated when we think it has been destroyed. (GP IV 482/L 456)

This wording recalls that of the passage from the *Pacidius* quoted above: a body is formed into parts possessing a certain resistance to folding, takes shape for a while, and is then transformed. Because an organic body remains a machine in its least parts (i.e. in however small a part), none of its parts is so small that it does not possess a certain resistance to penetration or antitypy, and this prevents it being divided into a powder of points. But this would still be true of a body that was divided into a finite number of parts, each of which was a machine (with some rudimentary machines at the bottom of the resolution). Clearly the infinitude of the machinic parts of the organic body is relevant. Yet it cannot be simply its infinite complexity, its mere possession of an infinity of machinic parts, that constitutes the "organism" of such a body, and is responsible for its indestructibility.[78] Consider, for example, an inanimate aggregate like a flock of thirty sheep. This could be destroyed if it were separated into two parts fleeing in opposite directions as a result of being attacked by wolves, even if none of the sheep were lost; yet each of the sheeps' bodies is itself an organic body, and therefore has an infinity of natural machines as parts. The flock, therefore, is an example of a body that is infinitely complex, but which itself has no lasting unity of function, no organic unity. What prevents an organic body from being destroyed is the fact that it has an enduring functional unity, as does each of the organic bodies that are its parts, with their functions subordinated to its own. Indeed, as testified by the above passage, there is no machine of nature so small that it does not possess an infinity *of organs*: i.e. that does not have functionality together with the organs necessary for performing the corresponding functions. This enduring functionality is what constitutes its form.[79] But no activity can be accomplished corresponding to these functions without physical organs. Hence Leibniz's insistence (following both Zabarella and Gassendi) that a form must always have a portion of matter that it informs.[80] Now the infinite enfolding of

[78] Cf. Smith: "physically speaking, the difference between an organic body and an inorganic body is found in the complexity of the organic body" (Smith 2011, 108).

[79] This supports Ohad Nachtomy's notion of "nested individuality". "I interpret the relation of 'nested in' in terms of activity and, in particular, in terms of functionally organizing activity. This activity gives an ensemble of individuals its unity by organizing each of them according to their proper function within the program of the individual" (2007, 241).

[80] Cf. Daniel Sennert: "But the human soul, as long as it is in the body, necessarily uses corporeal organs, and because of this its propagation is also not outside of matter. So it is false what they say, that if after death the human soul subsists per se and without matter, then it is also produced outside of and without matter. For just as it pleases God that the human soul should not subsist without a body, but

matter ensures that there will always be such a portion, however minute, in which the form or soul can be situated.

Of course, it is a central ambition of the mechanical philosophy to reject appeals to such entities in created things as forms or vital forces acting on matter (except possibly in the case of human beings). Leibniz, as we have seen, accepts that no reference to such entities must be made in order to give an intelligible explanation of the operations of bodies, whether of living beings or inanimate matter. But, he insists, a full account of the natures of bodies cannot be provided if they are regarded simply as machines, as these are understood in a purely geometrical physics. There are roughly three interrelated areas of difficulty: (i) how a given individual can remain the same individual while its body undergoes (sometimes profound) changes, such as the caterpillar becoming a butterfly; (ii) how to account for the activity of bodies, when body, as conceived (mechanically) in terms of size, shape, and motion, is essentially passive; and (iii) how to account for the functioning of machines, in particular their role in God's providential plans, without appealing to direct divine action. Let us compare his views with Boyle's.

Boyle sees no difficulty with individuation. The individual is simply the machine: the systematic interrelation of its parts and their motions is what accounts for its being the individual it is. Of course, this implies that the traditional distinction between an *unum per se* and an *unum per accidens* ceases to have application. According to this traditional distinction, the body of a living creature is an *unum per se* that is united by its own form, whereas an inanimate body is an *unum per accidens*, a mere aggregate of such real unities. Even Scaliger subscribes to this distinction, despite his having toyed with an account where such an aggregate could be made into one "by a making continuous of the boundaries" (Scaliger 1557, 143).[81] But Boyle does not see why any body that operates as a machine could not be classified as an *unum per se*:

> And indeed if the parts of a Body, whether merely natural or factitious, be by their union or conjunction brought to become the principle of a Property or Operation, which belongs to neither of them single, I see not why such a body may not passe for *unum per se*, as well as divers bodies that are wont to be look'd upon under that notion. (Boyle 1667, 346)[82]

Since for Boyle form (insofar as it is intelligible) is simply mechanism, it follows that body is a conjunction of parts operating together in a systematic relationship. When this functioning relationship breaks down, the individual ceases to exist. This will be the case even for the intricate machines that are living organisms. To use Boyle's

should have a subsistence naturally in its own body, so in the same way he wishes it to be propagated with and in the seed" (*HP* 4.14, 206/1659, 524).

[81] As noted in Chapter 3 (n 90), Scaliger called such a fused aggregate a *crama*. It is a mixt whose parts retain their own forms intact while fusing together so that their boundaries are lost. But he went on to reject this idea of the unity of certain bodies, holding that every real unity requires a substantial form. See Sakamoto (2016, ch. 7).

[82] This wording evokes Leibniz's draft of his letter to Arnauld of 30 April 1687, when he concedes that it is permissible to allow a definition of substance on which even a "rainbow can pass for a substance" (A II 2b, 169). (I am indebted to one of OUP's readers for this observation.)

example, just as a mill will cease to function as a mill when the stream that drives it dries up, so will a plant cease to function as a plant when it ceases to be "irrigated by a vital liquor".

But this raises the whole question of *function*, and how it can be explicated in a way that is compatible with the mechanical philosophy. According to Leibniz, function necessarily involves consideration of *final causes*. If a machine is made to perform a certain function, then it must operate to achieve a certain end, an end assigned by its designer. Thus, in a fragment dated as from 1680–2 whose importance has been stressed by Pasini, Duchesneau, and Smith,[83] Leibniz argues:

> The human body, and that of every single animal, is a sort of machine. Every machine, however, is best defined in terms of its final cause, so that in the explanation of its parts it is therefore apparent how each of them is coordinated for its intended use.
>
> (*Corpus hominis*…; Pasini 1996, 217/Smith 2011, 290)

The best way to describe a clock, for example, is as "a machine made to indicate equal divisions of time, so it is necessary for the clock-hand to undergo uniform motion for some period of time" (217–18/290).

Now, it is often supposed that function has no place in a mechanist philosophy, and that the notion of end-directed or telic action must be rigorously excluded. But as many seventeenth-century philosophers were acutely aware, if end-directedness is not part of the natural world, then there is no place for divine providence, for God's creating the various things in the world with an end in view. This was the case for Boyle, who, notwithstanding his conception of the world we live in as "an *αυτόματον* or *Self-moving Engine*" (Boyle 1666, 92; 1667, 61), did not see this as precluding teleological explanation. Far from it: as several scholars have emphasized, he saw the investigation of final causes as of paramount importance. This is evident, above all, from his having written a whole book on the subject in 1688, the *Disquisition about the Final Causes of Natural Things*. There he expresses the concern to avoid the absurdity of the Epicurean position,[84] where order is supposed to arise by chance, and also Descartes' rejection of final causes on the grounds that "'twere Presumption in Man to think his Reason can extend to Discover them" (1688, Preface, and 3–4). Although the *Disquisition* is a late publication, the same concern is also evident in earlier works such as in the *Origine*, where he identifies the same adversaries:

> I do not at all believe, that either these *Cartesian laws of Motion* or the *Epicurean casual concourse* of atoms could bring meer Matter into so orderly and well contriv'd a Fabrick as this World; and

[83] The fragment *Corpus hominis et uniuscujusque animalis machina est quaedam* (*The Human Body, and that of every single Animal, is a Sort of Machine*) was first edited and published by Enrico Pasini (1996, 217–24). It was given a French translation by François Duchesneau in his (2010, 318–25) and an English translation by Justin E. H. Smith (2011, 290–6).

[84] Worthy of note is Boyle's exemption of Gassendi from this criticism: "Epicurus and most of his Followers (for I except some few late ones, especially the Learned Gassendus) Banish the Consideration of the Ends of Things, because the World, being according to them made by Chance, no Ends of any Thing can be suppos'd to have been intended" (Boyle 1688, Preface).

therefore think that the wise Author of Nature did not *onely put Matter into motion*, but when he resolv'd to make the world, did so regulate and *guide the motions* of the small parts of the Universal Matter, as to reduce the greater systems of them into the order they were to continue in;… (Boyle 1667, 103)

So far, this echoes Sennert's criticisms of Democritean atomism: "Even if maybe Democritus thought so, natural things do not come about through the fortuitous collision of atoms";[85] and "matter does not rush off spontaneously to generate and nourish things with just that weight and measure it should;…".[86] But this consideration constituted one of the primary reasons Sennert adduced for the necessity of supposing forms. Admitting the difficulty of understanding Zabarella's claim that the soul manages to extend itself as an animal acquires parts in growing, Sennert comments that this "is so obscure as to make Sébastian Basson, otherwise perspicacious enough in physics, propose that substantial form be denied, and hold, absurdly, that form is nothing but a certain aggregation of parts of the same kind optimally concentrated" (*HP* 4.6, 182/1659, 486). But in that case there would be no explanation of how natural kinds manage to generate other things of the same kind—a consideration which, as we have seen, Sennert extended to the tendency of chymical atoms to attract other atoms of the same kind. There is some recognition of this difficulty in Boyle. For in the continuation of the above passage from the *Origine*, he concedes that in order to explain the generation of plants and animals from creatures of the same kind, seeds or seminal principles are necessary:

…and did more particularly contrive some portion of that Matter into Seminal Rudiments or Principles, lodg'd in convenient Receptacles, (and as it were Wombs), and others into the bodies of Plants and Animals; one main part of whose contrivance did, as I apprehend, consist in this, that some of their organs were so fram'd, that, supposing the fabrick of the greater Bodies of the Universe, and the Laws he had establish'd in Nature, some juicy and spirituous parts of these living creatures must be fit to be turned into prolifick Seeds, whereby they may have a power, by generating their like, to propagate their *Species*… (Boyle 1667, 103)

In fact, in various works Boyle follows Sennert in availing himself of this notion of a "plastick power" by which seeds effect generation. But, as Peter Anstey has concluded,[87] his attempts to explain the operation of such a power purely mechanically are unpersuasive and inconclusive: sometimes he will remain content with declaring nescience: how such a power operates mechanically, he does not pretend to know (Anstey 2002, 628). A similar difficulty arises in Boyle's criticism of the Cartesian view

[85] Sennert (1650, vol. III, 780); translated from Emily Michael's Latin quotation (Michael 2001, 357, n. 91).

[86] Sennert (1619, 353) cites Scaliger's objection in his (1557, Exercise 307, sect 20), that "Unless these four elements have a regulator, any of them will toss and be tossed about blindly and without means or measure. For what is it that mixes so much earth with so much of the other elements?"

[87] See Anstey (2002). As he explains, the notion of seminal principles was of interest to Boyle throughout his career as a natural philosopher, featuring (as here) in his account of God's creation of the original species when he made the world, and also in the generation of animals and plants (although he will become sceptical about their role in the formation of minerals and apparent spontaneous generation).

that restricts divine action to the creation of laws of motion and the setting of matter in motion in Creation. For Boyle does not say *how* God is supposed to "regulate and guide the motions of the parts of matter" beyond his establishing the laws of motion. Since he has denied that body has any "nature" by which this could be achieved, this would appear to oblige him to have God act directly on matter, either through a Cartesian continuous creation, or through God's occasional direct action on his Creation, as Newton and Clarke will later maintain.[88]

This is the nub of Leibniz's disagreement with Boyle. For him, no less than for Sennert and Gassendi, there must be agency within a natural thing in order for it to bring about its own actions, as opposed to God's bringing them about on its behalf. Sennert had argued that the difference between an artefact and a natural thing is that in the case of an artefact, the designer or artist is "outside the matter", whereas "in natural things the artist is in the matter, and diffused through the matter" (*HP* 4.9, *Hypomn.*, *Works* I, 191; Michael 1997, 295). "In the generation of any natural thing, a determinate and specific agent is required, and one that is an actual agent" (191/295), Sennert wrote. Leibniz agrees, although not of course with Sennert's conception of this agency in terms of a "plastic power" guiding matter by some non-mechanical means. As he will later write in opposition to Cudworth's "immaterial plastic natures", "*Non mi bisogna, e non mi basta* [I neither need them, nor are they enough for me], for the very reason that this infinitely complex organism provides me with material plastic natures sufficient for the need" (*Considerations on Vital Principles and Plastic Natures* [1705], GP VI 544/L 589). Leibniz sees the difference between an artefact and a "machine of nature" to consist in the fact that whereas the artificial machine needs an external source of power and replacing of worn parts to keep it functioning properly, the natural machine has its own source of power within, and replaces its own parts as needed. "Since the motive force is always finite", he argues in *Corpus hominis*, "a purely mechanical perpetual motion is impossible" (Pasini 1996, 219/Smith 2011, 291). Thus "for the continuation of the [man-made] machine an external restitution of the motive power is also needed", which is provided by the "the man in charge of it, who repairs what is broken down or worn out in time, who applies an external force and adjusts it to agents and patients, . . . and conserves the power of the Machine in various ways". The case is different for natural machines:

> Nature brings it about that her Machine is able to do these very things by itself, that is, that it is now nourished, whereby its worn out parts and forces are restored, that it is now moved towards the very nutriments or other means of sustaining its functions that are to be procured, as well as avoiding impediments, and now finally, that it is warned by internal or external things, and prompted [*solicitaretur*] to take this motion as the need arises. (219/291–2)

[88] For a very thorough treatment of Boyle's attitude towards occasionalism and the alternatives, see Peter Anstey's account (1999). Anstey attributes to Boyle a variation of the concurrentist position ascribed to him by Timothy Shanahan (1988), in which God's "incessant concourse" is required on the occasion of each collision between bodies in order to maintain the laws of nature by "particular volitional acts", a position Anstey dubs "nomic occasionalism" (75).

Of course, not all such impediments can be avoided; so Nature "contrives a way in which Machines are able to produce others of a nature similar to themselves": hence their organs of reproduction, to go along with the organs of nutrition and excretion, necessary for the maintenance of force and jettisoning of parts whose force has been exhausted, and the necessary means for self-movement. So, Leibniz concludes, by considering the "end of nature"—the purpose of living things in God's providential plan—"we have at once the origin of three *functions*, to wit, *vital*, *animal*, and *genital*" (219/292).

There are two important things to note about this argument. First, the notion of power or *motive force* Leibniz is appealing to here is not mechanical impulse, as in the efficient cause explanations favoured by his contemporaries, but rather a notion of power as an enduring and inherent ability to bring about effects. Leibniz is explicit about this, both in *The Human Body is a Sort of Machine* and in the preface to the *Elementa physicae* (A VI iv 1989/LLC 235). It is premised on his recent discovery that "force is one thing, motion quite another" (Pasini 1996, 223/Smith 2011, 295). All machines have such a motive force, but only machines of nature are able to sustain it in the cause of their own self-perpetuation, and that of the species. Second, Leibniz is availing himself of a *teleological* argument to derive the properties organic bodies must have in order to serve the purpose of divine providence. Although, he cedes, it may be "difficult to determine the purpose of Nature before the event" (218/290), it is possible to do so after the event. Boyle, like Sennert before him, had posited seeds or seminal principles as the vehicles through which God's design for Nature could be brought about. These seeds, Leibniz proposed, must be machines able to conserve their force by extracting it from their environment as they discard parts that no longer serve the machine's function.

Regarding the first point, motive force is estimated from the quantity of the effect. Now "the power of the effect and of the cause are equal to each other", Leibniz reasons, "for if the effect were greater we would have a mechanical perpetual motion, if less, we would not have physical perpetual motion" (A VI iv 1989/LLC 235). This alludes to Leibniz's discovery of the conservation of *vis viva* earlier in the same year (1678). Using his new principle of the equipollence of cause and effect, and equating force with the ability to bring about a definite effect, Leibniz had shown that force could not be identified with impulse (proportional to the quantity of motion), otherwise the effect could be made greater than the cause, and perpetual mechanical motion would be possible. But some ability to do work (energy) is always lost to friction, necessitating either an external intervention to replenish that energy, as in artificial machines, or the ability to sustain it from within, as in living systems.[89]

There is thus a crucial link between Leibniz's discovery of the correct measure of force and his reinstatement of substantial forms, as we will explore further in Chapter 5. For not only is the quantity of force conserved in all elastic collisions, the agency of the

[89] This may be seen as a partial anticipation of Schrödinger's argument in "What is Life?" See Nachtomy (2011, 61–2).

conservation of force is found in the existence of living organisms, which conserve their force by means of a constant change of the constituent parts of their organic body and redistribution of motions within it. Animal bodies are "*Machines of perpetual motion*", Leibniz writes in *Corpus hominis*, "comparable to a certain determinate and singular species of perpetual organic motion that must always be conserved in the world" (Smith 2011, 291). They are "so well apportioned and resistant to all accidents that it is impossible to destroy them" (*Nouveau Système*, 1695; GP IV 482/L 456). It is through the artful design by which they remain the same thing despite their infinite complexity that they are distinguished from any man-made or accidentally constituted machine. Consequently, they are as everlasting as the substantial form within them that constitutes their principle of unity. These animated bodies, and not atoms, are the temporal continuants that God made in Creation in order to carry out his divine plan through their own agency.

Regarding the second point concerning teleology, Leibniz has argued that these living beings must have a power within them capable of bringing about future states that are desired as necessary for their survival, and this in turn requires them to have some way of representing means for and threats to their survival, as well as a tendency to act towards bringing about some future state. For bodies, insofar as they are merely material, are constituted by their *present* state, and have nothing in them to make reference to a future state.

Boyle makes this very point himself, in the course of objecting to the view of proponents of the plurality of forms that one form prepares the matter for the introduction of another (more noble) form to which it then becomes subordinate. He can see how, if the subordinate form were material, this preparation of matter could be achieved through the action of a body's various component fluids and organs. "But," Boyle objects,

> it seems not to me so easie to conceive, how a Substance distinct from Matter, (for such both [Sennertus] and they make their substantial Forms to be) can properly be said to have its capacity confounded with that of the Matter. . . . For bodies are what they are by the Matter and modification that do for the *present* constitute them, whatever they may prove to be in the *future*, and tis extra-essential to the Form that is said to be *previous* that it is to be succeeded by another that is said to be more noble. (Boyle 1667, 305–6)

The difficulty is that bodies, considered merely in terms of shape, size, and motion, are what they are at any given time, and are not constituted at that time with respect to what they might become in the future. For Leibniz, it is precisely because a material form can only constitute the present state of a substance that it is necessary to appeal to an immaterial form, a law from which the future states of a substance would follow from its present state, and tend towards greater perfection. As we have seen, Boyle had dispensed with the distinction between entities that are *una per se* and those that are *entia per accidens*, assimilating the former to machines and dismissing the distinction as unneeded metaphysics. But without a nature, an internal principle which determines all its future states, Leibniz argues, there is no substance to a machine, only a succession

of motions of parts accidentally contributing to a system of motions. Regarding the need for incorporeals, he wrote in the preface to the *Elementa physicae* of 1678, "There happen to be certain things in body which cannot be explained by the necessity of matter alone. Such are the laws of motion which depend on the metaphysical principle of the equality of cause and effect." This in turn, he notes, indicates the need for "a soul, ôr a kind of form", without which "a body would not be one entity, since no part of it can be assigned which would not again consist of further parts, and so nothing could be designated in a body which could be called *this something* or *a unity*".[90] If it is agreed that machines are defined by reference to final cause, then the final cause of an organic machine must be identified with God's providential design for that individual. But there is no agent in a Boylian machine to enable it to act towards its own ends. By the above argument, however, Leibniz has established that in order to act towards those ends, a machine of nature must have its own force within it, as well as something akin to an appetition, a tendency to work towards those ends, and something akin to perception, whereby it might represent to itself the changing things around it, especially those needed for its own survival.[91]

Leibniz sees nothing in these features of living things to derogate from the fact that their bodies are machines, and that everything material about them will be explicable in terms of shape, size, and motion. He is quite prepared to grant Boyle that the distinction between an *unum per se* and an *unum per accidens* is metaphysical. It will not be possible to determine with any certainty whether some particular body is the organic body of a living being, or merely an extraordinarily well-contrived machine, and this will make no difference to its mechanical operation. But it makes all the difference to the constitution of the physical world if that depends on there being such enduring existents, with their own final cause determinations, and from a consideration of which, he believes, the laws of mechanics can be derived. Final cause explanations, he argues, complement efficient cause explanations.

One of Leibniz's first articulations of this thesis of complementarity is given in his introduction to the *Elementa physicae*, of 1678–9. There he insists that "every effect has a final as well as an efficient cause—final, because everything that happens is done by a perceiving being, and efficient because everything that happens naturally in a body takes place through the corporeal organ and the laws of bodies" (A VI iv 2008/L 288). This means that two kinds of explanation are possible, parallel to one another and mutually compatible. Mechanical explanations resolve confused attributes into the

[90] A VI iv 1988/LLC 233–5. A very similar point has recently been made by Terence Deacon (with no knowledge of Leibniz's philosophy of biology) in his *Incomplete Nature* (2012): "The life of an organism is not resident in its parts. It is embodied in the global organization of the living process. Moreover, the so-called parts that analysis produces—the individual molecules, organelles, cells, tissue types, and organs—are not parts in the sense that machine parts are" (Deacon 2012, 135).

[91] "*For this perpetual motion it will have been necessary for the animal to have been able to conserve its forces, to move towards those things that are fitting for its usage and avoid those contrary to it, to judge which are such, and finally to propagate its species*" (*Corpus hominis*; Pasini 1996, 219/Smith 2011, 291).

distinct attributes dealt with by mathematics, but non-mathematical distinct attributes, including final causes, are drawn from metaphysics:

> Mathematical science provides magnitude, figure, situation and their variations, but metaphysics provides existence, duration, action and passion, the force of acting, and the goal of action or perception of the agent. Hence I believe that there is in every body a kind of sense and appetite, ôr soul, and therefore that to attribute a substantial form and perception or soul to man alone is as ridiculous as to believe that everything has been made for man alone and that the Earth is the centre of the universe. (A VI iv 2010/L 289)

This emphasis on final causes is of course connected with Leibniz's "Platonist turn" in 1676 discussed above. The appeal to forms in things is not to be understood materialistically, as Gassendi had tried to do. Whatever can be explained mechanically will be explained mechanically without any reference to substantial forms. These will be the accidental forms of bodies, explicable in terms of the extension, size, shape, and motion or corpuscles, subject to mechanical laws. But without any enduring forms, there is no self-identical subsisting thing of which these configurations can be accidents. Moreover, as we shall see in Chapter 5, what cannot be explained mechanically are the laws of mechanics themselves. Still, Leibniz insists, once general mechanical laws have been inferred from metaphysical principles, "it is . . . improper to revert to souls or substantial forms everywhere" in explaining particular natural phenomena:

> For the action of the soul is determined by the state of the organ of the soul and its object, and the operation of God by the conditions of the individual things, and this indeed not by the necessity of matter but by the impulse of the final cause or of the good. (A VI iv 2010/L 289)

Let me now summarize the argument of this chapter. Leibniz's metaphysics, I contend, can clearly be seen to be deeply conditioned by its gestation in this tradition of the plurality of forms. As we have seen, even in his earliest writings he identifies the substantial forms of all bodies, not just living beings, as immaterial principles of motion and rest—already in opposition to Gassendi and those scholastics who made only the rational soul of man immaterial. Identifying these immaterial principles with minds, he sees the possibility for a rapprochement between Aristotle and the mechanical philosophy. Accidental forms are always geometrical arrangements of bodies, and are produced by motion, whose principle is mind. Thus all particular phenomena are explained in terms of shape, size, and motion, but mind is the principle of generation of these forms. (The concurrent mind of non-living bodies is God himself, although this concurrent mind differs in each individual body.) Here the way in which mind is supposed to generate motion is left vague: it is somehow associated with a whirl or vortex. This is made more precise in phase 2 of Leibniz's metaphysics, where, under Hobbes' influence, he conceives these minds as enduring beings whose instantaneous states are incipient motions or Hobbesian endeavours. Mind is located in an unextended and therefore indivisible point, surrounded by an atomic core. Minds can therefore branch by division in keeping with Sennert's interpretation

of traduction as a multiplication of forms. But in 1676, after various attempts to account for mind's ability to make matter cohere by its associated vortex, Leibniz comes to see that these attempts involve a category mistake. The unity and multiplicity of minds or forms should not be explicated in terms "taken from the category of quantity, but rather from the category of substance". That is, something remains self-same because substance is metaphysically indivisible, not because its body is physically indivisible, atomic.

The pluralist foundations of Leibniz's metaphysics become more evident, in fact, once he abandons atomism. Having replaced atoms by the actually infinite division of matter into Baconian folds, flexible but actual parts of bodies, he conceives their actuality and plasticity as being due to their containing forms, in agreement with the pluralist doctrine of subordinate forms. Leibniz finds empirical evidence for this hierarchy of forms in the microscopic observations of Hooke, Kircher, Malpighi, and Leeuwenhoek, which seem to reveal living organisms at every level of magnification. Only, on his interpretation of the hierarchy of forms, there is no "bottom level" of division, neither a primary matter devoid of forms, as in orthodox Aristotelianism, nor form-containing atoms of the four elements, as in Sennert. Bodies, as in Boyle's philosophy, are machines. Organic bodies, however, are machines of nature, machines whose parts are also either themselves organic bodies of other living beings, or aggregates thereof, to infinity. They are distinguished from mere artefacts both by this infinite constitution and by their possession of a substantial form: each organic body is the body of a substance or *unum per se*, other bodies being mere aggregates or *entia per accidens*. These organic bodies, moreover, play the role played by the *semina* in the philosophy of various of his predecessors and contemporaries. They, together with their immaterial forms, are everywhere in matter, and immanent in things from the Third Day of Creation.

Leibniz's allegiance to the pluralist doctrine of forms is not explicitly acknowledged by him. But there are many indications of it in his mature writings. It manifests itself most obviously in the doctrine of subordinate and dominant monads, where the monads are entelechies associated with their own organic bodes, and the subordinate forms contribute teleologically to the goals of the dominant one, as in Scaliger and Sennert.[92] But the idea that the entelechies are what actualize the parts of these bodies is less obvious. It can be seen, for example, in his correspondence with Burchard De Volder, who maintains that the parts of matter are distinguished only modally. Leibniz reiterates his insistence that matter is actually infinitely divided, and adds: "Nor do the parts of matter differ only modally if they are distinguished from one another by souls and entelechies, which always persist" (to De Volder, 3 April 1699; GP II 170/LDV 73). When De Volder counters that he ascribes all the variety in bodies to motion alone, making the distinction among their parts modal rather than substantial (1 August 1699; GP II 188/LDV 115),

[92] For a sketch of some of the differences between the pluralist doctrines of Scaliger, Sennert, and Leibniz, see Blank (2011, esp. 127–8).

Leibniz responds: "Although I too ascribe all the variety of bodies to motion (including under that the causes of motion), I nevertheless acknowledge a substantial distinction among the parts of matter" (1 September 1699; GP II 194/LDV 129). And when De Volder asks in the same letter whether an animated body has an entelechy distinct from its soul, Leibniz points out that he is asking "about the animated body as a whole and not about its separately animated parts". He responds:

> I reply that such a body does not have another entelechy apart from the soul and the entelechies of the separately actuated parts; but that there would not be a soul of the whole body apart from the soul of a separately animated part unless it were at the same time a soul dominating in the whole on account of the structure of the whole. (GP II 194/LDV 129)

These replies make clear that he is thinking of the actual parts of matter as substantially distinguished by their containing entelechies, that the entelechies in these parts animate them and actuate them (thereby making actual the matter of which they are parts), and that the entelechies in an animated body are subordinate to a dominant form or soul.

Leibniz's challenge in the late 1670s was to make sense of the idea of a substantial form as an enduring principle of activity in bodies. For scholastics like Sennert this activity consisted in the action of the immaterial form on matter in the generation and development of organisms and minerals. This, Leibniz agreed with Boyle and the Cartesians, is unintelligible: there can be no action of an immaterial being on matter. On the other hand, however, bodies as conceived in the mechanical philosophy are purely passive, and incapable of acting or carrying out actions towards any ends. This is why an appeal to forms was necessary, even if the individuating, the acting towards an end, and the sustaining of the same substance in being, operate in the metaphysical rather than physical domains of explanation. What he needed in 1676, and found within a little over a year after arriving in Hanover, was an account of substance and its operations that was compatible with mechanism, but which supplemented it with a viable account of action. It is this line of reasoning that leads him to his dynamics and the conservation of force, as we shall see in Chapter 5.

5

Motion, Relativity, and Force

> "Thus action in a body cannot be conceived except through a kind of aversion. If you really cut to the quick and inspect every single moment, there is no action. Hence it follows that proper and momentaneous actions belong to those things which by acting do not change."
>
> (A VI iii 566)

> "There is nothing real in motion but that momentaneous thing which must be constituted by a force striving towards change."
>
> (*Specimen Dynamicum*, GM VI 235)

We have seen how in the 1670s Leibniz already considered substantial forms to be the principles of individuation of bodies. But the key to rehabilitating them fully was to show how they could function as principles of activity within bodies. In Leibniz's conception, such principles would be the *sources* of bodies' motions, and they would also constitute the *natures* of bodies, the idea being that a proper characterization of the nature of bodies would enable a derivation of the laws of motion. In his attempts to define such principles, Leibniz took the reality of motion to be an obvious fact of experience, but one that needed justifying in the face of various sceptical arguments, pre-eminently those stemming from difficulties associated with the composition of the continuum. This was the case from the outset. In his *TMA* Leibniz took the reality of motion as a premise in his argument for unextended and indivisible beginnings in any part of a physical continuum. As we shall see in section 5.1, even after he had rejected the existence in the continuum of such indivisibles in 1671–2, he continued to argue that the infinitely small (now extended) parts of a body are determined by a corresponding endeavour, or infinitely small motion. The endeavour is the instantaneous effect of mind as the principle of motion, and its conservation is assumed to underwrite the conservation of quantity of motion.

It is only after he has formulated the differential calculus in the spring of 1676 that Leibniz comes to the realization that endeavours should not be conceived as actually infinitely small parts of the continuum, but as arbitrarily small, finite motions. But this throws his understanding of the metaphysics of motion into a crisis, in which he reverts to a prior understanding of motion, now subtly reconceived, as a "transcreation" of a body by unassignable leaps between the assignable instants in motion, with God as the

sole cause of its continuance. Other factors are in play here in Leibniz's appeal to God as the guarantor of motion, as we shall see in section 5.2, notably his realization that he cannot ground the laws of motion geometrically, and the realization that the relativity of motion makes it impossible to assign a subject of motion if motion is conceived purely geometrically. The assignment of a subject of motion requires the consideration of causes, and this leads Leibniz to develop his dynamics, as discussed in section 5.3.

True motions are distinguished from merely apparent ones by appeal to the most intelligible hypothesis, which allows one to assign the causes of the changes of the phenomena in question. Although there will always be corresponding changes in all coexisting things, the reason for the change is located in the subject, which can correspondingly be said to act. Here the overarching principle that the full cause must be equivalent to the entire effect leads Leibniz to identify the true measure of motive force as equivalent not to impetus or quantity of motion (mv), but to living force (mv^2), which is conserved in every isolated body or system of bodies. Thus what is real in motion is a force that is intrinsic to bodies. On the one hand this is manifested phenomenally in derivative active force, to wit, the various instantaneous forces in bodies, whether dead (such as the centrifugal and elastic forces) or living force; on the other hand, the primitive active force contains the reason for the continuation of the motion, and is thus the ground for the laws governing the motions of bodies, such as the conservation of quantity of relative motion and of living force (energy). This primitive active force is therefore identified by Leibniz as the form of an organic body in the sense of its "principle of motion and rest": it is the indivisible thing in bodies responsible both for what is real in motion at any instant, and also for the continuity of the changes constituting it.

Evidently this is a tangle of issues of daunting complexity. The surest way to proceed will be to follow Leibniz's own path through his labyrinth as he struggles to identify how to construe the *principle of activity* he is convinced is in each enduring thing, in such a way that it is consistent with the mechanical philosophy. This is the Ariadnean thread we will follow in this chapter. It will take us through Leibniz's foundation of motion on the notion of endeavour in section 5.1, and in section 5.2, a discussion of the problems with this foundation that lead him to return to a species of occasionalism in 1676. Then in section 5.3 we will see how Leibniz finds his own Ariadnean thread in what he calls "the calculation of powers", using his Principle of Equipollence to found his dynamics around his new notion of force. Now the substantial form that he has taken as the principle of individuation, and also the principle of motion and rest, becomes primitive active force.

5.1 Endeavour as the Foundation of Motion

Leibniz does not often refer to Zeno's paradoxes. When the Achilles paradox is brought to his attention by his friend the Academic Sceptic Foucher in 1692, he replies lightheartedly:

> Never fear, my dear sir, the tortoise which you Pyrrhonians make go as fast as Achilles. You are right to say that "all magnitudes can be divided to infinity, there is none so small that one could

not conceive an infinity of divisions in it that will never exhaust it." But I do not see what harm will come of that, nor what need there is to exhaust them. A space divisible without end is traversed in a time also divisible without end. (to Foucher, January 1692; GP I 403)

Here he invokes the solution of Father Gregory of St Vincent, who, he says, showed how to sum infinite series in geometric progression, and on this basis showed "how Achilles must advance beyond the tortoise, or in what time he should catch the tortoise if it had a head start". Thus, against Foucher's derivation of indivisibles using this argument, he concludes: "I cannot at all conceive physical indivisibles (without a miracle), and I believe that nature can execute every littleness that geometry can consider" (GP I 403).

But as we shall see, Leibniz had not always been so sanguine about the relevance of Zeno's paradoxes to proving the existence of physical indivisibles, nor to their bearing on the reality of motion. For in his *TMA* he had used an inverted form of Zeno's dichotomy paradox to prove that the reality of motion entails unextended and indivisible beginnings in any part of a physical continuum, which contains an infinity of such actual parts. So let us turn to a consideration of that.

We are no longer in possession of Zeno's original statement of the dichotomy, and Aristotle assumes familiarity with the original in his terse references to it. Of Zeno's four arguments against motion, he writes, "The first says that there is no motion, because the moving body must reach the midpoint before it gets to the end" (*Physics* 239b 11); "we should make the same response to anyone who uses Zeno's argument to ask whether it is always necessary to traverse half the distance first, and points out that there are infinitely many half-distances" (*Physics* 263a 4).[1] The Neoplatonic commentator Simplicius gives us a more complete rendering of Zeno's reasoning as follows:

If there is motion, the moving object must traverse an infinity in a finite [time]; and this is impossible. Hence motion does not exist. He demonstrates his hypothesis thus: The moving object must move a certain stretch. And since every stretch is infinitely divisible, the moving object must first traverse half the stretch it is moving, and then the whole; but before the whole of the half, half of that, and again, the half of that. If then these halves are infinite, since, whatever may be the given [stretch] it is possible to halve it, and [if, further] it is impossible to traverse the infinity of these stretches in a finite time…it follows that it is impossible to traverse any given length in a finite time.[2]

That is, in order for a body to move from *a* to *b*, it must first reach the halfway point *c*, and before that the midpoint of that subinterval *d*, and so on *in infinitum* (Figure 5.1). Therefore no finite stretch can be completed if an infinity of its subintervals cannot be.

[1] Aristotle also refers briefly to the paradox at *Topics*, 160b 7 and *Physics*, 233a 21. All four passages are given by Gregory Vlastos in his (1968, 22–3, 29). Michael White (1992) and Samuel Levey (1999) and (2012), have given insightful analyses of Leibniz's treatment of the dichotomy which the reader should consult for important points I have left untreated here.

[2] *Phys*ics, 1013, 4ff.; also quoted from Vlastos (1968).

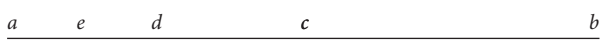

Figure 5.1 Zeno's dichotomy

Here we may take the reference to a finite time to be inessential to the gist of the paradox, for we can agree with Aristotle that if the body moves at a constant speed, the time will be divisible into just as many subintervals each of which is in the same proportion to the corresponding subintervals of the distance (*Physics* 263a 4–10). As Leibniz reports to Foucher, Gregory utilizes this insight together with his geometrical summation of the series to resolve the paradox. But the paradox still has bite, for, since a half of each subinterval must be traversed before the whole of it, by dichotomy *in infinitum*, there is no beginning of motion in any extended subinterval of time, so there is no assignable time at which the motion can begin. Therefore there is no motion.

Leibniz appears to recognize this, at least when he writes the *TMA* in 1670–1. For there, in the *Fundamenta praedemonstrabilia* (A VI ii N41), he provides a very similar argument to Zeno's in which he too asserts that any motion must have a beginning. But he assumes that there *is* motion, and by this means *inverts* the dichotomy to establish the reality of the beginnings (Figure 5.2). This is the first avatar[3] of what I call Leibniz's Inverted Dichotomy:

(4) *There are indivisibles ôr unextended things*, otherwise neither the beginning nor the end of a motion or body is intelligible. This is the demonstration: any space, body, motion and time has a beginning and an end. Let that whose beginning is sought be represented by the line *ab*, whose midpoint is *c*, and let the midpoint of *ac* be *d*, that of *ad* be *e*, and so on. Let the beginning be sought to the left, on *a*'s side. I say that *ac* is not the beginning, since *dc* can be taken away from it without destroying the beginning; nor is *ad*, since *ed* can be taken away, and so on. Therefore nothing from which something on the right can be taken away is a beginning. But that from which nothing having extension can be taken away is unextended. Therefore the beginning of a body, space, motion, or time (namely, a point, an endeavour [*conatus*], or an instant) is either nothing, which is absurd, or is unextended, which was to be demonstrated.

(A VI ii 264/LLC 339)

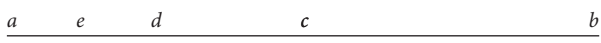

Figure 5.2 Indivisibles in the continuum

There is much to say about this argument, but I shall try to restrict myself to what is relevant here. First, to state the obvious: body, space, motion, and time are all continua, which is why Leibniz represents them by a line. Second, like Ockham before him,[4]

[3] My use of the term 'avatar' alludes to the fine essay by Jorge Luis Borges, "Avatars of the Tortoise" (Borges 1964, 202–8). Borges takes the Achilles for his paradigm (although he notes that the mechanism for the Dichotomy is almost identical), and traces its avatars through Aristotle, Hui Tsu, Aquinas, Lotze, Bradley, and James.

[4] Philip Beeley (1996, 56–66) has drawn attention to Ockhamist precedents of Leibniz's doctrine of actually infinite division.

Leibniz insists that the continuum is not merely infinitely divisible in this way, but *actually infinitely divided*. Thus Aristotle's way of refuting Zeno's dichotomy paradox by saying that the subintervals and divisions are alike merely potential (*Physics* 233a 26–31/LLC 350) is precluded for him. Third, the "points" or "indivisibles" mentioned here are not to be confused with Euclidean points. Euclid defines a point as "that which has no part" (*Elements*, Book, Def. 1); Leibniz calls a point in this sense a *minimum*, and claims that there are no minima in either space or body.[5] As Leibniz defines it in the *TMA*, however, a point is an *unassignable* (*inassignabile*), i.e. something "smaller than can be expressed by a ratio to another sensible magnitude unless the ratio is infinite" (A VI ii 265/LLC 340). Fourth, these unassignables may nonetheless stand in a finite ratio to one another. The endeavours in a given instant of two unequal motions will be in the ratio of the motions themselves; and the respective points traversed by the moving bodies in that instant will be in the same proportion.[6] Fifth, he is not explicit about whether these indivisibles or points compose to form the continuum resulting from the motion. Traditionally, geometers had either rejected the generation of a line through the motion of a point as not properly geometrical, or had seen this conception as an advantage precisely because it avoids the problems of the composition of the continuum. It seems likely that Leibniz took the latter view.[7] Sixth, Leibniz sees the proof of indivisibles as crucial to "the true distinction between bodies and minds" (A VI ii 266/LLC 341): for "thought consists in endeavour, as body consists in motion" (A II i 173), and since endeavour cannot last in a body for more than a moment, the mind of a body is momentary, as opposed to true minds, which are able to sustain and compare endeavours.[8]

To recap: Zeno had argued in his Dichotomy that since one could not move across any interval without first crossing the first half of this, and before this the first half of this, ad infinitum, there can be no beginning of any motion; therefore motion is impossible. Leibniz inverts this reasoning, arguing that since motion is real and must therefore have a beginning, and since (by the Dichotomy) this beginning cannot be found in any extended subinterval of the continuum, each and every subinterval of

[5] The idea of indivisibles as beginnings of lines is reminiscent of the doctrine that Aristotle ascribes to Plato: "Plato even used to fight against this class of things [sc. points] as being something that geometers believed in, whereas he called indivisible (*atomoi*) lines the origin of the line, and this he often postulated" (*Metaphysics* I 9, 992a19–22); quoted from Sorabji (1982, 47). Whether Leibniz is knowingly advocating a Platonist position here is an intriguing question.

[6] The comparability of the indivisibles is guaranteed by their being generated in equal instants by moving points with proportional velocities (A VI ii 266). Following Hobbes, Leibniz correctly discerns the similarity with Cavalieri's method of indivisibles, where only indivisibles generated by the *transitus* or passage of the same *regula* may be compared. For the latter, see Giusti (1980) and Andersen (1985).

[7] In some of my publications I have inferred or assumed that the composition of the continuum from indivisibles is implicit in Leibniz's calling them parts (see LLC, xxxii–xxxiv) (Arthur 2009, 22; 2014, 83). But Federico Raffo Quintana (private correspondence, November 2014) has persuaded me that I was probably correct to have resisted this inference in other publications, citing Arthur (2001a) and Arthur (2003b).

[8] For an extended discussion of these aspects of Leibniz's thought, see Garber (1982).

the continuum must have an unextended beginning. (The same argument will apply to body, time, and space, assuming they are real.)

An important corollary of Leibniz's inversion of Zeno's dichotomy is that every continuum must contain an actual infinity of unextended beginnings (endeavours, points, or instants). That is, these beginnings do not just mark potential cuts in the continuum, as they would if it were merely potentially or indefinitely divided, but instead constitute actual divisions in the continuum. Although Leibniz does not claim that the continuum is composed of these indivisibles, he does claim that this allows him to represent motion as truly continuous: "Motion is continuous, i.e. not interrupted by any little intervals of rest" (A VI ii 265/LLC 340).

The significance of this remark is that Leibniz himself had formerly embraced just such a theory, according to which "a slower motion is one interrupted by small intervals of rest".[9] In his unpublished *De rationibus motus* of 1669 Leibniz had written "Whatever moves more slowly does so because of several little intervals of rest (*quietulas*) interspersed. What moves more quickly does so because of fewer. A little interval of rest is an existence in the same place for a time smaller than any given" (A VI ii 171). Such a doctrine had been propounded by Arriaga and promoted by Mersenne and Gassendi as the soundest way of solving the problem of how one continuous motion can be faster than another. But what is novel in Leibniz's wording is his characterization of an interval of rest as an existence for a time "smaller than any given", which he explicitly distinguishes from moments or instants in the rigorous sense of points or true minima of time. This contrasts with Gassendi's view, for whom the duration of such a *quietula* would be the smallest time into which a given interval could be physically divided, a "physical point" of time, extremely small, insensible, but finite. The physical continuum is thus, for Gassendi, in fact a discontinuum, even if the discontinuity is not discernible by the senses.[10] But for Leibniz "things which collide remain in the same place for a time smaller than any given, yet for longer than a moment" (A VI ii 171). A quantity smaller than any given, as we have seen, is what Leibniz calls an "unassignable" or infinitely small quantity.

The theory outlined in *De rationibus* seems to be of a piece with the theory of motion that Leibniz describes with pride to his former teacher Jakob Thomasius in a letter of the same period:

> Nothing must be supposed in bodies which does not flow from the definition of extension and antitypy. But only magnitude, figure, situation, number, mobility, etc. flow from them, whereas motion itself does not. Hence, properly speaking, there is no motion in bodies existing as a real

[9] The quotation is from Leibniz's dialogue *Phoranomus* (1689), where he testifies that he subscribed to this doctrine in his youth. Here I demur from what I wrote in the introduction to LLC (see n. 7 above), where I imply that Leibniz only came to reject the composition of the continuum out of *inassignabilia* in his *De minimo et maximo* of winter 1672–3. One should note, however, that Leibniz does explicitly uphold such a composition in his *Demonstratio substantiarum incorporearum* of autumn 1672, albeit in a cancelled draft (A VI iii 74, 79–81/LLC 2–5).

[10] See LLC, Appendix 2c for a selection of relevant passages from Gassendi's works.

entity in them, but as I have demonstrated, whatever moves is continuously created, and bodies are something at any instant assignable in a motion, but are nothing at any intermediate time between the instants in an assignable motion—a view unheard of till now, but one that is plainly necessary, and that will silence the voice of the atheist.

(30 April 1669; A II i 23–4/L 102)

The theory of continuous creation is not what is novel here: both Leibniz and Thomasius would have been perfectly well aware that Descartes (and many others, such as Erhard Weigel, Leibniz's teacher in Jena) had proposed such a view. The originality lies in the interpretation of motion as consisting in a body being created in a given location at an assignable time, and then lapsing into non-existence "at any intermediate time between the instants in assignable motion". These times between assignable instants must then be *inassignabilia*, unassignable. They therefore correspond to the *quietulae* of *De rationibus*, the little intervals of rest in the same place for times smaller than any given. If this reading is correct, Leibniz conceives of a body's motion to consist in its being created at each assignable instant, and to be non-existent for the unassignable intervals between the instants. Thus creation will be continuous, in that there will be no assignable time at which the body is not being created at a different place; yet motion will be "metaphysically discontinuous" (to use Leibniz's own later term for this), in the sense that it does not continue to exist beyond the instant at which it is created, even though its non-existence during this period will be unassignable.

A possible objection to identifying the theories of motion given in the above two passages from 1669 is the discrepancy between the claim in the *De rationibus motus* that the body is "in existence" in a little interval of rest for an unassignable time between instants or moments, and the claim in the letter to Thomasius that a moving body is "nothing" during such a time. But this discrepancy is removed when one takes into account Leibniz's belief that matter "is nothing if it is at rest". As he argued explicitly in another fragment of this period, dated winter 1670–1, "*Primary matter is nothing if it is at rest*. . . . There is a demonstration of this. For whatever is not sensed is nothing. But that in which there is no variety is not sensed" (A VI ii N423/LLC 344).

Leibniz's remark in the *TMA* that motion is "continuous, i.e. not interrupted by any little intervals of rest" (A VI ii 265/LLC 340) must therefore be taken as a repudiation of this earlier theory. In fact, what he takes exception to in the *TMA* is precisely the claim that motion will not continue beyond the instant at which it is created. "For", he writes, "once a thing comes to rest, it will always be at rest, unless a new cause of motion occurs" (265/340). Thus his former theory is contradicted by (what we call) the law of inertia, as articulated by Hobbes in *De Corpore*.[11] Moreover, in the *TMA* Leibniz

[11] See Hobbes, *De corpore*, 8.19: "*whatsoever is moved, will always be moved, except there be some other body besides it, which causeth it to rest.* For if we suppose nothing to be without it, there will be no reason why it should rest now, rather than at another time; wherefore its motion would cease in every particle of time alike; which is not intelligible" (Hobbes 1655; quoted from Hobbes 1839). Hobbes is here demonstrating what Leibniz calls "that celebrated axiom of philosophers, already employed by Aristotle: *Whatever is once set in motion will always move in the same way unless it meets with an obstruction*" (A VI iii 568/LLC 215, 409 n. 59). The statement in italics is a quotation from Aristotle's *Physics* (215a

no longer has a need for unassignable gaps between instants. The instants become the unassignables, or times smaller than any given, and there are no such things as instants in the strict sense of absolutely minimum times (*Foundation* 14). Every interval is a part of the continuum, and every part of such an interval is bounded by unassignables as its endpoints, so that every interval contains infinitely many unassignables. But there are no minima, that is, no partless points or instants.

But at this juncture we must raise a question of consistency. If Leibniz's *inassignabilia* are the endpoints of intervals, what arguments can he give against minima that would not also apply to his indivisibles? In the *TMA* Leibniz rejects minima ("things which have no magnitude or part") on two grounds: first, such things would "have no situation", "since whatever is situated somewhere can be touched by several things simultaneously that are not touching each other", something impossible for such partless points; and second, "a minimum cannot be supposed without it following that the whole has as many minima as the part, which implies a contradiction" (A VI ii 264/LLC 339). The first objection might well have been taken straight from Plato's *Parmenides* (138a); I will not comment further on it here.[12] But the second, as we shall see, depends not on whether the points have any internal structure, but only on the fact that they are endpoints of subintervals of a line. Thus, since this is an essential feature of Leibniz's indivisibles in the *TMA*, it should preclude them too.

Leibniz appears to have realized this in late 1671, as recounted in Chapter 1. So when he comes to lay out this second argument against minima explicitly in a piece written in Paris two years later (*De minimo et maximo*, November 1672–January 1673) he argues that it will indeed rule out indivisibles just as surely as minima: "*There is no minimum, ôr indivisible, in space and body*" (A VI iii 97/LLC 9) is the title of this section. The argument's main premise is that each point contained in a line may be conceived as the endpoint of another line cutting it there: "every indivisible point can be understood as the indivisible boundary of a line" (97/9). From this and the fact that any given line *ab* can be indefinitely divided, it follows that "if there is [an indivisible] in the line *ab*, then there will be one in it everywhere" (97/9). If this is so, however, there will be as many points in the diagonal of a square as in one of the sides, since parallel lines can be drawn through them. But it can also be established that there are as many points in the side *ab* as in a segment *ai* of the diagonal of the same length as *ab* (97/11). Now,

> since there are as many points in *ai* as in *ab*… and as many in *ab* as in *ad*, as has been shown, there will be as many indivisible points in *ai* as in *ad*. Therefore there will be no points in the difference between *ai* and *ad*, namely in *id*, which is absurd. (97–8/11)

The upshot of this argument is that a line cannot be regarded as constituted from indivisibles if these are conceived as indivisible boundaries of lines.

19–22). Thus Leibniz is aware that Hobbes is following Aristotle, not Descartes. See Daniel Garber's erudite discussion (Garber 2016).

[12] See Owen (1970) for a discussion of the impact of this argument on Aristotle's treatment of points and lines in his *Physics*.

Nevertheless, this does not rule out infinitely small elements in the continuum if they are not considered as indivisible endpoints. In the interpretation of Cavalieri that Leibniz had learnt from Hobbes, the points of a line are proportional to the endeavours or "beginnings" of the motion that generates that line. The inverted dichotomy can therefore still be applied to establish such beginnings of motion, but the beginnings can no longer be conceived as unextended, as in the *TMA*. Indeed, immediately after the above proof in *De minimo et maximo*, he reiterates his Inverted Dichotomy to prove the existence of infinitely small beginnings of lines and motions (Figure 5.3):

There are in the continuum certain [things] that are infinitely small, i.e. infinitely smaller than anything given that can be sensed.

First I show this for the case of space as follows. Let there be a line *ab*, to be traversed by some motion. Since some beginning of motion is intelligible in that line, so also will be a beginning of the line traversed by this beginning of motion. Let this beginning of the line be *ac*. But it is evident that *dc* can be cut off from it without cutting off the beginning. And if *ad* is believed to be the beginning, from it again *ed* can be cut off without cutting off the beginning, and so on to infinity.

For even if my hand is unable and my soul unwilling to pursue the division to infinity, it can nevertheless in general be understood at once that everything that can be cut off without cutting off the beginning does not involve the beginning. And since parts can be cut off to infinity (for the continuum, as others have demonstrated, is divisible to infinity), it follows that the beginning of the line, i.e. that which is traversed in the beginning of the motion, is infinitely small. (A VI iii 98–9)

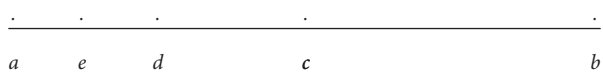

Figure 5.3 Infinitely small things in the continuum

Nevertheless, such an infinitely small beginning cannot be "something lacking a part" or "something smaller than which cannot be imagined, since this kind of thing has been shown to be impossible" (A VI iii 100/LLC 17). That is, if an infinitely small line is understood to be an indivisible beginning of a body (without taking motion into consideration), this leads to a contradiction, "since something can still be cut off from it, namely the difference between it and another infinitely small line that is still smaller than it" (100/17). Rather, the infinitely small must be defined through motion: there can be no "space in the nature of things distinct from body" and no "body distinct from motion".

[I]f a body is understood as that which moves, then its beginning will be defined as an infinitely small line. For even if there exists another line smaller than it, the beginning of its motion can nonetheless be taken to be simply something that is greater than the beginning of some other slower motion. But the beginning of a body we define as the beginning of motion itself, i.e. endeavour, since otherwise the beginning of the body would turn out to be an indivisible. Hence it follows that *there is no matter in body distinct from motion*, since it would necessarily contain indivisibles. (100/17)

The logic of this argument is not exactly pellucid. Although there are in the continuum certain infinitely small things, identified here as infinitely small beginnings of a body, such a beginning is not a line smaller than all other lines, that is, not one that is a least line or minimum. It is infinitely smaller than any given line that could be sensed, but not smaller than all lines, since there may be other infinitely small lines that are smaller still. As in the *TMA*, infinitely small constituents of the same order of infinity are comparable in size to one another (having the same finite ratio as do the generating motions that define them). Thus an infinitely small line is infinitely smaller than any finite line segment, bearing a ratio to such a quantity of 1 to ∞.

An unorthodox feature of the argument, however, is Leibniz's interpreting of all this in terms of bodies (albeit, bodies considered in abstraction from all other properties). This indicates that he is still close to Hobbes in the way he is conceiving geometry. To conceive a line as generated through the motion of a point, or a plane through the motion of a line, and so forth, is traditional. But Hobbes interpreted such generation of mathematical objects as a generation of physical objects in real time, subject to a certain abstraction away from all their particular characteristics, and in this Leibniz seems to be following his lead. This aspect of Hobbes' philosophy, it would seem, is part of its allure for Leibniz in the first place. It is through the notion of endeavour that bodies are connected with minds, and a purely geometrical physics is seen to be deficient without such an underpinning. In keeping with this, Leibniz proceeds in a crescendo of enthusiasm to the conclusions that "to be a body is nothing other than to be moved", that motion and body are nothing more than "being sensed by some mind", and that this requires "some mind immune from body, different from all the others we sense", namely God (A VI iii 100–1/LLC 17). What is essential here is Leibniz's insistence on the *ontological primacy of endeavour*: what is real in motion at an unassignable time is more fundamental than body itself. Body is nothing except insofar as it is defined by an endeavour; and space and time have no reality in themselves, in abstraction from the bodies and motions individuating them.

How, then, is body determined by motion? Without going into the details, the gist of the idea is that bodies are individuated by sharing a motion or endeavour in common. On the face of it, this is the same as Descartes' view, where a body is individuated by its own proper motion, so that all its parts, in sharing this motion, are relatively at rest (even though they may also possess differing proper motions of their own).[13] Similarly, according to Leibniz's theory:

> It is manifest that a body is constituted as definite, one, particular, distinct from others, by a certain motion or particular endeavour of its own, and if it is lacking this it will not be a separate body, but [there will be] one continuous body cohering with it by whose motion alone it is moved. And this is what I have said elsewhere, that cohesion comes from endeavour

[13] "By a 'body' or a 'part of matter' I understand everything that is transferred together, even though this may consist of many parts which have different motions relative to one another" (Descartes, *Principles of Philosophy*, II, §25 [1644]; AT VIIIA 53–4).

or motion, that those things which move with one motion should be understood to cohere with one another.[14]

The difference is that on Descartes' view mutual rest can be the cause of the cohesion, something Leibniz emphatically rejects. According to his theory, it is the endeavour of a given body to enter the place of another that is responsible for their cohering together as a continuous whole; for as it endeavours to enter, it will occupy a greater point, and therefore encroach on the other body.[15] Thus it is by virtue of occupying two places at once (its own and a vanishingly small part of the other body's place) that one body coheres with another.[16] Moreover, according to Leibniz no body is ever completely at rest, since all endeavours persist even when their observable effects are masked by the composition of motions.[17]

That this doctrine is no passing whim is shown by his appeal to it in an exchange with Malebranche in 1675. Malebranche, arguing in favour of the Cartesian identification of matter with extension, had tried to persuade Leibniz that an extended void would have distinct parts, which would therefore be separable and movable, and therefore be parts of matter.[18] In rejecting this, Leibniz had declared his belief that "it is necessary to maintain that the parts of the continuum exist only insofar as they are effectively determined by matter or motion" (Letter to Malebranche, March–April 1675; GP I 322; Malebranche 1961, 97).

But a decisive break with all this occurs in the spring of 1676 with Leibniz's rejection of infinitely small actuals. By early April he is claiming to have shown that the only unassignable is an endpoint, a true minimum, and that the differentials of his calculus are not infinitely small "but nothing at all".[19] Leibniz does not tell us where he proves this or how. I have surmised that it might have been an application to his unassignable differences of what he later calls "that Herculean argument of mine"—that "all those things which are such that it is impossible for anyone to perceive whether they exist or not, are nothing".[20] For given his definition of an unassignable difference as one

[14] Proposition 14, *Propositiones quaedam philosophicae* (A VI iii N2: 28). Leibniz wrote this tract, probably intended for publication, in early-to-mid-1672.

[15] Further analysis of this theory can be found in Arthur (1999a).

[16] "*If one body endeavours to move into the place of another, these two bodies are continuous.* Endeavour is the beginning of motion at a given moment. Therefore it is the beginning of a change of place, i.e. of a transition from place to place, and therefore is in both places at the same time, since it cannot be in neither, i.e. nowhere" (*De consistentia corporum*, A VI iii 95–6/LLC 21).

[17] "No endeavours die away, but all are in general *efficacious and perpetual*, even though they cannot be sensed, having been mixed up with the other endeavours added on top of them, with lines of motion varied beyond measure by such a manifold composition" (A VI iii 95/LLC 21).

[18] See the exchange in GP I 321–7, reproduced in Malebranche (1961, 96–104).

[19] "[A] differential is not infinitely small, but that which is nothing at all" ([26 March] A VI iii 434/LLC 65); "[We] have supposed a point to be that whose part is nothing, an extremum; for we have already shown that there is nothing else unassignable"; "the unbounded, i.e. that which is greater than anything finite, is something, and the infinitely small is not" (*Numeri infiniti* [*c.* 10 April]; A VI iii 498, 502/LLC 89, 97).

[20] In *Corpus non est substantia* (A VI iv 1637/LLC 261) Leibniz argues that application of this "Herculean argument" will put an end to controversy over the existence of the infinitely small. This is presumably because the latter is usually defined as a difference smaller than any that can be assigned or perceived. The

"smaller than can be expressed by a [finite] ratio to another sensible magnitude" (A VI ii 265/LLC 340), this means that it is one that is smaller than any that can be sensed; such a difference is in principle not one that could be perceived, and is therefore, according to the "Herculean argument", non-existent. At any rate, from late March 1676 onwards, points for Leibniz are mere endpoints but not infinitesimals, and endeavours are no longer actually infinitely small motions. In *On Motion and Matter* written between 1 and 10 April, Leibniz claims he has "demonstrated elsewhere very recently that endeavours are true motions, not infinitely small ones" (A VI iii 492/LLC 75). This means, he writes, that there may be no curvilinear motion, strictly speaking, nor any uniformly accelerated motion, as in Galileo's analysis of falling bodies. For the composition requires a new endeavour to be impressed at each instant, which is impossible if the endeavours are not infinitely small. A body is still regarded by Leibniz as individuated by the motion its parts share in common, and as containing other parts moving with their own diverse motions *in infinitum*. The difference is that now the actual infinite division is explicitly understood as containing no smallest part. Just as the converging infinite series summed by Gregory of St Vincent contain an infinity of terms, but no smallest, so a finite body can contain an infinity of subdivisions without this entailing that it is resolved into minima.[21]

This decisive change in Leibniz's views on the infinitely small is closely connected with his developing ideas on the calculus in 1675–6. It is in this period that he writes his *De quadratura*, a seminal work on the calculus (which, for contingent reasons, remained unpublished until recently). As has been shown by Eberhard Knobloch and others, Leibniz demonstrates in this work how one may calculate the area under a curve (its "quadrature", or what we would call integration, a term coined by Johann Bernoulli and Leibniz) "without a *reductio ad absurdum*" (Prop. 7, *Scholium*; Leibniz 1993, 35), by what we would now call Riemannian integration. This involves the use of "fictitious quantities, namely the infinite and the infinitely small" (35). He justifies this "direct method" by appeal to the Archimedean Axiom, which entails that no matter how small a geometric quantity is given, a smaller can be found. By adroit use of this axiom, he demonstrates that any quadrature can be performed without assuming anything but finite variable differences, since the error involved in calculating the area

Akademie editors date this piece from about 1689 on the basis of (inconclusive) watermark evidence. But to judge solely on the basis of content, I surmise that it could have been written as much as ten years earlier. At any rate, by January 1677 Leibniz was already applying the principle that "whatever cannot be distinguished, not even by someone omniscient, is nothing" to refute the existence of motion in a vacuum (A VI iv 1971/LLC 229). I have treated this argument and its relation to both Leibniz's and Newton's justification of infinitesimals in Arthur (2008).

[21] "Accordingly, being divided without end is different from being divided into minima, in that [in such an unending division] there will be no last part, just as in an unbounded line there is no last point" (*De veritatibus*… [15 April 1676]; A VI iii 513/LLC 119). See also A VI iii 498/LLC 89 and A VI iii 565–6/LLC 209: "There is no portion of matter that is not actually divided into further parts… This does not mean, however, either that a body or space is divided into points, or time into moments, because indivisibles are not parts, but the extrema of parts; which is why, even though all things are subdivided, they are still not resolved all the way down into minima."

can, by taking a difference in successive values of the abscissae sufficiently small, be reduced to a quantity less than any given quantity, thus rendering it effectively null. Thus one can perform the calculation using the fictional differences *dx*, since the difference *dA* between the actual area under the curve and that calculated by adding arbitrarily many finite component areas will be proportional to *dx*, and thus can be made less than any assignable difference by taking the greatest of the *dx* sufficiently small. This "shows that the difference between the two quantities is nothing, so that they are then equal" (35). Quantities such as *dA* and *dx* are therefore not actual infinitesimals, quantities smaller than any finite quantity, but variable finite quantities that can be made as small as desired. This is Leibniz's syncategorematic interpretation of infinitesimals, which corresponds neatly with his syncategorematic account of the infinite. Just as there is no actually infinite number of parts of matter, but so many that however large a finite number of them one takes, there are more; so, there are no actually infinitely small parts of matter, but parts so small that no matter how small a part is taken, there are others still smaller.

It is this change of interpretation of the infinitely small that forms the context for the dialogue on continuity Leibniz pens in November of the same year (1676), the *Pacidius Philalethi* (A VI iii N78/LLC 127–221).[22] This dialogue is extremely rich in insight, and we will have further occasion to reflect on its implications here and in Chapter 7. For in it Leibniz examines the question of the continuity of motion without presuming the existence of actually infinitely small unassignables or endeavours. Indeed, he is explicit that, in stark contradiction to his theory of cohesion based on infinitesimal endeavours, no body can ever be in two places at one moment.[23] Let us now turn to his arguments there.

In the preamble to the dialogue Leibniz refers to his previous difficulties with "beginnings", as if they took place in a remote past. Through the character of Charinus (partly representing a younger version of himself, but whose name appears to be a play on that of his friend and companion in Paris, the mathematical physicist Walther Ehrenfried von Tschirnhaus), he says: "But when it came to motion, all my care and diligence were in vain. . . . For I always became stuck at the very beginning of an incipient motion, since I had noticed that what must come about in the whole of the remaining time must somehow already happen at the first moment" (A VI iii 532/LLC 135).

[22] For informative and penetrating analyses of Leibniz's metaphysics of motion in the *Pacidius*, and of the implications of the non-uniformity of motion he embraces as a solution to his labyrinth, see Levey (2003b) and Levey (2012). My analyses differ at their heart from Levey's however, in that I take Leibniz to hold fast in the *Pacidius* to his belief that there are no minima resulting from a passage to the limit, except as fictions: the only minima he countenances, on my reading, are endpoints of subintervals; whereas Levey sees Leibniz as using "his analysis of the dichotomy to argue that motion contains minimal elements, partless beginnings and ends of motion" (2012, 35).

[23] "[A body in instantaneous motion] will either be nowhere or in two places, the one it leaves and the one it acquires, which is no less absurd than what you have shown, that it simultaneously is and is not in some state" (A VI iii 545/LLC 167).

Here we have a subtle allusion to the Inverted Dichotomy establishing endeavours, but that's all. In the ensuing analysis Leibniz pursues the subject entirely classically, making dextrous use of the traditional paradoxes of continuity known to the ancients, in particular, Plato, Aristotle, the Stoics, and Sextus Empiricus. By means of these he establishes there can be no state of change in a moment, and that "whatever changes is in two opposite states at two neighbouring moments" (562/201). The model here is that of a line that is actually divided so that its parts are contiguous, not truly continuous, in keeping with Aristotle's definitions (discussed in Chapter 1). Accordingly, the division of the interval is marked not by one point, but by two: the end of the first subinterval, and, immediately next to it, the beginning of the second. There cannot, however, be more than two such neighbouring moments immediately next to each other without the continuum being composed of points, an outcome he rejects as implying a contradiction:[24] "And although the moments and points that are assigned are indeed infinite, there are never more than two immediately next to each other in the same line, since indivisibles are nothing but bounds" (565/209). This appeals to the conception of actually infinite division of bodies described above, where every portion of matter is "actually divided into further parts, so that there is no body so small that there is not a world of infinitary creatures in it", but without entailing a division of space or body into points (565/209). Now Leibniz extends this conception to motion as well: "the motion of a moving thing is actually divided into an infinity of other motions, each different from the other, and does not persist the same and uniform for any stretch of time" (565/207).[25]

Actually, even more revealing are the marginal notes Leibniz had made for himself on how to improve the first draft of the dialogue:

(N.B. Just as bodies in space form an unbroken connection, and other smaller bodies are interposed inside them in their turn, so that there is no place void of bodies; so in time, while

[24] As Levey observes, this claim by Leibniz, while respectably Aristotelian, cannot be reconciled with standard point-set topology, since in such a space not even two points can be immediately next to each other: "The difficulty here is a serious one, and I know of no mathematically coherent way, within standard models, to spell out Leibniz's idea of distinct but indistant boundaries residing at the locus of contact or change" (Levey 2003b, 375). Of course, as Levey acknowledges (412, n. 28), point-set ontology presupposes infinite collections of points, so Leibniz would not have accepted this as a damning objection. For him the continuum consists in all possible points of division; any actually divided interval does not. But see also White (1992).

[25] This means that motion is non-uniform in the sense that it is divided into sections of apparently uniform motion that are themselves, on a smaller scale, further divided. This yields a fractal quality to space, motion, and time for Leibniz. This analogy with fractals is explored and beautifully analysed by Levey in three related articles: Levey (2003b), (2005), and (2012). He notes that Leibniz's conception of infinite division anticipates two central notions of fractal mathematics, *fractal dimension* and *complexity on all scales*. He maintains, though, that "The new fractal conception in fact cannot prevent the consequence that motion (or body, space or time) will be 'resolved all the way down into minima' on Leibniz's account—his own assertions to the contrary notwithstanding" (2003b, 403); see also the same author's (1999) "Leibniz's Constructivism". Here I cannot agree. See n. 49 in Chapter 2, for the parallel argument concerning the infinite division of matter, where I maintain that if "every" is taken in the distributive sense, then indeed *every* subinterval is extended, so matter is not dissolved into a "powder of points", even though it is resolvable into constitutive unities.

some things last through a momentaneous leap, others meanwhile undergo more subtle changes at some intermediate time, and others between them in their turn. And in these (as it were) blows or vibrations there seems to be a wonderful harmony. At any rate, it is necessary for states to endure for some time or be void of changes. As the endpoints of bodies, or points of contact, so the changes of states. Smaller bodies move more quickly in a plenum, larger ones more slowly. Nor is any time or place empty. During any state whatsoever some other things are changing.) (559/195–7)

This idea of momentaneous leaps is intriguing on two counts. First, the concept 'momentaneous' is given a thoroughly syncategorematic interpretation: no matter how small a time something endures between changes, something else undergoes subtler changes within this time, thus giving further assignable times within. A moment is therefore no longer "a time smaller than any given" (A VI ii 171), as in the 1669 theory and in the *TMA*; rather it is a time that is not so small that there does not always exist a smaller. Likewise, a leap or "little interval of rest" is an existence in the same place through such a moment. Second, the leaps in question are not discontinuous leaps from one interval or state to the next, but continuous leaps from the beginning of the interval to its end.[26] But despite their finitude, they are smaller than can be perceived by a body of the same scale: "Matters are to be explained in such a way that bodies never perceive these leaps. So when a large body leaps smaller bodies will also leap, but they need a longer time" (569/217).

If, however, a body undergoing a leap is undergoing no change, it is not acting, and might as well be said not to exist between the beginning and end of the interval—just as in the former theory of 1669. Leibniz prompts himself to declare this: "Why not rather say that the conclusion that things exist only for a moment, and do not exist at an intermediate time, will follow if it is supposed that things do not exist unless they act, and do not act unless they change?" (558/191). When he rewrites this section of the dialogue, this conclusion is brought to the fore:

> *Pacidius*: But I would like you to notice something else, that this demonstrates that bodies do not act while they are in motion.
>
> *Theophilus*: Why is that?
>
> *Pacidius*: Because there is no moment of change common to each of two states, and thus no state of change either, but only an aggregate of two states, old and new; and so there is no state of action in a body, that is to say, no moment can be assigned at which it acts. For by moving the body would act, and by acting it would change or be acted upon; but there is no moment of being acted upon, that is, of change or motion, in the body. Thus action in a body cannot be conceived except through a kind of aversion. If you really cut to the quick and inspect every single moment,

[26] As such they are very reminiscent of the Neoplatonist Damascius, who "gives the name 'leap' not, as we might expect, to the instantaneous transition from one time to another, but to the intervening period between two transitions" (Sorabji, "Introduction", in Simplicius 1992).

> there is no action. Hence it follows that proper and momentaneous actions belong to those things which by acting do not change. (566/211)

Here we have a third avatar of the Inverted Dichotomy, even if it is not as explicit as the others.[27] For the argument is that in an apparently continuous motion there is motion, and therefore action, in as small an interval as you wish to choose. But there is no action in a body at any assignable moment: there is only an aggregate of two states, old and new. And between these assignable moments (in what were the unassignable intervals in his theory of 1669 discussed above) there are arbitrarily small leaps, but which are void of changes, and therefore of action. Consequently the action underlying a continuous motion is not in the moving body. From this Leibniz concludes that bodies' existence requires their creation by God at each assignable moment, though not in between, a doctrine he dubs "transcreationism".

Leibniz's overall argument in the *Pacidius* is subtle, and very difficult to grasp. As Samuel Levey has observed, it is something of a labyrinth in its own right. Although it purports to deliver a "first philosophy of motion", "it is hard to discern in it what Leibniz finally intends as his first philosophy of motion—or whether in the end the *Pacidius* even offers such a first philosophy at all" (Levey 2003b, 371).[28] It is worth dwelling on it a little more to see how his doctrine of transcreation involves a different conception of continuous creation than his contemporaries'. As noted above, it is in the fragment *De motu et materia* from April that Leibniz first mentions his realization that endeavours are not after all actually infinitely small motions that can constitute a continuous motion, and urges himself to investigate the implications of this for the metaphysics of motion. In that fragment he immediately rules out motion's being interrupted by little intervals of rest (*quietulae*) (A VI iii 493–4/LLC 78–9), not only for its intrinsic difficulties, but also because the remaining portions of the motion will need to be assumed continuous. Yet only a few lines further on, he finds himself "forced

[27] As Samuel Levey has reminded me, however, there is a more explicit instance of the Inverted Dichotomy in the dialogue. This is when Leibniz transposes the argument of the Sorites from discrete to continuous quantity, concluding that one body must become near to another by the gaining of a part of the line "smaller than any named by us", i.e. a minimum (A VI iii 540). In his (2003b), Levey takes this to be the intended overall conclusion of Leibniz's argument, whereas I take this to be only a preliminary conclusion of a dialectical argument. See n. 28.

[28] According to Levey, Leibniz's strategy in the dialogue "is to show that change itself is transacted by the addition or subtraction of a minimal difference in the state of the thing that changes, and thus that the very possibility of change entails the existence of minima in reality" (2003b, 375). Similarly, in his more recent and very discerning treatment of Leibniz's Inverted Dichotomy (Levey 2012), Levey distinguishes clearly between the passage to the limit being achieved by the whole sequence of subintervals, and its being achieved only by some putative last part, the minimum, and argues that Leibniz is arguing for the latter (in anticipation of some versions of his Law of Continuity); whereas I take his argument to be that there is no last subinterval in an actually infinite sequence of subintervals, nor a collection of all of them. But it would require further substantial discussion to do justice to all the excellent points raised here by Levey, and this is perhaps not the place for it. So I will restrict myself to establishing what I take to be the overall conclusion of the dialogue: namely, that there is no state of change or action in a body, so that a body must therefore be recreated by the direct action of God at each assignable moment of its motion. On my reading, this is what the "fractal" theory of motion, and concomitant analysis of change, is designed to support.

to conclude that motion is not continuous, but happens by a leap; that is to say, that a body, staying for a while in one place, may immediately afterwards be transplanted to another; i.e. that matter is extinguished here, and reproduced elsewhere". This conclusion is reaffirmed in *Numeri infiniti*, written very soon afterwards, where Leibniz again opts for a conception of motion "*per saltus*" and dubs such motion through a leap "*transcreation*" (A VI iii 500/LLC 92–3).

This apparent contradiction could be put down to the fact that in these two pieces Leibniz is thinking aloud on paper, if it were not for the fact that exactly the same structure of argument is repeated, at much greater length and in dialectical form, in the *Pacidius Philalethi*. First the hypothesis of leaps with interspersed rests is introduced (A VI iii 542/LLC 158–9); then it is shown that this presupposes other further intervals of continuous motion that are not interrupted by any further little rests. "But if a motion is continuous for a while through some space and time, without any rest intervening, then it follows that this space is composed only of points and time only of moments" (546/168–9), which is shown to lead to paradox by the argument from the square and diagonal as above. So rests must be rejected. But then Leibniz has his main spokesman Pacidius again advance the position that motion occurs by a leap, in which the last moment of a body's state of rest at point *A* "is immediately succeeded by *O*, the first moment of the time *OP* of its existence not at *A*, but at *B*", a point "apart from *A*" (557/190–1). As in *Numeri infiniti*, this solution is asserted to be equivalent to the theory of *transcreation*, where the body is "annihilated in the earlier state, and resuscitated in the later one" (559/194–5).

This, however, only heightens the perplexity. How can Leibniz deny these minimal leaps through tiny spaces and times, only subsequently to reassert them and restate their equivalence to transcreation, as he does at the end of the rewritten section (567/212–13)? The answer he gives there is that there are two different kinds of leaps: the leap involved in transcreation "is not the kind of leap we refuted above" since the transcreation leap is from one point to another contiguous to it, the two points being "indistant". This is hard to follow. For if the contiguous points are no distance from one another, it is hard to see how they can be called leaps from one place to another one "apart from it". Also, Leibniz has already said that the momentaneous leaps are *between* the assignable moments—that they are arbitrarily small states void of discernible change whose boundaries are marked by the assignable changes, not the changes themselves. Still, it remains the case that the inference from the idea of an immediate change of state between contiguous points to the composition of motion from an infinity of neighbouring points at neighbouring times is thwarted by Leibniz's denial of the uniformity of motion. There is no continuous uniform motion, since there are only ever two points or moments immediately next to one another:

> The whole thing therefore reduces to this: at any moment which is actually assigned we will say that the moving thing is at a new point. And although the moments and points that are assigned are indeed infinite, there are never more than two of them immediately next to each other in the same line, since indivisibles are nothing but bounds. (565/208–9)

What we have, then, is something very like a reversion by Leibniz to his 1669 theory described above, where motion is analysed as occurring by the creation of a body at each assignable instant, it being non-existent in the unassignable times between. But there are two fundamental differences. First, in the former theory the assignable instants are supposed to be simply points in the temporal continuum, whereas in the *Pacidius* theory the only instants that are assigned are the endpoints—beginnings or ends—of finite temporal intervals. Because the only instants are endpoints of intervals, and no two intervals have an endpoint in common, there is therefore no moment of change. But if the moment of change is taken to be the aggregate of the last moment of existence in the prior state and the first moment of existence in the posterior state (541/157), and "if it is supposed that things do not exist unless they act, and do not act unless they change", then "the conclusion will follow that things exist only for a moment and do not exist at any intermediate time" (557/191). Thus bodies exist at every assignable moment—the assignable moment being here the aggregate of the two contiguous moments over which change occurs—but they do not exist at the unassignable times between.

Second, the unassignable times of the previous theory have also been reinterpreted: they are no longer times smaller than all assignable times, but times not so small that there are not always smaller times. A "momentaneous" existence in a given state is in fact a state of non-existence for a finite time that is small, but not so small that there are not always smaller times. Thus existence in a given state for an unassignable time is in fact a state of non-existence, even if this is not discernible. In a passage from the first draft that he subsequently deleted, Leibniz explicitly linked this analysis to his treatment of infinitesimals in mathematics:

> And these kinds of spaces are taken in geometry to be points or null spaces, so that motion, although metaphysically interrupted by rests, will be geometrically continuous—just as a regular polygon of infinitely many sides cannot be taken metaphysically for a circle, even though it is taken for a circle in geometry, on account of the error being smaller than can be expressed by us. (A VI iii 569/LLC 409–10)

This alludes to what I have called Leibniz's Principle of Unassignable Difference (Arthur 2008, 19). It may be expressed as follows:

> Two quantities or ratios of quantities whose difference can be made smaller than any assignable difference (by varying a co-dependent quantity), are equal.

Applied to motion, the "differences" will be unassignable leaps, so that although a given continuous motion will be "metaphysically" interrupted by such leaps, it will be geometrically continuous: the "leaps" will correspond to differentials of the calculus, such as dy, which (by varying dx) can be made so small as to be in principle indiscernible, and therefore null.[29]

[29] Leibniz adds: "It is not at all to be defended, lest the reasonings of geometry of mechanics are subverted by metaphysical speculations", and then deletes the passage (569/4100). What the 'It' refers to is far from clear. Earlier in the dialogue in a bracketed passage, he has Charinus suggest that the infinitesimal

In this way, Leibniz thought he could avoid the contradiction involved in the usual notion of continuous creation, which requires space to be composed of points and time of instants, and still give "a wonderful confirmation of what the theologians once declared, that conservation is a kind of perpetual creation; for this opinion [says Gallutius] is related to the one you have demonstrated, that all change is a kind of transcreation" (568/215). We will return to Leibniz's conception of continuous creation later, and provide a fuller analysis of its implications in Chapter 7, where we will also revisit his analysis of change and his conception of momentaneous states.

5.2 Relativity and the Subject of Motion

This analysis of the continuity of motion clearly provides one motivation for Leibniz's reverting to a version of occasionalism. But there are other factors in play in his very rich thought in this period. One is no doubt the strength of the occasionalist arguments themselves, to which Leibniz was exposed in Paris in his interactions with some of the doctrine's chief proponents, especially Malebranche and Cordemoy. Their critique of substance–substance interaction leaves an indelible mark on this thought, and from this time onward he never wavers in his conviction that the passing of an influence of any sort from one substance to another is wholly unintelligible.

Despite the triumphalism of the appeal to divine action at the conclusion of the *Pacidius*, however, there are indications that Leibniz is not comfortable with such an appeal to God's direct action, which would qualify as precisely the kind of *deus ex machina* that he had previously disparaged, and will continue to disparage in his mature critiques of occasionalism. For even in setting out his argument for transcreation, Leibniz's reference to "those things which by acting do not change" signals that he has not abandoned the idea of *substances* (in the plural)—indeed this would be a handy definition of what he will later call "simple substances". We have already discussed his theological and biological motivations for wishing to retain such incorporeal principles in bodies, but at this stage in the development of his thought he cannot see how this can be achieved on the basis of mechanist principles alone: that is, in terms of extension, shape, size, and motion, supplemented with endeavour (as that feature of mind conformable to mechanist desiderata of intelligibility). In fact, a major consideration in Leibniz's appeal to the "universal mind" is the failure of his attempt in the *TMA* and *HPN* to provide a derivation of the law of conservation of quantity of motion ("the law of compensation" underlying collisions) in terms of endeavour alone. In *De motu et materia* of early April 1676 he concludes that no account in terms of bodies containing individuating minds can explain how "magnitude compensates for speed" in collisions: "for when two bodes collide, it is clear that it is not the mind of each one

rests and times "are perhaps not absurd", only for Pacidius to comment: "I would indeed admit these infinitely small spaces and times in geometry, for the sake of discovery, even though they are imaginary. But I am trying to decide [*delibero*] whether they can be admitted in nature" (A VI iii 564/LLC 207).

that makes it follow the law of compensation, but rather the universal mind assisting both, or rather all, equally" (A VI iii 493/LLC 77).

This difficulty is reinforced by the fact that what is conserved in collision is not the quantity of absolute motion, but the quantity of *relative motion*:

> On the other hand, it is not necessary for the same quantity of motion always to be conserved in the world, since if one body is carried by another in a certain direction, but is moving of its own accord equally in the contrary direction, it will certainly come to rest, i.e. it will not leave its place. From this it follows that the conservation of the quantity of motion must be asserted of the action, i.e. relative motion, by which one body is related to another or acts on another.
> (A VI iii 493/77)

This consideration highlights another difficulty with the theory of the *TMA*, which implicitly assumes an absolute space with respect to which all the motions could be determined. But, as we shall see, Leibniz has concluded by early 1677 that "in reality space is not such a thing, and motion is not something absolute, but consists in relation" (A VI iv 1968/LLC 225). This, however, creates a further problem. For if motion is entirely relative, then it becomes arbitrary whether it is assigned to one body rather than another: it lacks a determinate subject. If no body can be said to "have" the motion rather than any other (since any of them may equally be regarded as at rest, so long as the relative motions are all preserved), then it appears that the system of relative motions is more nearly a property of the world as a whole (again in keeping with occasionalism), as Leibniz argued in February 1677:

> A remarkable fact: motion is something relative, and one cannot distinguish exactly which of the bodies is moving. Thus if motion is an affection, its subject will not be any one individual body, but the whole world. Hence all its effects must also necessarily be relative. The absolute motion we imagine to ourselves, however, is nothing but an affection of our soul while we consider ourselves or other things as immobile, since we are able to understand everything more easily when these things are considered as immobile.
> (*Motion is Something Relative* A VI iv 1970/LLC 229)

As Leibniz's thought develops over the next year or so, however, he will instead interpret both these difficulties as indications that there is more to bodies than can be derived from merely mechanical principles. He had already noted in the margin by the title of the *Pacidius*: "Still to be treated are, first, the subject of motion, to make it clear which of two things changing their mutual situation we should ascribe motion to, and, second, the cause of motion ôr motive force" (A VI iii 529/LLC 129). It is only when (in early 1678) Leibniz is able to re-identify motive force as living force[30] (mv^2) rather than quantity of motion (mv) that he sees himself clear to reject occasionalism. Now force and the cause of motion, although not themselves geometrical, can be attributed to

[30] Michel Fichant notes (following Yvon Belaval) that Leibniz "does not yet call mv^2 *living force*" in 1678 (Fichant 1994, 64). This is true of *De corporum concursu* of 1678. But in various texts from 1675–8 soon to be published as A VIII, it can be seen that Leibniz is already using the terms *vives mortua* and *vives viventes* (dead and living forces), a terminology which he inherits from Galileo.

individual bodies, obviating the need for God to cause changes of state directly. Thus by the time he came to write *Principia mechanica ex metaphysicis dependere* scarcely more than two years after the *De motu et materia* of May 1676,[31] Leibniz could already refer to his attempt to give a geometrical derivation of the laws of impact as though it were an episode from the distant past:

> There was a time when I believed that all the phenomena of motion could be explained by purely geometric principles, assuming no metaphysical propositions, and that the laws of impact depend only on the composition of motions. But, through more profound meditation, I discovered that this is impossible, and I learned a truth superior to the whole of mechanics, namely that although everything in nature can indeed be explained mechanically, the principles of mechanics themselves depend on metaphysical and, in a sense, moral principles, that is, on the contemplation of efficient and final cause, namely, on God's acting most perfectly, and can in no way be deduced from the blind composition of motions. (*PMMD*, A VI iv 1976)

Leibniz proceeds to explain in detail how his earlier attempts were deficient, and the concluding passage is worth quoting at length for the light it throws on the development of his thought in this period:

> But when I considered how in general a reason could be given for what we experience overall, that when bulk is increased speed is diminished, as when we see the same boat carried downstream the more slowly the more heavily it is laden, I at last became stuck, and all my attempts having been in vain, I discovered that this, so to speak, inertia of bodies cannot be deduced solely from the initially assumed notion of matter and motion, where matter is understood as that which is extended ôr fills space, and motion is understood as change of space ôr place. (A VI iv 1980)

That is, if motion be taken *entirely* geometrically, then one is not entitled to assume any forces in it, not even passive forces such as the greater resistance to being put in motion of a more massive body assumed by the Cartesians. Therefore in order to account for the correct laws of collision (specifically, what we now call the law of conservation of linear momentum), a passive force of inertia must be assumed that is not reducible to purely mechanical principles. He continues:

> Rather, over and above what is deduced solely from extension and its variation ôr modification, we must add and recognize there to be in bodies certain notions ôr forms that are immaterial, so to speak, ôr independent of extension, and which one may call powers, by which speed is adjusted to magnitude. These powers do not consist in motion, nor indeed in endeavour or the beginning of motion, but in that cause ôr intrinsic reason for which a law of continuing the motion is required. And other authors have been mistaken in that they have considered motion

[31] This piece is translated in Garber and Ariew as "On the Nature of Body and the Laws of Motion ca. 1690" (Leibniz 1989, 245–50). Afterwards the Akademie volume VI 4 appeared, in which the editors give the piece the title "*Principia mechanica ex metaphysicis dependere* (The Principles of Mechanics Depend on Metaphysical Principles)", and date it as between the summer of 1678 and winter 1680/1 by watermark. They suggest that content-wise it belongs together with the *De corporum concursu* of January 1678 (A VI iv 1976). I shall abbreviate its title as *PMMD*.

itself, but not motive power ôr the reason for motion, which . . . must be understood not as being in God himself, but as being produced and conserved by him in things. From this we shall also show that what is conserved in the world is not the same quantity of motion (which has deceived many people) but the same quantity of power. (1980)

The cogency of this reasoning is not exactly self-evident. For it is not obvious why the addition of a passive power to matter must involve the supposition of immaterial forms, and it is doubtful whether many other natural philosophers of the time would have been persuaded by this argument for the need to introduce them. A comparison with the views of some of them may be useful in clarifying Leibniz's line of reasoning.

Huygens, for example, simply set aside the Cartesian idea that all the essential properties of bodies must be derivable a priori from their natures as movable, extended substances, and added inertial mass as an additional primitive property of body. But this would not address the difficulty Leibniz has identified, as to how a body could "know" to adjust its speed in accord with the law of compensation. If there is no principle or power within the body, then this would have to be achieved by divine fiat. Leibniz was not alone in making such an inference. Indeed, Pierre Bayle saw the incapacity of (Cartesian) bodies to know how to behave in accordance with the laws of motion without divine assistance as a major reason for adopting occasionalism.[32] On Huygens' philosophy, moreover, there is also no explanation of how the universe does not run down, given that a quantity of motion (*mv* treated as a scalar) is lost in every inelastic collision. Finally, if all motion is relative, as Huygens acknowledged, then there would be no truth about what motion a body does in fact have. Motion would be a merely extrinsic denomination, not grounded in any substance, and nothing could be said to act rather than be acted upon.

Newton was alive to all these difficulties, so it will be instructive to see how he handled them, even though Leibniz would not become acquainted with Newton's views until well after he had formulated the position we are examining.[33] For, like Leibniz, Newton regarded inertia as a force bodies have for continuing their motion, a "passive principle" enshrined in the three laws of motion that he articulated in the *Principia*, requiring supplementation by active forces.[34] Also like Leibniz, he insisted that motion could not be a merely external denomination, and must be an accident of something substantial. As he wrote in the manuscript *De gravitatione* (unpublished until the 1960s), there is "but a single physical motion of any body, and . . . the rest of its changes of relation and position with respect to other bodies are just external

[32] As Thomas Lennon has explained, Pierre Bayle expressed this concern in various texts as follows: "God is the cause of motion in the world because things cannot put themselves in motion and, lacking knowledge, cannot have a tendency toward it; lacking knowledge, bodies cannot determine what quantity of motion should be communicated, and the specific motion a thing has . . . can depend only on the free choice (*bon plaisir*) of God. Bodies are indifferent to motion, and, lacking knowledge, they cannot determine themselves to one or the other, as more appropriate" (Lennon 1993, 183).

[33] For an extended exposition of this and the following points, see my "Newton and Leibniz on the Relativity of Motion" (Arthur 2015b).

[34] See Newton's discussion in Query 31 of his *Opticks*, reproduced in Alexander (1956, 175–83).

denominations" (Hall and Hall 1962, 95). This means that each body possesses a determinate, absolute quantity of motion, "compounded from both the velocity and the magnitude of the moving body",[35] as a cumulative result of all the forces they have been subjected to since their creation, and this results in its tracing a unique path in absolute space. The loss of quantity of motion in inelastic collisions, according to Newton, is made up by the injection of motion through active forces, and also by God's direct action on matter.

Of course, the premises on which Newton's position depends are unacceptable to Leibniz. Newton's conception of God as an agent acting on bodies in his sensorium—"an ever-living agent, who being in all places, is more able by his will to move the bodies within his boundless uniform sensorium, and thereby to form and reform the parts of the universe, than our spirit, which in us is the image of God, is able to move the parts of our bodies", as he is described in the *Opticks* of 1704 (181)—will draw Leibniz's fire in his correspondence with Clarke in 1715–16. Leibniz will also not accept the indeterminism that Newton sees as a prerequisite for free will, nor the idea that minds can impart motion to bodies. With respect to Leibniz's own reasoning described above, however, the more pertinent objections would be: (i) that on Newton's conception there is no basis in the nature of bodies for them to act in accordance with the three laws of motion, so that this must be externally established by God's action; (ii) that the supposition of absolute space is not supported by the three laws, which hold for relative motion at any instant; and (iii) that on the essentially geometric conception of bodies that Newton supposes, motion is necessarily relative.

These comparisons do not yet address Leibniz's argument for reintroducing immaterial forms under the banner of his new interpretation of force. But they do suggest that the relativity of motion is crucial to his reasoning. And as we shall see, this is key to his argument for bodies containing the basis for the attribution of causes, and his understanding of motive forces as involving the "reason for motion". We should proceed, then, to investigate why he took the relativity of motion to be a necessary consequence of motion as understood geometrically.

Leibniz gives perhaps his most thorough explanation of this in another early manuscript, the *Principia mechanica* (*Mechanical Principles*), most probably penned in Paris in the summer of 1676.[36] Although the treatise is an ambitious attempt to ground mechanics on indubitable first principles, once Leibniz gets onto the topic of motion, the issue of its relativity takes centre stage, and occupies him for the majority of the manuscript. Geometrically understood, motion is simply change of situation (*situs*). So he begins by defining the latter. "Situation," he writes, "is a mode according to which any body can be found, even though we recognize nothing in it specifically by which it can be distinguished from the others" (A VI iii 103). Finding a body "depends on

[35] *De gravitatione*, 115. Cf. *Principia*, Def. 2 (Newton 1999, 404).
[36] (A VI iii 101–10); translation and commentary in Arthur (2013c).

knowing its distance from other bodies, and also on knowing the angle, that is, the figure which it makes with another body".[37]

With this characterization of situation in hand, Leibniz proceeds to argue that change of situation is entirely *respective*, i.e. dependent on the point of view from which the moving bodies are observed. First he considers four cases on the supposition that "there are only two bodies *A* and *B* in the world". The appearances will be the same whether *B* is at rest and *A* is moving towards it with a uniform velocity $\underline{v}$, or *A* is at rest and *B* moving towards it with a uniform velocity $-\underline{v}$, or *A* and *B* are moving along a line towards one another with velocities $\frac{1}{2}\underline{v}$ and $-\frac{1}{2}\underline{v}$, or *A* and *B* are moving uniformly in the same direction with a difference in velocities of *v*. Then he considers whether, by assuming an eye in a third body *C* (assumed to be at rest) observing the motions of *A* and *B*, "something certain can be determined concerning the absolute and proper speed of bodies". But again all the phenomena—all the mutual situations at each instant—will appear the same, and this is so even when *C* is allowed to move in the same direction as B but with half its velocity, as he considers in case 6. Therefore, Leibniz concludes, not even an omniscient being will be able to determine which body is in absolute motion: "whatever speed or direction we attribute by assuming an absolute motion for one of the bodies, we will always find that anyone must then understand motion in the others in such a way that everything will appear as before" (109).

This conclusion, of course, conflicts with our normal attributions of motion. "No one doubts," Leibniz notes, "that the stagecoach moves over the ground rather than the ground under the coach" (104–5). The reason for this is that we know the *cause of the motion* of the coach, and in such cases we are able to distinguish motion from mere change of situation. In the case of two bodies, he writes, "motion is attributed to that one which contains the cause of their mutual situation having changed" (104). Thus when people "go for a walk, they believe they are approaching the town, rather than the town approaching them, because they feel some fatigue and exertion in themselves" (104). The expenditure of work allows us to identify that it is we who are walking, or that it is the horses pulling the coach.

In more complicated scenarios, however, the cause of motion must be identified by reference to the *simplest hypothesis* for explaining the phenomena in question. Although "not even the least determination can be found for excluding any of the various possible hypotheses" about which particular bodies are in absolute motion (110), still "we will be permitted to choose the simpler mode of explaining, which involves reference to a cause from which the remaining changes may be derived more

[37] This is essentially Hobbes' characterization of situation. But the attempt at a more general definition marks the beginning of Leibniz's attempt at a science of situation, the Analysis Situs, which he developed in numerous drafts from 1679 until his death in 1716, but did not bring to a successful completion. In its dependence on distances and angles, it presupposes Euclidean space. But the idea is to characterize all the algebraic relations holding among situations, and then use them to define situations algebraically, jettisoning the Euclidean framework as a mere scaffolding. Situation reduces to the recognition of distance, and "distance is the shortest path from one thing to another".

easily" (111). Thus in the case of a solid body moving through a liquid, "we will not hesitate to attribute motion to the solid body from which we can deduce the undulations of the surrounding liquid, rather than thinking of those undulations as originative" (111). Leibniz will continue to use this same example in his mature work to explicate his philosophy of cause. Thus in the *Specimen inventorum* of the late 1680s he writes that in the case of a solid moving through a liquid, the hypothesis of the solid's moving is "infinitely simpler than the others", and "that thing from whose state a reason for the changes is most readily provided is adjudged to be the cause" (A VI iv 1620/LLC 311).

Significantly, in the *Principia mechanica* Leibniz uses this distinction between purely *geometrical motion* (change of situation) and *motion with respect to cause* to argue for the Copernican hypothesis. He notes many considerations in support of both the annual motion and the diurnal motion of the Earth, including the far greater simplicity of the Copernican hypothesis in dispensing with the imaginary epicycles and eccentric circles, the potential changes in the apparent diameters of the fixed stars and changes of situation of the Earth relative to the fixed stars, and observations of oscillations of hanging lamps, and of tides "impinging only on eastern and western shores" (A VI iii 105). As he concludes, "these things can be explained more distinctly by the supposed motion of the Earth and its being reduced to a simple cause" (111).

This does not mean, however, that we can conclude that the Earth is moving in an absolute sense. Leibniz acknowledges that a rotating body will be accompanied by centrifugal motion: "when a solid body is rotated around its own centre it rejects contiguous bodies along the straight line that is tangent to the circle of the motion" (110). But, he objects:

> it does not follow that it can be determined with absolute or mathematical certitude that the solid body is moving rather than at rest, since one may always imagine various compositions of motion in the parts of a liquid through which the same phenomena will be explained with the solid at rest; even if these suppositions are remarkably complicated, and that is the simplest which rather attributes motion to one solid and derives from it the motion in the parts of the liquid. (A VI iii 110)

Thus, Leibniz concludes, "no certain knowledge can ever be had concerning absolute motion and rest from the phenomena of the changed situation alone" (110). Indeed, he was even more explicit in notes he had written on Descartes's *Principia* at the end of 1675: "Rejection along the tangent does not argue the real motion of the rotating thing, since it would be the same if everything moved around it" (A VI iii 215/LLC 25).[38] At any instant, a body on the surface of the rotating body will tend to move along a tangent with respect to the surrounding fluid; but their mutual situations and relative

[38] The last phrase is a paraphrase of Seneca, from his discussion of Aristarchus, the "ancient Copernicus". Leibniz makes the same tacit classical allusion in a letter to Perrault in 1676, and in a manuscript written in Rome in 1690 (see LLC 383–4).

motion would remain the same at any instant if the body were stationary and the fluid were revolving around it. Granted, it would be an enormously complicated hypothesis that could account for all the motions in this way if the body were supposed to remain at rest through time with the fluid rotating around it. Leibniz took this to show (1) that if motion is understood purely geometrically, the universal relativity of motion must be upheld; and (2) that it is nevertheless possible to determine the subject of motion by reference to the causes of the motions, by choosing that hypothesis "from which the remaining changes may be derived most easily" (111). Thus whether the Earth is moving or the fluid matter surrounding the Earth is moving in complex ways, "these things can be explained more distinctly by the supposed motion of the earth and its being reduced to a simple cause" (111).

Leibniz maintained and elaborated on this position in his later writings. In a manuscript he drew up while in Rome in 1690, he advised his Italian colleagues that they "could freely follow Copernicus without damaging the authority of the censors, if only they were to recognize, with us, that the truth of a hypothesis should be taken as nothing but its greater intelligibility" (C 592/AG 91). Thus when the subject of motion is determined according to the most intelligible hypothesis, one will be able to identify the true motions, such as the diurnal and annual motions of the Earth. Similarly, in his *Dynamica* of 1695, Leibniz wrote: "Universally, when motion occurs, we find nothing in bodies by which it could be determined except change of situation, which always consists in relation (*in respectu*). Thus motion by its nature is respective" (Part II, §3, Prop. 19; GM VI 507–8). "Meanwhile", though, "we attribute motion to bodies according to those hypotheses by which they are most aptly explained, and the truth of the hypothesis is nothing other than its aptness" (508). All this explains how Leibniz could grant Clarke that "there is a difference between an absolute true motion of a body and a mere relative change of its situation with respect to another body" (Fifth Paper to Clarke, §53; GP VII 404/L 706). For, he explains: "when the immediate cause of the change is in the body, that body is truly in motion, and then the situation of other bodies with respect to it will be changed consequently, though the cause of that change be not in them".

The preceding discussion has great bearing on the issue of phenomenalism that some commentators have seen in Leibniz's position in this period, discussed in Chapter 2. For Leibniz often identified the relativity of motion (formally considered) as one of the chief reasons for regarding it as a phenomenon, or "something not entirely real". For example, in a fragment probably written in 1678–9, Leibniz wrote:

> That matter and motion are only phenomena, or contain in themselves something imaginary, can be understood from the fact that different and contradictory hypotheses can be made about them, all of which nevertheless satisfy the phenomena perfectly, so that no reason can be devised for determining which of them should be preferred. In real things, on the other hand, every truth can be accurately discovered and demonstrated. Thus concerning motion I have shown elsewhere that it is not possible to determine which subject it is in…
>
> (A VI iii 1463/LLC 257)

But, as his discussion in the *Discourse* makes evident, this applies only to motion insofar as it is considered geometrically, as change of situation:

> For motion, if one considers only what it precisely and formally comprises, that is to say, change of place, is not an entirely real thing, and when several bodies change situation among themselves, it is not possible to determine, solely by a consideration of these changes, to which among them the motion should be attributed—as I could show geometrically if I wanted to stop to do so. But the force or immediate cause behind those changes is something more real, and there is enough of a basis for attributing it to one body rather than another. Also, it is only in this way that we can know to which body the motion belongs.
>
> (*Discourse on Metaphysics* §18 [1686], A VI iv 1559/WFT 71)

That is to say, motion considered simply as change of situation is a mere appearance, something that will appear differently to observers in different states of motion with respect to the body in question. But when the cause behind these changes is known, it is possible to determine which body is in motion with respect to these changes. It is in this way that we can say that it is the stagecoach that is really moving, since it shares its motion with the horses, and the reason for their motion is in their expending energy to pull the stage.

Another way of approaching Leibniz's characterizing of motion as phenomenal is in terms of extrinsic denominations. Situation is the paradigm of an extrinsic denomination, since a body only has a situation relative to other bodies. But according to Leibniz "there can be no purely extrinsic denominations". This means that there must be something in the bodies, some quality, that is the basis of its having a situation to those around it. This is found in the fact that it expresses them, and expresses nearer ones more distinctly than ones further away. So Leibniz writes, in a piece written towards the end of the century:

> To be in a place seems, abstractly at least, to imply nothing but position. But in actuality, what is placed must express place in itself; so that distance and the degree of distance involves also a degree of expressing a remote thing in itself, either of affecting it or receiving an affection from it. So, in fact, situation really involves a degree of expressions…
>
> (*On the Principle of Indiscernibles* [*c.* 1696], C 8–9)

Analogously with motion: as change of situation, motion is relative to other bodies, and thus also an extrinsic denomination. So there must likewise be some quality in bodies that grounds such changes, and this is identified as the reason for the changes, or force:

> Transition itself…is nothing but a complex of two opposed and unmediated states, one together with a force or reason for the transition, which is itself a quality. (C 8–9)

Thus motion is not a *mere* phenomenon. When it is grounded in force or the reason for the transition, it is a veridical appearance, a well-founded phenomenon.

A return to the comparison with Newton may help clarify Leibniz's position here. For Newton, a body that is truly in motion is tracing a unique path in absolute space through time, and its motion is the result of all the forces that have acted upon it to

give it a unique quantity of motion at any time. This quantity of motion is an intrinsic denomination of the body; its motions relative to other bodies taken to be at rest are merely external denominations. This must be so even if it is not possible to distinguish whether a given system of bodies is at rest or moving in a straight line with a constant velocity or constant linear acceleration (Newton's Corollaries 5 and 6 to the Laws of Motion). According to Leibniz, however, motion is essentially relative. If body is understood entirely geometrically, motion is mere change of situation. The phenomena (appearances) will be the same whichever of two bodies in relative motion is taken to be the subject of motion; even the force of impact on collision will be the same, provided the relative velocities are the same.

But (Leibniz agrees with Newton) motion cannot be a purely extrinsic denomination, any more than can situation. If that body is truly in motion which contains the immediate reason for the motion, there must be some basis for that body to contain the reason in itself, and in Leibniz's mind this was connected with body's containing the basis for behaving in accordance with the law of compensation.

So Leibniz's predicament in 1677 is this: he has satisfied himself that bodies must contain some substantial basis or power for continuing in their motions that is not reducible to mere changes of situation, not merely a passive power for continuing motion, such as inertia, but a reason for the motion being ascribed to them insofar as they are its active cause, and a reason for continuing in their changes in such a way that velocity is compensated by mass. But he is not yet able to see how to derive any physical laws (such as the law of compensation) from such considerations. This changes in the first two months of 1678 when, in a concerted engagement with the physics of colliding bodies, the *De corporum concursu*, he produces ten sheets or *schedas*, culminating in his articulation of the law of the conservation of force (energy).

A consideration of these matters will require a substantial digression: but it is one that is pivotal if we are to understand Leibniz's claims that this discovery of the true nature of force constituted his means of escape from the labyrinth of the composition of body and related issues; and that his own Ariadne's thread enabling this escape was his identification of the new principle he took as the foundation of his dynamics, the Principle of Equipollence.

5.3 Active Force and the Cause of Motion

Leibniz was constantly striving to establish general, overarching principles by the aid of which he could derive the laws specific to some context, and in 1675–8 he was especially concerned to find principles from which the laws of motion could be derived.[39]

[39] In a fragment probably dating from 1677, for example, Leibniz wrote: "For a long time I have been trying to find *a reason (ratio) according to which the systematic laws of motion could be established mechanically*, and according to which the rules for individual things would not be violated (*Diu quaesivi qua ratione regulae motus systematicae praestari mechanice possent nec regulae sejunctorum violarentur*" (A VI iv 1959).

One obvious example of such an architectonic principle was his Law of Continuity, which (in his unpublished *De corporum concursu* of 1678 and his published letter to Malebranche of 1687[40]) he used most successfully to show how Descartes' laws of collision produced inexplicable discontinuities as the velocities were varied, whereas the correct laws, based on a revised concept of motive force, produced a smooth, consistent result. A less famous principle, but one dear to his heart, was first articulated by him in an unpublished paper, "On the Secrets of Motion" of 1676.[41] It is necessary, he wrote "that the laws of motion, which have hitherto seemed various, be reduced to some one principle, by the aid of which certain analytic equations can be arrived at. But hitherto I see only particular cases proposed" (A VIII ii 133). The principle he identifies is "*that the entire effect is always equal in power to the full cause*", which he later called the Principle of Equipollence.[42] He conceives it as a metaphysical principle underlying mechanics analogous to the principle in geometry that the whole is the sum of its parts:

> Hence just as the primary axiom of geometry is that the whole is equal to all its parts, so the primary axiom of mechanics is that the power of the full cause is the same as that of the entire effect. And both axioms are demonstrated by metaphysics. Indeed, the former depends on the definition of whole, part and equal; the latter on the definition of cause, effect and power. (A VIII ii 135)

In mechanics the particular cases he has in mind are Archimedes' demonstration that "there is equilibrium when the centre of gravity of a heavy body, of whatever composition, cannot fall any further", and Huygens' demonstration that "the same body falling through the same height, with whatever [angle of] inclination, will acquire the same velocity" (135). He sees both these as instances of a kind of equation, where equivalents are exchanged for equivalents: the force a body gains from being raised through a certain height is equivalent to the effects the force can produce, provided all sources of friction or wasted force are absent. Thus the principle appears to be that:

> Any full effect, if the opportunity presents itself, can perfectly reproduce its cause, that is, it has forces enough to bring itself back into the same state it was in previously, or into an equivalent

[40] For the first formulation of these criticisms see Fichant (1994, 198–200); the published criticism is in his reply to Malebranche in the *Nouvelles de la république des lettres* of July 1687: see GP III 51–5, GM vi 129–35, A VI iv 2031/L 351–4. Leibniz elaborates the graphical representation of the "monstrosity" in Descartes' collision laws in his *Critical Remarks* on Descartes's *Principles*, which he prepared for publication and sent to Basnage de Beauval in 1692 (GP IV 381–4/L 397–403, 412).

[41] *De Arcanis Motus*, A VIII ii 133–62. This is dated as February to September 1676 on basis of watermark; it had previously been dated as summer 1676 by Heinz-Jürgen Hess, who first unearthed it: see Hess (1978).

[42] In my (2014) I called this the "Full Cause Principle". But Leibniz himself called this his Principle of Equipollence: see his *De aequipollentia causae et effectus* (A VI iv 1963), Daniel Garber's discussion of it in his (2006), and the recent article by Mogens Lærke (2015). The principle takes centre stage in all Leibniz's accounts of his dynamics, for instance in the *Specimen Dynamicum*: "But I hold for certain that nature never substitutes unequal forces for one another; rather, the entire effect is always equal to the full cause" (§31; GM VI 245).

state. In order to be able to estimate equivalent things, it is therefore useful that a measure be assumed, such as the force necessary to raise some heavy thing to some height. . . . Hence it happens that a stone that falls from a certain height, can, if it is constrained by a pendulum, and if nothing interferes and it acts perfectly, climb back to the same height; but no higher, and if none of the force is removed, no lower either. (A VIII ii 136; Hess 1978, 204)

Here Leibniz is alluding to Huygens' conclusions in his celebrated *Pendulum Clock* (Huygens 1673), according to which a pendulum bob cannot be made to rise to a greater height than it had fallen through; and that the more all sources of friction could be reduced, the more nearly such a bob would return to the same height.[43] The full cause would be the force produced in the bob by raising it to a certain height, and the effect would be the motive force produced in the bob at the lowest point of the pendulum's swing. For a long time Leibniz laboured under the assumption that this motive force would be proportional to the bob's mass and to its velocity, and thus to mv, the accepted measure of the force of a body's motion. Thus he begins his *De corporum concursu* of early 1678 by stating three general principles:

In every motion the same force is always conserved.

Force is the quantity of effect, ôr, what follows from this, the product of the quantity of the body and the quantity of velocity.

If the force were to increase, one would have artificial perpetual motion; if the force were to decrease, one would in the end have a natural perpetual rest; both of which are absurd.

(Fichant 1994, 71)[44]

But Leibniz finds himself forced to abandon the accepted measure of motive force because of its incompatibility with the constant rectilinear translation of the centre of gravity of a system of bodies.[45] In sheet 2.2 he is considering the collision between a smaller body m_1 moving at velocity u_1 colliding with and then rebounding from another body m_2 at rest, resulting in them both moving away with respective velocities v_1 and v_2.[46] Using the Cartesian measure for motive force together with "the hypothesis of the conserved distance"—which, over any given duration, reduces to the conservation of the relative velocity, $u_1 - 0 = v_2 - v_1$—he finds that the force after the collision "is

[43] In order to prove that the centre of gravity of several weights falling under gravity "cannot rise higher than the place at which it was located at the beginning of its motion" (Hypothesis 1, Part IV; Huygens 1986, 108), Huygens had taken it to be "beyond doubt" that this was so for a single heavy body (108).

[44] *De corporum concursu*, in Fichant (1994, 71).

[45] For details and an excellent analysis of Leibniz's intellectual odyssey in identifying the correct laws of collision, I refer the reader to Michel Fichant's commentary in his *La réforme de la dynamique* (Fichant 1994), which explains many important developments and nuances that I am glossing over here: Leibniz's doubts about the invariance of translation of the centre of gravity of a system, the emergence of his principle of continuity, his examination of and reaction to the views on elastic collisions of Wallis and Mariotte, his detailed experiments and analysis thereof, etc.

[46] Here I have modernized Leibniz's notation: he had e for u_1, ε for u_2, y for u_1, etc. See Fichant (1994, 89ff.). I have also translated his *celeritas* (literally, swiftness) as velocity. Leibniz conceived the impinging body as coming from the right of the body at rest, so positive velocities are those towards the left, and negative are those towards the right; and all velocities are uniform and rectilinear.

greater than the force which existed before the collision, which is absurd" (91).[47] This moves him to investigate "what would result if what must be conserved is not the same quantity of motion, but rather (in a way that I have explained elsewhere) the same quantity of force, for then one would have to multiply the body by the square of the velocities" (Fichant 1994, 91). By a short calculation he then shows that if one assumes

$$m_1 u_1^{\,2} = m_1 v_1^{\,2} + m_2 v_2^{\,2} \quad \left(\text{conservation of } mv^2\right) \text{ and} \tag{1}$$

$$m_1\left(u_1 - v_1\right) = m_2 v_2 \quad \begin{array}{l}\text{(constancy of translation of the centre of gravity,}\\ \text{i.e. what we call conservation of momentum)}\end{array} \tag{2}$$

then subtracting $m_1 v_1^{\,2}$ from both sides of (1) and dividing the resulting equation by (2), we obtain

$$u_1 + v_1 = v_2, \text{ or } u_1 - 0 = v_2 - v_1 \tag{3}$$

This is the conservation of relative velocity (the relative velocity between the two bodies is the same in any given direction before and after a collision).

Now Leibniz reverses the calculation, so that the conservation of the measure of force mv^2 (1) follows from the two assumptions (2) conservation of momentum (which he usually calls the conservation of total direction), and (3), the requirement of conservation of relative velocity. So he has derived the conservation of mv^2 from these two principles. This will hold not just for this case, but for all elastic collisions, and Leibniz will later repeat it in his *Essai de dynamique* of 1699–1700: from any two of the following equations the third can be deduced:[48]

$$m_1 u_1^{\,2} + m_2 u_2^{\,2} = m_1 v_1^{\,2} + m_2 v_2^{\,2} \quad \left(\text{conservation of } mv^2\right) \tag{1}$$

$$m_1\left(u_1 - v_1\right) = m_2\left(v_2 - u_2\right) \quad \left(\text{conservation of total direction}\right) \tag{2}$$

$$u_1 - u_2 = v_2 - v_1 \quad \left(\text{conservation of relative velocity}\right) \tag{3}$$

This amounts to saying that in all and only perfectly elastic collisions, defined as ones in which no force is lost, the relative velocity will be conserved. But the relative velocity is not conserved in inelastic collisions, as when an arrow hits its target, for example. For this reason, Huygens and others would not have expected this result to remain valid beyond the ideal case of two perfectly hard bodies rebounding from one another. Leibniz, however, followed Mariotte in believing that all matter is elastic, to a greater or

[47] In a note on sheet 2.2 Leibniz writes, "In this sheet it is rightly concluded that the same path, or same distance, of the centre of gravity is not conserved, when it is supposed that the same quantity of motion is conserved. It is absolutely true that it is wrongly concluded that the distance and path of the centre are not conserved, for the Cartesian hypothesis of the conservation of quantity of motion is false" (Fichant 1994, 89).

[48] (GM VI 226–8); cf. Fichant (1994, 211).

lesser degree. Moreover, he wished to explain elasticity mechanically (as noted in Chapter 2), in terms of the motions of particles within. Thus on his analysis, when some force is apparently lost in an inelastic collision between two bodies, it is in fact redistributed among the component particles of the bodies (or given off as particles of sound).[49] In another unfinished fragment from this period, partially redacted by Fichant, Leibniz writes:

> In every entire machine, ôr in every total aggregate of bodies being subjected to some action, the power remains the same before and after the action. Hence when the sensible power of the agents declines little by little, this happens not because the impetus perishes, but because it is redistributed in the insensible parts of the surrounding bodies (which I count as being in the entire machine). And since the whole universe is a most perfect entire machine, for no body can be assumed outside it that would take away part of the impetus, it follows that the same power ôr force always endures in the world.[50]

As Fichant perceptively observes, this accords with what Leibniz had written in *Scheda* 7 about change always being minimized:

> *The entire effect is assimilated to the full cause in to the extent that this can occur*. For the entire effect is only a certain change of the full cause, and indeed as small a change as possible. For example, the present state of the world differs as little as possible from its entire cause, sc. its preceding state. Of course, the effect and cause only differ in some formal particular, in sum, they agree. (Fichant 1994, 145)
>
> The same quantity of forces always remains in the same machine, i.e. in the same aggregate of however many bodies constituting it by their action and passion. Any external body, though, is excluded, or at least, not considered. There is always the same quantity of forces in the world, because the whole world is a machine. (146)

Leibniz did not remain content with an a priori argument against the Cartesian measure of motive force. He conducted a whole series of detailed experiments with pendulums whose bobs were made of hard wood, tabulating how much motive force was lost and comparing it with theoretical predictions (sheet 2.2, Table 2). Having come to the realization that the correct measure of motive force should be mv^2 and not mv, he redid the calculations accordingly in his Table 3, noting that the substitution of Table 3 for Table 2 was done "after the appearance of sheets 8, 9 and 10, to make it possible to reconcile the conservation of distance and direction with the conservation of forces" (137).

But where does the measure of force mv^2 come from? This depends on Leibniz's identification of raising a weight to a certain height under gravity being a perfect

[49] As Leibniz explained to De Volder in his letter of 3 April 1699, "According to my hypothesis [of the conversation of force], to the extent that bodies are not perfectly elastic, the force is taken up by their internal parts, which are also elastic themselves, and so it does not perish but just becomes insensible" (LDB 70/71).

[50] *Principium Mechanicae Universae Novum* (*New Principle of the Mechanical Universe*), LH XXXV, 10, 5, fo 1–2, 3–4; date uncertain, probably after 1680; quoted from Fichant (1994, 290).

exemplar of a *full cause*. For, as he well knew, Huygens had proved in Proposition III of the *Pendulum Clock* that for a given mass in free fall the distances of fall are proportional to the squares of the times of fall, or "the squares of the velocities acquired at the end of these times" (Huygens 1986, 36). As Huygens had shown, this follows from Galileo's result that the velocities produced by falling bodies are as the square roots of the heights through which they fall.[51] If all friction is absent, the entire effect of the force of raising the pendulum bob through height h consists in the motive force of the bob's motion at the lowest point of the swing. Now an application of the Principle of Equipollence shows that the motive force, as the entire effect produced by this full cause, must be proportional to "the body" (i.e. to its mass) and the square of its velocity.

This origin of the mv^2 measure is acknowledged by Leibniz on sheet 2.2. Summarizing the series of experiments he has performed and analysed in Table 2, he writes: "Some force is always found to be lost in the experiment, and certainly the quantity of motion never increases. By these experiments, then, the systems of Huygens, Wren, Wallis and Marriotte are overturned." But in a note added along with the revised Table 3 ("after the reform," as Fichant puts it), Leibniz adds:

> *I see now where they were mistaken: namely, in the fact that the force in a body should not be estimated by the speed and magnitude of the body, but by the height through which it has fallen. But the heights through which bodies have fallen are as the squares of the sought speeds. Therefore so are the forces, assuming the bodies are the same. But generally forces are in the compound ratio of the bodies taken simply and the squares of the speeds. Hence two bodies have equal forces not, as is commonly thought, when the speeds are reciprocally as the bodies, but when the squares of the speeds are reciprocally as the bodies. Hence it is clear that the same quantity of motion is not conserved, but only the same force. (Fichant 1994, 134, 269–70)

Now, it may be objected, this is all physics. What does it have to do with any changes in Leibniz's metaphysics? In the heading to section §18 of his *Discourse on Metaphysics* Leibniz asserts that "The distinction between force and quantity of motion is important, among other reasons, for judging that one must have recourse to metaphysical considerations distinct from extension in order to explain the phenomena of bodies" (A VI iv 1558/WFT 71). Likewise, in a passage from a dialogue Leibniz wrote in Rome in 1689, he makes a similar assertion, specifically identifying the Principle of Equipollence as the thread that led him out of the labyrinth:

> Accordingly I discovered no other Ariadnean thread that would finally extricate me from that labyrinth than the calculation of powers, assuming this metaphysical principle, *that the entire effect must always be equal to its full cause*. I realized that this is really in perfect agreement with experiments, and satisfies all doubts, and I became all the more confirmed in the opinion I had stated that the causes of things are not surd, so to speak, and purely mathematical, as are

[51] Huygens, however, has unwittingly introduced a subtle but momentous change in interpreting "velocity". For Galileo, this is the swiftness of the overall fall; for Huygens and subsequent tradition, it is the instantaneous velocity at the end of the fall. See Damerow et al. (1992) and Arthur (2016) for analyses.

collisions of atoms or a kind of blind force of nature, but proceed from a certain intelligence which employs metaphysical reasons. (Leibniz 1991, 811)

But of course it is no less true of the views of Malebranche and the occasionalists that one must have recourse to the divine nature to ground the laws of nature, yet they all subscribed to the Cartesian measure of motive force as quantity of motion. So the discovery of the new law of force in itself seems insufficient to motivate the rehabilitation of substantial forms. Indeed, two of Leibniz's most influential and perceptive commentators have argued that the connection between the discovery of the correct measure of force and the philosophy of forms is tenuous. Michel Fichant and Dan Garber both argue that in the *De corporum concorsu* Leibniz has not emancipated himself from the occasionalism of the *Pacidius Philalethi*. Commenting on the passage from the *Pacidius* we analysed in section 5.2, where Leibniz asserts that bodies are in themselves devoid of action and that "a body cannot even continue its motion of its own accord, but stands in continual need of the impulse of God" (A VI iii 567/LLC 213), Fichant observes, rightly, that "the occasionalism to which Leibniz here adheres consequently rids motion of all internal efficacy and relocates all efficient cause in God". But, he claims, this "quasi-occasionalism of the *Pacidius Philalethi*, which is expressed also in the considerations of sheet 7, finds a provisional confirmation" in the *De corporum concorsu* in the continuation of the above passage from the note added to sheet 2.2:[52]

Furthermore, from these things it follows that bodies are ordinarily carried by themselves, once they have conceived impetus, for in this way they can remember from what height they have fallen, or understand in what system they are carried; but it is necessary either that they are perpetually carried by a general motive force [*motor*] (which is not satisfactory, because a body would also have its own force, which would be compounded with the general one), or rather that they are continuously impelled by a very wise cause that remembers everything and can never fail; and so the Laws of Motion are nothing other than the reasons of the divine will, which assimilates the effects to the causes as much as the reason of things allows.

(Fichant 1994, 134, 270)

Garber follows Fichant in seeing in this passage "a clear statement of the view" (*viz.*, occasionalism) (2009, 192–3). But I read this passage somewhat differently. It is true that we are only at a transitional stage here, and Leibniz has yet to work out all the metaphysical implications of his discovery of the correct measure of motive force. Nevertheless, I think in this passage one can see significant changes from the philosophy of the *Pacidius*, for now bodies are "carried by themselves", despite the fact that they

[52] Fichant (1994, 269). In the same vein Fichant writes in his introduction: "In sum, he could have integrated these newly obtained results to a philosophy of 'the irresistibility of nature', in giving the exact expression of an original dynamist intuition; but this dynamism does not yet find its physical justification in the analysis of the internal spontaneity without which bodies, according to the latter doctrine, do not involve anything substantial; in this sense the conservation of mv^2 is still accommodated to a quasi-occasionalist interpretation, whereas later it will contribute to accrediting the productive action of the internal force to 'nature itself' " (64).

need God as a source of their motive force. (As I shall argue in Chapter 7, even in his mature writings Leibniz continues to subscribe to continuous creation in this sense: bodies depend on God's force for their continued activity, even though this is manifested as a force within them.) Moreover, in this passage bodies are described as carrying within them a *memory* of the height through which they have fallen, and as being *sensitive* to the system of which they are a part. Both of these are characteristics of his notion of a substantial form under the guise of "mind" in the Paris period, as we have seen above.[53] What is important for Leibniz is to locate the reason for the body's motion or sequence of states within the body itself. God may still be the source of the force that the bodies possess, but if the reason for the particular changes a body undergoes derives directly from God, then no created thing can be the source of its own actions. Garber draws our attention to the final sentences of the fragment we considered at length in section 5.2, the *PMMD* of 1678–81 which he identifies as signifying a change away from the occasionalism of the *De corporu concorsu* in the direction of the view expressed in the *Discourse*. I agree that it represents a definitive break with the quasi-occasionalism of the *Pacidius*, but regard it as a carrying to their conclusion of the implications of the passage we have just been considering:

> And other authors have been mistaken in that they have considered motion itself, but not motive power ôr the reason for motion, which, even though we derive it from God, author and governor of all things, must be understood not as being in God himself, but as being produced and conserved by him in things. From this we shall also show that what is conserved in the world is not the same quantity of motion (in which many people have been deceived) but the same quantity of power. (*PMMD*, A VI iv 1980; cf. Garber 2009, 193)

I see the connection between the physics and the metaphysics as follows. A substance is a thing that acts. For the Cartesians, the action of an extended substance is its motion. But Leibniz considered himself to have shown in the *Pacidius* that there is no action in body insofar as it is considered a movable extended substance, that is, insofar as it is treated merely geometrically. This would have the consequence that God is the only substance, since it is only God that can be said to act, *stricto sensu*.

As we saw in section 5.2, however, below the surface of the *Pacidius* is the idea that there are "things which by acting do not change", and also the view he had expressed a few months before, that "whatever acts cannot be destroyed, for it certainly endures as long as it acts, and therefore it will endure forever" (A VI iii 521/LLC 121; see Chapter 4). This is evocative of Aristotle's axiom in his *Physics* that "Whatever is once set in motion will always move in the same way unless it meets with an obstruction" (*Physics* IV, 8, 215a 19–22), but applied to *action* instead of to motion. In the *Pacidius*

[53] Compare these statements from the spring of 1676: "matter is not homogeneous, and we cannot think of anything by which it differs except mind" (A VI iii 491/DSR 50), and "even though it is not destroyed, mind nevertheless senses all endeavours, and receives them through its own body" (A VI iii 393, LLC 59). Earlier, albeit in a cancelled fragment, Leibniz had argued that "Cohering bodies are sympathetic [*sympathica*]", on the grounds that "every passion of a body is a being moved ôr being impelled by another. Therefore it is necessary that cohering bodies sympathize" (A VI iii 80, LLC 3–5).

Leibniz puts Aristotle's axiom in the mouth of the character Gallutius, who adds that "this axiom can be demonstrated from the fact that no reason can be provided why it should stop at the present moment when it has not already stopped a little while before" (A VI iii 568/LLC 215).[54] In reply, Pacidius notes that this had been used by some as an argument for matter not needing the aid of God to keep it in motion, since "having once received impetus, it retains it spontaneously from its own nature" (568/215). Now, the doctrine of motion he has developed in the *Pacidius* undermines this, since a body's "motion stops altogether, and does not last for any time however small", until it is "resuscitated by the aid of a superior cause". But since God acts in the most perfect way, "once he has chosen the forms of changes in some stretch of time, he will not change them without a reason", with the result that the Aristotelian axiom "remains upheld in nature" (568/215–17).

After Leibniz has rehabilitated substantial forms, however, he is able to place a source of action in the substance within the body. Now the reason for its present state's following from its preceding ones can be located in that substance rather than in God, without detracting from its need for God's continuing concurrence to keep it in existence. Consequently, the Aristotelian axiom can be applied to the actions of individual substances. For in the absence of substance–substance interaction there is no external thing which can cause a substance to cease acting. There being no reason why it should cease to act at any given time, a substance must (given God's concurrence) therefore act at all times. "Every substance is actually operating, as is demonstrated in Metaphysics," he writes in his *Metaphysical Definitions and Reflections* of *c.* 1678–9.[55]

Thus the significance of the Principle of Equipollence and the calculation of powers—the reason why Leibniz regarded it as his Ariadnean thread—is that it enabled him to reconceptualize action in terms of powers possessed by bodies, residing in the substances they contain. The action of one body on another in a collision cannot consist in the exchange of impetus or quantity of motion, since the same effect is produced whichever of two bodies is moving, and depends only on their relative velocity. But once action is conceived as the ability to bring about an effect, this can be calculated by appeal to the Principle of Equipollence. In the case of the pendulum we see that (neglecting force lost to friction) it has the same power when it has risen to a certain height and is no longer moving, as when it is moving with maximum speed at the bottom of its swing. Given the equipollence of cause and effect, the power or ability to do work that the pendulum bob has at the top of its swing is calculable as equivalent to its motive force when it has fallen through a given height, mv^2, even when it is not

[54] As Leibniz knew, this demonstration had been given by Hobbes, who argued that "whatever is moved will always be moved" in the absence of an external impediment to its motion, for without any external cause of its ceasing "there will be no reason why it should come to rest now rather than at some other time, thus its motion would cease in every point of time altogether, which is unintelligible" (Hobbes, *De corpore* ch. 8, §19).

[55] Cf. Aristotle's argument in his *Metaphysics*: "If there is to be generation and destruction, there must be something else which is always acting in different ways" (Book L, chapter 6, 1072a).

moving. This force or power of bodies is the phenomenal manifestation of the action of the substances it contains, and to the extent that it remains the same machine, it retains the same total force or power.

In order for a body to act as opposed to be acted upon, moreover, it must contain within itself the reason for motion to be ascribed to it rather than the patient. Again, this is determined by appeal to metaphysical considerations, not to physical ones (as it is in Newtonian mechanics), namely by appeal to the most intelligible hypothesis. This involves consideration of simplicity, a criterion that has often been criticized for its vagueness. But Leibniz understands it distinctly enough, as involving the minimization of the outlay of force to achieve the same effect. Thus it is clearly more intelligible to explain the rotational motion of the Earth relative to the heavens as resulting from the Earth's spinning on its own axis, since it would require incalculably more outlay of force (in the sense of capacity to do work) to move the heavens around the Earth. It is in this sense, I believe, that Leibniz is to be understood when he claims that an appeal to force provides the basis for attributing motion to one body rather than another, despite the relativity of motion, understood purely geometrically. In this sense, then, Leibniz can say that the Earth is truly spinning, despite the equivalence of the phenomena in the Copernican and Tychonic systems.

Causation, in sum, does not consist in a body's imparting an endeavour or quantity of motion to the patient, but in its having the power to produce a certain repeatable effect, that is, a capacity for doing a certain quantum of work. A body must also, as we have seen, have a power to resist change of motion, a power that cannot be derived geometrically (that is, if its nature consists solely in its being a movable extended thing). Such powers in body, Leibniz concludes, cannot be "deduced from extension and its variation or modification alone", and must therefore consist in bodies containing "certain notions ôr forms that are immaterial, so to speak, ôr independent of extension, and which one may call powers, by which speed is adjusted to magnitude", as Leibniz writes in the *PMMD* of *c.* 1678 (A VI iv 1980). Thus it is not as if Leibniz discovers the conservation of force and only then interprets these forces as supporting a metaphysics of forms: they are conceived from the beginning of his mature dynamics in 1678 as immaterial forms that are derived from metaphysical considerations concerning cause and effect. "These powers do not consist in motion, nor indeed in endeavour or the beginning of motion, but in that cause ôr intrinsic reason for which a law of continuing the motion is required" (1980).

The powers are enduring forms in body—a revised version of the Aristotelian "principles of motion and rest".[56] But these do not work like the scholastics' substantial

[56] Cf. what Leibniz wrote in an untitled manuscript from May 1702: "With Plato and Aristotle, but against Democritus and Descartes, I acknowledge a certain active force or entelechy in body, so that to me it seems Aristotle was right to have defined 'nature' as 'the principle of motion and rest',… because I believe every body always has a motive force, indeed an actual intrinsic motion, implanted [*insitum*] in it from the beginning of things" (GP IV 393/AG 250).

forms by actually effecting changes in the body they inform, as the form of a plant, say, steers it towards the light. Rather such enduring powers must be presupposed in bodies in order to explain how they are able to run through their changes following the laws of motion without having to call upon God's direct action. They do this by containing the reason for the body's behaviour, its succession of states, in relation to those around it, and with something analogous to a memory of its past states, so that its activity can be regarded as this succession of states, together with an internal principle for generating them, namely appetition. In constituting what it is in a body that acts, such a form is what is substantial in its motion. It provides the reason for regarding the body containing it as the cause of certain phenomena, and as the subject of the motion involved. As Leibniz writes in an important early statement of his new theory of substance, written on the back of a bill dated 29 March 1683:

> And just as colour and sound are phenomena, rather than true attributes of things that contain a certain absolute nature without respect to us, so too are extension and motion. For it cannot really be said just which subject the motion is in. Consequently nothing in motion is real besides the force and power things are endowed with, that is to say, beyond their having such a constitution that from it there follows a change of phenomena constrained by certain rules.
>
> (*Wonders concerning the nature of corporeal substance*; A VI iv 1465/LLC 263)

As this quotation evinces, the powers in things are what bring about changes of phenomena according to certain rules, and are thus the principles for the laws of motion in things. Bodies do not "know" how to react in any strict cognitive sense; but they do contain within them the nomological basis for the changes in phenomena, as well as the force for continuing their motion. The significance of the discovery of conservation of *vis viva* is that it is the phenomenal manifestation of this self-continuing force.

For Leibniz, of course, it is the fact that this force is "inherent [*insitum*] in bodies from the beginning of things" that crucially distinguishes his philosophy from occasionalism, as he explains in the 1702 manuscript (GP IV 393/AG 250). Even though motions have their origin in God as general cause, their immediate and specific cause "ought to be attributed to a force implanted [*insitum*] in things by God".

> For, to say that in Creation God gave bodies a law for acting means nothing unless, at the same time he gave them something by means of which it could happen that the law is carried out; otherwise, he himself would always have to manage the carrying out of the law by extraordinary means. Rather, however, his law is efficacious, and he rendered bodies efficacious, that is, he gave them an inherent [*insitum*] force. (GP IV 396–7/AG 253–4)

Substantial forms are also supposed to be the principles of individuation of bodies. Such a form is what makes the ever-changing material body (consisting of perhaps imperceptibly different aggregates of constituents from one moment to another) the body of the same thing. Leibniz has abandoned the idea that what persists are atoms,

as we saw in Chapter 3. But how, one might ask, is Leibniz's restitution of forms related to his discovery of the conservation of force?

In 1676 he had speculated that perhaps each atom might act with an equal force: "it should be discussed . . . whether perhaps some remarkable proportion is observed, so that the velocities of bodies tending in different directions are in inverse proportion to their magnitude, so that every single atom would act with an equal force overall" (A VI iii 525–6/LLC 63). At this juncture he was thinking of force in terms of the product of "magnitude" and velocity, i.e. as quantity of (directed) motion. But when in 1678 he discovers what he considers the correct measure of force, Leibniz reconsiders the idea of the conservation of force in connection with the way matter is divided into parts. In his *Metaphysical Definitions and Reflections* (1678–9) he notes that the key to a given body's being one despite the multiplicity of its divisions, as we saw in Chapter 4, is not the conservation of matter or of motion, but of *power*. "Anyone seeking the primary sources of things", he writes there, "must investigate how matter is divided into parts, and what their motion is". His own investigations show that:

> A unity must always be joined to a multiplicity to the extent that it may. So I say that matter is divided not even into parts equal in bulk [*mole*], as some have supposed, nor into parts equal in speed, but into parts equal in power, but with bulk and speed unequal in such a way that the speeds are in an inverse ratio to the size. (A VI iv 1401–2/LLC 251)

Leibniz is no longer thinking of the parts of bodies as atoms. A body has no constant shape or size: it constantly undergoes deformations of shape and size depending on the motions of its parts. But the parts into which it is divided are still actual parts, individuated at each moment by their motion in common. The idea here is that an isolated body, suffering no exchanges of matter, retains the same total quantity of force, which gets differently distributed among its constituent parts from one moment to the next in such a way that quantity of progress (what we call, following Newton, *momentum*) is also conserved in all the collisions. This *ratio*[57] for the motions of its constituent parts is thus also the reason for its divisions, both of which are infinite.

Of course, in the plenum bodies do not remain truly isolated from one another, but are always experiencing the effects of the motions of other bodies. As we saw, this was one of Leibniz's arguments for supposing atoms in the first place: without any principles to sustain their unity, the effects of the motions in the plenum will always result in the dissolution of bodies. Once Leibniz has reintroduced substantial forms, however, atoms are replaced by corporeal substances, each consisting of an organic body and its associated form. But an organic body is a machine, indeed, a machine in all its parts. As I suggested in Chapter 4, this suggests an interesting connection between the restitution of forms and the discovery of the conservation of force. For

[57] For a lucid explanation of Leibniz's concept of *ratio*, as well as of the Platonist underpinnings of Leibniz's early work in general, see Christia Mercer's discussion in her (2001).

"the same quantity of forces always remains in the same machine, i.e. in the same aggregate of however many bodies constituting it by their action and passion" (Fichant 1994, 146). A corporeal substance therefore is not a unity in the sense of something that retains the same material parts. It remains the same aggregate—no matter what particular parts it has—to the extent that it manages to sustain the same force, notwithstanding any losses of matter or internal divisions or foldings and unfoldings that it undergoes. Force is not lost; it is simply redistributed in the forces of the parts constituting the organic body of the substance from moment to moment.[58] This conservation of derivative active force is therefore a phenomenal manifestation of the self-identity of substance, as well as of its power to produce work. A substance is a thing that acts, and that, once it is acting, cannot fail to continue acting. Since derivative active force—what we call energy—is the instantaneous measure of the capacity for work, this also cannot fail. This is Leibniz's ground for introducing the conservation of *vis viva*, and thus the origin of one of the most important conservation laws in modern physics. But the fact that force is always conserved in the same machine, coupled with the fact that what makes an organic machine the same machine is its possession of an entelechy, suggests that an animal will continue to exist with the same total force for as long as its entelechy exists, notwithstanding any loss of material parts—or even its apparent death! This entails that *the living being or corporeal substance is naturally indestructible*, just like the monad or entelechy it contains: "Thus we can say that not only is the soul—the mirror of an indestructible universe—indestructible, but so too is the animal itself; even though its machine may often come to an end in part, and throw off or take on an organic coating" (*Monadology* §77; GP VI 620/WFT 279).

In sum, Leibniz appeals to his reconstituted substantial form to perform several functions. As the principle of activity in bodies, it is the entelechy responsible for their actuality, and as such is presupposed in every actual part of a body. This principle of activity is identified by Leibniz as primitive active force, a power existing in an organic body that accounts for that body's activity, and thus constitutes its form. It is what is real in motion at any instant, and the ground for the continuity of the changes constituting that motion. Primitive active force is manifested phenomenally in its various instantaneous modifications, the derivative active forces in bodies, including living force and dead forces such as the centrifugal and elastic forces. These forces consist in the power to produce work, and are therefore proportional to mv^2 not to mv. Just as the primitive force is an enduring power of acting that can never cease, so the derivative active force is likewise conserved in every organic machine and in every isolated system of bodies, and therefore in the universe as a whole.

[58] A point that is deserving of much fuller discussion is Leibniz's description here of a body's force as *infinite*: "The power of every body is infinite; but I call a body one if every action of its parts is an action of that one body and if the parts of this body are infinite" (A VI iv 1401/LLC 249). This may not be a position that Leibniz will continue to uphold, but it is clearly significant in assessing the origins and meaning of his conservation principle.

Bodies, however, do not just act; they are acted upon. The power responsible for this receptivity to being acted upon is the primitive passive force, the second constituent of substance. How these two powers are related, and how the passive power can be said to constitute the materiality of bodies, remain to be discussed. Many doubts have been raised about Leibniz's continuing commitment to the foundational role of dynamics in the last period of his life, as well as the status of corporeal substance in those years. These are the subject of Chapter 6.

6

Passive Force and Corporeal Substance

> "I think the extended has no unity except in the abstract, that is to say, when we abstract the soul from the internal motion of the parts by which each and every part of matter is again actually subdivided into different parts. . . . Nor do the parts of matter differ only modally if they are distinguished from one another by souls and entelechies, which always subsist."
>
> (to De Volder, 3 April 1699; GP II 171/LDV 73)

> "We correctly maintain that bodies are things, for even phenomena are real. But if someone wishes to maintain that bodies are substances, it will require, I believe, some new principle of real union."
>
> (to Des Bosses, 15 March 1715; LDB 330/331)

In Chapter 5 we saw how Leibniz achieved the rehabilitation of substantial forms by identifying force as the principle of activity in bodies. This primitive active force is a power existing in an organic body that accounts for that body's activity, and thus constitutes its form. It is what is real in motion at any instant, and the ground for the continuity of the changes constituting that motion. Its modification is derivative active force, which is conserved in every isolated system of bodies, and therefore in the universe as a whole. Now it may be objected that if a substance is a thing that acts, this would seem to imply that substance is constituted by primitive active force alone, rendering the status of primitive passive force moot or uncertain. Matter, on this reading, would be a pure phenomenon. It has also been suggested that Leibniz's labelling of derivative forces as phenomena indicates a demotion of corporeal substances to the realm of appearance. The latter suggestion is fortified by doubts over how composites could qualify as simple, and also by the failure of Leibniz's attempts to articulate the idea of substantial bonds in his correspondence with Des Bosses, which has been taken as evidence of the demise of corporeal substance in his mature philosophy.

These are the issues I will explore in this chapter. If the above analyses are correct, and such tensions in his position did indeed prompt Leibniz to modify his philosophy of substance in these ways, his rehabilitation of substantial forms as a solution to the continuum problem would be utterly compromised. Monads could still be principles of unity underlying phenomena, although they would no longer be the entelechies *of*

bodies, just perceivers producing appearances of bodies. But if matter were a mere appearance or if it were not actually divided by active and passive derivative forces seeded everywhere in it, this would obliterate the contrast between the actual parts that are prior to the whole and the merely potential parts into which matter could be divided, the foundation on which Leibniz's solution to the continuum problem rests.

There are no explicit statements on Leibniz's part of any such change of position regarding his philosophy of substance. The quotations I gave at the beginning of the introduction show that he still regarded monads as necessary for the solution to the continuum problem in 1710, and even 1716. Of course, that does not prove that the tensions noted above are merely imaginary. But if Leibniz was indeed being pulled in the direction of idealism, it would be very strange for him not to have acknowledged the relevance of this to his vaunted solution to the continuum problem. I hold that he did not change his position. Accordingly, in this chapter I shall try to show how the difficulties outlined above can be circumvented when Leibniz's philosophy of substance is understood from the perspective of constituting a solution to the continuum problem.

With regard to the first objection concerning the status of passive force, I argue that Leibniz's position is that an entelechy can never act in isolation: its action must always take into consideration the actions of the other created substances with which it coexists. This constraint on its actions manifests itself in each substance as a passive force. As a permanent power in created substance, passive force is essential to the substance. But like active force, it is not a pure potentiality, but is always manifested at each instant. For example, as I discuss in section 6.1, the extension of a body is a manifestation of the diffusion within it of the derivative passive forces of the substances constituting the body. But these passive forces are only manifested as resistances to motion or penetration, and therefore presuppose active forces that they are resisting. What is diffused, therefore, is "the principle of acting and being acted upon"—i.e. both primitive active and primitive passive force taken together, the ground of the derivative active and passive forces. On this reading, derivative forces are not restricted to some phenomenal "realm" distinct from that of primitive forces. They are the phenomenal effects of the primitive forces—phenomenal in the Platonic sense that they are instantaneous modifications of those forces, of forces which are substantial because they are the enduring entities.

As we shall see, this analysis of extension links nicely with the conclusions of previous chapters. Extension is not an independently existing thing, as in Descartes' philosophy. It is a characteristic of a plurality of bodies. Bodies, as we have seen, are aggregates of actual parts that are individuated by the entelechies existing in matter. These entelechies manifest at each instant as the active forces or endeavours with which differing parts are moved, and are complemented by the passive forces accounting for these parts' resistance to penetration. In this way matter is actually divided or folded into parts that are not purely modal, or dependent on being perceived. But although the resulting folds are actual, they are also infinitely variegated, on ever smaller scales. Unities of matter, bodies, appear only on certain scales and relative to particular observers and the

fineness of their sensory discrimination. So bodies are aggregates of actual parts, but their unity is perceptual or relative to the observer.

But in his correspondence with the Jesuit Batholomew Des Bosses, Leibniz experiments with a different account of the unity of bodies, according to which the constituent monads of an organic body are linked by a substantial bond (sometimes translated "substantial chain") to form a real continuity. This notorious heterodoxy is the subject of section 6.2. I argue that Leibniz conducts this experiment (in epistolary collaboration with Des Bosses) as an attempt to provide an account of the real union of body and soul that would be acceptable to the Jesuits, and not out of any shortcoming he finds in his own metaphysics. According to what I take to be his standard conception, the body of a corporeal substance is an aggregate of subordinate substances that is always changing, so that it is not some self-same thing that can enter into a real union with the soul. What Leibniz comes to see as required to satisfy the Jesuits' demand for the real union of body and soul is something that would unite the subordinate monads which constitute the body, independently of the dominant monad. With such a substantial bond uniting the subordinate monads, the body itself would be rendered a corporeal substance in its own right, which might then be (miraculously) united with the substance of Christ, as required in the Catholic interpretation of the Eucharist. The idea goes through various formulations in response to Des Bosses' criticisms. All of this, however, is in an effort to provide a supplement to his metaphysics that would satisfy the Jesuits' desiderata, not something Leibniz regards as necessary, either for his own metaphysics, or for his (Lutheran) understanding of the miracle of the Eucharist. It does not stem from a dissatisfaction with his standard account, in which the spatial continuity of bodies, like their unity, is constituted by perception, and the per se unity of a corporeal substance, its principle of individuation, is the dominant entelechy itself.

6.1 The Status of Passive Force

In Aristotelian philosophy the active is incomplete without the passive, and the passive incomplete without the active, and substance requires both together. Leibniz states his agreement with this axiom very clearly,[1] and as we have seen, puts it to use in his critique of Cartesianism and of the atomism of his contemporaries. *Res extensa*, as something merely passive, cannot be a substance. This is spelled out by him in his *Mira de natura substantiae corporeae* of March 1683, from which we have already had occasion to quote as one of Leibniz's first accounts of the phenomenality of extension and motion.

[1] His agreement is explicitly stated, for example, in his *Addition à l'Explication du système nouveau…* of 1700: "The opinion of the Schools, that the soul and matter are something incomplete, is not as absurd as one might think. For matter without souls and forms or entelechies is only passive, and souls without matter would only be active: the complete corporeal substance, truly one, that the Schools call an *unum per se* (as opposed to an *unum per aggregationem*) must result from the principle of unity, which is active, and from the mass that constitutes the multitude, which will be passive only, if it contains only primary matter" (GP IV 572). Cf. also his reply to Johann Bernoulli (GM III 551/AG 168).

Contrary to the Cartesians, he explains there, it is not extension that belongs to the substance of a body, but matter and form:

> Extension does not belong to the substance of a body, and neither does motion, but only *matter*, i.e. the principle of passion or of limited nature, and *form*, i.e. the principle of action or of unlimited nature. For every created thing contains both the limited and the unlimited: the limited in respect of distinct cognition, and of irresistible power, and the unlimited in respect of confused cognition and of refracted action. For every soul, or rather every corporeal substance, is confusedly omniscient and refractedly omnipotent. For nothing happens in the whole world which it does not perceive, and it has no endeavour that does not extend to infinity. . . . Every created thing has matter and form, i.e. is corporeal. (A VI iv 1465–6/LLC 265)

We can shed further light on these rather gnomic claims by returning to the highly interesting set of reflections that Leibniz had penned in late 1678 apparently as drafts of his "little book on the Elements of Physics". We discussed these reflections in Chapter 1, but it will be worth going over them again in some detail. In them Leibniz begins by defining body as an extended substance, a definition he will soon come to abandon. But he adds that this is equivalent to defining it as "a movable extended thing [*extensum*]", an equivalence that follows from his defining "substance as that which can act, while the action of an extended thing is by motion, namely local motion" (A VI iv 1398/LLC 245). So what is important is that a body "can act and be acted upon", and that this action occurs by local motion. Now since a body's being acted upon is its receiving a new endeavour, this will effect divisions in it. A body incapable of being divided is incapable of being acted upon. Consequently, every body

> is actually divided into smaller parts endowed with their own particular motions, so that there are no atoms. For every finite substance is actually acted upon (for, since it is actually acting, and is finite ôr imperfect, its action is always refracted, ôr to some extent impeded), whereas every passion of a body is by division. (A VI iv 1398/LCC 245)

A "passion" is an instance of being acted upon. So the "principle of passion" is that by which a body is divided by motions introduced into it. Thus matter is a principle of multiplicity: it is the source of the passions that result in the body's being divided; form, on the other hand, is identified as the principle of unity and the source of the motions that result in these divisions.[2] Thus, Leibniz continues:

> Substantial form ôr soul, is the principle of unity and duration, matter that of multiplicity and change. For since we have said that body is actually divided into parts, each of which is agitated with a different motion, and since for the same reason each part is again divided, then certainly

[2] This way of conceiving matter and form is something Leibniz could well have inherited from his reading of Zabarella, who attributed it to Averroës: "This is why Averroës, in the solution to the eighth doubt of the first disputation against Al Hazel, says that matter is the cause of numerical multitude, but that the cause of the distinction in numerical multitude is form" (Jacopo Zabarella, *De constitutione individui*, *c.* 345–7 in Zabarella 1590, *c.*34; quoted from Andreas Blank (2015, 4). See this article also for Blank's persuasive argument about Zabarella as a likely source for Leibniz's views on the soul as a principle of diachronic identity.

if we consider matter alone, no point will be assignable that will remain together with another, nor a moment at which a body will remain identical with itself; and there will never be a reason for saying that a body is a unity over and above a point, and the same for longer than a moment. And since points and moments themselves are not things, but bounds, i.e. modes, of things, it follows that if there were only matter in body, there would be no reality or perfection in it. But if there were only form in body, there would be nothing changeable and imperfect in it.

(AV VI iv 1399/LCC 245)

The connection with perfection is further explained as follows. Things strive for perfection through their forms, and these involve capabilities of sensing and of having appetite: "Every form is in a way a *soul*, ôr capable of sensation and appetite" (1400/247). Sensing is interpreted, following Hobbes,[3] as being acted upon, and appetition in terms of the propagation of endeavour: "Every body acts on all others and is acted upon by all others, ôr perceives all others", "Every body acts on every other body, and is acted upon by it. For since everything is a plenum, every endeavour is propagated to infinity" (1400/247, 249). But since a body can only act on others to the extent that they are capable of receiving that action, its endeavour "is refracted ôr to some extent impeded", thus limiting its power of action. "Thus every substance has in itself some participation in divine omniscience and omnipotence, even though its knowledge is confused, and its action is refracted by things acting in contrary ways" (1400/249).

For every substance is as perfect as it can be through all the other substances. But it cannot depend on all the others without there being in each one a soul, i.e. as much appetite as there is in it a force of acting, and as much sensation as there is in it a force of being acted upon. But to attribute a soul only to man and to a few other bodies is as inept as believing that everything is made for the sake of man alone. (A VI iv 1398–9/LLC 245)

This last remark echoes similar thoughts in the Conspectus for his *Elementa physicae*:

It is foolish to want to attribute perception to man alone; for all things can have some perception in proportion to the measure of their perfection; and so they do have it, since whatever can happen without detriment to others, does indeed happen, since all things happen as perfectly as possible. (A VI iv 1989/LLC 235)

This passage in the Conspectus continues with further themes that persist into Leibniz's mature philosophy: pleasure is perception of one's own perfection; pain is resistance to satisfying one's endeavour; and "there are as many universal mirrors as minds, for every mind perceives the whole universe, but confusedly" (1989/235).

One feature that will certainly change, however, is the description of body as a substance, and consequently the characterization of a substance's action solely in terms of endeavour, instead of in terms of force. Although (as we have seen) Leibniz has by this time (1678–9) already come to the conclusion that "force ôr power . . . must be estimated by the quantity of its effect" (1989/235), in this piece he still appears to be thinking of action and being acted upon in orthodox mechanical terms, namely, as the propagation

[3] See Garber (2009, 123), and Chapter 1 above.

and reception of endeavours in a body. As we saw in Chapter 5, however, as Leibniz develops his dynamics he will interpret a substance's ability to act in terms of its possession of active force, a force that is not even imparted to other bodies on impact, but rather conserved in each corporeal substance or body insofar as it remains an isolated system. Correlatively, a body's capacity for being acted upon, its passive force, will no longer be characterized simply in terms of its refracted endeavours, but also in terms of its capacity for resisting penetration (antitypy) and for resisting new motion (inertia).

One might think, though, that this metaphysics of substance as a composite of principles of acting and being acted upon is entirely undercut by the mature metaphysics, such as is sketched in the *Discourse on Metaphysics*. There Leibniz is moved to write: "It can therefore be said, in a way, and in a good sense, although one far from current usage, that one particular substance never acts on another particular substance, any more than it is acted upon by it" (§14; A VI iv 1551/WFT 67). But if properly speaking no substance can ever act on or be acted upon by another, it is hard to see how substance can be "a being that is capable of action", as he describes it on numerous occasions.[4] The *Discourse*, of course, was not published during Leibniz's lifetime, but the thesis that substances cannot strictly speaking be said to act on one another was a staple of his published essays—for example, in the *Nouveau système*: "It is quite true that, speaking in metaphysical rigour, there is no real influence of one created substance upon another" (GP IV 483/WFT 149–50).

It is clear, however, that Leibniz did not perceive a conflict between the two theses—that "the very substance of things consists in the power of acting and being acted upon" (*De ipsa natura*, §8; GP IV 508–9/WFT 214),[5] and that "in strict metaphysical rigour, there can be no proper influx from one created substance into another" (*Specimen dynamicum,* §§20–1; GM VI 242/WFT 162). The key to their compatibility is the theory of expression, according to which it is the nature of a substance to be able "to express the beings outside it in relation to its organs" (*Nouveau système*, §14; GP IV 484/WFT 150),[6] and for these internal perceptions in the soul to arise spontaneously in a sequence according to its own series of reasons. From this it follows that:

> since each of these substances accurately represents the whole universe in its own way and from a particular point of view, and since its expressions or perceptions of external things occur in the soul at just the right time in virtue of its own laws, . . . there will be a perfect agreement among all these substances, which produces the same effect as would be observed if they communicated with one another by means of a transmission of species or qualities. (GP IV 484/WFT 150)

[4] The quotation is from the *Principles of Nature and Grace* of 1714 (GP VI 598/WFT 258).

[5] Cf. also "the intrinsic nature of created things does not differ from the force of acting and being acted upon" (*De ipsa natura*, §9; GP IV 509/WFT 215) and "every substance is comprised by a force of acting and being acted upon" (*Specimen inventorum*; A VI iv 1623/LLC 317).

[6] Cf. *Principles of Nature and Grace*: "Every simple substance . . . is surrounded by a mass composed of an infinity of other monads which constitute the body of that central monad; and in accordance with the ways in which that body is affected, the central monad represents, as in a kind of centre, the things which are outside it" (GP VI 598–9/WFT 259).

Thus Leibniz is able to say both that "*every individual created substance exercises physical action and passion on all others*", and that "in rigour, *no created substance exercises metaphysical action ôr influence on any other*". These claims are made, with Leibniz's own emphasis, at the beginning of consecutive paragraphs in another unpublished manuscript, drawn up in 1689 most probably for his Italian colleagues. This has traditionally been known as *Primary Truths*, but the Akademie editors have now titled it *Principia logico-metaphysica* (A VI iv 1646–7). In justification of the first claim Leibniz cites his ultra-realist thesis that any change in the denomination of one substance results in a corresponding change in the denomination of every other coexistent: "when a change is made in one, there follows a corresponding change in all others, because its denomination is varied"; but he also appeals to the experimental fact that a motion made in the middle of a fluid (such as that filling the plenum) will propagate to all its extremities, "even though it is rendered more and more insensible the more it recedes from its origin" (1646). In justification of the second claim, he explains that "not to speak of the fact that it cannot be explained how something could pass from one thing into the substance of another, it has already been shown that from the notion of each individual thing all its future states already follow. And what we call causes are in metaphysical rigour only concomitant requisites" (1647). Again, Leibniz cites evidence from physics: "The same thing is illustrated by experiments on nature, for in fact bodies recede from other bodies by their own elastic force, not an external force, even though the other body would be a requisite for the elasticity (which arises from something intrinsic to the body itself) to be able to act" (1647). Leibniz had made the same claim in the roughly contemporaneous *Specimen inventorum*: "these things are true to the extent that in physics too, on careful investigation of the matter, it is evident that no impetus is transferred from one body to another, but each body moves by an innate force, which is determined only on the occasion of another, ôr with respect to it" (A VI iv 1620/LLC 311).

That is, strictly speaking and in metaphysical rigour, there is no action of one thing on another if this is interpreted as any kind of metaphysical influence, as of the mind on the body, and the same goes for the propagation of physical influence too. As we saw in Chapter 5, however, this is not intended as a denial of efficient causation, but as a thoroughgoing reinterpretation. Leibniz believed it possible to save orthodox accounts of one thing truly causing another to move by appeal to the provision of a reason or to the most intelligible hypothesis. One thing acts on another or causes it to move if and only if the reason for the change is more clearly represented in it than in the thing acted upon. The same account is intended also to save ordinary notions of things interacting with one another. Although the deep account of interconnection is that of all coexisting things mutually representing one another, this is not intended to usurp the idea of interaction—to which Leibniz freely helps himself in all his writings—but to explain how it is properly to be understood. For instance, in *De ipsa natura* (1698) Leibniz writes: "the *interaction* of *substances* or monads does not arise through an influx, but through an agreement resulting from divine preformation" (§10; GP IV

510/WFT 216). In the *Specimen inventorum* (1686–8?) he even presents the mutual interaction of all things as entailing the representational nature of substance:

> Indeed, since all things interact with others, either mediately or immediately, it is a consequence that this is the nature of every substance, that it should express the whole universe by its force of acting or being acted upon, that is, by the series of its immanent operations.
>
> (A VI iv 1620/LLC 321)

So we see that Leibniz's account of action in terms of degree of expression within the monad is not after all in conflict with his earlier claim in his drafts of the *Elements of Physics* that "the action of an extended thing is by motion, namely local motion". Indeed, this is how action and being acted upon manifest themselves in the phenomena, as local motions. This is a claim that Leibniz continues to make in describing his mature dynamics, since it is an essential component of his commitment to mechanism. "I recognize", he reassures his readers in the *Specimen dynamicum*, "that all corporeal action arises from motion, and that motion itself comes only from other motion, either already in the body or impressed from the outside." This is despite the fact that "there is nothing real in motion but that momentaneous thing which must be constituted by a force striving towards change . . . " (§1, GM VI 235/WFT 155). Thus Leibniz goes so far as to claim in *De ipsa natura*, that "not only is everything that acts an individual substance, but also every individual substance acts without interruption, even body itself, in which no absolute rest is ever found" (§9; GP IV 509/WFT 215).

But of course, as we have seen above, body is not strictly speaking a substance, even though it contains substances, any more than motion can properly be said to be an action, even though its reality derives from the forces of the substances contained in it. Leibniz gives a more nuanced account of how this talk of action in bodies should properly be understood in the *Nouveaux essais*, in terms of a likeness (*image*, in the French):

> As for motion, this is only a real phenomenon because the matter or mass to which the motion belongs is not properly speaking one substance. Still, there is a likeness of action in motion, as there is a likeness of substance in mass, and from this point of view one can say that a body *acts* when there is spontaneity in its change, and that it *is acted upon* when it is pushed or impeded by another body; just as in the true action or passion of a true substance one can take for its *action*, and attribute to the substance itself, the change by which it tends towards its own perfection, and likewise take for a *passion*, and attribute to an external cause (although not an immediate one), the change by which the reverse happens, because in the former case the substance itself, and in the latter case the external things, serve to explain the change in an intelligible way. (A VI 6, 210–11)

He attributes only a "likeness" of substance and of action to bodies, he explains, "because something made up of parts cannot be counted *a* substance, any more than a herd can; though one can say that there is something substantial there whose unity, what makes it like *one* being, comes from thought" (211). Leibniz adopts a similar strategy in his correspondence with De Volder, where he classifies bodies as "quasi-substances" (to De

Volder, 19 November 1703; GP II/LDV 277), declaring that "a body is substances, not a substance" (to De Volder, 21 January 1704; GP II/LDV 287).

The upshot of this, as Leibniz explains in *De ipsa natura* of 1698, is that in any corporeal substance there is "a first entelechy or first subject of activity", together with a primitive passive force or mass. This entelechy "always acts, but in interactions among bodies is modified in various ways through endeavour and impetus"—i.e. through the derivative passive and active forces. As the subject of the body's activity, the entelechy is a substantial principle (a soul or substantial form) which "insofar as together with matter it makes up a substance that is truly one ôr one per se, it forms what I call a *monad*" (§11; GP IV 511/WFT 217). Without such "true and real unities . . . there would be no real beings in bodies" (511/217).

As already noted in the introduction and in Chapter 2, many commentators claim that Leibniz abandons this ontology shortly afterwards for an idealistic philosophy in which corporeal substances are eliminated and the actions of substances are reduced to changes in internal representations alone. Thus we are presented with a picture where in the *Monadology* of 1714 the "true atoms" or "elements of things" are no longer corporeal substances, but monads, equated with entelechies (§3, 18). Here Leibniz says that "*activity* is attributed to a monad insofar as it has distinct perceptions, and *passivity* insofar as it has confused ones" (§49). Such passages have persuaded many commentators that Leibniz's mature metaphysics should be assimilated to the phenomenalist tradition that came after him, instigated by Kant.[7] On this reading, as expounded lucidly by Robert Adams, phenomena have no being "except in the existence or occurrence of qualities or modifications of perceiving substances" (1994, 223); their existence is internal to the things perceiving them, real phenomena being those in which actually existing monads are "appropriately expressed by organic bodies belonging to the system of phenomena".[8] Thus bodies are aspects of a consistent system of representations of all perceivers in a given world, as are their changing spatial and temporal relations.[9]

[7] A notable exception is Martial Gueroult, who, as noted by Justin Smith (2011, 122), wrote that this only appears as phenomenalism if we "give to the word 'phenomenon' a sense that is no doubt familiar, but that it did not possess prior to the Kantian philosophy" (Gueroult 1934, 187). Smith himself takes an agnostic view about Leibniz's late immaterialism or phenomenalism, but argues that this agnosticism is compatible with maintaining that Leibniz held that "substances involve real, physical bodies, which are themselves composed out of other substances with real, physical bodies, and so on to infinity" (Smith 2011, 135).

[8] Adams writes: "Phenomena are real, in a weak sense, if and only if they fit into a single scientifically adequate system of harmonious phenomena of all perceivers. Those phenomena, and only those, that are real in this weaker sense are also real in a fuller sense to the extent that there exist real monads that are appropriately expressed by organic bodies belonging to the system of phenomena" (Adams 1994, 261).

[9] Cf. Adams: "The most fundamental principle of Leibniz's metaphysics is that 'there is nothing in things except simple substances, and in them perception and appetite' (GP II 270/L 537). It implies that bodies, which are not simple substances, must be constructed out of simple substances and their properties of perception and appetition" (1994, 217); "In order for there to be corporeal aggregates that are real by virtue of the reality of the substances that are aggregated in them, they must appear as material masses in this coherent system of phenomena" (261). I have argued at length elsewhere against this interpretation of bodies and spatial relations as mere appearances; see Arthur (2013b) and (2015a).

Even Daniel Garber, while proposing a "middle period" in which Leibniz's substances are Aristotelian form–matter composites and primary matter a "non-mental material component of reality", has granted (in Adams' words) that "Leibniz, in his last years, conceived of primitive passive force . . . as merely an aspect, the passive aspect, of the monad or simple substance, a function of the degree of confusedness of its perceptions" (Adams 1994, 324–5).

I have already addressed what I see as the shortcomings of such a way of understanding Leibniz's metaphysics in the introduction. Here I will restrict myself to trying to show the advantages of understanding Leibniz's dynamics in the integrated way I have introduced it above. On that reading, there is no eliminative reduction. Rather, there is a parallelism: metaphysical actions are manifested phenomenally as physical actions, each reflecting the other. What is happening metaphysically is reflected in what happens physically, rather than the physical being only an appearance of the metaphysical. Thus just as (strictly speaking) no substance has metaphysical influence on any other, so no body has physical influence on any other: while the action of a substance consists in its teleological endeavouring towards new states (final causation), the actions of bodies (efficient causation) consists in their being concomitant requisites of one another, the cause being the body in which the reason for the ensuing phenomena is more distinct.

In fact, I believe that precisely such an account of the metaphysics and physics of action is present in the *Monadology*, notwithstanding the confident references of commentators to a "monadological metaphysics" (e.g. Garber 2009, 315–21) in which bodies and motions are eliminatively reduced to the perceptions of immaterial perceivers. Here, despite the fact that no created substance exercises metaphysical action on any other and simply undergoes changes of representation internal to itself, it is still the case that monads are represented as the entelechies of their organic bodies, through which they exercise physical action on all others in the universe through the motions corresponding to these changes of representation. Leibniz explains that all mechanical action of body on body is by contact, so that "each body is affected in some way by those bodies with which it is in direct contact, . . . and also feels the effects of all the bodies they are in contact with, so that such communication extends indefinitely" (§61; GP VI 617/WFT 276). Each created monad "represents more distinctly the body which is particularly assigned to it, and of which it forms the entelechy", so that "as that body expresses the universe through the interconnection of all matter in the plenum, so the soul represents the entire universe by representing the body which particularly belongs to it" (§62; 617/276–7). In the monad itself the action of its body on another is represented by its degree of expression: "it is *active* insofar as what can clearly be understood in it serves to explain what happens in the other; and it is *passive* insofar as the explanation for what happens in it is to be found in what is known distinctly in the other" (§52; 615/275). In a body the modifications of the primitive forces of its constituent monads result in differing derivative passive and active forces in it at any instant, by which "it is actually subdivided without end, every part into smaller parts, each one of which has

its own motion" (§65; 618/277). All this is consistent with what we found in Chapter 5. Bodies and their motions are real (i.e. actual) phenomena, coming about as immediate results of the actions of substances. Although aspects of them (such as the unity of body and its velocity) depend on the point of view of the perceiver, and thus on how they are represented, what constitutes them is external to the perceiver.

6.2 Extension and Corporeal Substance

This non-phenomenalist reading is exemplified particularly clearly, I believe, in the way Leibniz argues about *extension*. Leibniz does not regard extension as a mere appearance, but as "something relative" that is more nearly analogous to colour and sound—in other words, a secondary quality. Like colour and sound it is based in qualities in things, but is different in nature from how it appears in our perception. What is a facet of our perception is not *the fact that things are extended*, but *the way that they are perceived as extended*. The two reasons he typically gives for a body's phenomenality are (i) the difficulties stemming from the composition of the continuum, which show that it cannot be composed of points or of atoms; and (ii) considerations arising from the infinite division of bodies, which show that there cannot be any precise shapes. Neither of these arguments makes a great deal of sense if extension is simply a quality internal to perceivers.[10] Shapes are imprecise because of bodies' fractal boundaries, always further divided on smaller scales into other lines and surfaces making other shapes.[11] This is not an argument that there is nothing outside the perceiver at all, but rather depends on there being something there that we are confusedly perceiving as homogeneous and continuous. That there are always smaller bodies making up any given body with no smallest, is not an argument that spatial relations are merely apparent, but rather relies on there really being the spatial relations "smaller than" and "being contained in". Leibniz is not arguing that external to the perceiver there are no extended bodies to be perceived, but that extension does not, as the Cartesians suppose, constitute their nature. Extension is, he claims, "only an abstract thing, and requires something extended. It needs a subject; it is something relative to that subject, like duration" (GP VI 584/AG 261). This subject is not the perceiver, but that which is perceived as extended. As he writes in 1702: "[Extension] is relative to something that must be extended" (GP IV 393/AG 251) He is explicit about what this "something" is that must be extended: it is *passive force* or resistance.

Extension in the concrete, Leibniz argues, is "a diffusion ôr repetition of a certain nature", and this repetition is continuous and simultaneous (393–4/251). But "the continuous diffusion of colour, weight, malleability and similar things that only look

[10] Adams makes an admirable attempt to explain this doctrine of imprecise shapes as a species of phenomenalism (see his 1994, 229–32). See also Robert Sleigh (1990).

[11] Here I cannot improve upon the excellent analysis of Leibniz's "no precise shapes" doctrine given by Samuel Levey in his (2005), to which I refer the reader. He argues (convincingly in my opinion) against Robert Adams' analysis (Adams 1994, 229–32). See also Levey (2010) for a reply to Crockett (2009).

homogeneous is merely apparent and cannot be found in arbitrarily small parts of those things, so that it is only the extension of resistance, diffused through body, that can bear this designation under a strict examination" (394/251). But this resistance is a passive power, which can only be manifested as a resistance to penetration or to change of a state of motion. There must also be active things in matter to bring about the resistance. These are the active forces or entelechies in matter. "There is something besides matter in body", he explains, and "this can only consist in the *dynamicon* [το δυναμιχὸν] or inherent principle of change and resistance" (394/251). It follows that "the *dynamicon* or power in bodies is twofold: passive and active" (395/252). The resistances that bodies display to new motion or to being pressed upon "would not happen if there were not in body, beyond extension, the *dynamicon*, ôr principle of the laws of motion, which brings it about that the quantity of forces cannot increase, and that a body cannot be impelled by another unless its force is refracted" (395/252). Thus, as Leibniz also tells De Volder in a letter of 30 June 1704, the distinction between extension and what it is that is being extended, i.e. diffused, repeated, continued, "cannot be found in anything but the principle of acting and being acted upon" (GP II 269/ LDV 305).

I interpret what Leibniz is saying here as follows. We cannot understand the extendedness of matter without presupposing that there is something extended. Abstractly, this is the primitive passive force, which we understand to be continuously distributed throughout a body, and in fact, to constitute its bulk. Concretely, this extendedness is the result of a discrete repetition of entelechies, by whose actions and resistances to being acted upon at each instant extended matter is constituted in fact.[12] The actions and passions of these entelechies are manifested as the derivative forces diffused throughout any extended body, which are the instantaneous modifications of the primitive passive and active forces.

Robert Adams has objected to such a reading of primitive passive force as continuously distributed throughout a body on the grounds that Leibniz "opposes any belief in a real thing or constituent of a real thing that is infinitely divisible (or infinitely divided) and not composed of indivisibles" (1994, 336). He therefore rejects Garber's view, according to which (at least in Leibniz's putative middle period) Leibniz embraced an Aristotelian realism in which primary matter is understood as a positive component of substance, a divisible substratum in which the forms inhere. Adams takes this to support his general position that for Leibniz passive force is only an imperfection or privation, "contributing nothing positive", a mere by-product of God's having created form or what is active in a substance. I will come back to that issue in section 6.3. For now I want to address Adams' contention that primary matter is indivisible, and so cannot be construed as continuous. In further support of this Adams suggests that Leibniz's

[12] This seems confirmed by what Leibniz told Wagner in his letter of 1710: "The resistance of bare matter is not action, but mere passion, as long as it has antitypy ôr impenetrability, by which it indeed resists whatever would penetrate it; but it does not react, unless there be added an elastic force, which must be derived from motion, and therefore also from the superaddition of the active force of matter" (E 466/Leibniz 1890, 190).

claim in his letter to Arnauld of 9 October 1687, that primary matter is "always essential to the same substance" (G II 120) "carries the implication that it is not divisible" (Adams 1994, 377).

To these objections I think the following responses are in order. Abstractly, primary matter is a power, an enduring concomitant of the substance's activities that is essential to its nature. But as a homogeneous thing, it is "something incomplete", Leibniz writes in his comments on Wachter's exposition of Spinoza's philosophy, "since it exists merely potentially" (Leibniz 2002, 6/AG 274). Conceived thus abstractly, primitive passive power is what underlies the very possibility of division and plurality. Since it is concerned with possibility prior to division, it is homogeneous, a continuum. As such, it is not an existing thing, as Adams observes. For according to Leibniz no continuous thing—whether Cartesian extension or Newtonian space—can be an existent. Unlike the primary matter of the Thomists, however, this passive power for Leibniz is not a pure potentiality, but is actually manifested at each instant. Just as active force always involves an endeavour towards future states, so passive force always involves an actual resistance to the endeavours of other substances. Considered in abstraction from these forces it is just the *extensum*, extended body.

> Thus extension, or if you prefer, primary matter, is nothing but a certain indefinite repetition of things insofar as they are similar to one another, ôr indiscernible. But just as number presupposes things numbered, so extension presupposes things that are repeated, which contain accidents proper to them [*propria*] in addition to those they have in common. These proper accidents produce actual limits in size and shape, that beforehand were only possible.
>
> (Leibniz 2002, 6/AG 274)

The "things that are repeated" here are the subordinate substances constituting the body of a given substance. What they have in common is passive force, manifested as impenetrability and as inertial mass, both of which, Leibniz says, "are everywhere equal in a body, ôr proportional to its extension" (to De Volder, 3 April 1699; GP II 171/LDV 75). These are homogeneous and continuous properties, precisely insofar as they involve repetition of what is similar or indiscernible in the accidents of the substances constituting the body. The accidents producing the actual limits in size and shape, moreover, are the derivative passive forces manifesting themselves in the interactions of bodies, as concomitants of the actions of their entelechies. These produce the "actual limits in size and shape" existing in secondary matter.

My analysis here is in line with that of Pauline Phemister, who writes: "On its own, primary matter cannot exist. . . . primary matter without entelechies is incomplete and purely abstract" (Phemister 2005, 111); "the completion of the primary matter by the dominant entelechy is the completion of primary matter that is already imbued throughout with subordinate entelechies . . . " (52)—except that, I would say, once it is completed by being imbued with subordinate entelechies, the matter is no longer primary, but secondary. As should be clear, this analysis accords with the pluralist metaphysics of forms described in the introduction, and treated in Chapter 4. Primary matter is not a pure potentiality; it has a being of its own, although it cannot actually exist apart from

form. Matter is made actual by the forms existing within it, and is not dependent for its existence on a supervening form. Granted, as Adams argues, the matter that has actually been divided by varying motions within it is secondary matter, not primary matter.[13] The point is, though, that without any subordinate entelechies within a body, there would not be in it any motions or tendencies to penetrate, and thus no occasion for the operation of the resistance for which primitive passive force is responsible.

In sum, primitive passive force is an enduring power in bodies. It is the capacity to be acted upon, which is manifested mechanically in a body's forces of resistance to a change of state (its natural inertia) and to its being penetrated (antitypy). These manifestations of passive force are the derivative passive forces. Such passive forces depend on there being everywhere in the body instantaneous active forces which are being resisted—whether these are solicitations constituting elastic force and gravitational tendency towards a centre, or the endeavours of bodies in actual motion. The fact that these derivative forces, active as well as passive, are instantaneous, is one reason that Leibniz adduces for calling them *phenomenal*. They are phenomena in the Platonic sense of being transitory, always becoming, but not permanently existing. They are modifications or accidents, just as shape is an instantaneous modification or accident of extension.[14] Thus derivative forces are physical, but *also* phenomenal—not *as opposed to* being phenomenal. Being instantaneous, they are as evanescent as the body that is aggregated from them at each instant.

We have seen that the extended differs from extension in the abstract in that it consists in a diffusion or repetition of resistance in matter, a resistance resulting from the derivative forces operating at each instant. But these derivative or accidental forces cannot occur in a substance without primitive force, for accidents are nothing but modifications or limitations. As Leibniz explains to De Volder in 1704, "Unless there is something in us that is primitive and active, there cannot be derivative forces and actions in us, since everything accidental ôr mutable must be a modification of something essential ôr perpetual" (LDV 307). It follows that the primitive forces or entelechies must also exist in matter, in the sense that they are powers whose modifications are the phenomenal forces. In the *Specimen dynamicum* of 1695 Leibniz argues that we can actually experience these forces in things, since they manifest themselves to the senses at each instant as *nisus* or strivings: "This force of nature implanted in things", Leibniz writes in the *Specimen dynamicum* published in 1695, is an endeavour or striving that

[13] Thus Phemister argues that primary matter "can exist only as an actually divided, not divisible, mass" (Phemister 2005, 111), which is open to Adams' objection: "Any matter composed of entities unified by forms would be, by definition, secondary rather than primary matter" (Adams 1994, 337). I would say rather that primary matter involves an abstraction away from the discontinuities of secondary matter to what is similar and indiscernible in it, namely the impenetrability and inertial mass found in phenomena.

[14] Cf. Leibniz to Johann Christoph Sturm (before 5 July 1697): "derivative [force] indeed exists only as a modification of the primitive, just as affects are modifications of the soul, and shapes are modifications of extension; whereas the primitive force of acting (which persists the same) I think constitutes a kind of form, ôr even a soul" (A II iii (Vorausedition), 8104). Cf. also the *Theodicy*: "And the qualities or derivative forces, or what are called accidental forms, I take to be modifications of the primitive entelechy, even as shapes are modifications of matter" (§396; GP VI 352/H 361).

"will often make itself felt by the senses, although in my view reason shows that it is everywhere in matter, even when it is not apparent to the senses" (GM VI 234/WFT 154).

On Adams's phenomenalist interpretation, this location of forces within bodies cannot be taken literally. For him, forces are phenomena in the sense that "they have their existence only in substances which perceive them", even if "we are indirectly perceiving something that is primitively real independently of our minds", namely monads (Adams 1994, 227). But it is difficult to square this view with what Leibniz himself writes about forces and entelechies being distributed everywhere in matter. This is something he explicitly argues for in a number of texts that leave little scope for phenomenalist glosses.

In the *De ipsa natura* of 1698, for instance, Leibniz's main contention is precisely that force is inherent in matter, contrary to the views of Johann Christoph Sturm.[15] There he stresses that forces, and the motions that result from them, must be in things, must be constitutive of the nature of substances, and not brought about by the will of God directly. Sturm, like the occasionalists, maintains that bodies contain no power to continue their own motion, so that a body's motion is merely its successive existence in the different places God creates it. But in that case, Leibniz argues, it follows that "at the present moment (and therefore at any moment) a moving body *A* will in no way differ from a body *B* at rest" (§13; GP IV 513/WFT 218–19).[16] But "in a perfectly homogeneous, full, and undifferentiated mass, no shape, no boundary or distinction between its various parts can arise, except through motion itself" (513/219). So "if motion provides no distinguishing mark then it cannot provide one for shape" (513/219), since there is no way of defining the boundaries of any given body without it. What is necessary is that there should exist at each instant an entelechy producing the motions that actually determine the boundaries of the body; for the differences marking one body from another "result from the different degrees and directions of impulses, and so from the modifications of the indwelling monads [*monadum inexistentium*]" (514/220). In a world such as Sturm's there can be no difference between extension at one instant and extension at any other: the world is reduced to mere modifications, but such modifications are not even possible without a principle that would account for their being different from one instant to another. And such inherent principles must exist in things:

> The very substance of things consists in the force of acting and being acted upon, from which it follows that no enduring thing can be produced if the divine power cannot impress on it some force which lasts through time. Without this, it would follow that no created substance

[15] The full title of this piece is *De ipsa natura sive de vi insita actionibusque Creaturarum, pro Dynamicis suis confirmandis illustrandisque* (*On Nature Itself, ôr on the inherent force and actions of created things, confirming and illustrating the author's Dynamics*), published in the *Acta Eruditorum* of Leipzig in September 1698 (GP IV 504–16).

[16] If "the state of the corporeal universe at one moment does not differ from that at another except by the transposition of equal and congruent portions of matter, it obviously follows that no momentary state of the corporeal world can be distinguished in any way from any other by this perpetual substitution of indistinguishables" (219).

would remain the same thing, and nothing would be conserved by God, and then all things would be mere vanishing or fleeting modifications and phantasms, so to speak, of one permanent divine substance. (§8; GP IV 508/WFT 214)[17]

The parts of matter with their individuating motions are certainly *in* bodies, in a perfectly literal sense. But according to this argument they result, not from the mere existence of monads, but from principles that are actually in these bodies, the derivative forces. But these forces are the accidents or modifications of their "indwelling monads" or entelechies. So the entelechies themselves are dispersed in matter, as Leibniz says explicitly in the following passage:

But since it can be shown from the nature of motion that there are dispersed everywhere in matter primitive entelechies that are immune to dissolution [*indefectibiles*], why should we not attribute to them not only motive action but also perception, so that they can be taken for souls when they are conjoined with organic bodies?[18]

Now, the *Specimen dynamicum* (part 1) was published in 1695, and the *De ipsa natura* in 1698. This leaves open the possibility that Leibniz changed his view thereafter, as Garber has proposed. For in the "new monadological metaphysics" that he ascribes to Leibniz after about 1700, "the primitive active and passive forces, the form and matter that in the earlier view have a fundamental metaphysical status, are, in the monadological view, understood as features of perceptions of these monads" (Garber 2009, 319). Primitive force, Garber contends, "gets folded into the perceptual life of non-extended perceiving things" (319). So on his account of Leibniz's mature metaphysics, as on Adams', bodies and motions "have their existence only in substances that perceive them", thus aligning it in this respect with Berkeley's idealism (Adams 1994, 227).

But there is no reason to believe that Leibniz abandoned the account he gave in *De ipsa natura*, according to which monads must be dispersed everywhere in matter, with their modifications determining the boundaries of the organic bodies in it. Indeed, it was this publication that drew some of the warmest accolades from his contemporaries, giving Leibniz plenty of occasions to renounce his former views if he had indeed relinquished them. Bartholomew Des Bosses, for instance, reports his delight on reading Leibniz's "most beautiful demonstration against the Cartesians", that "if nothing is admitted in nature besides uniform matter, figure, and motion, then no variety will be

[17] Cf. also Leibniz's remarks in a letter to Bourguet in December 1714: "[Spinoza] would be right, if there were no monads; then everything except God would be passing, and would sink into mere accidents and modifications, since there would not be in things the basis of substances, which consists in the existence of monads" (GP III 575; Russell 1900, 261).

[18] This is from an untitled and undated piece on the souls of animals, transcribed by Gerhardt (G VII 329). Russell's translation is remarkably different: "Since, therefore, primitive entelechies are dispersed everywhere throughout matter—which can easily be shown from the fact that principles of motion are dispersed throughout matter—the consequence is that souls also are dispersed everywhere throughout matter" (Russell 1900, 258). The original Latin is "Sed quia aliunde, nempe ex natura motus ostensum est, in materia dispersas esse Entelechias primitivas, easque indefectibiles, quidni eis non tantum actionem motricem, sed et perceptionem tribuamus, ut scilicet pro animabus haberi possint, quando corporibus organicis sunt conjunctae."

observed in things either" (to Leibniz, 12 February 1706; LDB 17). He does have some misgivings however, for which he seeks clarification. He does not see how Leibniz's "force striving towards change" will be more than a potential for change (15), nor how it could bring about any changes in matter (17); moreover, the way Des Bosses conceives the division in matter defining the surfaces of bodies is such that it could be brought about "at least by a mind" (17), in which case it would be only a potential division.

Leibniz's responses are firm: force involves actual change ("change itself"), not merely potential change; but the entelechy does not itself act on matter—"the soul is an entelechy or primitive active power in a corporeal substance, through which the matter or primitive passive power of the same substance is completed"; and it is "by the modification of these primitive powers that actions and passions are produced in the corporeal substance itself" (to Des Bosses, 14 February 1706; LDB 23). Clearly, there is no evidence here of a removal of primitive force from corporeal substance into the inner life of a monad. In fact, it is to this letter that Leibniz sees fit to add the postscript quoted in the introduction above, "Since monads or principles of substantial unity are everywhere in matter, it follows from this that there is also an actual infinity, for there is no part, or part of a part, that does not contain monads" (LDB 25).

Similarly, in his 1710 response to Gabriel Wagner's inquiries about the content of *De ipsa natura* (E 465–8/Leibniz 1890, 190–3), Leibniz is obliged to amplify his remarks about the soul and active force. He stresses (as he had in *De ipsa natura*) that he does not attribute active force to "bare or primary matter, which is merely passive, and consists only in antitypia and extension"; secondary matter, on the other hand, "contains a primitive entelechy or active principle", which complements the merely passive force (466/190). By itself "the resistance of bare matter is not action, but mere passion"; "it does not react, unless there be added an elastic force, which must be derived from motion, and therefore the active force of matter must be superadded". This active force is the "first entelechy, a vital principle, endowed also with the faculty of perception, and incorruptible" (466/190). Again, all this necessitates the diffusion of these entelechies or vital principles everywhere in matter:

> While, therefore, I admit active principles superadded everywhere in matter, I also posit, everywhere disseminated throughout it, vital or percipient principles, and thus monads, and, so to speak, metaphysical atoms wanting parts, and incapable of being produced or destroyed naturally. (E 466/Leibniz 1890, 190)

What follows is also in keeping with what Leibniz had explained earlier in the *De ipsa natura*: "to each primitive entelechy there is united a certain natural machine, which comes to us under the name of organic body; which machine, moreover, even though it preserves its form in general, remains in flux, and is, like the ship of Theseus, always being repaired" (467/191). Thus Leibniz does not appear to change his views on primitive and derivative forces in his mature writings. The derivative forces are responsible for the internal motions which differentiate the actual parts of matter at any instant, and these forces are modifications of the primitive powers of bodies. If the primitive forces

were not powers *of bodies* disseminated throughout matter, then their modifications could not be *in* bodies either, and it is hard to see what would be being diffused to constitute extension.[19] This corroborates what I argued in Chapter 2: monads must be in a body in the sense that the boundaries of the bodies existing in it result from the modifications of the monads to which they belong.

In the letter to Wagner, Leibniz describes the first entelechy as "a vital principle, endowed also with the faculty of perception", and this may seem to point in the direction of phenomenalism, an internalization of primitive force. But Leibniz's subsequent explanation exemplifies rather the parallelism I described in section 6.1. Broadly speaking, he tells Wagner, the vital principle is "the principle of action existing in the simple thing or monad, to which there corresponds external action. And", he continues, "this correspondence of internal and external, ôr representation of the external in the internal, of the composite in the simple, of multiplicity in unity, in fact constitutes perception" (466/191).[20] Thus it is not a question of reducing external actions to internal ones—say, motions to perceptions of motion; rather, perception consists in the representation of the external in the internal, thus presupposing the independent existence of the external actions.[21] The point of the entelechies is to make the phenomena real, to actualize them. If the phenomena were simply internal to perceivers' souls, representations would not have anything external corresponding to them. But they do: the motions of the sense organs, in receiving endeavours from all over the universe, are enfolded and unfolded in perfect correspondence with the contents of the representations themselves. In order for this correspondence to work, the aggregates of substances constituting bodies need to be there, external to the perceiver. So it is with the divisions in bodies caused by their internal motions. As we have seen, Leibniz says as much to De Volder: the parts of matter do not differ only modally, as they would on Spinoza's philosophy and De Volder's too, but are divided by the forms or entelechies they contain:

I think the extended has no unity except in the abstract, that is to say, when we abstract the soul [*animum*] from the internal motion of the parts by which each and every part of matter is again actually subdivided into different parts, something that plenitude certainly does not prevent.

[19] Cf. also Leibniz's "On Body and Force, Against the Cartesians" of May 1702: "derivative and accidental ôr changeable force is a certain modification of the primitive passive power [*virtutis*] that is essential and perduring in every single corporeal substance"; and "even if we accept this primitive force ôr form of substance (which also in fact determines shape in matter by bringing about motion), nonetheless in explaining elastic force and other phenomena, we must proceed mechanically, namely by means of the shapes that are modifications of matter, and the impetuses that are modifications of form" (GP IV 397/AG 254).

[20] "*Isque corresponsus interni et externi seu repaesentatio externi in interno, composito in simplice, multitudinis in unitate, revera perceptionem constituit*" (E 466). Similarly, in his *Nouveau système* Leibniz distinguishes "our internal sensations (that is, those which are in the soul itself and not in the brain or in the subtle parts of the body)" from the external things they represent. It is because "the soul's perceptions or expressions of external things occur in it at just the right time in virtue of its own laws, as if in a world apart" that there is "a perfect agreement" among the perceptions (§14; GP IV 484/WFT 150).

[21] This tallies with what Leibniz had told Bartholomew Des Bosses in his letter of 31 July 1709: "The soul can indeed operate internally without the aid of bodies, but not externally. Nevertheless, external things in bodies always correspond to its internal actions" (LDB 138/9).

Nor do the parts of matter differ only modally if they are distinguished from one another by souls [*animabus*] and entelechies, which always subsist.

(to De Volder, 3 April 1699; GP II 171/LDV 73)

The divisions of the extended are effected not by a soul perceiving from the outside, but by the souls and entelechies in the internal parts that distinguish these parts by their motions. Abstracting these souls, the unity of any aggregate of these parts is provided by perception; below a certain threshold, the divisions will be indiscernible, and the body will appear continuous. If the divisions in bodies were simply those made by a perceiving soul, we would lose the contrast between the actual division of matter and its potential divisibility as a representation which appears continuous to a perceiver. Perceiving a certain aggregate as continuous and as a unity is modal; its being divided into a multiplicity is not, it is an actual division effected by the entelechies in it.[22]

So we have reached analogous conclusions about the phenomenality of motion and extension. Motion is phenomenal in that it cannot be attributed to a unique subject, but is instead relative to which bodies are taken to be at rest. Its reality, however—that from which it results—consists in the derivative active force that is implanted in bodies—a force that is at any instant a real accident in the substances contained in it. Similarly, extension is phenomenal in that it "is relative to what is extended or diffused", rather than "an absolute primitive attribute of body". To the senses it appears homogeneous and continuous, but in reality it is the result of the discrete repetition of derivative passive forces within body, responsible for the forces of impenetrability and inertia that are apparent to the senses.

6.3 Substantial Bonds

In my argument up to this point I have provided an explication of Leibniz's account of the constitution of body, according to which it is (at any instant of its existence) a discrete, infinite aggregate of corporeal substances, lacking any substantial bond. A corporeal substance, on this interpretation, is not a body, it is a substance that *has* an organic body. In particular, it is not a body that is constituted as a per se unity by a substantial form or entelechy that acts to unify its constituents at any given time. Its constituents

[22] This, I believe, resolves the dilemma pointed out by Phemister. She observes that the actual divisions in matter are created by the motions internal to it, as I have argued; but that according to the perceptual unity thesis, "Tables and chairs and other aggregates are only aggregates by mutual agreement" (Phemister 2005, 122). According to my analysis, the divisions (though not yielding perfectly precise shapes) are not conventional, but the identifying of a certain aggregate of parts (at a certain scale) as a unity is. A chair has such a phenomenal unity, in that all its visible parts move together (although its being a chair as opposed to so much wood and fabric depends on the use for which it is designed). But it would not appear as a unity to a sufficiently small animalcule. Similarly in modern physics, at a microscopic level no precise boundaries in bodies are observable; and at sufficiently small scales, even constituent particles lose the main aspects of their thinghood, such as determinate location in space and time. Likewise in modern biology, because of symbiosis and the mutual interaction of organism and environment, it is not always straightforward to identify individual organisms. I will discuss these matters further in the book's Conclusion.

are unified, rather, only insofar as they contribute to its actions, and these unfold over time and involve different constituents at different times as the body undergoes continual changes. Thus there is no unity in the sense of a substantial bond that ties the constituent substances of the body into one being at any time. The unity possessed by a corporeal substance is rather the entelechy itself, which is the substance or form of its body. What is substantial about a corporeal substance is the entelechy or dominant form it contains, and by virtue of which it can be understood as one thing, by reference to its actions and functions; the corporeal substance's organic body itself, on the other hand, is continuously changing. The subordinate substances constituting its body (secondary matter) do not themselves constitute any collective unity, except insofar as all their motions and perceptions agree with one another and form a system. Each of these subordinate substances is nonetheless made actual and constituted as one being by its own dominant form, so the secondary matter is actual, even in the absence of a dominant form, in keeping with the doctrine of the Plurality of Forms.

Notoriously, however, during the last ten years of his life Leibniz experiments with a hypothesis that is quite different from the above account (which I will style Leibniz's "standard account"). On this new hypothesis a body can indeed be made into a corporeal substance by virtue of a *vinculum substantiale*, a unifying, substantial bond or chain. This hypothesis (to which Leibniz never seems entirely committed) arises solely in his correspondence with the Jesuit Des Bosses and manuscripts related to some of the issues they discuss.[23] It has been alleged that his experiment with this hypothesis attests to Leibniz's hesitancy about the reality of corporeal substance, and that its failure signifies a relapse by him into an idealistic metaphysics in which corporeal substances are rejected. I will contest that interpretation here; but not without admitting that the affair is quite strange, and that some of the various things he says in connection with the substantial bond hypothesis are difficult to square in all particulars with what I have styled his standard account. The problem Leibniz is addressing, on my reading, is *what it would take to make a body into a substance*; in particular, what it would take to unite the substances constituting, say, my body, into a per se unity, giving them a "real continuity" in space at any time, and one that could endure for a certain duration, as opposed to the ideal continuity provided by the primary matter of a composite substance. Such a unity, and such a continuity, he claims, "can only arise from a substantial bond" (29 May 1716; LDB 370/1).

First, some background: in early 1706 Des Bosses informs Leibniz of his intention "to accommodate the substance of your notions, preserving them as far as possible, with the doctrines of Aristotle, or rather, to accommodate the former with the latter and both with the dogmas of the Church" (LDB 7). This looks feasible to Des Bosses because Leibniz, instead of simply rejecting the Aristotelian philosophy espoused by the Jesuit Order, has taken pains to show how it can be reinterpreted so as to provide a

[23] This is contested by Brandon Look and Donald Rutherford, as we will see below.

foundation for the emerging natural philosophy.[24] Des Bosses' project would have appealed not only to Leibniz's vanity, but also to his own ecumenical ambitions. He was already confident that he could supply a philosophy which would help to unify the faiths by providing a firm foundation for the real presence of Christ in the miracle of the Eucharist—one that is not simply symbolic, as the Zwinglians, for instance, believed. This is something he had worked on in his youthful collaboration with Boineberg, and in several collaborations since, notably with Paul Pellisson-Fontanier in the 1690s. The main problem that needed solving, in his eyes, was how the substance of Christ's body could be *really present* in all the various places where the sacrament of the Eucharist was being performed. This he was confident he could do in terms of his theory of primitive force, *το δυναμιχὸν*. As he explained to Pellisson:

> Then it is by the application to several places of this principle [of action and resistance], which is nothing but the primitive force of which I have spoken, or (to speak in more ordinary terms) the particular nature of the thing, that the multipresence of a body is to be saved.... I would even say that it is not only in the Eucharist, but everywhere else, that bodies are present only by this application of primitive force to place, but this occurs naturally only in accordance with a certain extension, size or shape, and in regard to a certain place, from which other bodies are excluded. (A I 7, 249/Adams 1994, 355)

This is in accord with Leibniz's general attitude to religious mysteries, as explained in the *Theodicy*: no explanation of the supernatural is required of philosophy. All that is required is that the mysteries should not be rendered impossible by one's metaphysics.[25] So the presence of Christ's body in many places at once would be possible, on Leibniz's view, since the substance of body is not extension (as the Cartesians supposed), but primitive force. *Naturally*, this would be accompanied by the body of the substance's being in a particular place; but *supernaturally*—and here we might bear in mind that God is immense, and thus present everywhere—the particular nature of Christ could be manifested in many places at once.

A potential stumbling block for the acceptance of his philosophy, Leibniz recognized, is the notion of a real union between soul and body. This was of great importance to the Jesuits, at least in part (or so I shall argue) because the notion of a real union of Christ's body and soul is implicit in their interpretation of the Eucharist. According to the Council of Trent, constituting Catholic orthodoxy, the Eucharist involves not just the doctrine of the real presence of the substance of the body of Christ in this sacrament, but also transubstantiation. On this interpretation the substance of the bread and wine is transformed into the substance of the flesh and blood of Christ, despite its still appearing as

[24] As Leibniz wrote to Des Bosses, "I have always been of a mind rather to emend received opinions than overthrow them. That is why I have formulated those conciliatory meditations that you in your humanity praise so highly" (2 February 1706, LDB 11).

[25] "Mysteries may be *explained* as much as is necessary to believe them; but one cannot *comprehend* them, or give an understanding of *how* they come to pass.... Nor is it possible for us any longer to *prove* mysteries by reason; for all that which can be proved a priori, or by pure reason, can be comprehended" (§5; GP VI 52/H 76).

bread and wine, so that Christ himself, with his soul forming a real union with the matter of the bread and wine, is made present in the Eucharist. According to the Lutheran interpretation of the Eucharist, however, all that is required is the real presence of the substance of Christ's body in the bread and wine, without any such transubstantiation.[26] Leibniz's collaboration with Pellisson was premised on their agreement about the doctrine of real presence, and he made no attempt in it to defend the doctrine of transubstantiation.

At any rate, Leibniz declared his hand concerning real union in his first letter to Des Bosses (2 September 1706) by attaching his only copy of his reply to the criticisms of his account of the union of body and soul by the French Jesuit René-Joseph de Tournemine. As he had only recently discovered, in 1703 Tournemine had objected that the position Leibniz had outlined in his *Nouveau système* was no more convincing than the Cartesians', since "*correspondence* or *harmony* are neither *union* nor essential connection". A real union requires an essential connection between the soul and body, so that it is clear how this particular body is animated by this particular soul. As Leibniz tells Des Bosses, his response to Tournemine's criticism was that "it was my intention only to explain the phenomena, but that the union is not numbered among the phenomena, and it is not described well enough for me to dare advance an interpretation of it" (LDB 12/13). This is an accurate representation of the gist of his reply, in which he had conceded that it would indeed have been wrong of him

> to object to the Cartesians that the agreement God immediately maintains between soul and body, according to them, does not bring about a veritable union, since, to be sure, my pre-established harmony would do no better than it does. My intent was to explain naturally what they explain by perpetual miracles, and I tried to account only for the phenomena, that is, for the relation that is perceived between soul and body. But since the metaphysical union one adds is not a phenomenon, and since no one has ever given an intelligible notion of it, I did not take it upon myself to seek a reason for it. (GP VI 595/AG 196–7, LDB xlvii)

Des Bosses immediately realized that this reply was problematic. In his *Nouveau système* Leibniz had proposed a perfect concomitance between the motions of the animal spirits in the body and the passions and perceptions of the soul, so that "it is this mutual relationship, arranged in advance in each substance in the universe, which produces what we call their communication, and which alone constitutes *the union of soul and body*" (GP IV 484–5/WFT 150–1).[27] Tournemine's response reflected the declaration

[26] I am ignoring here a third alternative espoused by some Lutherans, that of consubstantiation, the idea that the substance of Christ exists together with or alongside the substance of the bread and wine. Leibniz does not take it to be constitutive of Lutheran belief, as we shall see; and in any case, he does not believe that the bread and wine are substances.

[27] Leibniz is even more explicit in an unpublished note from March 1689–90: "The true reason for the union between soul and body, and the cause of one body's accommodating itself to the state of another body, is simply that the different substances of the same world system were created from the beginning in such a way that they harmonize with one another as a result of laws of their own nature" ("*Vera igitur Ratio unionis inter animam et corpus, et causa cur unum corpus sese accommodet ad statum alterius corporis non*

of the Fifth Lateran Council that the human being is a *real union* of body and soul, and Leibniz's position, like the Cartesians', seemed to him to make the union of a soul with its body something accidental. That this is a difficulty is confirmed later in the year 1706 when Des Bosses learns that the newly elected Superior General of the Jesuit Order has issued a condemnation of "thirty philosophical propositions, mostly drawn from Descartes and Malebranche". Among them is the Cartesian account of the real union of soul and body as consisting in a mere concomitance:

> 22. The union of the rational soul with the body consists in this alone, that God willed that for certain changes of the body, certain perceptions or motions are excited in the soul, and, vice versa, that for certain thoughts or volitions of the soul, there follow certain motions in the body. (LDB 46/7, 58/9)

Des Bosses did not regard the other proscribed propositions as problematic for his project of accommodating Leibniz's philosophical notions. In particular, none of the following proscribed propositions were espoused by Leibniz: proposition 4, Descartes' claim that a finite mind could know nothing certain about the infinite; 6, that modes or accidents are able to endure without needing a cause for their conservation; 7 and 16, concerning the quantity of motion and its conservation; 10, that extension is the essence of matter or body; 19 and 20, alleging that since created beings (whether souls, bodies, or angels) cannot produce any effects through efficient causation, it is God alone who brings these effects about, created beings serving only as their occasional causes; 25, that any differences among mixts (such as the bodies of beasts) are reducible to differences in arrangements of their component particles or atoms; and 28, that "there are no corporeal substantial forms distinct from matter" (LDB 48–9). Proposition 23 also targeted Malebranche: "This communication of motions and affections is not required by the very nature of body and soul, but only by God's free decision." This was not a difficulty for Leibniz, who denied that God's free decision was required each time there was (what we call) communication between body and soul.[28]

But proposition 22 presents a difficulty, as Des Bosses has already foreseen on receiving Leibniz's reply to Tournemine. In his reply to Leibniz of 12 February 1706 he takes up Tournemine's objection, and sets about exploring how to emend Leibniz's philosophy to make it acceptable in this respect. The union between body and soul "cannot consist in a relational mode", he insists, "for relations, like other accidents, presuppose a substance already constituted" (LDB 18/19). He adds that "this is why Aristotle denies that the parts of substance [*viz*., matter and form] are related, either to the whole or to each other, prior to the work of the mind". Any relation between them

alia est, quam quod diversae substantiae ejusdem systematis mundani ab initio ita creatae sunt, ut ex propriae naturae Legibus conspirent inter se") (A VI iv 1641).

[28] Des Bosses had originally (in his letter of 20 August 1706) sent Leibniz only some of the proscribed propositions, namely, 6, 7, 10, 16, 19, 20, 21, 22, 23, 25, and 28. At Leibniz's request he sent the full text of all thirty in his letter of 17 September (LDB 54–9).

can thus only come "through a mental abstraction of body and soul from one another",[29] and not from a real relation[30] that would constitute their union.

Des Bosses' suggested emendation, however, is not such as Leibniz could accept. It depends on the Thomist doctrine that "whatever constitutes the individual substance besides the soul and body is the absolute existence itself of the whole concrete substance" (LDB 18–19). Whereas matter and form are the essence of substance, Des Bosses says, both Aristotle and St Thomas hold that its absolute existence is distinct from them, and common to both. He refers Leibniz to "St. Thomas's book on the nature of matter", where "he considers 'how in man there may be many forms according to essence (*secundum essentiam*) but only one according to existence (*secundum existentiam*)', and 'how it is impossible for two things that are without qualification substantial to exist in the same material composite'" (18–19). But as we saw in Chapter 4, Leibniz sides with the pluralists against both these Thomist doctrines. For him there is an actual infinity of forms actually existing (i.e. "*secundum existentiam*") in any body however small, and therefore not just one but infinitely many unqualifiedly substantial beings in every material composite. So he has to tread delicately around this point, rather than contradicting Des Bosses outright.

In fact, there is an unresolved tension underlying the exchange between the two thinkers that results from this difference of views on forms. Des Bosses is clearly committed to the Thomist doctrine that when one of the forms subsisting essentially in a composite comes into existence, this making actual of its form ("actual existence") is what confers a unity on the composite: the dominant form is the only existing form, and it makes the corresponding matter actual rather than merely potential. The Jesuit, while accepting Leibniz's monads, understands them as unities or forms in just this sense. He tries to persuade Leibniz that monads are in composites only potentially, and are not made actual until they come into being later as the dominant form of some new creature. As late as his letter of 12 June 1712, he still wishes to persuade Leibniz that it is

> with respect to their essence ôr metaphysical actuality, but not with respect to their existence or physical actuality, that forms, and therefore monads themselves (I set aside the rational soul) always exist more or less in the way that parts are said to be in a whole only potentially, or, as Averroës and Zabarella think, that elements remain in a mixt as refracted [forms]. In an animal, for example, a horse, only the dominant form, namely, the soul of the horse, has existence or physical actuality. (LDB 247)

The reference to Averroës and Zabarella shows that Des Bosses is familiar (as one would expect) with the pluralist doctrine on forms. But he has not appreciated that Leibniz,

[29] This is reminiscent of the doctrine that Adams attributes to Leibniz. Cf. his discussion in Adams (1994, 369–77), where he concludes that "primary matter is an abstraction, as is substantial form" (375).

[30] Although Leibniz has classed the union as a relation that is perceived between soul and body, he has not termed it a "real relation". In fact he denies a real relation in the Jesuits' sense of an accident that is posited as actually existing independently of a subject; but his official position on space and time is that they are real relations in the (different) sense of orders of all possible existents whose reality derives from their existing in the divine mind. See his letter to Des Bosses of 15 February 1712 (LDB 232/3).

like Sennert before him, sides with Scaliger rather than Averroës and Zabarella: Leibniz rejects the idea, as we saw in Chapter 4, that subordinate forms lie refracted within the body of the dominant form, or exist only potentially, and instead regards each of them as actually existing integrally, and as being responsible for the actual parts into which matter is actually divided.

In that letter Des Bosses goes on to assert that monads, notwithstanding their "metaphysical actuality ôr entelechy", "are not complete in the manner of a physical substance, except insofar as and when a dominant entelechy bestows existence and therefore unity on the whole organic mass, for example, on the body of the horse" (LDB 247). To Leibniz the idea that the dominant monad contributes existence, or even deprives subordinate monads of full existence, is no more intelligible than talk of metaphysical unity itself. In his reply of 16 June 1712, he is emphatic:

> Monads, I believe, always have full existence, and cannot be conceived as parts that are said to be potential in the whole. Nor do I see how a dominant monad could detract from the existence of other monads, since there is in fact no communication among them, but only agreement. The unity of the corporeal substance in a horse does not arise from any refraction of monads. . . . Some worm can be a part of my body, and subject to my soul as the dominant monad, while the same worm can have other animalcules in its body subject to its dominant monad. But considered in themselves, the domination and subordination of monads consists in nothing but degrees of perception. (LBD 256/257)

The worm is a corporeal substance that is fully existent, even while its dominant monad or entelechy is subordinate to Leibniz's. The relation of domination is not conceived in terms of some metaphysical influx from the dominating monad bestowing existence on the subordinate monads in its body; rather the actions of the worm as part of Leibniz's body are more clearly expressed in his own states, that is, as contributing more to his body's own purposes than to the worm's.

So at this stage in their exchange Leibniz is still conceiving the problem of the union of soul and body very differently than Des Bosses. As in his reply to Tournemine, he insists that he has explained one aspect of the union, namely how it is that the soul appears to act on the body even though no influence can be transmitted from one to the another, in metaphysical rigour. This is explained in terms of what in the *Nouveau système* he called the "*hypothese d'accords*" (*hypothesis of agreements*) (GP IV 485/AG 144). The only reason he is trying to do more by introducing the hypothesis of substantial bonds, is to try to give some account of real union that would be satisfying to the Jesuit Order. This would require bodies to be substances, per se unities consisting in a body that is united through all the instants it endures by a substantial bond, together with its dominant monad. As Leibniz writes somewhat tiredly in his letter of 15 March 1715, after trying out many versions of the substantial bonds hypothesis only for Des Bosses to shoot them down, "We correctly maintain that bodies are things, for even phenomena are real. But if someone wishes to maintain that bodies are substances, it will require, I believe, some new principle of real union" (LDB 330/331).

One can see another instance of this unresolved tension between the two philosophers' differing views over the relation of an entelechy to its body earlier in the correspondence. In his letter of 14 February 1709, Des Bosses objects that if entelechies are inseparable from matter, then God could not have created matter first and then human souls and other entelechies "on only the fourth or fifth day of creation", as Leibniz had suggested to Sturm (LDB 117/118). For, he insists, "before the human soul was created, the matter that was afterwards to be its own certainly existed, and had some entelechy, for without a principle of unity it could not exist" (LDB 117/118). That is, if the primary matter with which the human soul is to be united was already actual prior to the soul being introduced, it must have already had a soul, since otherwise it would have been a mere potentiality. But then, Des Bosses objects, either the primary matter would have to be destroyed, or it would have two entelechies after the creation of the human soul in it. Yet if the entelechy is what makes the matter actual, as Des Bosses believes, then the same (primary) matter cannot have two entelechies.

But for Leibniz it is the *secondary* matter that God would have created prior to human souls, and this consists in matter actualized by the entelechies it contains. So in his letter of 16 March he responds that, although "entelechies cannot arise naturally", God could (miraculously) create a new entelechy without having to create new matter, since all that would be necessary would be for the new entelechy to be "placed in command of" the subordinate monads constituting the already existing mass—secondary matter—"for certainly there are as many entelechies as there are organic bodies". He adds: "Moreover, the primary matter proper to an entelechy, that is, the primitive passive power that is inseparable from the active power, is co-created with the entelechy itself, (which it completes, so that it constitutes a monad or complete substance)" (LDB 118–19).

Brandon Look and Donald Rutherford have argued that in 1706, at the beginning of his correspondence with Des Bosses, Leibniz was already having doubts about the theory of corporeal substance he had previously entertained.[31] After analysing various of Leibniz's formulations of what such a corporeal substance is, and finding apparent inconsistencies among them, they take his theory at the beginning of 1706 to be that the constituent unities in an organic body are united by a substantial form into an *unum per se*, so that the corporeal substance is the monad together with this unified body, a form–matter composite, as on the Aristotelian account. As evidence that Leibniz was already having doubts about the reality of corporeal substance in 1706, they cite the following (albeit, cancelled) passage from the draft of his second letter to Des Bosses:

> The union I find it difficult to explain is that which joins the different simple substances or monads existing in our body with us in such a way that a unity results from this; nor is it sufficiently clear how a new existent may arise over and apart from the existence of the individual

[31] "The vinculum first appears in his writings as an attempt to provide a satisfactory explanation of corporeal substance within the theory of monads" (LDB lviii). See also Look (2000, 219): "We have seen that Leibniz's doctrine of the *vinculum substantiale* is not concerned exclusively with transubstantiation, but with the nature of composite substance in general."

monads, unless it is because they are joined by a bond of the continuum that the phenomena display to us. (LBD 22/23)

This is a gloss on a passage that ends "For the rest, the soul is an entelechy or primitive active power completing matter, taken as passive power. In this sense, each is as incomplete as the other." He crosses out both this and the gloss, replacing them with the following:

For the rest, the soul is an entelechy or primitive active power in a corporeal substance, through which the matter or primitive passive power of the same substance is completed; and by means of the modification of these primitive powers, actions and passions are produced in the corporeal substance itself. (LBD 22/23)

I take this to be a reiteration of his standard account of corporeal substance, as outlined in section 6.2. On my reading of that account, Leibniz's position was always that the unities constituting the body of a corporeal substance at any time do so by contributing materially and formally to the achieving of the actions and goals of its dominant monad, thus distinguishing its organic body from a mere aggregate by reference to their bodies functioning as (transitory) parts of its machine. At any given time, then, these subordinate monads constitute the body of the substance, so that they are distinguished from a mere aggregate only by this association. But such an association does not unite them metaphysically; it does not bestow on them any kind of real union with each other, or with the dominant monad. They constitute the body of the corporeal substance whose form is the dominant monad, which is a per se unity.[32] The organic body remains the same through time, but this is only identifiable by reference to the substance or per se unity whose functions it serves, and not by the self-identity of the aggregate of constituent unities, which is always changing. Thus on my reading the doubts Leibniz expresses in the cancelled passage are only doubts about how he could account for the real union that the Jesuits perceive as necessary, and speculation that it would require making phenomenal continuity into a substantial bond.

Look and Rutherford note that the issue of transubstantiation does not occur until rather late in the correspondence, "not until Letter 30—after three and a half years of correspondence" (lix), although Leibniz and Des Bosses have already been wrestling with issues concerning real unity from the start. They take this as further evidence that Leibniz's hypothesis of substantial bonds has its origin in worries with his own theory of corporeal substance, as opposed to providing an account that will satisfy the Jesuits. When Des Bosses does raise the issue of transubstantiation in his letter of 8 September 1709, Leibniz responds that:

for us [Lutherans] there is no place for either the transubstantiation or the consubstantiation of the bread, but only for the fact that when the bread is received Christ's body is perceived at the

[32] On this reading, a corporeal substance is a unity per se only in the sense that it is a principle of unity together with an ever-changing body; the body itself is merely an aggregate, not a unity through itself (*unum per se*).

same time, so that the presence of Christ's body is all that needs to be explained. And I have already replied to Tournemine that presence is something metaphysical, like a union, which is not explained through the phenomena. Whether and how your transubstantiation can be explained in my philosophy would be a more difficult question. (LDB 152–3)

I interpret this to mean that what Leibniz initially saw himself as having to provide was an account of the real presence of Christ's body that would make the miracle of the Eucharist possible, even if, as a miracle, it would not be explained through the phenomena. But it had quickly become apparent to him that the Jesuit's prohibition of proposition 22 would require the provision of a metaphysical union going beyond a mere agreement among phenomena, namely a real union among the substances constituting the bread and wine into continuous masses so they could be unified with the substance of Christ's body—something not necessary for his own metaphysics of nature, but demanded by Catholic orthodoxy to explain the mysteries. This would explain why the idea of some kind of unifier is already playing on his mind prior to 1709. But as the correspondence proceeds, Des Bosses makes penetrating criticisms of Leibniz's various attempts to articulate the idea of such a bond that could really unify subordinate monads prior to the added presence of the soul of Christ. As Look and Rutherford note, these criticisms persuade Leibniz that his initial attempts to provide an account of metaphysical union are not adequate to explain the revealed mysteries of incarnation, let alone transubstantiation (LDB lxxiv). In his letter of 10 October 1712, he expresses his worry that "we cannot explain the mystery of the incarnation and other things unless real bonds or unions are accepted" (LDB 278/9). This would explain why he continues to trouble himself with substantial bonds despite Des Bosses' rejection of their adequacy to explain transubstantiation, in which the unified subordinate monads would actually constitute corporeal substances.

But now it is high time for us turn to the hypotheses Leibniz advances to support the Jesuits' requirement for a real union between body and soul that goes beyond the phenomena. On the Thomist interpretation this involves the idea that the body is actualized by the form: its primary matter, which was otherwise merely potential, becomes actual when combined with the form, and *the body thereby becomes a substance*. It will be convenient to reserve the term *composite substance* for this idea of a unified and actualized body constituting a substance, to distinguish it from Leibniz's standard conception of a corporeal substance as a dominant monad along with its own organic body that is constantly changing. Prior to the start of the correspondence, Leibniz had been confident that he could at least allow for the presence of the substance of the body of Christ in the bread and wine on his own principles without claiming to give an account of any metaphysical union of body and soul. But Des Bosses' acute criticism of his reply to Tournemine brings a real difficulty to his attention: namely, that on his account the union is reduced to a mere relation, yet "relations, like other accidents, presuppose a substance already constituted" (LDB 18/19). So when Des Bosses raises the issue of how on his principles Leibniz manages to "defend the real presence of Christ's body in the Eucharist" (8 September 1709; LDB 148/9) Leibniz replies as quoted above, but adds:

> If you wish to hold that real accidents remain without a subject, it must be said that when the monads constituting the bread are destroyed with respect to their primitive active and passive powers, and the presence of the monads constituting Christ's body are substituted for them, there remain only the derivative forces that were in the bread exhibiting the same phenomena that the monads of the bread had exhibited. (LDB 152/3)

This is consistent with what Leibniz had earlier written to Pellisson: real presence would consist in the substance of Christ's body being supernaturally present where the monads constituting the bread were previously, with the appearances remaining the same. This is also consistent, as Des Bosses concedes in his letter of 18 January 1710, with the Jesuits' view that "real and physical accidents remain in the Eucharist without a subject" (LDB 158/9). But, he observes, it is not consistent with Leibniz's own metaphysics since, according to this, "derivative forces are nothing other than modifications of primitive forces" (158/9). Primitive forces, consequently, could not be destroyed without also destroying the derivative forces that are their modifications. The mysteries involve events that are supernatural, but they cannot involve things happening that are self-contradictory, as would be the existence of the modification of a force without the force itself existing.

Leibniz's reply (2 May 1710) is interesting. He suggests that "since bread is in fact a being by aggregation ôr substantiated being, its substantiality will consist in the union of the monads, and so it is not necessary to destroy the monads in order to destroy that union" (LDB 166/7). In the corresponding passage of a fuller unsent draft he is more forthcoming: this means that the phenomena of the bread and wine will "arise not from those monads, but from some divinely substituted equivalent to the union of those monads" (LDB 170/1). What Leibniz appears to be suggesting here is this. On the Jesuits' interpretation of corporeal substance as composite substance, the form makes the extended matter real. So what is essential to satisfy the Jesuits is to provide some account that will provide for the possibility that God, by a supernatural action, could make extension a real accident of something substantially unified, so that this real extension and all the phenomena grounded in it will result.

By 1712, in Letter 48 of the correspondence, Leibniz is able to state this as a stark alternative: either, as on his account, extension is simply a phenomenon, whose unity is supplied by the perceiver; or, "if faith drives us to corporeal substances [under the Jesuit's understanding of them], such a substance consists in that unifying reality which adds *something absolute* (and therefore substantial), albeit a flux, to the things to be unified" (LDB 226/7). Monads, he adds, are not ingredients of this added thing, the substantial bond, but merely requisites of it; consequently they are not to be "involved in that supernatural change of the substance of the body" which the substantial bond is designed to bring about (228/9). In a clarifying supplement he adds that such a bond does not unify just any monads, rather "it suffices that it unites those monads which are under the domination of one monad, that is, make one organic body ôr one machine of nature" (232/3).

In his reply of 20 May Des Bosses objects to Leibniz's calling the bond a "substance", as opposed to an accident. Since Leibniz has acknowledged that it presupposes monads

as its requisites, and cannot naturally exist without them, it should therefore be classed as an accident. "And so body, since it superadds to the monads nothing but this absolute thing, will superadd only an accident to them" (LDB 236/7). He also enlists "the basic principles of all philosophers together with those of common prejudice" in support of the view that "there is something more in body than phenomena, that is, something more than continued dreams, however perfectly they may agree with one another" (236/7). As Look and Rutherford explain, both these criticisms are consistent with "the Church's interpretation of the appearances of bread and wine as 'real accidents' that endure without a subject" (LDB lxv). The body is not just a phenomenon, but is made real by the addition of the real accident of continuous extension.

In his reply of Letter 50, Leibniz resists these criticisms of Des Bosses. He refuses to accept the idea of an accident that can exist without a subject.[33] As he tells Des Bosses, "if you deny that what is superadded to monads in order to make a union is substantial, then a body cannot be said to be a substance, for in that case it will be a mere aggregate of monads" (LDV 240/1). Note here that what is in question is *how to make a body into something substantial*, how to find a "new principle of real union" that will unify the constituent unities into an enduring, really unified thing. Leibniz recognizes that "the Peripatetics acknowledge something substantial besides monads", but according to his own principles, "monads do not constitute a complete composite substance, since they do not make a unity per se, but a mere aggregate, unless some substantial bond is added" (LDB 242/3).

It is at this point in the correspondence that the issue of the correct interpretation of substantial forms arises. As explained above, Des Bosses takes the line that the dominant entelechy "bestows existence and therefore unity on the whole organic mass", so that, for instance, the body of a horse "is made into one thing by this existence" (to Leibniz, 12 June 1712; LDB 246/7). Because Leibniz rejects this Thomist view in favour of a Scaligerian one, where entelechies exist in the body making its parts actual independently of the dominant monad, he also rejects the idea that the dominant entelechy bestows any spatial unity on the substance. On his own account, "no [real] extension or composition of the continuum is involved, and all difficulties about points disappear" (LDB 254/5), since whereas mathematical points are only modes, the "metaphysical or substantial points (constituted by forms or souls)" that he wrote of in the *Nouveau système* (GP IV 482/WFT 149) do not themselves enter into any relations of spatial nearness or remoteness. They are situated only derivatively, through their phenomenal bodies.

Expanding on this in Letter 52, Leibniz states: "I regard the explanation of all phenomena solely through the mutually conspiring perceptions of monads, with corporeal substance set aside, as useful for the fundamental investigation of things" (LDB 254/5). This is usually taken as evidence that his standard account is a phenomenalist idealism. But in the gloss to this statement he reiterates his standard philosophy of space and

[33] Look and Rutherford argue that if Leibniz were to accept the bond as an accident, then "he would have to accept that transubstantiation involved the destruction of monads" (LDB lxv). For since transubstantiation must involve a change of substance, making the vinculum an accident of monads would mean that the bond could only be changed if the monads constituting the bread and wine were replaced by the monads constituting Christ's body.

time, stressing that no problems of composition can occur here, "since there is no absolute or spatial nearness or distance among monads", making reference to his comments in the *Theodicy* on the composition of the continuum. Then he considers "what would have to be superadded if we were to add a substantial union, that is to say, if we were to suppose a corporeal substance and thus matter; and whether it would then be necessary to have recourse to a mathematical body" (254/5). This suggests that the corporeal substance he is considering here is the hypothesized substantial bond, with its really continuous extension. Des Bosses had recognized that Leibniz objected to "the reality of mathematical body ôr a dimensional quantity going beyond the phenomena" (LBD 250/1), without understanding why a mathematical body could not be "realized". In this reply Leibniz urges that a substantial union does not require a mathematical body, since monads need not be thought of as existing in "absolute places" or in "the indivisible localities that throw us into such difficulties". Rather, "it suffices that corporeal substance should be something realizing phenomena external to souls; but I would not want to conceive actual parts in it, except those that arise from an actual division, nor indivisibles, except as extrema". Thus he still conceives extended matter as actually divided by the motions in it; this would not change if body were "realized".

As the correspondence progresses, Leibniz makes other chops and changes in his characterization of substantial bonds in response to Des Bosses' criticisms. In Letter 54 (20 September 1712) Leibniz makes explicit the implication of his previous letter that the *vinculum* is simply to be identified with corporeal substance—"corporeal substance, ôr that thing which produces a bond of monads" (LDB 268/9)—and proposes that it can come into or go out of existence independently of the monads with which it is associated, whereas the monads are (naturally) ungenerable and indestructible: "Simple substance is perpetual; a substantiated thing can arise and perish, and be changed" (LDB 270/1). At Des Bosses' suggestion, he reverses himself on this in Letter 58, proposing instead "that the substantial bond, or the substance of the animated body, does not arise and perish naturally, but that, since it is something absolute, it only varies according to the changes of the animal" (23 August 1713; LDB 318/19). Finally, Leibniz acknowledges that the *vinculum* possesses primitive active and passive force, so that it is able to act and be acted upon (physically, but not merely phenomenally) on its own account.[34] It thereby becomes nearly identical with Aristotelian corporeal substance, save only that it experiences neither generation nor corruption. Thus in his last letter to Des Bosses (Letter 71), from May 1716, he writes:

I do not believe I depart from the Scholastic doctrine of corporeal substances except in this one thing, that I do away with the generation and corruption of a true substance, whether simple or

[34] Against the claims of Des Bosses that what "realizes" the phenomena, turning a body into a composite substance, might be a real accident, Leibniz insists that it would have to be a substance: "since the true mark of a substance is action, unless composite substance, insofar as it is a composite, itself acts, it will not be a composite substance, but only a mere phenomenon". "In fact, I judge that the Scholastics' primary matter and substantial form, namely, the passive and active primitive powers of the composite, and the complete thing resulting from them, are really that very substantial bond that I am urging" (LDB 364/5).

composite, since I find it to be neither necessary nor explicable… But in this way I restrict composite or corporeal substance to living things alone, that is, solely to organic machines of nature. The rest are for me mere aggregates of substances, which I call substantiated things; but an aggregate constitutes only an accidental unity. (LDB 372–5)

But what remains intact through these chops and changes is Leibniz's view that, in order for bodies to become really unified, something substantial must be superadded that gives them a real connection in extension. He is aware that this is contrary to his official views on extension and on continuity, which is why he keeps contrasting it with them. On his standard account, "aggregates are nothing but phenomena, since besides the ingredient monads, everything else is added by perception alone by the very fact that they are perceived at the same time [*simul*]" (LDB 370/1). In particular, extension is the result of the discrete repetition of derivative passive forces within body, and its continuity and unity are supplied by perception. In contrast to this, if the phenomenal bodies are to be rendered real substances, which is what Leibniz is trying to achieve in this correspondence, then their real union and real continuity "can only arise from a substantial bond" (370/1).[35]

The resulting final theory of substantial bonds has many peculiarities. As Look and Rutherford point out in their introduction, in the end "the *vinculum* itself does nothing by way of providing a real union to the monads constitutive of an organism"; rather, "that unity is located in the vinculum itself" (LDB lxx). For it "persists as a corporeal substance whether or not there exist monads with appropriately ordered perceptions" (lxx).[36] So it does not constitute a union of the kind that Des Bosses and the Jesuits desired, where possession of a substantial form unifies the substances in a body into a composite substance whose continuous extension can subsist as a real accident and be unified with the soul of Christ in the Eucharist. Leibniz rejects that idea as impossible: an accident cannot introduce a relation of connection between two monads, because it would have to "exist in both at the same time, that is really in neither, that is to say, in the mind thinking this relation" (LDB 370/1). In order for extension to be a real accident it would have to be founded in "something substantial, which is the subject of the common predicates and modifications, that is, those joining them together" (370/1). Likewise real continuity could not consist in any ordering of monads, but would have to have its source in the primitive passive power of composite substance:

The foundation of continuity is contained in the primary matter…ôr primitive passive [power] of a composite substance, from which it follows that a true continuum arises from composite substances placed next to each other, unless God removes the extension supernaturally by removing the order among those coexistents that are thought to penetrate each other. (LDB 376/7)

[35] To Des Bosses, 29 April 1715: "body, if it is to be considered a substance, can be nothing but what results from a real union of monads" (LDB 336/7); "Real continuity can only arise from a substantial bond" (to Des Bosses, 29 May 1716, LDB 370/1).

[36] See, for example, Leibniz's notes on Des Bosses' letter of 12 December 1712: "souls can be destroyed with the composite or corporeal substance remaining, or can remain when it is destroyed" (LDB 300/01)—supernaturally, that is, as Leibniz makes clear in his letter (to Des Bosses, 24 January 1713, LDB 296/7).

This is to be contrasted with his standard account, according to which continuous extension does not arise from the juxtaposition of overlapping really extended composites, but from the repetition of the passive forces accompanying all the entelechies in the aggregate constituting the body, together with an abstraction in the perceiver away from all the inhomogeneities.

Moreover, the composite substance constituting the substantial bond has its own entelechy, distinct from the dominant monad of the corporeal substance or living animal: the primary entelechy of the "composite substance, namely the primitive active force,… differs from a monad, in that it is that which realizes the phenomena" (LDB 372/3). Instead of simply *being* the dominant monad, "the entelechy of a composite substance always naturally accompanies its dominant monad" in such a way that "if the monad is taken together with the entelechy, it will contain the substantial form of the animal" (LDB 374/5).[37] There are thus two entelechies simultaneously existing in any living being, that of the dominant monad, and that of its composite substance, which makes its body real.

So how does all this solve the problem of the Eucharist? One might have thought that the bread and the wine are both composite substances, each possessing a primary entelechy that actualizes their phenomena. God could then supernaturally replace the substantial bonds constituting the substances of the bread and wine by that constituting the composite substance of Christ. But the bread and wine are *substantiata*, not composite substances, which are restricted to living things alone. And if their appearances remain the same throughout the process of transubstantiation, then so must the monads constituting these appearances.[38] So, in fact, what must happen is this. Whereas naturally the ingredient substances in a substance's body can come and go "gradually and individually" while the substance remains the same, in the Eucharist "through a miracle the separation occurs, so to speak, in one go and all at once, with every composite substance ôr realizer of the phenomena in the terrestrial thing having been destroyed and substituted by the realizer of the phenomena in the celestial thing" (LDB 374/5). This would be a miracle indeed: the bread and wine would continue to look exactly the same, and the substances constituting them would still be exactly the same, excepting only that the added entelechies of the substantial bonds or composite substances existing in the substantial forms of the little organisms constituting them would be exchanged for the bond making up Christ's body. Des Bosses rejects this as an interpretation of transubstantiation, since the monads in the bread and wine are not destroyed and replaced by Christ's. Leibniz's idea, however, is that it is transubstantiation, since the *composite*

[37] An oddity of Leibniz's phrasing here is his equating of a monad with its primitive active force or entelechy alone. More typically, he regards the monad as the complete thing constituted by primitive active and passive force together.

[38] Thus Leibniz tells Des Bosses (2 May 1710): "Since bread is not in fact a substance but a being by aggregation ôr a substantiatum resulting from innumerable monads through some superadded union, its substantiality consists in this union. So it is not necessary, on your view, for God to destroy or change those monads, but only to remove that by which they are produced, namely, the Union." He adds: "But we who reject transubstantiation have no need of such things" (LDB 170/1).

substances are so replaced; and, as in his earlier attempts to account for transubstantiation with Pellisson, it is through its primitive force that the substance of a body occupies place. It is worth noting, too, that the resulting theory fits well with his characterization of the union of soul and body (insofar as it goes beyond a pre-established relation between what occurs in each) as "metaphysical" and "not a phenomenon that makes itself known by sensible effects beyond this relation".[39]

Most commentators are agreed that the hypothesis of substantial bonds is heterodox, not a doctrine to which Leibniz was committed as part of his official metaphysics (e.g. Adams 1994, 300–1, LDB lxxviii). But interpretation of the correspondence has generally proceeded on two assumptions, (i) that Leibniz's official "monadological" metaphysics of this period is a phenomenalism or substance idealism; and (ii) that the composite substances he is discussing here are to be identified with the corporeal substances he endorses elsewhere.[40] Accordingly, commentators have seen the hypothesis of substantial bonds as a last, somewhat distracted, attempt to defend the reality of corporeal substances, and have taken its heterodoxy, and perhaps its failure, as a confirmation of idealism in Leibniz's final metaphysics. I have argued against (i) throughout this book. On my reading of his standard account, Leibniz takes bodies and their motions to be real; not substantial beings, but real phenomena, made actual by their containing entelechies as a foundation; and a corporeal substance is as he described it to De Volder, a living being, consisting in a dominant monad together with the ever-changing organic machine constituting its body. In opposition to (ii), I have argued here that Leibniz's intent with the hypothesis of substantial bonds was to make room in his metaphysics for the possibility of a real union of the kind desired by the Jesuits, involving (in its final form) composite substances whose bodies are spatial unities, possessing a real, continuous extension. Such composite substances, I contend, are something that Leibniz had not entertained outside this context in his mature writings,[41] and are not equivalent to the corporeal substances he had endorsed elsewhere. He had not admitted a really continuous extension since abandoning the metaphysics of the *Theoria Motus Abstracti*, where a real continuum (in extension, time, and motion) was constituted by indivisibles, minds were contained in points, and bodies were momentaneous minds.

Accordingly, in opposing Des Bosses' Aristotelian realism Leibniz constantly has to emphasize that bodies and motions on his standard account are phenomena, and not real accidents without subjects. This leads him to characterize them as "mere phenomena"—but this, I argued in the introduction, is the position of the Cartesians and Academic Sceptics that he is at pains to criticize. I think this discrepancy is explained by a difference in contexts: he is arguing against the Cartesians and Sceptics that bodies

[39] Letter to the Electress Sophie, March 1706, quoted from LDB (395).

[40] An exception is Pauline Phemister, who rejects (i), but still subscribes to (ii), explicitly identifying the substantial bonds of 1715–16 with what she calls "the De Volder monad", namely the monad completed by a dominant entelechy together with primitive passive force. See her 2005 (chapter 7, esp. 169–75).

[41] Leibniz says as much. To Des Bosses (30 June 1715) he writes: "I have certainly not treated this argument about the raising of phenomena to reality except on the occasion of your letters" (LDB 340/1).

are *well founded* as opposed to *mere* phenomena; while against the Jesuits, that they are not composite *substances*, but merely (well-founded) *phenomena*. Nonetheless, it must be granted that Leibniz never refers to Des Bosses' Aristotelian composite substances as, for instance, "your composite substances", nor does he contrast them with "corporeal substances as I understand them, namely, embodied monads". He therefore gives the distinct impression that the composite substances described in the correspondence are the same as the corporeal substances he endorses elsewhere. But against this and in favour of my reading I would adduce two main considerations: (1) the only models for corporeal substance that Leibniz considers in the correspondence are ones in which there is a real continuous extension, contrary to his standard accounts of extension and the continuum; (2) the account of the union of mind and body he gives elsewhere in the same period is the standard one, where it amounts to nothing more than a coordinated agreement between the motions and forces produced in the fluids in the brain, and corresponding perceptions in the soul.[42] Since in most of these writings Leibniz subscribes to corporeal substances, or equivalently indestructible living animals consisting in an organic body with animating entelechy,[43] this strengthens the case that the composite substances of the Des Bosses correspondence are intended as a hypothesis extraneous to his standard account, intended only to satisfy the Jesuits' demand for a substance that is a body–form composite with really unified matter.

[42] Thus in the *Monadology* Leibniz writes: "§78. These principles have given me a way of naturally explaining the union, or rather the conformity, of the soul with the organic body. The soul follows its own laws, and the body likewise follows its own; and they agree in virtue of the pre-established harmony among all substances, since they are all representations of one and the same universe" (GP VI 620/AG 223).

[43] In the *Entretien entre Ariste et Théodore*, revised in 1715, Leibniz says that "there is no part of mass in which there is no organized body, or endowed with some perception or with a kind of soul", for which he prefers the term "corporeal substance" (GP VI 588/AG 264), while also claiming that he "reduces everything to monads, or to simple substances and their modifications, along with the phenomena that result from them" (590/265). On the other hand, the *Monadology* of 1714 is often claimed to make no mention of corporeal substances. But as I noted in the introduction, Leibniz writes in unrestrained fashion of indestructible animals: "§77. Thus one can say that not only is the soul… indestructible, but so too the animal itself, even though its machine often may often perish in part, and cast off or put on organic coatings" (GP VI 620/WFT 279).

7

Continuance through Time

> "There is only one case of a substance acting immediately on another substance, namely the action of the infinite substance on finite ones, an action that consists in continually producing ôr constituting them."
>
> (to De Volder, 21 January 1704; GP II 264/LDV 291)

> "If created substance is a successive being, like motion, if it does not endure beyond a moment, and does not remain the same during any specified period of time, any more than its accidents . . . why shall one not say, with Spinoza, that God is the only substance?"
>
> (*Theodicy*, §393; GP VI 350–1/H 359–60)

In this final chapter I turn to the question of the continuity of existence through time. According to Leibniz, substances' continued existence and their continuous production of states through time is what distinguishes them from their modifications, so it is central to their role in solving the problem of the continuum. But there are various difficulties surrounding the whole question of the continuity of the existence and action of substances, profound difficulties that take us to the heart of Leibniz's metaphysics. A treatment of these difficulties is the subject of this chapter.

There are three main issues, all linked through Leibniz's rejection of occasionalism: his position on divine concurrence, his upholding of the doctrine of continuous creation, and the status of monadic states. Leibniz's insistence (against the occasionalists) that created substances are active powers spontaneously producing their own actions led some (such as Des Bosses) to worry that this would preclude God's concurrence in the actions of created things. To forestall this objection, Leibniz typically appealed to the traditional doctrine of continuous creation, according to which God's direct action is required to keep each thing in existence at each instant it endures. But Descartes had appealed to continuous creation precisely because created substances, on his view, lack any force or action save that deriving from God's continuously creating them, making Leibniz's appeal to it seem otiose, given his attribution to substances of their own force. I contend that Leibniz evades this difficulty by arguing that the force of each substance, while really residing in it, is nevertheless to be understood as a limitation of God's infinite power, and is consequently necessarily dependent on divine concurrence; and that, on the other hand, the substance produces its modifications—the states or

perceptions towards which it tends through its appetitions—out of its own store. Like its force, the substance's perceptions and appetites are also limitations of divine attributes, respectively divine omniscience and the perfection of the divine will, so they also depend on the concurrence of God. This divine concurrence, however, produces only what is perfect in force, perception, and appetition; the limitations of these perfections are produced by the creatures themselves.

But a further difficulty with Leibniz's appeal to continuous creation is that most occasionalists interpreted the doctrine as entailing God's creating successive distinct states at distinct moments, making for a time that is not continuous but discrete. Leibniz, in keeping with his Law of Continuity, could not countenance the action of a substance as anything but continuous, and consequently monadic duration could not for him consist in an aggregate of discrete moments constituting a discontinuous time. But it is hard to see how this appeal to the Law of Continuity is consistent with his claims that what is actual is discrete, and that phenomenal change is discontinuous. These difficulties are resolved, I contend, through a careful analysis of Leibniz's subtle views on the moment of change, minute and confused perceptions, vague states, and the mathematics of continuity, as epitomized in his Law of Continuity and his syncategorematic interpretation of the infinite and infinitesimals.

7.1 Divine Concurrence and Continuous Creation

In Chapter 6, we discussed Leibniz's views on the union of body and soul and transubstantiation, with particular attention to what he wrote to Des Bosses. But these were only two of the issues that arose in that correspondence. The very first issue raised by Des Bosses was Leibniz's treatment of divine concurrence, especially in connection with the doctrine of Continuous Creation. For here there appear to be difficulties with some of Leibniz's central doctrines. If God's concurrence in the production of things amounts to no more than his endowing substances with their own power of acting, then this would seem to reduce it to his acting as first cause; in a word, to an espousal of deism. On the other hand, if God's concurrence is necessary for a substance's existence at every single moment, as Leibniz claimed, then it is hard to see what causal role the substance could have. And, third, the idea that God produces substances at every moment of their existence seems to resolve time into a succession of discrete moments, contradicting his claim that a substance produces its own states *continuously*. Leibniz's responses to these criticisms are very subtle, and an adequate account of them will give us a deeper appreciation of his metaphysics.

Des Bosses raised the issue of concurrence in connection with Leibniz's rejection (in his published essay *De ipsa natura*) of Johann Christoph Sturm's occasionalist position (LDB 5–6). Leibniz objected to Sturm, as he tells Des Bosses, that if all there is in nature is a uniformly extended matter and motion, "then there could exist no variety in phenomena, so that, besides figure, magnitude and motion, forms must be admitted, through which difference in appearances might arise, and I do not see where these

forms could intelligibly be sought except in entelechies" (LDB 10–13). Des Bosses approved Leibniz's argument as being completely in accord with Aristotelianism, and added to it by pointing out an inconsistency in Sturm's own position: since he recognizes an active force in souls, it follows that "what he himself says about souls, I could say of other forms, as is obvious".[1]

His concern about Leibniz's position, though, was that if God's concurrence amounted to nothing more than his having produced (as first cause) this entelechy or power of acting in things, "or an endeavour modified by the endeavour of other acting things", then this would "[deny] the immediate influence of God on the actions of created things" (LDB 7). God's concurrence would be reduced to his acting as a first cause, as in the unacceptable deistic position of Guillaume Durand de Saint-Pourçain (*c.* 1275–1334), contrary to accepted theological doctrine.[2] As we already noted in Chapter 4, Leibniz agrees with Gassendi and Boyle that to regard substances as entirely self-sufficient would be to deny their continuing dependence on God. Accordingly, he replies to Des Bosses in his letter of 2 February 1706:

> I myself recognize God's concurrence to be so necessary that, whatever creaturely power is assumed, it would not be followed by action if God were to withdraw his concurrence. I also believe that neither active force itself nor even a bare faculty would exist in things without divine concurrence, since I hold in general that however much perfection there is in things, it flows forth from God by his perpetual operation. . . . From active force (which of course involves endeavour) ôr from entelechy, action follows, provided only that the ordinary concurrence of God is added. (LDB 10/11)

So we can see Leibniz attempting to avoid two unwanted extremes. One was to assign all causal power and action to God, as had the Cartesians and Sturm. This courted the theological danger of making God the author of the sins and errors of created beings, as well as entailing the metaphysical consequence—if it is agreed that a substance is a being capable of action—that the only substance would be God. As Leibniz had argued in the *Theodicy*:

> In my system every simple substance (that is, every true substance) must be the true immediate cause of all its actions and inward passions; and, speaking strictly in a metaphysical sense, it has none other than those which it produces. Those who hold a different opinion, and who make God the sole agent, are needlessly embroiling themselves in expressions from which they will hardly be able to extricate themselves without offending religion; apart from the fact that they unquestionably offend against reason. (§400; GP VI 354/H 362–3)

[1] This remark is from his first letter to Leibniz (25 January 1706; LDB 6–7); his approval of Leibniz's own argument ("your most beautiful demonstration against the Cartesians, which you inserted in your dissertation against the famous Sturm") is given in his second letter, sent 12 February (LDB 16–17).

[2] In his "Creation *and* Conservation *and* Concurrence" (McDonough 2007, 58), Jeffrey McDonough references Durand's *In Sententias theologias Petri Lombardi*., II, dist. 1, quest. 5 (Venice 1571; reprinted at Ridgewood, NJ, 1964), 130d–131d. My discussion in this chapter is indebted to McDonough's treatment of Leibniz's views in this article, as well as to Donald Rutherford's "The Actual World" (Rutherford 2016).

But at the other extreme was the danger pointed out by Des Bosses, that if substances, once created, possessed their own power of acting, God would be reduced to a first cause, as in deism. As I argued in Chapter 5, Leibniz tried to steer between these poles by proposing that although created things do indeed possess active power, this is only by virtue of God's action in continually creating them. Taken by itself, however, this proposal might seem hard to distinguish from Descartes' own position. For in both his *Meditations* and his *Principles of Philosophy*, Descartes had appealed to continuous creation precisely because created substances, in his view, lacked any force or action save that deriving from God's continuously creating them.[3] In order to conserve any being in existence, God would need to exert "the same force and action at each moment it endures as would be needed to create it anew if it did not yet exist" (Descartes, *Meditations* 3: AT VII, 48–9/Cottingham et al. 1984, 33). This was interpreted—by Descartes' followers, at least, such as La Forge—to entail that God would not only have to conserve the substance at each successive moment of its existence, but also create the modes or states appropriate to the substance at each such moment.[4] This is where Leibniz disagrees. Each created thing, according to him, must have the power to act and "be the true immediate cause of all its actions and inward passions"; but causation is not the same as creation. Substances do not create themselves, their substantial forms, but they certainly produce their own modifications or accidental forms. "The production of modifications has never been called *creation*", he writes against Bayle in the *Theodicy*, "and it is an abuse of terms so to terrify the world. God produces substances from nothing, and the substances produce accidents by the changes of their limits" (§395; GP VI 351/H 360).[5] This agrees with what he had written in his published *Reply to Bayle's Note L*:

> Neither does it seem to me that we have to deny action or power to created things on the grounds that if they produced modifications they would be creators. For it is God who conserves and continually creates their power, that is to say, the *source* of *modifications* within a created thing, or a state of that thing from which it can be seen that there will be a change of modifications. Otherwise, it seems to me . . . that God would have produced nothing, and there would be no substances other than God—which would bring back all the absurdities of the God of Spinoza. (GP IV 567–8/WFT 252)

Whereas on the Cartesians' and Bayle's understanding of continuous creation, God has to exert this force or action on an otherwise inert substance at each distinct

[3] See my (1988) for a treatment of Descartes's views on Continuous Creation.

[4] Cf. Bayle, quoted by Leibniz in the *Theodicy*: "'One of the absurdities', says M. Bayle (p. 779), 'that arise from the so-called distinction alleged to exist between substances and their accidents, is that if created things produce accidents, they would possess a power of creation and annihilation'" (§394; GP VI 351/H 360).

[5] Here again it is worth comparing Leibniz's position with Sennert's: "Indeed, after God has once ceased from creation, he creates nothing further, except miraculously . . . And now God concurs even in the creation of all natural things as the primary and universal cause, but the things produced are the immediate effects of the secondary causes, and God is called the efficient cause of all things both because he first created them, and because he gave the secondary causes the force and power for producing their effects immediately" (*HP*, 4.2, 169/Sennert 1659, 465–6).

moment in a discrete act,[6] for Leibniz the force each substance is endowed with at each instant exists only as a delimitation of God's infinite power—without which there would be no force, and thus no substance. This means that the separate substances themselves—all created monads—are, in terms of their power, simply offshoots of the one infinite substance, God. Leibniz does not shrink from saying this:

> God alone is the primary unity, or the originative simple substance, of which all created or derivative substances are productions. They are generated, so to speak, by continual flashes of the Divinity from moment to moment, delimited by the receptivity of the created thing, to which being limited is essential. (*Monadology* §47; GP VI 614/WFT 274)

Created things are not simply delimitations of God's *power*, however, but also of his *knowledge* and of his *will*. As Leibniz explains in his *Principles of Nature and Grace* of 1714, these are the three essential attributes of God, each of them unlimited or infinite: divine "omnipotence, omniscience, and supreme goodness" (§9; GP VI 600/WFT 262). In created things these attributes manifest themselves in delimited fashion—in accordance with the receptivity of the thing in question—and "are what constitute the subject or basis, the perceptive faculty, and the appetitive faculty", respectively (*Monadology* §48: GP VI 615/WFT 274).[7]

This idea that perception and appetite are essential faculties of substance, and exist in created substances as mere delimitations of divine attributes, is not a late development in Leibniz's thought. The construal of perception as a delimitation of divine omniscience appears as early as April 1676, and remains a feature of his thinking from that point onwards.

> It seems to me that every mind is omniscient, confusedly; and that any mind perceives simultaneously whatever happens in the whole world; and that these perceptions, of infinite varieties fused together at the same time, give rise to those sensations we have of colours, tastes, touches. (*On the Plenitude of the World*, April 1676; A VI iii 524/LLC 59)

In the *Metaphysical Definitions and Reflections* of 1678–9, as we saw, Leibniz explicitly construed perception as confused knowledge, a delimitation of divine omniscience, and proposed a similar analysis of appetition as a delimitation of divine omnipotence:

> Thus every substance has in itself some participation in divine omniscience and omnipotence, even though its knowledge is confused, and its action is refracted by things acting in contrary ways. (A VI iv 1400/LLC 249)

As we noted in Chapter 6, however, at that time Leibniz conceived appetitive action and its refraction in terms of the propagation and refraction of endeavours. Substance has "as much appetite as there is in it a force of action, and as much sensation

[6] Daniel Garber calls this the "divine impulse view" or "Divine Shove" (Garber 1992, 278).

[7] Maria Rosa Antognazza (1999) has drawn attention to the theological underpinnings of this doctrine in Leibniz, and its roots in the Trinitarian theology of Bisterfeld. As Leibniz explains in the *Theodicy*, (GP VI 189–90/H 217), "power relates to the Father, . . . wisdom to the Eternal Word, . . . and will or love to the Holy Spirit".

as there is in it a force of being acted upon", while the action of every extended substance is "by motion, namely, local motion" (1399/245). Appetitive action is thus a delimitation of divine omnipotence through the refraction or diffusion of endeavours.[8] But this seems to differ from Leibniz's mature position noted above, where he characterizes appetition as a delimitation, not of divine *omnipotence*, but of divine *will*. In the *Monadology*, appetition is described as "the action of the internal principle that brings about the passage from one perception to another" (§15; GP VI 609/WFT 269), and appetite as tending towards future perceptions and towards what the creature perceives as best; while in the *PNG*, "the law of appetites" is equated with "the law of final causes of good and evil" (§3; GP VI 599/WFT 259).

We will consider the reasons for this change of position later; discussing it further here would take me too far from my purpose. The crux of the matter so far as it concerns concurrence, I believe, is this. Leibniz subscribed to the traditional view that God concurs in the continuous production of substances, and that his conserving them is equivalent to his continuously creating them. Bayle was among those who claimed that this entailed that God would also have to recreate each substance with the particular modifications it had at each instant—warts, wrinkles, and all. Leibniz resisted this idea, holding that it is sufficient for God to concur in continually creating the primitive force that is the source of a created thing's modifications, which it produces by limiting or modifying that force. Still, he could not deny that God also concurs in the creature's production of those modifications, without denying either divine omnipotence or divine omniscience. So the onus was on him to show how God's concurrence in substances' actions—including the sinful actions of human beings—is not the same as his causing them. This will be worth a digression, since it throws further light on the status of passive force in Leibniz's metaphysics, namely, its crucial link with optimization and the Principle of the Best.

In response, Leibniz appealed (as had Descartes before him) to Augustine's interpretation of sin as imperfection: "only perfection ôr what is positive is decreed by God", he wrote in *On Freedom* from 1689, "whereas limitation, and the sin arising from it, is permitted by the very fact that there is no basis for its absolute rejection if certain positive decrees remain in force" (A VI iv 1657/L 265); and in the Latin summary of the argument of the *Théodicée*, "10. In acting, things depend on God, while God concurs with the actions of things insofar as there is some perfection in the actions, which certainly must flow from God."[9] That is, God continually produces whatever is perfect

[8] This also seems to be Leibniz's view in the *Mira de natura substantiae corporeae* of 1683: "There is in every created thing the limited and the unlimited: limited with respect to distinct cognition and irresistible power, but unlimited with respect to confused cognition and refracted action. For every soul, or rather every corporeal substance, is confusedly omniscient and refractedly omnipotent. For nothing happens in the whole world which it does not perceive, and it has no endeavour that does not extend to infinity" (A VI iv 1465–6/LLC 265). Here limited omnipotence is construed in terms of refraction or diffusion of a corporeal substance's endeavours.

[9] Cf. what Leibniz wrote summarizing his conversation with Dobrzensky in 1695: "The Platonists and St. Augustine himself have already shown that the cause of good is positive, but that evil is a defect, that is to say, a privation or negation, and consequently comes from nothingness or non-being" (Leibniz 1948, 364/AG 114).

in a created being; our limited knowledge and power is what produces in us sin, so these follow from our lack of perfection. On this conception God does not actually produce imperfections as positive creations: they are rather the result of the fact that the maximal perfection that he does produce is limited. An analogy would be the creation of a beautiful line drawing: the gaps between the lines of the drawing are not themselves part of the creation, but are an immediate result of it, and also necessary for the existence of the drawing.[10] In the same way, Leibniz holds, God creates what is positive in creatures' actions, and does not need to create the imperfections that are the immediate results of those actions, and which make them possible.

The difficulty for Leibniz in upholding this Augustinian analysis has been succinctly described by Rutherford:

> The distinctive contribution of the creature, the part that is independent of God, is limited to what follows from the *absence* of power or perfection. But how is that consistent with there being any genuine causal role for the creature, or for its assuming responsibility for the outcome of its actions? (Rutherford 2016, 27)

As Rutherford observes, Leibniz's most informative answer to this appeals to his theory of substance. What is perfect in a substance is its substantial form or entelechy. Indeed, as Leibniz notes in the *Monadology*, etymologically an entelechy *is* what has in itself some perfection (*en* = in, *telos* = perfection, end, *echein* = have) (§18, 48; GP VI 609, 615/WFT 270, 274). Leibniz identifies a substance's entelechy with its primitive active force; what is imperfect is its primitive passive force, or primary matter. But this takes us back to the difficulty raised by Adams, noted in Chapter 6. If primitive passive force is mere limitation, and not something positive in a substance, it appears to be a mere by-product of a substance's activity; and if that activity is simply the internal action of a simple substance, consisting in the generation of perceptions (*Monadology* §15, §17; 609/269–70), then according to Adams, it reduces to a mere "aspect of the *perceptual* operation of that substance" (1994, 377).

I would like to suggest a different interpretation. To begin with, I note that confusedness of perception is just one aspect of the limited receptivity of creatures to divine perfection (namely, limited receptivity to divine omniscience); creatures are limited also in their receptivity to divine omnipotence, and to divine goodness. According to Leibniz, limitation is essential to the created monad itself: it is a mark of the limited receptivity of the monad to God's continuous creation of it. As we saw above, in *Monadology* §47 Leibniz describes monads as "generated, so to speak, by continual flashes of the Divinity from moment to moment, delimited by the receptivity of the created thing" (GP VI 612/WFT 274). This action, consisting in God's continual

[10] Leibniz offers a similar comparison in his dialogue with Dobrzensky: "It is a little like what happens in music and painting, for shadows and dissonances set the other parts in relief, and the wise author of such works derives such a great benefit from these particular imperfections for the overall perfection of the work that it is much better to make a place for them than to want to do without them" (Leibniz 1948, 365–6/AG 115).

creation of substances, "namely the action of the infinite substance on finite ones", is the "only case of one substance acting immediately on another" that Leibniz countenances (GP II 264/LDV 291). Now as we have seen, a substance is perfect insofar as it is active, and imperfect insofar as it is acted upon, and its power of being acted upon is its passive force. So if, in metaphysical strictness, a substance is acted upon only by God in continually creating it, it follows that primitive passive force, metaphysically speaking, is a manifestation of the limited receptivity of that created substance to the divine creative force. *Passive force is therefore primarily a limitation of divine omnipotence*, not of creaturely perception, even though the creature is limited in its capacity for being created also by its limited receptivity to divine omniscience and divine goodness.

But why does a created substance have this limited receptivity to being created? Leibniz's answer is that it is because it is in competition with other possible substances for existence. In *On the Radical Origination of Things* Leibniz presents this in terms of possible substances having an "exigency for existence", or tendency to exist, in proportion to the degree of perfection they contain (GP VII 303/L 487; 304/488). Such a tendency is to be understood in terms of the claim to existence each thing has in the divine mind for its being created rather than other possible things that might exist instead. But because of the connection of all things, no possible thing has a claim to existence except insofar as it fits with others: the actions of some substances will prevent or constrain the actions of others. This means that there is a natural limit on the perfection of each substance that follows from the requirement of all its actions being compatible with those of the substances that might coexist with it—that is, with the possible substances that are *compossible* with it, where such a combination of compossible substances consistent with it constitutes a possible world. Thus what is brought into existence is that combination of possibilities and possible series which contains the most perfection, and the existence of any given possible thing will exclude the existence of others.

There are therefore two constraints on substances' receptivity to being created that have to go into the estimation of the most perfect world. One is that each state of a subject at a given time is constrained by its having to agree with all simultaneously existing substances in the same possible world, since a state is a perception or representation of the whole of the rest of the universe. Such a perception is therefore confused—in its root meaning of the fusing together of its perceptions of all the other beings coexisting with it in the same world. This constraint on the distinctness of its perception, as a result of the existence of other substances, is interpreted by Leibniz as limited receptivity to divine omniscience. It is a constraint that characterizes all substances insofar as they are possible.

The other constraint follows from the teleological character of entelechies. Here Leibniz's etymological point about entelechies meaning "perfection-havers" can be supplemented by the observation that the *telos* in *en*/*telos*/*echein* is also Greek for "end": the action of an entelechy is end-directed, teleological. So in the "Divine Mathematics ôr Metaphysical Mechanism" of creation (GP VII 304/L 488), whatever

perfection a substance has is evaluated with respect to how well it achieves its ends, and thus involves its whole history as a possible substance. From this point of view an entelechy consists in an optimal series of actions (or transitions between states) with its own law, a kind of best path from its initial to its final state, *modulo* the constraints of the actions of other substances, which manifest themselves as constraints on its own actions. A given substance, taken by itself, might have a lesser claim to existence than another possible one. But if the perfection of the possible world in which the second would exist is less than the perfection of the first's world, the first is preferred for existence. Thus "just as possibility is the principle of essence, so perfection or degree of essence is the principle of existence (since the degree of perfection determines the greatest number of things that are compossible)" (304/488). Again, as Leibniz explains in an unpublished manuscript, *On Freedom and Necessity*, perfection "is an exigency for existence from which existence indeed follows per se, not necessarily, but from the denial that another thing more perfect than it prevents it from existing" (A VI iv 1446/AG 20).

It is this second constraint, Leibniz argues, that distinguishes his metaphysics from a necessitarian metaphysics like Spinoza's. If existence followed necessarily from the exigency to exist, then either things would not need the continued action of God in order to exist, or, if they needed a God to create them, it would not be a God freely choosing to create the best of all possible worlds—to create, from among really existing alternatives, that world which contains the greatest perfection. His continued creation, consequently, is not simply his creation of actual things, with the laws governing them following by inexorable logic from the creative acts themselves. Rather, God's concurrence in creating the actual world is a consequence of an implicit comparison in the divine understanding of degrees of perfection of differing really possible worlds, and his (independent) free decision to choose among them the most perfect. Leibniz lays a lot of stress on this point, that the receptivity of a substance to creation must be assessed, not in terms of "actual things themselves", but in terms of "entire notions or ideas of possible things, which cannot be denied to be in the Divine Mind prior to every decree of will and the existence of things" (A VI iv 1528). The degree of receptivity of a substance to its creation issuing in its primitive passive force is a consequence of the competing claims to existence of possible substances, evaluated over their whole sequences of states; and subsequently, their belonging to that possible world or aggregate of possibles that contains the maximum degree of perfection. It is only the most perfect possible world that God creates, and so only this world is supported by his concurrence.

A comparison with the views of Descartes may help to clarify Leibniz's position. As noted above, Descartes had also taken the Augustinian line on sin, where God is responsible only for what is perfect in human actions. He offered an analogy with his physics. Just as "God alone is the author of all the motions in the world insofar as they exist and are rectilinear", he wrote in *Le Monde*, so he "is also the author of all our actions insofar as they exist and have some goodness"; and just as "it is the various

dispositions of matter that render them irregular and curved", so "it is the various dispositions of wills that can render them evil" (AT XI 46–7/CSM I 97). But are these dispositions of matter a positive power? Descartes claimed that "the power of any given body to act on or resist the action of another . . . consists simply in the fact that everything tends, as much as it can [*quantum in se est*], to persist in the same state, as laid down in our first law" (AT VIIIA 66/CSM I 243). This presents a picture of each body endeavouring to continue in a straight line, and being prevented by collisions with other bodies, which have their own endeavours to continue in their straight lines—"an endeavour modified by the endeavour of other acting things", as Des Bosses had thought Leibniz was proposing (LDB 7). A composition of instantaneous tendencies to motion (the parallelogram law) then gives the resultant tendency. No further passive power is attributed to body beyond its endeavour to maintain its motion in a straight line.

But Descartes did not stay true to this framework, since (following Isaac Beeckman) he framed his laws of motion in terms of the conservation of the *quantity of motion*, the product of a body's velocity with its "magnitude" (his interpretation of Beeckman's "corporeity")—not in terms of a composition of tendencies alone. Given his equating of matter with extension, Descartes had difficulty explaining how two equal volumes could have different magnitudes. Quantity of matter (Newton's 'mass'), in distinction from quantity of extension, was a property alien to the geometric foundations of Descartes' plenist physics.[11] In fact, it was the young Leibniz who tried to erect a foundation for physics entirely in accord with the interpretation of passive force Descartes had given in the *Principles* when, in his *Theoria Motus Abstracti* of 1670–1, he attempted to derive the laws of mechanics solely on the basis of the composition of endeavours. It was the failure of this project, he never tired of explaining, that led him to recognize that there was something more in bodies than could be derived from geometrical considerations alone.

What this "something" is, Leibniz claimed, is a power residing in bodies "by which speed is adjusted to magnitude". As he wrote in 1702, "a body endeavours to persist in its prior state, not only in the sense that it will not spontaneously abandon that state, but also in the sense that it opposes the thing changing it" (GP IV 395/AG 252).[12] This power of resisting changes of motion must be understood as actually being in things, just as is the motive power, containing the reason for the things' changes. Together, these powers are the sources of the various motions and endeavours of the body and the laws governing them. As explained in Chapter 5, the contrast here is with the metaphysics of his contemporaries, the Cartesians, Bayle and Newton, who conceived

[11] For a discussion of the profound debt Descartes owed to Beeckman for the foundation of his physics, and the respects in which they differed, see Arthur (2007).

[12] Daniel Garber gives an illuminating comparison of Leibniz's and Newton's conceptions of force in his (2012); see also Arthur (2015b). My discussion here suggests a difference between their conceptions not noted by Garber: Leibniz objects to the Cartesians and Newtonians alike that they are bound to ascribe the resistances of bodies to other bodies' motions to God rather than to the created things themselves.

passive force rather as a result of God's instituting the laws of motion by his direct action, so that for them the laws are encapsulations of the way in which God habitually recreates bodies. Thus the correct interpretation of passive force is intimately bound up with how one interprets the action by which God conserves the world in being.

This deep connection between passive force and continuous creation helps to explain why Leibniz, like Descartes before him, typically illustrates his Augustinian line on sin by reference to the inertial motion of bodies. According to Descartes' account of continuous creation, God exerts "the same force and action" to maintain the created universe in being at each moment of its duration as he did to create it in the first instant, with these forces and actions variously distributed in subsequent instants according to the laws of collision. This force or action is in bodies only by virtue of God's creative action itself, of which it is a manifestation; and at each instant it can only be directed in a straight line; its limitation is explained by other bodies offering obstacles to its continuation. But by Leibniz's lights, Descartes has failed to show how the limitation of this creative force follows from its taking into account the actions of the bodies it coexists with. A body's *natural inertia*—the term he adopts (like Descartes) from Kepler—must be posited as a power *in* that body, a *principle of multiplicity*, a limitation of its own perfection resulting from the existence of these other bodies in the same possible world, to which it is linked by "the interconnection of all things".

Given this Cartesian precedent and the fact that he believes he can correct its deficiency, it is therefore no accident that Leibniz appeals to natural inertia when he seeks to explain sin as a limitation. And almost every time he does, he uses the same illustration of a heavily laden ship whose mass gives it a resistance to being moved by the current in a river.[13] Just as the mass or natural inertia of the ship expresses the limitation of its receptivity to being moved by the river current, so "the limitation of the receptivity of the creature [to the action of God, who produces and conserves whatever is positive in creatures] is the cause of the defects there are in its action" (§30/H 141). The ship's natural inertia is a physical manifestation of the limited ability of its constituent substances to contribute to the actions of the whole, a limitation in their capacity to receive divine action; just as the imperfection of a free substance in sinning is an expression of its limited ability to achieve perfection in its actions in the moral sphere. The first is a limitation of receptivity to divine omnipotence; the second is a limitation of receptivity both to divine omniscience and to divine goodness.

This digression on Leibniz's views on divine concurrence has thus served to throw light on his conception of passive force and its connection with perfection, limitation, and optimization. It can also throw light, moreover, on the status of the determination in his thought, and the implications of this for the grounding of the laws of physics. Descartes, of course, had exempted minds from having to follow the laws appropriate

[13] McDonough describes Leibniz as offering the laden boat as an "imperfect analogy" (2007, 43), whereas Leibniz himself claims that "we will find that there is nothing so just as this comparison" (*Theodicy* §30, H 141). He articulates this analogy first in the late 1670s (A VI iv 1980/AG 249), but repeats it three times in the *Theodicy* (§30/H 140–1; see also §335/H 327, Summary, answer to objection 5, H 384).

to material bodies. Newton and Clarke maintained similarly libertarian views about freedom of the will, according to which God and minds simply will things without a determining reason (except the will itself). But Leibniz had rejected such libertarianism. Instead, in common with Hobbes and Spinoza, he had adopted the position that nothing happens without a determining reason, with the dispositions to act in the mind corresponding to endeavours in the body. Leibniz only belatedly realized (in 1677) the implication of this deterministic position that, if the laws of physics operated by geometric necessity, and the states of the mind or perceptions had to correspond to external motions, then perceptions would also follow one another with geometric necessity. This explains the importance for him of deriving the laws of physics by appeal to the Principle of the Best. Instead of their resulting from the actions of a motiveless will imposed externally on actual things, as in the libertarian account, they are derived "according to formal reasons", that is, from teleological principles, namely the principle that the "maximum effect should be achieved with minimum outlay" (GP VII 303/L 487); so that "the metaphysical laws of cause, power and action are present throughout all nature", and "prevail over the purely geometric laws of matter" (305/488–9).

Leibniz believes that the reasons things have for their (future) actions are determined through final causes, thus involving an appeal to maximizing perfection. Contingent events are not necessitated, but they are determined by virtue of being part of the world in which perfection has been maximized overall. That is, "even if the world is not necessary metaphysically, in the sense that its contrary would imply a contradiction or logical absurdity, it is nonetheless necessary physically, i.e. determined in such a way that its contrary would imply imperfection or moral absurdity" (304/488). Individual agents act in order to attain what they perceive as best, modulo the constraints of other agents preventing their full success, and modulo also the constraints of limited power and limited perception.[14] God, intuitively seeing all of this, creates the set of compossible substances that contains the maximum perfection overall. The laws governing this universe are therefore determined by his willing the best, and are not simply results of an undetermined will. It is, finally, only this world, the most perfect of all those not containing any contradictions, that God conserves in being. All substances are entelechies, strivers after perfection, but only those entelechies in the best of all possible worlds have their power to act realized by divine concurrence.

Leibniz's metaphysics of physics is thus connected at its roots with his metaphysical account of action, free will, and determinism. On the account he is opposing, the soul's

[14] Leibniz believed that this distinction between physical necessity, where one's actions are determined in accord with what one perceives to be best, and metaphysical necessity, where the contrary of one's future action is contradictory, licenses his notion of a free substance's being "inclined without being compelled". As he wrote in the *Theodicy*, "The free substance is determined by itself, and that according to the motive of the good as apperceived by the understanding, which inclines it without necessitating it" (§288; GP VI 288/H 303). See my 2014 (chapter 8).

tendencies to new perceptions will simply be endeavours towards them, where the endeavours are refractions of divine omnipotence, and the perceptions geometrically necessitated by prior perceptions. But if perceptions are refractions of divine omniscience, and the future states of any substance follow from its present one with necessity, then the supposed contingency of events will simply be a reflection of our lack of knowledge of their causes, as in Spinoza. So if Leibniz upheld this account, his position on determination would collapse into one indistinguishable from Spinoza's, where contingency is just the result of our limited knowledge of causes.

I surmise that this explains why Leibniz abandoned his earlier view idea that appetition is a delimitation of divine *omnipotence*, in favour of his mature account, where it is instead a delimitation of divine *will*. Endeavours do indeed follow on one another deterministically, in keeping with the laws of physics. But this is because the laws are determined according to the Principle of the Best, depending on God's good will, and not because their not holding would be logically or metaphysically contradictory. From this, moreover, it would follow that Leibniz's passive force cannot reduce to a mere limitation of a substance's perception, as Adams interprets it, "a function of the degree of confusedness of its perceptions" (Adams 1994, 324–5). For since confusedness of perceptions is the consequence of our limited receptivity to divine omniscience, this would make passive force the result merely of our limited knowledge of causes. Leibniz, on the contrary, construes passive force to involve not only a limitation in the distinctness of a substance's perceptions, but also a limitation in its capacity to achieve its ends because of the actions of all the other substances in the same possible world, to which it is linked by "the interconnection of all things".

If the preceding analysis is correct, it goes some way towards explaining Leibniz's delay in advertising his reintroduction of substantial forms. For most elements of his mature theory seem to be in place already by 1678–9: regarded as a continuum, matter is merely ideal and has no actual constituents, but as an existing thing it is divided into infinitely many actual, finite parts by the differing motions in it, due to the entelechies presupposed in every such distinct part; each such entelechy, soul, or substantial form has perception and appetite; beings by aggregation, such as a heap of stones, taken apart from the substances from which they are aggregated, are merely phenomenal; every substance is animated and embodied, so that there are as many corporeal substances as there are souls or substantial forms. But all this would be consistent with a necessitarian physics such as Spinoza's. It is only after Leibniz has sufficiently developed his new theory of contingency in the early 1680s that he is able to connect his emerging dynamics with a non-necessitarian theory of action. The laws of physics are still deterministic, but the fact that they are derived from optimization principles, and so depend on the Principle of the Best, is what enables him to avoid necessitarianism. On this analysis, then, there is a change in Leibniz's metaphysics. But it comes about before rather than after his attempt to gain Arnauld's endorsement of it in 1686; and it is not a move into idealism, but a move from a bipartite account of divine concurrence involving delimitations in created substances of the divine attributes of omnipotence

and omniscience, to a tripartite one involving God's "omnipotence, omniscience, and supreme goodness".

This same account of concurrence allows us to tackle the question raised earlier, of how Leibniz is able to account for God's concurring in the actions of things, including the free actions of humans, without this entailing that he *causes* them. The circumstance that each substance is tightly linked to all coexistent substances by the fact that their states must express the same phenomena from their own point of view also means that the internal action of change of perceptions must correspond with similar actions in all things that are coexistent with and external to it. This allows Leibniz to give an account of the action of one substance on others external to it, despite the lack of an influence propagating from one to the other. "This *interconnection*, or this adapting of all created things to each one, and of each one to all the others", Leibniz explains in the *Monadology*, "means that each simple substance has relationships which express all the others" (§56, GP VI 616/WFT 275). Thus, although "one created monad could never have a physical influence over the interior of another" (§51, 615/275), a "created thing is said to be *active* externally insofar as it has perfection, and to be *passive* towards another insofar as it is imperfect" (§49, 615/274). Note that here Leibniz acknowledges that a created thing can be active *externally*, provided this is understood in the sense we described in Chapter 5 in discussing Leibniz's account of causation. It can truly be said to be *active* externally, to *cause* something to occur in another, "insofar as what can be clearly understood in it serves to explain what happens in the other". Likewise, it is *acted upon* to the extent that the imperfection of its actions is explained by reference to God's adapting them to those of other things in the same possible world (§52, 615/275).

It will be useful to contrast Leibniz's position on causation with Malebranche's. In arguing for occasionalism, Malebranche had argued that the very supposition that any one body can move another—for instance, that "you are able to move your own armchair"—"is a contradiction".[15] For in order to continuously create the armchair, God has to create it somewhere. It would therefore be impossible for any finite cause to move it anywhere else, and therefore to contribute in any way to causing it to be where it is. By Leibniz's lights this is not a sound argument. In fact, it commits the fallacy known as the "Lazy Sophism". An event is not necessitated to happen as a result of a cause whatever causal sequences might have taken place in the interim. "It is untrue that the event happens whatever one may do", Leibniz writes in the *Theodicy*: "it will happen because one does what leads thereto" (Preface, H §57). God does indeed concur in the causal sequence, which could not happen without his will; but this is to say he concurs in continuing to produce the substance that is a denizen of the best of all possible worlds, having foreseen what will follow according to its own free choices (if it is a rational substance). So he empowers the substance with the force to carry out its

[15] See *Dialogues on Metaphysics and on Religion*, Dialogue VII (Malebranche 1997, 111).

own actions in accordance with its own decisions, and it is for this reason we can identify the substance as the secondary cause by which God's will is effected.

Thus God's concurring in substances' actions—including the sinful actions of human beings—is not the same as his causing them. God is the primary cause as creator, but the effects that he produces are brought about through the agency of the secondary causes that he conserves in existence, namely substances.[16] In this sense it is true to say that God produces the cause, and also the effect; but the creature is that which constitutes the best means to join them, and its actions are necessary for the end to come about. The effect is determined by the creature's taking this optimal causal path. But the requisites at every stage depend on the other creatures with which it coexists, so that they conspire in causing the effect: they are concomitant requisites. God produces an effect *by* creating the agent (and agents) that he knows will produce the effect. And this requires the creature to have the power to produce effects as part of its nature. As we saw in Chapter 5, this power is its primitive active force.

There is a passage that Jeffrey McDonough quotes which nicely summarizes this last point. It is a response to criticisms made by Jean Louis Vigier which Leibniz found in an extract of the latter's *Discours de la Connoissance de soy meme* (1692) that was published in the *Journal des Sçavans* (35 and 36, 8 and 15 September 1698):

> I agree in some way with the first point, that God continually produces all that is real in creatures. But I hold that in doing so he also continually produces or conserves in us that energy or activity which according to me constitutes the nature of substance and the source of its modifications. And thus I do not at all agree that God alone acts in substances, or alone causes their changes, and I believe that this would be to make creatures absolutely futile and useless. (*Addition à l'Explication du système nouveau*…, 30 November 1702; GP IV 588–9)

What Leibniz describes here as the "energy [*energie*]" constituting the nature of substance is not the derivative active force of his physics (i.e. what we call energy in physics today), but the primitive active force, of which that is a modification. It is the enduring power in a substance by which it is able to effect physical changes through its modifications.

It is of course, not just an enduring power, but a *continuously* enduring one, as befits God's continuous creation of it. This signals the second way in which Leibniz's substances constitute a solution to the continuum problem (in addition to their being presupposed by bodies as aggregates): *monads are temporal continuants*. But how? How does his upholding of continuous creation not commit him to the composition of time from moments he decries in the Cartesians? And how is his claim that a substance

[16] In this respect, both Descartes and Leibniz are following Augustine, who does not deny that created souls have within them the power to act, but insists that in doing so "they do not create, but only make use of the forces supplied by God to bring forth what he has already created" (Sorabji 1983, 302). This is also the position of Sennert, as was noted earlier in footnote 5 above. For a discussion of how Descartes' Augustinianism distinguishes him from his occasionalist followers, see Arthur (2012).

continuously produces its own states compatible with his assertions of the discreteness of the actual and the discontinuity of phenomenal change? These questions will occupy us for sections 7.2 and 7.3.

7.2 Monads as Temporal Continuants

As Leibniz well knew, his theory of substances as temporal continuants contrasts with the views of some of his most influential contemporaries, for whom the states of bodies and minds change in synchrony from one moment to another, as God successively recreates the world according to the laws he has put in place. Descartes himself was careful to qualify all his references to *re*-creation with a *quasi*, "as it were", and seems to have regarded God's continuous production of substances as involving one, continued creative act. This appears to be the case with his famous demonstration of the existence of God from the "nature of time" in the *Meditations*, repeated in the *Principles*.[17] But many of his occasionalist successors interpreted the doctrine as entailing that God creates distinct states in successive distinct acts at discrete moments, making the duration of all substances fundamentally discontinuous.[18] Thus for thinkers like Louis de La Forge, the Cartesian doctrine of the separability of the moments of a substance's duration is read as entailing an explicit temporal atomism. But even in occasionalists like Erhard Weigel and Johann Christoph Sturm who did not advocate atoms of duration, there is a radical discontinuity between the world at one instant and at another. In the *Theodicy* Leibniz describes how his former professor Weigel had offered "a demonstration of the existence of God which in fact amounted to this idea of continuous creation", understood through an analogy with repeated numerical unities:

> These repeated unities were the moments of the existence of things, each of which depended on God, who resuscitates, so to speak, all things outside himself at each moment. And since they fall away at each moment, they must always have someone who resuscitates them, and that could only be God. (§384; GP VI 343/H 355)

But, Leibniz remarks, this interpretation is vulnerable to the difficulties concerning the composition of the continuum. "This dogma appears to resolve time into moments, whereas others regard moments and points simply as modalities of the *continuum*, that is to say, as extremities of the parts that can be assigned in it, and not as constituent parts" (§384). He had made a similar point in a letter to De Volder in September 1699:

[17] Jean-Marie Beyssade (1979) argued forcefully against the idea that Descartes conceived time as discontinuous (the "Classic Thesis"), and maintained instead that he understood God's continuous creation as involving one continued, creative act. I built on this (1988), where I argued that the "Classic Thesis" is incompatible with some of Descartes' most cherished principles, and that Cartesian time must be understood as continuous. Dan Garber simultaneously threw doubts on the received view (Garber 1987), but has maintained a studied agnosticism about whether Descartes' duration is continuous (see Garber 1992). For more recent treatments, see Gorham (2007, 2008), Arthur (2011b, 2012).

[18] For the occasionalism of La Forge and Cordemoy, see especially Nadler (1998, 2005).

> Anyone who completely rejects continuity in things will have to say that motion is essentially nothing but successive leaps through intervals flowing forth not from the nature of the thing but as a result of the action of God, that is to say, reproductions in separate places, and would philosophize almost as if one were to compose matter from mere separate points.
> (LDV 126/127)

This hypothesis of leaps cannot be refuted, Leibniz continues (126/127), except by an appeal to the Principle of General Order, by which he means his Law of Continuity. Stated colloquially, this is the principle that no changes in nature occur by leaps.

On the face of it, though, it is difficult to see how this appeal to the Law of Continuity can safeguard Leibniz's position from the criticism he makes of Weigel's and Bayle's interpretations of continuous creation. For if monadic states are truly momentaneous, if each exists only for a moment and reflects all others simultaneous with it, and yet "nature makes no leaps", as the Law of Continuity demands, then it is hard to see how time would not be resolved into moments. The characterization of moments as extremities of the assignable parts of time recalls the earlier discussion in the *Pacidius* of 1676, discussed in Chapter 5. But there he had argued that continuous creation was compatible with leaps of a certain kind, because there would be no assignable instant at which a body was not being created, it being nothing during the (unassignable) moments between these assignable instants. Further, he had argued, these "metaphysical leaps" made motion really non-uniform and discontinuous, so that, since there is no action in bodies so conceived, it is necessary to appeal to God for the continuation of motion. So we need to see whether the appeal to the Law of Continuity (in the mature doctrine of the *Theodicy*) is supposed to rule out leaps of this kind too; and also how it is that the rehabilitation of forms and the positing of force in bodies enables them to continue in existence. This will require a careful consideration of the development of Leibniz's views on time from 1676 onwards, in connection with his mature statements concerning the continuation of existence and the Law of Continuity.

As we saw in Chapter 5, in the *Pacidius* Leibniz had argued that "there is no part of time in which some change or motion does not happen to any part or point of a body", so that "there is no moment of time that is not actually assigned" (A VI iii 565–6/LLC 209). But he denied that this would result in a dissolution of time into moments, because the moments would only be the endpoints of time intervals, so that no more than two could ever be next to one another. Consequently, "there is no moment of change common to each of two states, and thus no state of change either, but only an aggregate of two states, old and new; and so there is no state of action in a body" (566/211). Furthermore, because there is no moment of change in a moving body between two such opposite states, there is no sense in which the body (understood as a geometrical entity) could be said to act or even to exist in such intervals.

That action cannot be ascribed to mathematical body is one of the reasons Leibniz gives for a return to substantial forms. In the dialogue, he had concluded that "proper

and momentaneous actions belong to those things which by acting do not change" (566/211), but maintained, like the Cartesians, that only God could be said to be such a thing. After his rehabilitation of substantial forms, however, Leibniz held that it is precisely the form or entelechy of a body that acts but does not change: it acts in producing the substance's states in accordance with the "law of the series" proper to the substance, though insofar as it constitutes that permanent law, it does not itself change. But the argument for the insubstantiality of bodies in the *Pacidius* turns on the non-existence of change between assignable moments, these being only endpoints of intervals. Does he abandon that analysis of change after reintroducing forms?

A review of his unpublished papers of the period reveals that he does not. In a list of definitions written around spring–summer 1679, Leibniz writes: "change is an aggregate of two opposite states in one stretch of time, with no moment of change existing, as I have demonstrated in a certain dialogue" (A VI iv 307). In another from between 1683 and 1685: "Change is an aggregate of two contradictory states. These states, however, are understood to be necessarily immediately next to one another, since there is no third thing between contradictories" (A VI iv 556).[19] Finally, in *There is no Perfect Shape in Bodies*, dated April–October 1686, Leibniz argues that the analysis of change he had given in the *Pacidius* implies not only that body cannot endure for longer than a moment, but that it cannot even have a shape between assignable instants:[20]

> Now I believe that what exists only at a moment has no existence, since it begins and ends at the same time. I have proved elsewhere that there is no middle moment, or moment of change, but only the last moment of the preceding state and the first moment of the following state. But that supposes an enduring state. Now all enduring states are vague, and there is nothing precise about them. For example, one can say that a body will not leave some such place greater than itself during a certain time, but there is no place where the body endures that is precise and equal to it. One can thus conclude that there is no moving body of a definite shape. (A VI iv 1613–14/LLC 297)

The claim that "all enduring states are vague" is important, as we shall see below. But for the present I want to concentrate on the contrast between *body*, which can exists only for an instant and therefore cannot properly be said to exist, and *form*, that which can endure through time while remaining the same thing. We already saw this contrast in the *Metaphysical Definitions* of 1678–9. Since each body is actually divided into parts within parts, "each agitated with a different motion", then

[19] See also Leibniz's *Definitiones: Ens, possibile, existens*, dated summer 1687–end of 1696 (?): "*Change* is a complex of two contradictory states immediately next to one another" (A VI iv 869). I am indebted to Rutherford (2008, 278) for this reference; his analysis there of the reality of derivative force in connection with Leibniz's conception of infinitesimals merits careful reading.

[20] Again, see Levey (2010) for a thorough discussion of Leibniz's contentions that "a thing that exists only for a moment does not really exist" and that "enduring states are vague", and how this issues in a conception of time as divided fractally. He assimilates the idea of "vague states" to Leibniz's treatments of the Sorites paradox and vague predicates, and thus to the "inexactness" of states (2010, 164). Below I connect it to the doctrine of *petites perceptions*, which implies rather the lack of discriminability of the microstructure of states below a certain perceptual threshold.

certainly if we consider matter alone,… no moment will be assignable at which a body will remain identical with itself, and there will never be a reason for saying that a body…is the same for longer than a moment. And since points and moments themselves are not things, but only bounds ôr mode of things, it follows that if there were only matter in body, there would never be any reality or perfection in it. But if there were only form in body, there would be nothing changeable or imperfect in it. (A VI iv 1399/LLC 245)

This contrast of body with form is made explicit in a discussion of time in another unpublished manuscript from the 1680s, *Divisio Terminorum* (*c.* 1683–5). There Leibniz asserts, in Aristotelian vein, that "the only difference…that brings it about that there is no contradiction of any kind when the same things are said to be both contiguous and separate, is the difference of *time*" (A VI iv 562/LLC 267). But he immediately notes that "whether those things are really the same that we think to be so is a matter for a more profound discussion. It is enough that there are some things that remain the same while they change, such as the Ego" (562/267). This seems to confirm the role of the substantial form (at least in humans) as the thing that by acting (that is, by producing its own changes) does not change (that is, remains the same thing).

But what is the argument for the perdurance of form? How can we be sure that the ego exists beyond a moment? Leibniz responds to a possible objection along those lines as follows:

But if someone contended that not even I endure beyond a moment, he cannot know whether he himself exists. For this he knows only by experiencing and perceiving himself. But every perception requires time, and so either he persists during the whole time of his perception, which suffices for us, or he himself does not perceive, otherwise he would perceive only for a moment, namely, for that moment alone at which he exists. (562/267)

This is an intriguing development of Descartes's *cogito*. The argument is that if the ego did not exist beyond a moment, then we would not even be able to infer our own existence from the fact of our perceiving, as we can.[21] Especially interesting is Leibniz's assertion here that "every perception requires time". We will come back to that presently. First, though, let us examine how Leibniz conceives this to be a criticism of the discontinuist interpretation of continuous creation.

In the continuation of the above passage from the *Divisio Terminorum* (subsequently deleted) Leibniz argues that "if all things that are in time are momentaneous, then it is necessary for time to be composed of moments.… But it is just as absurd for time to be

[21] Indeed, even the form of the argument is intriguing. Anyone asserting that the ego does not endure beyond a moment, would not be in a position even to assert this. So they would contradict themselves even in making this assertion. Or, to put it another way, unless it is accepted that the ego lasts longer than a moment, there is no means of deciding the question. In this form the argument seems to be a version of what Leibniz says in the *New Essays* "might be called the argument *ad vertiginem*, when one reasons thus: If this proof is not accepted, we have no means of obtaining certainty on the point in question" (ch. xvii; A VI vi 491). I am not sure whether the argument *ad vertiginem* has attracted any discussion in scientific epistemology, but it would certainly seem to warrant it. (I am indebted to my colleague Nicholas Griffin for drawing my attention to this argument form.)

composed of moments as for a line to be composed of points" (A VI iv 562/LLC 269). Those (like himself), however, "who say that the same things are continually produced by God, are not troubled by the same difficulty, for they do not have to divide time into moments, but have only to say that nothing . . ." Here the passage breaks off, and Leibniz strikes it through, although he gives no indication that this is because he is dissatisfied with its content; rather, perhaps, it has become too much of a digression from his account of how we come by our idea of time, which he then continues. But how might he have finished that sentence? Maybe: ". . . have only to say that nothing substantial lasts only for a moment, but endures as long as God continues to produce it".

This is what Leibniz's discussion of continuous creation in the *Theodicy* would suggest. There he contrasts his conception of substance as an enduring being with the Cartesian conception of substance implicit in Bayle's interpretation of continuous creation. According to that conception, the creature is simply the aggregate of the states produced directly by God. But, he argues, this is to make the creature not itself a being capable of action, and thus to destroy the distinction between substance and mere modification or accident:

> That which does not act does not merit the name of substance. If the accidents are not distinct from the substances; if created substance is a successive being, like motion; if it does not endure beyond a moment, and does not remain the same (during some specified period of time), any more than its accidents; if it does not operate any more than a mathematical figure or a number: why shall one not say, with Spinoza, that God is the only substance and that creatures are only accidents or modifications? (§393; GP VI 350–1/H 359–60)

If a substance doesn't endure beyond a moment, Leibniz argues, it will be indistinguishable at any instant from a modification, and unable to act. Moreover, the conception of substance as the aggregate of its successive states is vulnerable to all the contradictions attendant on composing the continuum from point-like elements. On his conception, by contrast, a substance must be something actively producing its modifications "out of its own store". And with the form of a substance modelled on the ego or soul, the modifications it produces are its *perceptions*.

Now, if these perceptions were strictly instantaneous, Leibniz would not be much further ahead regarding continuity of existence. For then, even if the perceptions were being produced by the substance rather than by God, the production of a different perception at each successive instant would still produce an aggregate of instantaneous states. It is here that one can appreciate the importance of his assertion that "every perception requires time" (A VI iv 562/LLC 267). For, given the identification of a substance's states with perceptions, this means that every monadic state must endure for some time, rather than being strictly instantaneous. It is this that allows Leibniz to retain the account of change that he had proposed in the *Pacidius*. The action of a substance is to bring about one perception from another in an ordered succession, and the principle that effects this is the substance's *appetition*, as Leibniz explains in the *Monadology* (§15) and elsewhere. The change is a change of state, that is, a change from

one state or perception to another contradictory state succeeding it. There is no action in the body (taken apart from the form), but change can still be conceived as the aggregate of two such contradictory states, one immediately succeeding the next, there being nothing between them.

The crucial feature of the soul and its perceptions that is not possessed by a body as conceived by the Cartesians is *memory*. It is this that links the perceptions together and forges the self-identity and persistence of substances through their changes, as we shall see. This motivation for modelling substantial form on the ego can be seen in the following passage from *Definitiones notionum metaphysicarum atque logicarum*, dated mid-1685, where the persistence of substance through its changes is explicitly linked to the fact that perceptions involve memory:

> Certainly those things which lack forms are no more one entity than a woodpile, indeed they are no more real entities than rainbows or mock-suns. Certainly they do not persevere the same for longer than one moment, whereas true substances persist through changes; for we experience this in ourselves, for otherwise we would not be able even to perceive ourselves, since each of our perceptions involves a memory. (A VI iv 627–8/LLC 273)

It might be objected that I am making rather a lot ride on an isolated passage in an unpublished paper where Leibniz declares that "every perception requires time". But in fact it has to be the case that perceptions or monadic states endure for a time in order to cohere with his doctrine of minute perceptions. According to this doctrine, any perception of anything sensible is "confused", that is to say, fused together from an infinity of smaller perceptions, including ones so minute as to be insensible. The following passage from [March?] 1676 constitutes one of the earliest statements of the doctrine:

> It seems to me that every mind is omniscient, confusedly; and that any mind perceives together [*simul*] whatever happens in the whole world; and that these confused perceptions, of infinite varieties fused together, give rise to those sensations we have of colours, tastes, and feels. For such sensations do not consist in one act of the intellect, but an aggregate of infinitely many; especially since some stretch of time is necessary for the sensation of any colour or other perceptible thing. Time, though, is infinitely divisible, and it is certain that at any moment the soul perceives one thing after another, but that perceptions of sensible things arise out of all the infinitely many perceptions fused together [*confusas*] into one. (A VI iii 524/LLC 59–61)[22]

In the *New Essays* Leibniz connects this doctrine of insensible perceptions with his Law of Continuity. "There is at every moment an infinity of perceptions within us, unattended by awareness or reflection. . . . but that does not prevent them from having their effect when they are combined with others, and from making themselves felt, at least confusedly, in the aggregate" (A VI vi 53). We can be made aware of them even

[22] The passage continues: "But the perception of existence, and of thought itself and other things of that ilk, occurs in a moment" (524/61). If a moment is taken as lacking duration, this would seem to contradict the discussion in the *Divisio Terminorum*. But if a moment is a vanishingly small part of a duration, as I shall argue presently, then there is no contradiction.

after they have occurred, "the awareness coming in this case when we have been alerted to them after some interval of time however small it may be" (54). Thus "one can even say that it is as a consequence of these minute perceptions that the present is big with the future and laden with the past" (55). For it is the preservation of traces of former perceptions in subsequent ones that constitutes the sameness of the individual:

> These insensible perceptions also indicate and constitute the same individual, which is characterized by the traces or expressions they preserve of the previous states of this individual, thereby connecting these with its present state; and even when this individual itself has no sense of these traces of previous states, that is to say, when there is no longer any explicit memory of them, they could be known by a superior mind. (55)

Each state or perception contains traces or expressions of previous ones, traces that constitute the memory of the same individual. But unlike in Locke's theory of personal identity, this memory does not have to be explicit or conscious to the individual.[23] It is true that conscious memory is necessary for *moral* or *personal identity*, as Leibniz cedes to Locke (A VI vi 236), and conscious memory requires a rational soul. For in order to be morally responsible for one's decisions and actions, and susceptible to reward and punishment, a person must be able to remember being the individual who committed these acts. But this presupposes a 'self' that the person remembers being,[24] and in order for there to be such a self, there must be a soul or form that has perceptions: "a single individual substance can retain its identity only by preservation of the same soul, for the body is in continual flux" (232).[25] The sameness of this soul, its "*real physical identity*" (236), is constituted by the fact that each of its perceptions contains within it a trace or expression of all its previous perceptions, even if such traces are insensible, or smaller than any that can be sensed. The continuous generation of perceptions out of preceding ones of which they contain traces or expressions is what constitutes each individual as the same thing.

It is in this connection that Leibniz refers to the Law of Continuity that he had published in the *Nouvelles de la République des lettres* in 1687 (GP III 51–5), according to which, he explains in the *New Essays* preface, "*Nature never makes leaps*" (A VI vi 56). This law

> implies that one always passes from the small to the large, and vice versa, through the intermediate, in respect of degrees as well as of parts, and that no motion ever springs immediately

[23] Locke held that "consciousness always accompanies thinking" (Bk 1, ch. XXVII, §12; Locke 1690, 273), so that one's sense of self is constituted by memory of one's past actions, and "in this alone consists personal identity" (A VI vi 237/RB 237).

[24] "The 'self'", Leibniz wrote, "makes real physical identity, and the appearance of self, when accompanied by truth, adds to it personal identity. So, not wishing to say that personal identity extends no further than memory, still less would I say that the 'self', or physical identity, depends on it" (A VI vi 237/RB 237).

[25] Here Leibniz explicitly renounces the kind of atomistic theory he had formerly espoused: "the soul does not reside in certain atoms that are reserved for it or in some little indestructible bone, like the *luz* of the rabbis" (233).

from rest, or is reduced to rest, except through a smaller motion; just as one could never complete the traversal of any line or length before having completed a smaller line. . . . And all of this supports the judgement that noticeable perceptions come by degrees from those that are too small to be noticed. (A VI vi 56)

Thus we are presented with the following picture. The perceptions of a given individual substance constitute it as continuously existing because each contains traces of all the previous ones. This is in keeping with one of his definitions of continuity, this one dating from around winter/spring 1689/90: "a continuum is that any part of which has something in common with all the rest of the parts it contains, at least termini, τὰ ἔσχατα [the endpoints]" (A VI iv 1002). Thus, since every perception of the same individual substance preserves traces or expressions of its previous states, it follows that the whole series of states forms a continuum, with each state or perception arising by degrees from the previous ones.

7.3 The Law of Continuity, Moments, and Derivative Force

Many commentators have charged Leibniz with inconsistency in regard to the continuity of the existence of substances. Russell assembled a number of passages under the heading "Continuity in one sense denied by Leibniz" (Russell 1900, 245), charging that "only space and time are continuous in Leibniz's sense, and these are purely ideal" (§59; 111). In contrast, substances, and what are truly actual, are necessarily discrete.[26] One of these passages that has been cited by other authors, as we saw in Chapter 1, is an extract from a letter to De Volder of 10 November 1705 in which Leibniz reiterates his view that multiplicities exist only through units, and adds "[The same holds of changes, which are not really continuous.]" (GP II 278/Russell 1900, 245, LDV 327).[27]

That the *changes* are discontinuous, it should be appreciated, is in keeping with the account of change in the *Pacidius*. There he affirms that "there is no part of time in which some change or motion does not happen to any part or point of a body", so that "there is no moment of time that is not actually assigned" (A VI iii 565–6/LLC 209). Thus every interval of time is interrupted by changes which actually divide it into parts, with the assigned moments marking the boundaries of the parts. Similarly, concerning

[26] In this respect Russell followed closely the analysis of Hermann Cohen in the passages on the history of mathematics in Cohen (1883). See Arthur and Griffin (2017) for references in Russell's lecture notes of 1898.

[27] Paul Lodge notes that this bracketed addition, even though written at the same time, was possibly not sent to De Volder. He also notes that the whole paragraph has a somewhat different appearance from the rest of the copy of the letter, and speculates that it might represent Leibniz's later thoughts on these matters (LDV 386–7); I doubt it, though, given its consilience with the contents of the following paragraph.

the states or perceptions of the monad, Leibniz writes in the *New Essays* that "there are a thousand indications that lead us to conclude that there is at every moment an infinity of perceptions within us, unattended by awareness or reflection, that is to say, changes in the soul itself, of which we are unaware, because these impressions are either too small and too numerous, or too unvarying, so that they are not sufficiently distinctive on their own" (A VI vi 53/RB 53). Here a *moment* is to be understood as an arbitrarily short duration, as I shall argue below. The idea is that a perception of however short a duration will still contain other perceptions in it. Even if it appears as one continuous state because of the limitations of sense, it is in fact infinitely divided into other smaller perceptions lasting for discrete durations. The instants that are actually assigned are the endpoints of these durations, change being the aggregate of its existence in one state at one instant and its existence in a contradictory state at the next. That these states should have duration, yet be internally divided, conforms with what Leibniz had noted in the margin of his first draft of the *Pacidius*, "it is necessary for states to endure for some time", but "during any state other things are changing" (A VI iii 559/LLC 195–7).

Thus Leibniz's assertion in his letter to De Volder that changes are not really continuous suggests a lasting commitment to the analysis of change he had given in the *Pacidius*. This is confirmed by his implicit allusions to the *Pacidius* analysis in the continuation of that letter to De Volder of October 1705:

> Endpoints of a line and unities of matter do not coincide. Three continuous points in the same straight line cannot be conceived. But two can be conceived: the endpoint of one straight line [segment] and the endpoint of a second that together make up the same straight line. In the same way in time there are two instants, the last instant of life and the first of death.
>
> (GP II 279/LDV 327)

(Leibniz has tightened up his terminology here, reserving 'instant' for the extremity of a period of time. In contrast, 'moment' is a stretch of time of arbitrarily short duration; although the term is also used for the moment of change, which, as we have seen, does not exist as a single entity, but is rather an ordered pair of instants terminating consecutive moments. I could have made his views more precise by using this terminology all along, but have preferred to follow his own usage. For the sake of precision, I shall use these distinctions from now on.) Thus, as in the *Pacidius* analysis, the duration of any given perception is actually divided by changes within it from one smaller perception to another, and these are likewise divided, and so on to infinity. So the duration of any perception is actually infinitely divided into smaller durations. "Time", he writes in the last paragraph of the letter, "is also resolved into unities of duration through actual changes, i.e. into just as many creations infinite in number" (279/327).

Further allusion to the analysis of change given in the *Pacidius* occurs in the intervening paragraph of the letter in the form of an appeal to the notion of *transcreation*,

although Leibniz gives it a slightly different meaning, and one more obviously in accord with his Law of Continuity:[28]

> One unity is not touched by another, but there is a perpetual transcreation in motion, which consists in this, that when a thing is in a state such that by continuing its changes for an assignable time there must be a penetration into the next state after a time, each of its points is in another place, as the avoidance of penetration and the order of changes demand. (LDV 327)

This agrees with Leibniz's description of the Law of Continuity in the *New Essays*, which implies that "no motion ever springs immediately from rest, or is reduced to rest, except through a smaller motion", so that no line can be traversed without a smaller one already having been traversed (A VI vi 56/RB 56). Similarly, no state or perception can arise out of a previous one without having passed through intermediate ones. A given perceiver will be aware of certain changes from one perception to another, dividing a given perception into smaller perceptions of finite duration. But each of these smaller perceptions will be divided into further perceptions which fall below the threshold of awareness. No matter how small a perception one takes, there are component perceptions still smaller than it: all perceptions are "confused" in this way.

The assertion that perceptions are confused in such a way that the perceiver cannot discriminate changes in them is a crucial feature of this analysis. It accords with what Leibniz had written in *There is no Perfect Shape in Bodies* of 1686, where he insisted that the analysis of change as occurring at a moment consisting in the last instant of existence in one state and the first in the next "presupposes an enduring state"; but "all enduring states are vague, and there is nothing precise about them" (A VI iv 1613/LLC 297). Thus the perception of a body's shape is vague, and a more perfect discrimination of its curved surface would reveal jagged edges where only homogeneity and continuity are apparent to the senses. Similarly, a body travelling in an apparently smooth curve, such as the elliptical orbits of the planets around the Sun, is in reality undergoing innumerable collisions, each resulting in a rectilinear motion that is itself further divided by collisions within. As Leibniz wrote in the unpublished *Dynamica*:

> *All motions are composed of rectilinear uniform ones*. For every motion in itself is uniform and rectilinear, but every action in bodies consists in motion. Thus rectilinear motion can be curved only by the impression of another motion that is also in itself rectilinear (although with the previous one remaining). Therefore the origin of curvilinear and non-uniform motion cannot be understood except by compositions of rectilinear uniform motions.
>
> (GM VI 502/Meli 1993, 76)

Thus although the apparently smooth continuous motion in a curved line is in reality actually divided by discrete collisions into innumerable smaller rectilinear ones, it is

[28] There are several references to transcreation in Leibniz's correspondence with Des Bosses (see LDB 127, 133, 135, 145, 147, 151), but this is a different notion, namely Sennert's idea of an irrational soul being "transcreated" into a rational soul at conception "through the miraculous addition of an essential degree of perfection" (LDB 127); but Leibniz thinks that his doctrine of preformation obviates the need to appeal to such miracles to explain a natural process (LDB 151).

infinitely divided, since there is no apparently continuous sub-motion that is so small that it is not further subdivided. As a result, there are sufficiently many ("actually assigned") points representing actual changes of motion that the error in representing the curve using continuous geometry will be less than any assignable pre-set error or limit of accuracy.[29] This is what Leibniz refers to on occasion as the *physical continuum*. Such a continuum "is not divided into points, nor is it divided in all possible ways—not into points, since points are not parts but boundaries, and not in all possible ways, since not all creatures are in a given thing, but there is only a certain progression of them *ad infinitum*" (A VI iv 1645/AG 34).[30] Leibniz gives the analogy of how someone bisecting a straight line and any part of that line would establish "different divisions", that is, a different, infinite partition of actual parts, from that produced by someone trisecting it in every part. Thus whereas a physical continuum consists in an infinite progression of actual parts, "the Mathematical Continuum consists in mere possibility, like numbers",[31] that is, it consists only in potential parts. As he explains in his reply to Bayle's article "Rorarius" in his *Critical Dictionary*:

> It is true that in nature we never find perfectly uniform changes, such as are required by the idea of motion that mathematics gives us, any more than we find actual figures that are precisely like those we learn about in geometry, because the actual world does not remain in an indifference of possibilities, but arises from actual divisions or multiplicities, whose results are the phenomena that present themselves, and which are varied in their smallest parts. Yet the actual phenomena of nature are ordered, and must be so, in such a way that one never encounters anything in which the law of continuity, or any of the other most exact rules of mathematics, is violated. (GP IV 568/ L 583)[32]

[29] Samuel Levey suggests that this idea of convergence will not work, and that "Leibniz's view appears to be divided by two competing intuitions: the first, that actual curves will 'converge towards continuity', the second, that actual curves are 'fractally divided'. Leibniz apparently wants to have it both ways, but those two intuitions will be difficult to reconcile" (Levey 2010, 168). I am more sanguine: we only ever apply mathematics to our models of reality, which necessarily abstract from the fractal detail of actual things. But we can nevertheless arrive at truths thereby, provided our idealized models correctly pick out pertinent features of the actual.

[30] These quotations are from *Principia Logico-Metaphysica* ("Primary Truths"), dated spring/autumn 1689. In his *On the Secrets of the Sublime* of February 1676, Leibniz had made a similar contrast between the "physical plenum", in which there are unassignable gaps, and a "true continuum" or perfect liquid that is "composed of points" (A VI iii 473/LLC 47). But in this and in a similar passage in his *On the Plenitude of the World* he assumes "that an unassignable is something" (A VI iii 525/LLC 61), in contrast to the interpretation of unassignables as "nothings" that he adopts shortly afterwards.

[31] Leibniz explicitly uses the terms "physical continuum" and "mathematical continuum" in his letter to Des Bosses of 24 January 1713: "on the hypothesis of mere monads, the infinitude of the physical continuum would depend…on the principle of sufficient reason, since there is no reason for limiting or ending [the progression], or for its stopping anywhere; whereas the Mathematical Continuum consists in mere possibility, like numbers, and therefore necessarily contains infinitude in its very concept" (GP II 474/LDB 299).

[32] Similarly, Leibniz wrote to Varignon: "One can say in general that, although continuity is something ideal and there is never anything in nature which has perfectly uniform parts, the real, in turn, never ceases to be governed perfectly by the ideal and the abstract; and that the rules of the finite reissue in the infinite, as if there were atoms (that is to say, assignable elements in nature), although there are none because matter is actually subdivided without end; and that, conversely, the rules of the infinite reissue in the finite, as if there were infinitely small metaphysical things, although we have no need of them; and that the division of matter never does proceed to infinitely small particles" (GM IV 93–4/L 544).

Exactly the same analysis, I contend, applies to perceptions. Although any apparently uniform and continuous perception is in reality actually divided, there are sufficiently many instants representing actual changes of perception that the error in representing the series of successive perceptions as temporally continuous will be less than any assignable. It is in this sense that we must understand Leibniz's claim that the series of monadic states is continuous. This does not mean that monadic duration is a perfectly continuous mathematical object composed of these states as its parts, nor does it entail that time is composed of instants. Rather, every state lasts for some finite duration, and the instants are simply bounds of these durations. Nature is discrete; but the instants and the states they bound are dense, so that nature approximates continuity to any desired degree of accuracy. Thus monadic series are precisely as continuous as is any curve in nature. The curve consists in a physical continuum of arbitrarily small rectilinear, uniform motions that are divided in turn by others without limit; a monadic series of perceptions consists in successive finite perceptions, each apparently uniform, although divided within by changes of which the perceiver is unaware, "because these impressions are either too small and too numerous, or too unvarying", with this division proceeding internally without limit. This analysis, I believe, resolves the main difficulty we noted at the end of Chapter 1 about the apparent incompatibility of Leibniz's assertions of the discreteness of the actual and the universal applicability of his Law of Continuity.

At this juncture, I should mention an opposing interpretation, lucidly expounded by Carla Rita Palmerino in her (2016). This is based on a fragment Leibniz wrote some time after 1693, first transcribed by Manuel Luba Alcoba in 1996, which, Palmerino demonstrates, consists in detailed notes made by Leibniz on Libert Froidmont's *Labyrinthus sive de compositione continui* (1631). In one passage, Froidmont states an argument for the composition of time from instants (which he does not himself accept): "Time and motion, they say, are composed of supposed pure moments […] because in time there can exist nothing but the present, for the past has ceased, and the future is not yet" (Palmerino 2016, 77). As Palmerino suggests, this seems to be the source of the following note by Leibniz: "Time is composed of instants, for it is composed of those things that exist in it, but there only exist in it instants, since only instants exist. In reality there is no time, nor is it an entity, any more than motion" (77). Palmerino takes this as a positive avowal by Leibniz of the composition of time from instants,[33] but I am not so sure. Certainly he wishes to avail himself of this traditional argument for the unreality of time, first stated by Aristotle and repeated by countless authors including Ockham—Leibniz uses it, for instance, against Newton and Clarke: "nothing of time does ever exist but instants, and an instant is not even a part of time" (Fifth Paper, §49; GP VII 402/L 705). But I believe he wishes to avoid asserting the composition of time from instants that this argument seems to entail (even if he cannot

[33] In favour of her view Palmerino also quotes the last line of the letter to De Volder quoted above. After claiming that time "is also resolved into unities of duration through actual changes", Leibniz writes: "For nothing exists of time but instants" (GP II 279/LDV 327). Clearly her argument is deserving of a fuller reply than I am able to give here.

see how), on pain of inconsistency with his expressed position.[34] We can see him still wrestling with unwelcome implications of such a composition in another fragment written probably after 1695,[35] and he never advocates the composition of time from instants in any of his published writings.[36]

But aren't monadic states momentaneous? So far I have treated monadic states or perceptions as being of finite but arbitrarily short duration. But given that any perception is in fact a physical continuum that is actually infinitely divided by changes within it, how can the units of duration into which its duration is resolved by this infinity of changes be anything other than infinitely small moments? And what about derivative forces? Leibniz's characterization of them as "momentary" [*momentanei*] suggests that they exist only for a moment. "Yet", Donald Rutherford argues, "this seems a disastrous route for Leibniz to take. We have seen that he rejects any attempt to quantify duration or distance in terms of infinitely small magnitudes. So what precisely could he mean in claiming that derivative forces are 'momentary'?" (Rutherford 2008, 275).

The answer to these questions depends on Leibniz's very subtle philosophy of the infinite and infinitely small. As he explains to Varignon, one can proceed in the calculus as if a line is composed of an actual infinity of infinitely small parts, the differentials *dx* etc., and can then use a direct method (namely, using differentiation or integration) to produce results which are either very difficult or impossible to produce using traditional geometry.[37] But one can do this without having to commit to the view that "there are lines in nature which are infinitely small in a rigorous sense in contrast to our finite lines, or as a result, that there are lines infinitely greater than our ordinary ones" (GM IV 91/L 543). It suffices, as Leibniz had explained in his "Lemmas on

[34] Palmerino also enlists the arguments of Vincenzo De Risi (2007, 270–7), who sees difficulties for Leibniz in applying to time the same arguments he had employed concerning congruence of situational relations in space, since only space is an order of situations. De Risi denies that Leibniz could define time in such a way that the instants in it could only be endpoints of subintervals (274); but this is just what I am contending he does do.

[35] As Palmerino notes, the fragment was first transcribed and published by Massimo Mugnai (2000). There Leibniz states the argument: "Indeed it seems that time is necessarily composed of instants, because two instants cannot exist simultaneously; thus only the present instant exists; the [past]* instant has existed, the future instant will exist." *[I have followed De Risi's correction of Leibniz's mistake in writing *futurum extitit* here.] Leibniz then argues that in the case of a line, "it does not follow that the line is composed of an infinity of points, but only that there is an infinity of points in the line. But now here is the difficulty: If time is composed from instants, then the multiplicity of instants in a time will be determinate. Is there then an equal multiplicity of points in the line?" (Mugnai 2000, 135)

[36] In a forthcoming book on the reality of becoming (Arthur forthcoming) I argue that this traditional argument for the unreality of time is an amphiboly resting on an equivocation between two kinds of existence: being real, and existing now. Leibniz and Ockham need their substances or *res permanents* to exist in the first sense; if only what exists now is real, the instantaneous modifications would be real, and the enduring things they are modifications of would be unreal.

[37] On Leibniz's infinitesimals as "syncategorematic", see Ishiguro (1990), Knobloch (1994, 2002), Levey (1998, 2008), and Arthur (2008, 2013a). This interpretation has been challenged by Doug Jesseph (2015), who interprets Leibniz's letter to Varignon as evidence that Leibniz has moved away from his characterization of infinitesimals as syncategorematically infinitely small, to an interpretation in which the calculus of transcendent curves could not be established without assuming their existence as mathematical entities. David Rabouin and I are in the process of composing a reply to these criticisms (and others by Katz and others) in a co-authored paper.

Incomparables" published in his essay *Tentamen* in the Leipzig *Acta*, to take "quantities incomparably greater or smaller than ours" (91/543). Thus the *dx* are what he had previously called "unassignables", differences that can be made smaller than any assignable difference. These incomparable magnitudes, he tells Varignon,

> are themselves not at all fixed or determined, but can be taken to be as small as we wish in our geometrical reasoning, and so have the effect of the rigorously infinitely small. For if any opponent tries to contradict this statement, it follows from our calculus that the error will be less than any error that could be assigned, since it is in our power to make this incomparably small magnitude small enough for that purpose, inasmuch as we can always take a magnitude as small as we wish.... From which it follows that if someone refuses to accept infinite and infinitesimal lines in metaphysical rigour and as real things, he can safely avail himself of them as ideal concepts which shorten reasoning, similar to the so-called imaginary roots in ordinary algebra, such as $\sqrt{-2}$. (GM IV 92/L 543)

This does not reduce the whole science of the infinite to fictions, he reminds Varignon, "for there always remains a 'syncategorematic infinite', as the Schools call it" (93/543). This Leibniz clarifies through the example of the Dichotomy series,

$$1/1 + 1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \ldots,$$

"which is an infinite series in which all the fractions whose numerators are 1 and whose denominators are in geometric progression of powers of 2 are comprised at once, although only ordinary numbers are used and no infinitely small fraction, or one whose denominator is an infinite number, ever occurs in it" (93/544). For to say that it has infinitely many terms in the syncategorematic sense is to say that, no matter how many terms are assumed, there are more than this. And "it remains true that $2 = 1/1 + 1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \ldots$" (93/543).

Leibniz had already clarified in his *Numeri Infiniti* of 1676 what it means to say that such an infinite series has a finite sum, in this case, 2. It means that any finite series of n terms with the same first term and law of progression has a sum S_n, and that as n increases the sum S_n can be made arbitrarily close to 2. The error of taking this as the sum of the infinite series "always diminishes as the series increases, so that it becomes as small as we would like" (A VI iii 503/LLC 98–9), and is therefore null. Thus when his friend and correspondent Johann Bernoulli insists that "if all the terms *actually* exist, then certainly the infinitieth term and all following it will be of an infinitely small magnitude" (16 August 1698; GM III 529), Leibniz replies:

> Let us suppose that in a line the parts $1/2, 1/4, 1/8, 1/16, 1/32$, etc. are actually given, and that all the terms of this series actually exist. From this you infer that there also exists an infinitieth term. I, on the other hand, think that nothing follows from this other than that there actually exists any assignable finite fraction, however small you please. (GM III 536)[38]

[38] Bernoulli had argued that "if all the terms in the series are finite, then all of them taken together constitute an infinite magnitude" (GM III 529). Leibniz replies (correctly) that he would concede this if there

In this decreasing geometric series the error in estimating the sum of the series by truncating it after n terms is equal to the nth term, namely $1/2^n$. Thus it is just as if there is really an infinitieth term, the infinitesimal $1/2^\infty$, so that the error is $1/2^\infty$, i.e. 0. But what this means is that the error $1/2^n$ can be made as close to 0 as desired by taking n sufficiently large. It is *as if* the last, infinitely small, infinitieth term is included in the series, whereas in reality the terms are all finite, and can be rendered as small as desired.

Correspondingly, Leibniz's moments are also infinitely small, not in the categorematic sense assumed by Bernoulli, but in the syncategorematic sense that however small a stretch of time is taken, there are others still smaller. Just as there is no term in the dichotomy series that is not succeeded by a still smaller term, so there is no time during which some further change does not occur in any substance. A momentaneous state is one that is assumed to be of sufficiently short duration for that purpose: it is so small that no change or inhomogeneity can be detected in it, and next to a state of any finite duration, it is incomparably small. To say that a state is momentaneous is to say that however small a perception you assume, lasting for some finite duration, there are further perceptions within it, down to ones that are insensible, and beyond to others indefinitely smaller still. But there are none smaller than all assignable (finite) moments.

It remains to tackle the question of Leibniz's characterization of derivative forces as momentary, and to clarify the role of endeavour. In the discussion so far I have elaborated Leibniz's account of the continuance in existence of substance entirely in terms of the succession of perceptions in a soul (or, at least, in a substance capable of having representations of the world outside it and generating them out of preceding ones according to its own law). But this raises the question: how is this perception-based account of continuance in existence related to Leibniz's physics? Is the characterization of continuity of existence in terms of perceptions a manifestation of a move by Leibniz to a frank idealism about substance, as Donald Rutherford and others allege? If so, what is the ground for regarding physical forces as founded on endeavour?

As we saw in Chapter 5, the metaphysics of the *Pacidius* (and related manuscripts like *De Motu et Materia* and *Infinite Numeri*) was conditioned by Leibniz's rejection of his prior conception of endeavour (*conatus*) conceived as an actually infinitely small motion. But in his mature dynamics endeavour nonetheless plays a crucial role: witness, for instance, Leibniz's remark in his February 1706 letter to Des Bosses: "From active force (which of course involves endeavour), ôr entelechy, action follows, provided only that the ordinary concurrence of God is added" (LDB 10/11); or, more radically, "each substance is a kind of force of acting, ôr an endeavour to change itself with respect to all

were some smallest finite term in the series, but that it is established that however small a part is assumed, there is another smaller finite part (GM III 536). Later Bernoulli produced what he considered a conclusive argument: "If there are ten terms, there certainly exists a tenth; if there are a hundred terms, there certainly exists a hundredth; if there are a thousand terms, there certainly exists a thousandth; therefore if there are terms infinite in number, there exists an infinitieth" (GM III 663). But this ignores Leibniz's denial of infinite number (the categorematic infinite); for him, that there are infinitely many terms connotes only that, however many finite terms are assumed, there are more (the syncategorematic infinite).

others according to certain laws of its own nature" (*Motion is Not Something Absolute* [1689–90?]; A VI iv 1638/LLC 333). Such statements indicate a very central role for the concept of endeavour as a foundation for force, and we need to see how Leibniz conceives it in his mature metaphysics.

A good place to start is the 1686 manuscript *There is no Perfect Shape in Bodies* (April–October 1686), since there Leibniz gives an explicit argument both for the necessity of endeavour and for its unintelligibility in a purely geometric physics. Having presented the analysis of change we quoted earlier in this section, where there is no moment of change but only an ordered pair of instants, the last of the prior state and the first of the succeeding state, he noted that "all enduring states are vague", so that there is nothing definite about the shape between these assignable instants. But, he argues, no more can a body be said to have a shape at the instant at which it changes, since there is no motion or endeavour in an instant, taken strictly:

> *In an instant*, without considering motion, it is as if the mass were all made one; and thus one can give it any shapes one wants. But also there ceases to be any variety in bodies; and consequently all bodies are destroyed. For motion or endeavour makes their essence or difference. And in this moment everything reverts to chaos. Endeavour cannot be conceived in mass alone. (A VI iv 1614/LLC 299)

I take the idea here to be that if the different parts of matter are determined by their different motions at an instant, or endeavours, then if there is no motion or endeavour in an instant, there will therefore be no parts of any determinate shape in it either.[39] This argument is spelled out in greater detail by Leibniz in 1698 in *De Ipsa Natura*, his polemic against the occasionalist philosophy of J. C. Sturm already considered in Chapter 5. To the latter's claim that "motion is merely the successive existence of a thing in different places", he objects that "at any moment of its motion, not only is a body in a place commensurate with itself, but it also has an endeavour or striving to change that place, so that its next state follows of itself from its present one by the force of nature" (GP IV 512–13/WFT 218). Were this not so, there would be no difference between a body in motion and one at rest. In that case, however, "there would be no way at all to distinguish different bodies, since in a plenum of mass uniform in itself there is no way of distinguishing them except through their motion" (513/219). It is also no good appealing to *shape*, "since in a plenum of perfectly homogeneous and undifferentiated mass no shape, no boundary or distinction of different parts can arise, except through motion itself" (513/219).

How then is endeavour to be conceived, if not "in mass alone"—i.e. if not in the terms of a purely geometric physics? We can find attempts to answer this in an important series of papers Leibniz wrote, the *De affectibus* of April 1679, consisting in drafts of his long-projected book *Philosophia de Mente* (Philosophy of Mind).[40] The first of

[39] For a quite different reading of Leibniz's "frozen moment" argument, see Levey (2010).

[40] *De affectibus: Ubi de Potentia, Actione, Determinatione* (On the Affects: including On Action, Determination); (A VI iv 1410–1, dated 20–22 April 1679 (NS)).

these drafts, (numbered [A] by the editors), contains definitions of "*force* or power" as "a state from which action will follow unless there is something else which ought to follow for the same reason" (1411), of *endeavour* as "the beginning of action", of *action* as "the state of a thing from which a reason can be given for some present change, which thing is called cause", and of *passion* as "the state of a thing insofar as in it there follows a present change, which thing is called the *subject of the change* or the *object of the cause*" (1412). He successively refines his definitions many times, and after some critical notes on Descartes' *Passions of the Soul*, in draft [E] he settles on a definition of affect in terms of the concept of *determination*:

> *Affect* is a determination of the soul toward a certain series of thoughts.
>
> A *determination* is a state from which something follows unless something else prevents it. So a determination makes a presumption for the future, until there proves to be an obstacle.
>
> A *series* is a multiplicity with a rule of ordering. (GP IV 1426)

An interesting feature of these definitions is that neither the states in question nor the determinations are exclusively predicated of the soul: there can also be states and determinations of body. Indeed, immediately after the above definitions Leibniz stresses the parallelism:

> *Affect* is in the soul what *impetus* is in the body. For just as an affect is a determination of the soul for running through a certain series of thoughts, so impetus is likewise some determination of a body for traversing a certain line of motion. (GP IV 1426)

Again, in draft [H], having defined an affect as "a determination of the soul to pursuing some line of thought", Leibniz adds, "just as *impetus* is a determination of a body toward running through some line of motion in a certain way" (1430).

This is not what one would expect if the point of describing states as perceptions is to give an eliminative reduction of the physical to the psychical. Now, there is no doubt that Leibniz believed that we have direct experience in introspection of perception and appetition, and that these cannot be reduced to mere mechanism. As Rutherford notes (2008, 278–80), he sought to understand the tendency of a body towards motion by analogy with volition, "the effort or endeavour to move towards what one finds good and away from what one finds bad, the endeavour arising immediately out of one's awareness of those things" (*New Essays*, II; A VI vi 210–11). But even though this reverses the direction of Hobbes' line of explanation, Leibniz was just as committed to a psycho-physical parallelism as was Hobbes. Where the latter explained desires and aversions as our subjective apprehensions of mechanical endeavours, Leibniz explains the appetitions of both kinds of states in terms of teleology, a determination involving "a presumption for the future, until there proves to be an obstacle". Mechanical endeavours can be understood through analogy with our subjective experience of appetitions, but more importantly, the laws of mechanics themselves can be derived from the Principle of the Best through consideration of maximization and minimization of certain quantities.

In the above examples from 1679, Leibniz analogizes affect with impetus. But at that time, as we discussed in Chapter 5, he has not yet developed his dynamics. In his mature conception, impetus, defined as the product of mass and velocity (and therefore equivalent to the Cartesian "quantity of motion at a moment" (GM VI 237/WF 157)), yields primacy to the notion of derivative force "ôr what is momentaneous in action" (to De Volder, 21 January 1704; LDV 289). As we have seen, in this later conception derivative active forces include both living and dead forces of various kinds, and impetus is one of the latter. These are significant changes. Nevertheless, all the other features of the analysis of change and its relation to force from the earlier period remain intact. In a series of definitions from some time between summer 1687 and the end of 1696, Leibniz continues to define change as "a complex of two contradictory states immediately next to one another" (*Definitiones: Ens, possibile, existens*; A VI iv 869). In another paper first edited by Couturat, *On the Principle of Indiscernibles* from around 1696, he writes:

> Moreover, transition itself, ôr variation—which, when combined with perfection is action, and when combined with imperfection is called passion—is nothing but a complex of two opposite states immediately next to one another, one together with a force or reason for the transition, which reason is itself a quality. Accordingly action or passion is itself a result of those simple states. Hence two intrinsic denominations are seen to be required, a force of transition, and that towards which the transition is made. (C 9/MP 133–5)

The state with the force or reason for the transition is what he had in 1679 called the determination, namely "the state from which, considered in itself, something follows" (A VI iv 1430). As an illustration of the idea of "a state considered in itself" Leibniz had there given the "state of a heavy body": "considered in itself, descent follows; but that descent will perhaps not follow if some obstacle is supposed" (1430). Now, in the mature dynamics, gravity is an example of a dead force. Like impetus, it is a tendency towards motion, but it is a *solicitation*, incomparably small compared with impetus, even though both are momentaneous. Thus "impetus itself, although momentaneous, is derived from an infinite series of increments", or solicitations (GM VI 237/WFT 157). While impetus is momentary quantity of motion, moreover, the value of the "quantity of motion taken over time"—more briefly, just the body's *motion*—"is derived from an infinity of impetuses" (237/157). But once a body is in motion, it acquires *living force*, which is proportional to the bulk or mass and the square of the speed at a given moment. Again, however, living force, as a derivative force, is what is momentaneous in action, *action* being the product of (a constant) living force with time (or the integral of a varying living force over time).

But we do not need to get distracted by all these intricacies of Leibniz's dynamics. The important point for our purposes here is that the derivative force of a body (no matter what its internal complexity) is that state from which the state immediately next to it will follow. Although "an internal tendency to change is essential to finite substance" (to De Volder, 20 June 1703; LDV 265), this is primitive force, and its

manifestation in bodies at each moment is derivative force. We get a clear statement of this by Leibniz in reply to De Volder's naïve assumption that Leibniz's derivative force is simply quantity of motion (over time):

> You say that motion, ôr the product of bulk and speed, is derivative force. But I do not take motion to be derivative force, although I do think motion (namely change) follows from it. Rather, derivative force is the present state itself insofar as it tends toward a following state, ôr pre-involves the following state, just every present state is pregnant with the future. But the very thing that persists, insofar as it involves all cases, has primitive force, so that primitive force is like the law of a series, and derivative force like a determination that designates some term in the series. (to De Volder 21 January 1704; LDV 287)

If we now turn to Leibniz's application of derivative forces in his physics, we find a free use of the differentials of his calculus. In the *Tentamen*, for instance, every body pursuing a curved path is said to have an endeavour to recede along the tangent, in keeping with Huygens' analysis of centrifugal force, and this is "measured by the perpendicular from the following point to the tangent at the unassignably distant preceding point" (A VI iv 2040/Meli 1993, 132). But such an outward endeavour is "infinitely smaller than the velocity of impetus acquired from the endeavour repeated for some time" (133). That is, the difference between successive values of r is dr, and therefore "expresses the paracentric velocity", whereas "the difference of the differences expresses the element of paracentric velocity", that is, the "solicitation" ddr. Leibniz proceeds to calculate an expression for ddr for a body constrained in an orbit, thereby giving the first application of a differential equation in the history of physics, and one which is (up to a lost factor of 2) equivalent to the correct expression for the acceleration of a body orbiting a centre in polar coordinates. Here the paracentric velocity is represented by a differential, a fictional infinitely small difference. The justification for treating such quantities as infinitely small is that "one can take them to be as small as one judges sufficient as to be incomparable, so that they produce an error of no importance, and even smaller than allowed" (131). In reality, changes in a body's position will be produced by collisions resulting in new states of motion along straight lines; but these enduring states are "vague", and mask the fact that they are themselves produced by further changes within, and so on to infinity. At whichever level of analysis one stops, moments of time may be taken as so small that elements of change produced, dx, are incomparable with any finite x. Thus

> if motion is represented by a finite line, which is traversed by a body in a given time, the impetus or velocity is expressed by an infinitely small line, and the element of velocity, which is solicitation of gravity or centrifugal endeavour, by a line infinitely many times infinitely small. (Meli 1995, 131)

We are now in a position to give answers to some of the questions posed above. To the question how Leibniz conceives endeavour in his mature work, we have seen that he identifies it with the appetition accompanying each state or perception, by which it tends towards following states in keeping with the Principle of the Best. A sentient

being experiences this as volition, an endeavour towards what it perceives as good and away from what it perceives as bad. But all monads have perceptions ordered in a series, with each perception or state retaining traces of previous ones, and endeavouring towards subsequent ones. Derivative force in a monad simply is the state insofar as it involves an endeavour or tendency towards a following state; and in an aggregate, it is the aggregate of the derivative forces of the monads making up the aggregate or body. Psychically, the derivative force manifests itself as the desires and aversions that we experience in ourselves; physically, derivative force manifests itself as the dead or living forces of which we also have experience: the dead forces of gravity, centrifugal force, and so forth, that we can feel the tensions in our muscles opposing; and the living forces of quantity of progress (momentum) and energy (*vis viva*).

Derivative force is momentary, since it concerns the state of the substance or aggregate at a given moment. We have seen that a momentary state, however, is one occurring during an arbitrarily small interval of time, during which no variation is considered.[41] Talking of it as instantaneous is therefore a kind of fiction. A strictly instantaneous state would be one whose duration has been made so small as to have a value smaller than any that is assigned, whose value would therefore be zero in comparison with any finite duration. Just like Bernoulli's infinitely small last term in a decreasing geometrical series, it can be included in the series—just as, to use one of Leibniz's examples of his Law of Continuity, a parabola can be regarded as the limiting case of an ellipse as one focus remains fixed and the other is moved out to infinity (GM VI 250/L 447). Consistently with this, in one of Leibniz's last essays on the metaphysical foundations of mathematics, the *Initia Rerum*, Leibniz characterizes a moment (in this limiting sense of an instant) as such a fictional termination, as a duration that is on the point of vanishing, and whose magnitude therefore equates to zero:

> *Duration is the magnitude of time.* If the magnitude of time is uniformly and continuously diminished, time disappears into a Moment, whose magnitude is zero. (GM VII 18/L 666)

What this means, then, is that Leibniz's treatment of moments and derivative forces is entirely consistent with the foundations of his differential calculus, as outlined in the *Tentamen* and elsewhere. In reality, all states have a finite duration, and all forces act in time; but because these durations can be made arbitrarily small, so small as to be incomparable with any finite duration, we can treat them fictionally as instantaneous. This is the same justification that he gives of differentials. A change in some quantity q is the difference between its consecutive values, represented by the differential dq. One can perform calculations with such an entity as if it is an actually infinitely small quantity. But in fact, as explained above, Leibniz regarded it as a difference "incomparably smaller" than any finite difference; it is "not at all fixed or determined, but can be taken to be as small as we wish", in such a way as to produce no assignable error.

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[41] See Douglas Jesseph (1998) for an illuminating account of the debt Leibniz owes on this score to Thomas Hobbes.

To recap the argument of this chapter: we have seen that Leibniz argued against the Cartesians (and others such as De Volder, Bayle, and Sturm) that created substances possess inherent forces making them capable of action, but that, contrary to the worries of thinkers such as Des Bosses, this did not commit him to a denial of divine concurrence. Rather, God's concurrence is required to maintain every substance in being by his continuous creation of it. In so doing, God bestows on each substance the power to produce its own actions as part of its nature, this power being its primitive active force. This power, however, is constrained by the substance's limited receptivity to God's continuous creation of it in three respects: its limited receptivity to divine omnipotence, to divine omniscience, and to divine goodness. These limitations combine to produce in it its resistance to the actions of other substances in the same world (its passive force), and in the moral sphere, sin.

Leibniz defended a conception of continuous creation, on the other hand, that was not susceptible to the difficulties of the composition of the continuum that he saw afflicting rival views. As in the *Pacidius*, there is no assignable instant at which some change is not occurring, yet these instants are endpoints of intervals, so that time is not composed of them. But rather than describing this as undermining the continuity of motion and of existence, as he had there, in his mature conception of continuous creation Leibniz sees the discontinuity of change as entirely compatible with his Law of Continuity. On the one hand, the perceptions of any one substance are connected by memory, so that each perception contains traces of every preceding one, and emerges from them "in degrees of the infinitely small" in a continuous process of change. On the other, to regard these perceptions or states as uniform and distinct is an idealization: each perception is further divided within by changes internal to it, so that there is no perception that is not internally divided into further changes, even if these are not discernible to sense. This division is such that the states form a physical continuum: there are so many that the difference from a true mathematical continuum can be made smaller than any assignable error by increasing the resolution of the analysis. In an ideal limit, they are momentary: change in some property x can be conceived as an arbitrarily small difference dx occurring in an arbitrarily small time or moment, dt. It is this feature that allows us to apply the differential calculus to represent truths about changing properties. But this inclusion of ideal limits in our conception of series is a fiction, and is licensed by the Law of Continuity. In reality, when God continuously creates the world, he maintains in existence all the substances, each with its own physical continuum of ever-divided states. The moments in which creation occurs "by continual flashes of the Divinity" (*Monadology* §47) are also idealized. They are arbitrarily small units of duration within which we do not represent the further changes that are of necessity going on inside them.

Conclusion

In this book I have sought to present Leibniz's metaphysics in what I see as its true light. It is not, I have argued, a phenomenalist idealism, aimed at reducing the world to representations in perceiving minds or monads. What any percipient correctly represents is really there, existing externally to and independently of the perceiver, even if it does not exist exactly as the senses represent it. But neither is his metaphysics a dualism in which what exists independently of any one monad is a matter posited as existing separately and independently of them all. For Leibniz, a body is an infinite aggregate of monads, although it is not composed of them.

Leibniz's metaphysics is thus an original philosophy that does not correspond to any existing "ism". It is idealistic in those respects in which it is opposed to materialism; but, equally, it is materialistic in those respects in which it is opposed to idealism.[1] The origins of perception cannot be found in mechanism, so that a monad's ability to represent the bodies and motions outside it must be posited as an essential attribute of any such enduring being. A second essential attribute, one that cannot be found in the passive matter of the mechanists, is active force, an appetitive tendency towards future states, evident from mental introspection. Nevertheless, monads with these properties are entelechies or forms *of bodies*: there are no disembodied forms. A monad as a centre of activity manifests its phenomenal effects through its body and motions; without a body it would not act on anything external to itself, as Leibniz explained to Remond (GP III 607; GP VII 343). Accordingly Leibniz adopts a psycho-physico parallelism that is more rigorous than that of any other mechanical philosopher: all of a monad's perceptions originate autonomously within it, but each corresponds in infinite detail with the material phenomena perceived. As he explains to Bayle, according to the idealistic half of his philosophy, "everything happens in the soul as if there were no body, just as, according to the first [materialist] half, everything happens in the body as if there were no soul" (to Bayle, August 1702; GP IV 560/WFT 247). "Although phenomena are explainable in detail mechanically, the ultimate analysis of mechanical laws and the nature of substances oblige us to appeal to active indivisible principles" (560/247).

[1] Cf. "This makes clear that [my hypothesis of the pre-established harmony] combines what good there is in the hypotheses of Epicurus and of Plato, of both the greatest materialists and the greatest idealists…" (to Bayle, 1702; GP IV 560/L 578). Similarly, in his notes for the Preface to the *New Essays*, Leibniz wrote that whereas on Locke's philosophy it would require a miracle for the soul to endure, "this is directly opposed to the Platonic philosophy joined to that of Democritus and Aristotle, such as mine is" (A VI vi 48/AG 301).

It is clear enough why Leibniz has nonetheless been read as an idealist: minds and other monads are substances, while bodies are not. Force, perception, and appetition are taken by Leibniz to be primitive; extension and motion are not—they require further analysis. They are the phenomenal effects of active indivisible principles, which are in themselves immaterial. As I have argued, though, this is not a reduction of bodies and motions to mere appearances, but to the active principles that constitute their reality. Leibniz's phenomena, including derivative forces, are Platonic phenomena: the substances endure in being, the phenomena are their evanescent modifications, ever becoming.[2] There is, however, a second sense in which bodies, extension, and motion are phenomena. They are phenomena in Democritus' sense: "they exist *νόμῳ* rather than *φύσει*", as *entia per aggregationem* rather than as *entia per se*.[3] Their existence as one continuous thing is only an appearance. But they are not Berkeleyan phenomena, constructed from ideas and existing only in the perceptions of minds. Consequently, I argue, Leibniz is not giving an eliminative reduction of phenomena to perceptions. Bodies and their motions are real, even if they owe their reality to force. They are constituted by derivative forces, which are the instantaneous, phenomenal manifestations of the primitive forces. As results of these forces, they are real phenomena, not mere appearances.[4]

It is therefore force that is the essence of substance, and this is the nub of Leibniz's solution to the labyrinth of the continuum. As Leibniz wrote in the *Specimen Dynamicum* of 1695, the striving that makes itself evident to the senses "is everywhere in matter", and if we are not to ascribe it to a miraculous action of God, it must "constitute the inmost nature of bodies. For to act is the mark of a substance, and extension, far from being able to comprise substance, indicates nothing other than the continuation ôr diffusion of an already presupposed striving and counter-striving (i.e. resisting) substance" (GM vi 235/WFT 154).

As I have tried to show, Leibniz reached these conclusions only after making his way through a maze of argument concerning the status of indivisibles, the infinite dividedness of matter, the nature of atoms, the origin of forms, the impossibility of action on a mechanist view, the status of final causes in philosophy, and the correct measure of force. I have attempted to reconstruct Leibniz's journey by picking up certain Ariadnean threads to retrace his path through this labyrinth.

In Chapters 1 and 2 I took up the enigma identified by Russell, according to which Leibniz's inferring the existence of immaterial, indivisible monads from the actual division of matter seems to imply that the monads are its actual parts. We saw that the

[2] "Thus it seems that in philosophical rigour bodies do not deserve the name substances; this seems already to have been the view of Plato, who remarked that they are transitory beings that never subsist longer than a moment" (*Conversation of Philarète and Ariste*; GP VI 583/AG 262).

[3] To De Volder, 19 January 1706 (LDV 339). Cf. also "But since only simple substances are true things, the rest are only entities by aggregation; to that extent they are phenomena and, as Democritus used to say, exist by convention not by nature" (to De Volder, 20 June 1703; LDV 265).

[4] Cf. Leibniz's letter to Samuel Masson of 1716, one of the last texts he wrote: "Matter is an aggregate, not a substance but a *substantiatum*, like an army or a flock; and insofar as it is considered as making *one* thing, it is phenomenon, very real in fact, but a thing whose unity is made by our conception" (GP VI 625/AG 227).

actual parts of matter are rather those into which it is actually divided by its internal tendencies to motion, and that, in contrast to physical monadologies, there is no composition of matter from monads according to Leibniz. But if monads are not the parts of body, how are they presupposed by it? Following this thread, we were led to see that Leibniz had elaborated a generalized concept of aggregation that is the complement of presupposition: if A presupposes some entities B_i as its immediate requisites, then it can be regarded as the aggregate of the B_i even if they are not its parts. In particular, if the immediate requisites are requisites of every part of A and are not further resolvable, they are the *constituents* of A. Monads, being simple substances, are not further resolvable in this way: they are constituents of bodies, although not their parts. This analysis allowed us to finesse Russell's conundrum. Every body is divided into other bodies as its actual parts, each of which is either an organic body possessing a simple substance that is adequate to it, or an aggregate of such organic bodies. Since each organic body therefore presupposes a simple substance that is not further resolvable as well as further bodies that are, it is resolved into simple substances as its constituents; it is therefore an aggregate of simple substances, although it is not composed of them.

Having established the logical structure of Leibniz's solution, I then set about investigating how he came to arrive at it. I began this in Chapter 3 by picking up the thread of Leibniz's early atomism. Here the enigma is to understand how he could ever have entertained atoms, given his later arguments that their existence contradicts the actual division of matter to infinity, when he had subscribed to actually infinite division all along. The solution, we saw, is that he inherited his atoms from a rich tradition fusing currents of thought from chymistry, medicine, and Aristotelian developmental biology. This medical humanism, especially in the persons of Scaliger and Sennert, had already sought to reconcile atoms with Aristotelian substantial forms and Neoplatonic seminal principles. The atoms of this tradition were replete with qualities, and contained their own principles of activity or forms—in contrast with the atoms Leibniz rejected, the infinitely hard, homogeneous corpuscles of thinkers like Cordemoy, Huygens, and Hartsoeker. More importantly, Leibniz shared with the Lutheran philosophers of his milieu a commitment to the version of Latin pluralism advocated by Scaliger and Sennert, according to which the seeds of all living things were created at the beginning of the world, seeds consisting in an immaterial soul or dominant form together with a body containing within itself further bodies made actual by their own subordinate forms, with these bodies containing still other forms subordinate to them. This hierarchy of forms reappears in Leibniz's mature philosophy of dominant and subordinate monads, with each embodied monad or form comprising a living being containing other embodied forms in its body, and so on down to infinity.

Equally relevant to Leibniz's mature metaphysics is the fact that he shared those thinkers' theological and biological motivations. This is evident in his early commitment to a version of traducianism, in accordance with Lutheran doctrine, in opposition to the Catholic orthodoxy that God must specially create a new human soul in every

case of conception. This opposition is only fortified in Leibniz's own later theory of transformationism, which he presents in the *Theodicy* as a "more intelligible kind of traduction" which "does not derive the soul from a soul, but only the animated thing [*animé*] from an animated thing, and avoids the repeated miracles of a new creation" (§397; GP VI 352–3/H 361). He also followed Sennert and Gassendi in rejecting spontaneous generation, and insisting with them that "the formation of animate organic bodies in the order of nature appears explicable only when one assumes a *preformation* already organic" (*Theodicy* §90; GP VI 152/H 172). Leibniz's commitment to both preformation and the hierarchy of living beings—"worlds within worlds to infinity"—was much fortified by what he inferred from the microscopic observations of Hooke and Malpighi, and what he learned first-hand from Swammerdam and Leeuwenhoek.

In Chapter 4 I followed this thread concerning Leibniz's rehabilitation of forms, examining his attempt to give an account of animate organic bodies that is compatible with the mechanical philosophy. In the light of that philosophy, the supposition that the immaterial form could act on matter in the generation and development of organisms and minerals was rejected as unintelligible. But despite agreeing with Sennert's rejection of the eduction of forms, Leibniz was persuaded by Boyle's criticisms that Sennert's own account of the origination and demise of individual forms was equally unintelligible. Leibniz's solution was to make them coeval with the created universe. Boyle's own version of the mechanical philosophy, however, was seen as inadequate to ground divine providence. For his characterization of living things as machines that are purely passive leaves them incapable of carrying out actions towards any ends. This accounts for Leibniz's insistence on the need for forms, conceived, with Sennert, as immaterial principles tending towards certain ends. The compatibility of final causation with mechanism is achieved by Leibniz through his insistence that machines can only be defined with respect to their purposes or functions. For him the world is immanently teleological, with each machine of nature contributing to the increase of perfection in accordance with God's providential plan.

The thread I followed in Chapter 5 is Leibniz's idea, conceived in his earliest writings, that the reality of motion presupposes unextended and indivisible beginnings. Just as bodies presuppose indivisible substances constituting them as real things, so their continuous activity presupposes an actually existing endeavour at each moment of their duration. In its earliest manifestation, according to my reconstruction of his views of 1669, the idea was that a continuous motion would be constituted by a body's being continuously created at each assignable instant, at rest during the unassignable intervals between the instants, when it is effectively non-existent. The force constituting the reality of its motion would thus be the divine creative force. We followed this thread through Leibniz's assimilation of Hobbes' conatus-based natural philosophy, where he conceived endeavour as the indivisible beginning of motion, through his rejection of indivisibles, to his arrival at a conception of the infinitely small as fictional. Between 1676 and 1678 he reverts to something like his first theory of the continuity of motion, where there is no state of action in a body—although this is now informed by

a fictional understanding of the "unassignable gaps" between the assignable instants of motion. Finally, with his reinterpretation of forms in terms of force, he is able to re-establish the continuity threading together the states of each individual monad. Now each state comes with an endeavour to pass into subsequent ones in its series, and it is on these endeavours that his dynamics is based (as explained in Chapter 7).

The chief implication of Chapter 5 is thus that force is the essence of substance, and substance is necessarily active. But this throws into doubt the status of passive force, since the combination of these two proposals seems to entail that passive force is not substantial, and so neither is matter. This has led some commentators to infer that Leibniz was either inconsistent or not entirely serious in his commitment to corporeal substance as a composite of matter and form. For secondary matter is a modification of primary matter, which is, for Leibniz, equivalent to passive force, so that, if passive force is not substantial, matter cannot be a constituent of substance. From this point of view, Leibniz's dalliance with substantial bonds in his correspondence with Des Bosses looks like an apparently failed attempt to restore reality to corporeal substance.

In Chapter 6 I challenged this reading. On the interpretation I have given in this book, a corporeal substance simply is the embodied monad, but the monad (or form) does not unite the constituent monads into a composite with lasting unity. Rather, the unity is the enduring monad itself, while the body is considered the organic body of that monad insofar as the differing aggregates of monads constituting that body at different times conspire to produce the actions of the dominant monad. Thus every monad is the dominant form of its own organic body, with the subordinate monads constituting the body at any time being in turn the dominant forms of their own bodies. A monad actuates (or makes actual) a body for Leibniz in the sense that it is the entelechy that is the basis of the actions of the substance towards its own ends. Thus the body of a monad is actual even prior to its receiving a dominant form, in that it is constituted by subordinate monads that are the principles of individuation and of action of their own bodies. On coming under the dominion of a monad, their actions conspire towards the dominant monad's own ends. This, I have argued, is in keeping with the pluralist origins of Leibniz's metaphysics, and in marked contrast to the Thomist view upheld by the Jesuits. There matter is actuated by only one form, the dominant form, and is entirely potential prior to its being so actualized, so that it is impossible for the same body to contain more than one form. One consequence of Leibniz's pluralist conception of forms is that the dominant form does not bestow a substantial unity or real continuity on the aggregate of monads constituting its body at a given time, contrary to the Jesuits' doctrine. I argue that this is part of Leibniz's motivation for introducing substantial bonds in his attempt with Des Bosses to try to augment his philosophy of monads to make it acceptable to that Order.

In Chapter 7 I reprised the issues raised in earlier chapters concerning Leibniz's subtle views on divine concurrence and continuous creation, showing how he negotiated a middle path between the self-sufficiency of substance and the occasionalist view that ascribed all causal action to God. On his view God's concurrence is required to

maintain every substance in being by his continuous creation of it, which he does by maintaining in it the primitive active force necessary for it to produce its own actions as part of its nature. This force, however is constrained by the substance's limited receptivity to God's continuous creation of it in three respects: its limited receptivity to divine omnipotence, to divine omniscience, and to divine goodness. These limitations in its perfection result from the need for its own actions to be compatible with those of other coexisting substances. They are the metaphysical basis for a substance's physical resistance to the actions of other substances in the same world (its passive force), and in the moral sphere, for its sin.

All this talk of entelechies, primary matter, divine concurrence, and substantial forms makes Leibniz's philosophy seem very old-fashioned. One might think he would have done better to leave these stones unturned, and to have developed the more modern aspects of his thought, his mechanism and his dynamics, without encumbering them with this scholastic apparatus. But this, I believe, is to underestimate both the subtlety of Leibniz's innovations, and the extent to which his metaphysics was conditioned by his engagement with science. So now let me turn to a brief discussion of what is forward-looking in his philosophy of substance.

One can make a case that Leibniz's influence on modern physics has been massively underestimated. He clearly stated what later became known as the First Law of Thermodynamics, having identified the energy (derivative active force) of a system as its capacity to do mechanical work, a quantity he proposed must be conserved in every isolated system. His distinction of living force (the *vis viva* or motive force of a moving body) from dead force (the potential possessed by a non-moving body to produce *vis viva* as its equipollent effect) was perfected by D'Alembert, Du Châtelet, and others in the eighteenth century to become the distinction between kinetic and potential energy. But most importantly, Leibniz's attempt to derive the laws of mechanics from principles of optimization (minimax principles) is now a staple of modern physics, and is one of the few points of deep consilience in the foundations of both relativity theory and quantum field theory. Whether Leibniz anticipated Maupertuis in proposing the Principle of Least Action is still a bone of contention.[5] But what is beyond debate is that it was he who conceived and defined the hugely important concept of action in the first place, and correctly determined its dimensions (as the product of energy and time, or of distance and momentum). His concept of substance has often been vilified. But Leibniz's idea of the state of a substance as a representation of its surroundings was a crucial ingredient in the development of the modern concept of a *field*—mediated, ironically, by Boscovich's assimilation of it to Newton's instantaneously acting universal gravitation; and his idea of appetition, the principle by which each state tends towards subsequent ones in the series, inspired Hamilton's reformulation of classical

[5] Herbert Breger (1999) has given several arguments intended to demonstrate that it is a forgery; Ursula Goldenbaum (2016) has subjected those arguments to vigorous refutation.

mechanics, yielding an analogue in the Hamiltonian operator in quantum mechanics, which operates on the state of an isolated system to generate its states at future times.

But the forwardness of Leibniz's thinking about substance appears in its best light through a comparison with developments in modern theoretical biology. This should appear a surprising and paradoxical thing to claim. After all, Leibniz's world view was fully immersed in a Christian framework centred on the Argument from Design. Leibniz's God is a Platonic Demiurge who created a world that is the best of all possible worlds, in which every individual being strives for greater perfection according to God's providential plan, and each was created on the Third Day of Creation. Ironically, though, Leibniz's transformationism was a stimulus to the birth of evolutionary thought of the eighteenth century, particularly for Buffon and Diderot. For according to his theory, novel forms of bodies could certainly emerge, having previously been folded up inside other organisms for eons. The picture is the optimistic one of a constant folding and unfolding of matter, with the new material forms gradually (and probably very unevenly) gaining in perfection. Although the genetic programmes for each organism were fixed at creation, the phenotypes could undergo radical transformations (on the model of the caterpillar becoming a butterfly), suggesting to these later thinkers that species themselves might undergo change.[6]

Even more conducive to modern biological thought, however, are Leibniz's views on teleology itself. Purposive behaviour, according to Leibniz, is not exclusive to animals capable of rational thought, although only rational agents will be aware of their behaviour and able to reflect on its possible future consequences in order to guide them more effectively towards the ends they are seeking. But all organisms need to be able to sense sources of food or danger (they need at least rudimentary *perception*), and need to be motivated to endeavour towards the first and away from the second (they cannot act without *appetition*).[7] On Leibniz's account, this requires the information necessary for this behaviour to exist in them, so that the states or perceptions of the organism follow one another (deterministically but contingently) according to an in-built programme ("the law of the substance"), but always in perfect conformity with the motions of their own body and with the bodies and motions among which it is situated. For non-living processes, on the other hand, a third kind of teleology is operative. Here a process such as that of a light ray is end-directed, but involves no reference to any intentions or knowledge (however rudimentary) on the part of the systems involved. As Leibniz showed, one can derive the laws of reflection and refraction by assuming the light ray will take an optimal or "most determinate" path, a path that will

[6] Leibniz himself suggested this in his *New Essays*, although this work was not published until 1765: "Perhaps at some time or in some place in the universe there are or were or will be species of animals more subject to change than those we have here now. Various cat-like animals, such as the lion, the tiger and the lynx, may once have been of the same race, and may now amount to new subdivisions of the ancient cat species" (A VI iv 317).

[7] "There is reason to think that there are infinitely many souls, or more generally of primitive entelechies, possessing something analogous to perception and appetite, and that all of them are and forever remain substantial forms of bodies" (*New Essays*; A VI vi 318).

be either a maximum or a minimum. But as he wrote in 1678–9, "it is not the ray itself, but the founding nature of optical laws that is endowed with cognition, and foresees what is best and most fitting" (A VI iv 1405/LC 257). These three distinct manifestations of teleology correspond fairly well with three of the five species of teleology distinguished by Ernst Mayr: respectively, (i) "animal behaviour that is clearly *purposive*, revealing careful panning" (Mayr 2004, 57); (ii) the *teleonomic* processes or behaviours that "are most conspicuous in the behaviour of organisms" and owe their goal-directedness to an internal programme (51); and (iii) the *teleomatic* processes that are goal-directed, but "automatically achieved" as the result of the operation of natural laws (50)—what Peirce called "finious processes". Moreover, Mayr's claim that, contrary to the long tradition of rejection of final causes in science initiated by Descartes, "there is no conflict between teleonomy and causality" (52), was already anticipated by Leibniz, as we saw in Chapter 4.

The fourth type of teleology identified by Mayr is that appealed to in reasoning about "adaptive features". This is the kind of reasoning parodied by Voltaire in his satire *Candide*, where every adapted feature is supposed to have been divinely selected for the purpose it happens to serve: "Observe", says Pangloss, "that the nose is formed for spectacles, and therefore we come to wear spectacles; the legs are visibly designed for stockings, and therefore we come to wear stockings!" (Voltaire 2009, 48). Such reasoning abounds in Noël Antoine Pluche's *Spectacle de la Nature* (1750),[8] but not in Leibniz, for whom optimal design is not necessarily to be found in any given individual process, event, or substance taken by itself, but is a feature of the world taken as a whole (and over its entire history). It is this idea of a world designed so as to increase towards progress or perfection that is the fifth species of teleology identified by Mayr, *cosmic teleology*. Here Leibniz's views can be seen to be in direct conflict with the Darwinian programme. The very idea that design could be the product of natural selection, premised on variation in genetic heritage and the contingent survival of individuals remaining after the least fit among them have died out, was at complete odds with his theological standpoint. The contingency implicit in evolution by natural selection is in contradiction with the determinism required by the idea of Divine Providence, and also with the idea of an overall increase in perfection as the world unfolds. It is therefore no accident that, as Mayr sagely observes, "the most determined opponents of natural selection were teleologists", as witnessed in the theories of Hans Driesch, Henri Bergson, K. E. von Baer, and Teilhard de Chardin. All the same, unlike these thinkers, Leibniz was not a vitalist, and he did not appeal to any non-mechanical agents in explaining any natural phenomena: for him, cosmic teleology works entirely through purely natural processes. He rejected the "plastic forces" or natures appealed to by his

[8] One could argue that the tendency to see every function as the result of design is not absent in the writing of many modern evolutionary thinkers, if design is interpreted as an adaptation that has been naturally selected for. This kind of thinking is the target of Stephen Jay Gould, who coined the term "spandrel" for an accidentally produced feature that becomes adaptive later as a contingent matter.

predecessors and contemporaries, such as Jacob Schegk and Ralph Cudworth, as well as the active forces which Newton assumed to operate outside the realm of mechanics.

But there are other features of Leibniz's thought that find echoes in modern philosophy of biology. In order to explain phenomena like symbiosis, biologists have had to abandon the naïve assumption that each biological kind is selected for independently of others.[9] Here Leibniz's idea of nested individuals was ahead of its time. On his conception, the body of each organism, such as ourselves, is constituted by other organisms on which it depends for its proper functioning, such as the bacteria in our stomachs necessary for successful digestion. The functions of these bacteria and our bodies are co-adapted. In Leibniz's scheme, the same organisms that are constituents of the aggregate forming our body at one time do not have to be there at another, provided other organisms then provide for the necessary functionality of our organism, coded for in its programme. The dominant monad may for a time co-opt the functions of subordinate ones, as it were, and it is in this co-opting of functions that monadic dominance may be seen to consist.

A final forward-looking aspect of Leibniz's philosophy of substance is his emphasis on the self-organizing capacity of living things. Leibniz's natural machines maintain their individuality throughout their existence, taking energy from their surroundings in order to preserve themselves in being as (infinitely ramified) organic bodies of individual substances. In this respect they anticipate the idea of *autopoesis* introduced by Humberto Maturana and Francisco Varela in 1972 to define the self-maintaining chemistry of living cells, an autopoietic machine being a kind of network of transformations of components that continuously regenerates and realizes itself, and constitutes itself as a unity.[10] The contrast between such a natural machine, the body of a living being, and a merely artificial one is one of Leibniz's central ideas. An artificial machine has no capacity for maintaining and perpetuating itself, precisely because only something that is properly a *self* can maintain or perpetuate it*self*. This is the "true unity corresponding to what is called 'I' in us. Such a unity could not occur in artificial machines or in a simple mass of matter, however organized it might be" (*New System*, §11; GP iv 482/L 456). Some such sort of self-organizing machine, it has been argued, must be ontogenetically prior to natural selection itself. Without a system that can act on its own behalf, sustain itself in being, and reproduce systems of the same kind, there would be nothing for natural selection to begin acting upon. Stuart Kauffman has been instrumental in arguing on this basis for a conception of living organisms as *autocatalytic systems*, emergent systems that can "act on their own behalf", and kick-start the process of evolution itself.[11]

[9] As Frédéric Bouchard notes, there are particular difficulties when one looks at cases involving symbiosis: how do you construe individuality when there are many unrelated organisms that nevertheless live as one entity? (Bouchard 2012, 248).

[10] See Maturana and Varela (1980, 78) for an account of autopoietic systems.

[11] See (Kauffman 1995) for a readable account of his ideas about life beginning with the evolution of collectively autocatalytic systems.

The centrality of the concept of self to this modern consensus has been summarized very succinctly by the biological anthropologist and neuroscientist Terence Deacon as follows:

> But self is not merely *associated* with life and mind, it is what defines the very individuation that characterizes an organism and is the most fundamental organizing principle. Only living organisms are truly individual in the sense that all aspects of their constitution are organized around the maintenance and perpetuation of this form of organization. (Deacon 2012, 465)

Despite no sign of awareness on Deacon's part that these were Leibniz's views, we can let that stand as a fitting epitaph for the continuing relevance of Leibniz's ideas about substance.

Glossary of Scholastics and Atomists

(listed in chronological order of date of birth)

Avicenna (Ibn-Sīnā) (*c.* 970–1037): propounded a theory of astral causality whereby a superior celestial intelligence ("Colcodea", the "Giver of Forms") produces vegetative and sensitive souls using seeds as its instruments, with the rational soul introduced into the organic body when it is appropriately prepared. In interpreting the formative power in seeds to be heaven-sent he followed Galen, appealing also to Aristotle's claim in the *Generation of Animals* that the vital heat contained in a seed is analogous to the element of the stars. He held that a mixtion only occurs when the four primary qualities of the elements (hot, cold, wet, and dry) undergo "remission" or become broken (*fractae*). But in the mixt the elements (fire, water, air, and earth) retain their substantial forms intact, with their broken or refracted qualities interacting to produce a mediate state or "complexion"; once this is suitably prepared, the Giver of Forms bestows a substantial form on the mixt from above, to which the forms of the elements are subordinate.

Averröes (Ibn-Rushd) (1126–98): hugely influential interpreter of Aristotle, especially for thinkers like Scaliger, who imposed a Christian interpretation of Creation and the Trinity onto his thought. Averröes held that when nature produces something very highly organized without itself being intelligent (as in spontaneous generation), this must be because "it is inspired by active powers which are nobler than it and are called 'intelligences' ", i.e. divinely directed causative agents. He maintained that on being combined in a mixt, the subordinate forms of the substances do not remain intact but are "refracted" or broken.

Marsilio **Ficino** (1433–99): Florentine metaphysician and translator of all Platonic dialogues into Latin, Ficino was the main conduit for Neoplatonist ideas in the Renaissance, including the interpretation of *semina rationales* as immaterial *seeds* situated in the sphere of *nature*. These seeds corresponded to *reasons* in *souls* in the sphere above them, to *forms* in the sphere of *matter* below them, and to *ideas* in the innermost realm, that of *intelligence*.

Julius Caesar **Scaliger** (1484–1558): born Giulio Bordoni, educated at the University of Padua, Scaliger left Italy for Agen, France, in the mid-1520s, where he became a French citizen, married, and had fifteen children, assuming a bogus Italian noble lineage (which was finally exposed by Myriam Billanovich in 1968). Scaliger was an enormously productive scholar, producing a long critique of Erasmus, treatises on Latin language and poetry, various works on botany, and most importantly for posterity, the quirkily titled *Exotericarum exercitationum liber XV de subtilitate ad Hieronymum Cardanum* (*The Fifteenth Book of Exoteric Exercises on Subtlety, against Girolamo Cardano*) (Scaliger, 1557). Scaliger's book—a long, discursive polemic on the philosophy of Girolamo Cardano's *De subtilitate* (*On Subtlety*; Nuremberg, 1550)—was reprinted ten times between 1576 and 1665, and widely used as a textbook for natural philosophy and metaphysics. Scaliger was influential on a diverse group of scholars, including Kepler, Basson, van Goorle, Sennert, Sperling, Gilbert, Galileo, Gassendi, and Boyle, especially for his criticisms of mainstream Aristotelianism, his doctrine of *minima naturalia*, his theory of mixtion, and his philosophy of immaterial and active forms. Scaliger propounded the theory

of the self-multiplication of vegetative and animal souls, regarding the soul as having the formative power to create its own body, although this does not apply in the case of humans, where God must create each rational soul directly. He also maintained that substances did not lose their forms on entering into the kind of compound (mixt) he called a '*crama*', which he regarded as a continuous whole that was nevertheless an aggregate and not a real unity. See Sakamoto (2016) for a detailed scholarly treatment of Scaliger's philosophy.

Paracelsus (Philippus Aureolus Theophrastus Bombastus von Hohenheim) (1493–1541): German-Swiss iatrochemist who initiated a transformation of medicine by insisting on its chymical basis: namely, in the *tria prima*, the three basic principles of Arabic alchemy, mercury (signifying fluidity, heaviness, and metallicity), sulphur (signifying flammability), and salt (signifying solidity and inertness). Paracelsus and his followers placed increased emphasis on analysis and synthesis (for which Paracelsus coined the term '*spagyria*', which Libavius would later assimilate to the tradition of Geberian alchemy based on Aristotle's *Metereology* (see Newman 2006, esp. chapter 7).

Jean **Fernel** (1497–1558): French physician at the University of Paris, invoked a shaping power (*vis conformatrix*) sent from the heavens to earth to explain the formation of organic bodies, holding that this power becomes the soul of the living being after the completion of the body (a view which influenced Scaliger in his denial of the difference between the formative power and the soul of the body); Fernel held that form is educed from the potentiality of matter when the matter is suitably prepared to receive it, but that in the case of human generation the rational soul is created specially by God once the foetus has been formed.

Philip **Melanchthon** (1497–1560): intellectual leader of the Lutheran Reformation, friend of Luther's, and professor at the University of Wittenberg; main author of the Augsburg confession outlining Lutheran doctrine on the Eucharist and other theological matters; advocate of the plurality of forms.

Jacob **Schegk** (1511–87): a moderate Lutheran professor of philosophy and medicine at the University of Tübingen; author of *On the Plastic Faculty of the Seed* (*De plastica seminis facultate*) (Strasbourg, 1580). A strong advocate of the Galenic notion of formative power or "plastic faculty (*facultas plastica*)", which, contrarily to Scaliger, he conceived as diffused throughout the universe, operating independently of the soul to form an organic body (see Sakamoto 2016, 132). A number of thinkers drew upon Schegk's theory, including Johann Amos Comenius (1592–1670), and William Harvey (1578–1678). The idea was later taken up by the Cambridge Platonists, Henry More (1614–87) and Ralph Cudworth, in the form of a doctrine of universal "plastic natures" (see Hirai 2011, 81ff.). Like Zabarella, Schegk adopted Averröes' position that the subordinate forms existing in a compound or "mixt" are "refracted" or broken.

Jacopo (or Giacomo) **Zabarella** (1533–89): Paduan philosopher, and one of the chief representatives of Renaissance Aristotelianism, particularly influential among Protestant Aristotelians in northern Europe; author of *Opera logica* (Venice, 1578) and *De rebus naturalibus* (Venice, 1590) (his collected writings on natural philosophy), Zabarella is noted for having developed the *regressus* method for obtaining knowledge in the theoretical sciences. He took substantial form to be the principle of individuation of substances, in opposition to Aristotle, for whom matter performed this role, in which he was followed by Sennert and Leibniz. He was an influential advocate of the plurality of forms, who, like Schegk, adopted Averröes' philosophy of the "refraction of forms".

Petrus **Severinus** (born Peder Sørensen) (1542–1602): much influenced by Ficino, he held that the generation of all natural beings is due to invisible and spiritual seeds, with both immaterial and material aspects, which he defended by reference to Hippocrates. His views were highly influential on Du Chesne, De Boodt, Libavius, Gassendi, Davisson, Jean-Baptiste van Helmont, and Leibniz's teacher Jakob Thomasius.

Joseph **Du Chesne** (Quercetanus) (1546–1609): French Paracelsian, Calvinist, and strong proponent of the plastic force of Schegk, whom he admired as a "second father" (Hirai 2011, 103).

Anselm **de Boodt** (1550–1632): ordinary physician to the emperor Rudolph II in Prague, who introduced the chymical notion of *spiritus* into mineralogical discussions. Crystals could not be formed without there being in the minerals a kind of seminal force (*vis seminalis*) operating through the actions of an elaborator spirit.

Andreas **Libavius** (born Andreas Libau) (1555–1616): an eccentric Saxon schoolteacher, historian, physician, and poet, Libavius was an outspoken opponent of Paracelsus, who nonetheless assimilated the Paracelsian notion of *spagyria* (alchemical analysis and synthesis) to the corpuscular tradition of Geberian alchemy based on Aristotle's *Metereology*. Through his *Alchymia* (1597) Libavius became one of the chief advocates of the reality of chrysopoeia (the ability to transmute a base metal into gold), although he also wrote books on logic, medicine, and theology, taking a strong Lutheran stance against the Jesuits and Calvinists. See Newman (2006, chapter 7) for an informative treatment of his contributions to chymistry.

Sébastien **Basson** (*c.*1560–1626?): combined classical atomism with the Stoics' all-pervading ether into a synthesis incorporating notions from chymistry. Like Sennert, Basson advocated atoms not only of the four elements, air, water, fire, and earth, but also of the Paracelsian *tria prima*, sulphur, mercury, and salt, adding to them atoms of phlegm; but he denied that these atoms contained forms. His invocation of a universal spirit guiding the combination, dissociation, and rearrangement of atoms is evocative of similar views expressed by Leibniz in 1671.

Sir Francis **Bacon** (1561–1626): advocated atoms or *semina rerum* (seeds of things) whose *virtutes* enabled them to assume any shape by folding and unfolding so as to fill any space. There are many anticipations of Leibniz's views that I believe deserve further study by scholars, from his conception of atoms as minimal bodies endowed with *anitypia*, by which they retain their identity through incessant motion, to his rejection of the vacuum in favour of matter divided by folds (*plicae*) and a conception of atoms in terms of force.

Daniel **Sennert** (1572–1637): professor of medicine at the University of Wittenberg, author of various works on matters chymical, biological, physical, and metaphysical, including the *Epitome Naturalis Scientiae* (1600, 1618), *De chymicorum* (1619), and his main work, *Hypomnemata Physica* (i.e. Physical Memoirs) (1636). Sennert upheld the Averroist theory of refracted forms in his earlier writings, but by 1619 had adopted Scaliger's theory of mixtion and theory of integral subordinate forms, and converted to atomism. Inspired by Liceti's doctrine of latent seeds causing spontaneous generation, Sennert reinterpreted Scaliger's *minima naturalia* as form-containing atoms, assimilating them to the atoms of the alchemical tradition. He also followed Scaliger in holding that all substantial forms are immaterial, and created on the Third Day of Creation, propagating by multiplication rather than being educed from the potency of matter. Under the influence of De Boodt, he extended the multiplication of forms to metals and minerals. More controversially, he extended Scaliger's idea of the soul creating its own organic body

to humans as well, vigorously defending the thesis of traducianism even for human generation. In his version of the plurality of forms, the forms of the elements are subordinate to those of the alchemists' principles, which in turn are subordinate to those of mixts such as gold and silver, and these to the forms of living creatures.

Fortunio **Liceti** (1577–1657): Paduan professor of philosophy and a friend of Galileo Galilei (1564–1642). His primary work was *On the Spontaneous Generation of Living Beings* (*De spontaneo viventium ortu*; Vicenza, 1618); he gave severe critiques of Ficino's doctrines of the world soul and of astral influences, and held that in spontaneous generation inferior living beings must be spontaneously born from agents lying hidden in matter. This explanation was adopted by Daniel Sennert and also by Athanasius Kircher, who reproduced key passages from Liceti without attribution. Sennert, though, was critical of Liceti for only partially rejecting eduction, insofar as he maintained that the external agency of heat is needed to generate specific forms from generic ones (see Hirai 2011).

William **Harvey** (1578–1657): criticized Scaliger and Fernel for holding that the seed has a soul. Harvey contended that the seed is a homogeneous body that does not possess any organs, and hence no soul either. He appealed to Schegk's notion of a plastic power independent of the soul that would form an organic body and prepare it to receive a soul. As Sakamoto observes, "This argument provided the basis for his theory of epigenesis" (2016, 144).

Johann **Freytag** (1581–1641): professor of medicine at the University of Groningen, and Sennert's severest critic, who denounced him "to the Academies of the Christian world" for allegedly advocating the transmigration of souls and the immortality of souls of animals and plants.

David **van Goorle** (Gorlaeus): (1591–1612): Dutch theology student who (like Sennert) identified Scaliger's *minima naturalia* with atoms, and also adopted Scaliger's theory of mixtion. This Scaligerian foundation, together with the arguments of Nicolaus Taurellus (1547–1606), led him to adopt the view that a human being is only an *ens per accidens*—a theologically explosive view that was later to resurface in the controversy between Gisbert Voetius and Descartes' supporter Henri LeRoy (Regius) in Utrecht. See Christoph Lüthy (2001) for a fascinating treatment of the link between Van Goorle's atomism and Northern Italian metaphysics.

Pierre **Gassendi** (1592–1655): the most famous atomist of the seventeenth century, Gassendi was instrumental in reviving Epicureanism in a version palatable to Christian belief. In his own time his metaphysics represented a strong viable alternative to Cartesianism, and one that was profoundly influential on Locke, Boyle, and Newton, as well as Leibniz. The richness of Gassendi's thought on atoms, however, is only now beginning to be appreciated, as more is understood of his debt to the theories of substance and matter of his contemporaries and predecessors. Of particular interest regarding Leibniz's professed youthful infatuation with his philosophy are his doctrine of the non-passivity of matter and of the necessity for there to be active forms within it, his insistence that an organic body can only be generated from organized matter that presupposes its own principle of organization immanent in it (preformation), his insistence that (whatever their causes) all explanations of phenomena must be given in mechanical terms, and his idea of organic molecules as the building blocks of living bodies enduring since their creation on the Third Day, as necessary instruments for the carrying out of God's providential plans.

William **Davisson** (1593–1669): a chymist from a family of Scottish aristocrats that had met financial ruin, Davisson quit Scotland for France in 1614, where he obtained his doctorate in medicine at Montpelier. Author of two works on chymistry published in 1635 and 1644, Davisson became councillor and physician to Louis XIV in 1644, and published a work on Severinus in 1660, *In ideam philosophicam medicinae Petri Severini*.

Athanasius **Kircher** (1602–80): famous Jesuit father and polymath; in his *Mundus subterraneus* (Amsterdam, 1664–5), Kircher gave an interpretation of the Creation of the world and origin of life that synthesized many of the ideas of his contemporaries: Severinus' concept of seeds, the Paracelsian principles of the chymists, Schegk's notion of plastic force (as developed by his friend, Johann Marcus Marci (1595–1667)), and Liceti's account of spontaneous generation, which he took over as his own view and popularized, provoking intense debate all over Europe (see Hirai 2007 and 2011).

Johann **Sperling** (1603–58): known chiefly as a disciple and defender of Sennert against Freytag's charges, Sperling was the author of a popular textbook on the corpuscularian theory of matter; he was also a diligent reader of Scaliger whose *Meditationes in Julii Caesaris Scaligeri Exotericas Exercitationes, de subtilitate* (Wittenberg, 1656) "devotes over six hundred pages to explaining the first ten exercises of the work" (Sakamoto 2016, 128).

Sir Kenelm **Digby** (1603–65): an English courtier and diplomat and leading Catholic intellectual, regarded by Leibniz as one who had paved the way for reconciling Aristotelian natural philosophy with the corpuscularianism of the moderns. Notably, Digby gives an account of animal self-motion in terms of causal relations between mutually dependent parts of an organic whole, without invoking an immaterial principle of agency (see Andreas Blank 2007).

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