# LEIBNIZ ON MATHEMATICS, METHODOLOGY, AND THE GOOD: A RECONSIDERATION OF THE PLACE OF MATHEMATICS IN LEIBNIZ'S PHILOSOPHY

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*Abstract*

Scholars have long been interested in the relation between Leibniz, the metaphysician-theologian, and Leibniz, the logician-mathematician. In this collection, we consider the important roles that rhetoric and the "art of thinking" have played in the development of mathematical ideas. By placing Leibniz in this rhetorical tradition, the present essay shows the extent to which he was a rhetorical thinker, and thereby answers the question about the relation between his work as a logician-mathematician and his other work. It becomes clear that mathematics and logic are a part of his rhetorical methodology, because they constitute one set of tools that he used to excavate the truth. Mathematical and logical insights are thus all part of his "art of thinking," employed in the service of philosophy.

## *Introduction: A Leibnizian Puzzle*

Scholars have long been interested in the relation between Leibniz, the metaphysician-theologian, and Leibniz, the logician-mathematician. For historians of science and for a long line of analytic philosophers starting with Bertrand Russell, it has been very tempting to think that the brilliant promoter of the universal characteristic and inventor of the calculus was *first* a logician-mathematician and *then* a metaphysician. In particular it is tempting to believe that the elaborate metaphysics of the *Monadologie* developed from Leibniz's ideas about truth, universal characteristic, and the continuum.

Given our concern with rhetoric and mathematics, the most relevant parts of the traditional story about Leibniz's intellectual development are as follows. (1) The only thing really original in Leibniz's very early years (1663-72) is his work in the areas of logic and the universal characteristic (besides some juvenile proposals in physics, which he would soon discard). (2) His main concern in Paris (1672-76) is with mathematical matters resul-

ting in the invention of the calculus in 1675-76. (3) Soon after settling in Hanover (his primary residence from late 1676 until the end of his life), this original work in logic and mathematics encouraged the development of his theory of truth (as concept containment), whose textual evidence appears in 1679-83 and whose breakthrough encouraged major parts of his metaphysics. (4) The development of his notion of force (*vis viva*) in the late 1670s also encouraged a reconsideration of metaphysical matters and thus influenced the development of his metaphysics. (5) The *Discours de métaphysique* of 1686 is the first presentation of his metaphysics. (6) Throughout the 1690's and early years of the eighteenth century, he reconsidered the details of his metaphysical proposals, added to his physical insights, and wrote some theology for his royal patrons (the *Theodicie* of 1710), until he arrived at his "mature metaphysics," as most accurately presented in the *Monadologie* of 1714.

This traditional story is a satisfyingly tidy tale about a rational process from logic through mathematics and physics to theology and finally to mature metaphysics by one of the greatest philosophers, mathematicians, and scientists of the early modern period. Hard biographical facts support each part of the story, and in the past two decades, prominent scholars have endorsed those parts.[1] Concerning part (1), it is true that Leibniz does not argue, in any straightforward fashion, for a metaphysics in the very early years. Concerning (2), most of his energies in Paris are given over to mathematical matters, and the most important product of the period is the development of the calculus. Concerning (3) and (4), during the years 1679-83, he composed some highly original logical papers and made a significant breakthrough in the science of dynamics. Concerning (5), the *Discours* of 1686 is the first fully developed account of his metaphysical doctrines and their interrelations. Finally, concerning part (6) of the story,

[1] Among the prominent Leibniz scholars who have argued for some part of this story are: Robert M. Adams, *Leibniz: Determinist, Theist, Idealist* (Oxford, 1994); Philip Beeley, *Kontinuität und Mechanismus* (Stuttgart, 1996); Daniel Garber, "Leibniz: Physics and Philosophy," in Nicholas Jolley, ed., *The Cambridge Companion to Leibniz* (Cambridge, 1995), 270-352, and his yet unpublished Isaiah Berlin Lectures, Oxford, 2004; André Robinet, *Architectonique disjonctive, automates systémiques et idéalité transcendantale dans l'oeuvre de G.W. Leibniz* (Paris, 1986); R. C. Sleigh, Jr., *Leibniz and Arnauld: A Commentary on their Correspondence* (New Haven, 1990); and Catherine Wilson, *Leibniz's Metaphysics: A Historical and Comparative Study* (Princeton, 1989).

he did not publish any extensive work in theology until the *Theodicie*, dedicated to his royal patron, Princess Sophie Charlotte, in 1710, and moreover the *Monadologie*, which has become the canonical Leibnizian text, was indeed written at the very end of his life, as a summary of his philosophy.

Leibniz's intellectual path and scientific contributions however are neither as tidy nor as cumulative as this traditional story maintains. Indeed, once we begin to place both the path and the contributions within the context of "the art of thinking mathematically," a very different story emerges. In the introduction to our volume, Cifoletti offers a brief account of the "historiographical 'air du temps'" out of which the studies of the volume arise. The traditional story about his intellectual development reveals more about twentieth-century historiography than about Leibniz's intellectual evolution and thereby exemplifies the traditional "*querelle*" of "two cultures." For twentieth-century historians, the divide has been between Leibniz's "scientific" productions—the scientific achievements, the philosophical summaries, the texts full of definitions and arguments—and everything else. But once we consider the "other" culture and place the facts that support the traditional story alongside the enormous complications of Leibniz's life and texts, each part of the traditional story becomes either misleading or patently false.

One might list several hundred facts that do not easily mesh with the standard tidy tale, but here are a few, chosen to suggest the complications and diversity of Leibniz's intellectual production and to show the inaccuracy of each part of the traditional story.

(1) According to the standard story, the only thing really original in Leibniz's very early years (1663-72) is his work in the areas of logic and the universal characteristic. But once we consider the context of his proposals about the universal characteristic and about logical matters, it is obvious that they are a mere part of a more general metaphysical project. For example, his famous *Dissertatio de arte combinatoria* of 1666 begins with a number of metaphysical proposals that situate the text's logical claims. Not only does Leibniz present a Platonist account of divinity in the text, he offers an analysis of the four Aristotelian primary qualities in mechanical terms. In short, Leibniz places his original logical claims within a rather elaborate metaphysical context. This original glimpse at Leibniz's logical talents suggests that it

is inappropriate to treat his logical work in isolation from his other intellectual projects. Leibniz did not see his logical researches as distinct from the other parts of his thought (including his views about the divinity). It seems reasonable not to treat them as distinct.

(2) According to the traditional story, Leibniz's main concern in Paris (1672-76) is with mathematical matters resulting in the invention of the calculus in 1675-76. It is true that most of his energies in Paris were applied to mathematics. But he also found the time for his first full-fledged discussion of the problem of evil (in a dialogue entitled *Confessio philosophi*), an account of philosophical methodology, and a brilliant series of notes, entitled *De summa rerum*, on topics related to the metaphysics developed prior to his arrival in the French capital. In brief, Leibniz was actively engaged with various interrelated philosophical projects in Paris.

(3) According to the traditional story, between 1676 and 1683, Leibniz worked on a number of logical problems out of which developed his account of truth and which led him to develop his metaphysics. In fact, the traditional story is accurate about the logical contributions, but inaccurate about the relation between this part of Leibniz's "scientific production" and the other elements of his thought. In April 1679, Leibniz produced a series of papers that develop a theory of truth and treat a number of questions related to formal validity. Underlying these discussions is the idea that an affirmative categorical proposition is true just in case the concept of its predicate is contained in the concept of its subject. He takes true propositions to signify "nothing other than some connection between predicate and subject" in the sense that "the predicate is said to be in the subject, or contained in the subject."[2]

Beginning with Bertrand Russell and Louis Couturat in the first years of the twentieth century and continuing until very recently, it has been a commonplace among scholars that Leibniz's quirky

[2] It is noteworthy that he presents this account of truth in a paper entitled *Elementa calculi*. See *G. W. Leibniz: Sämtliche Schriften und Briefe*, ed. Deutsche Akademie der Wissenschaften (Berlin, 1923-), Series VI, Volume iv, part A, p. 197. Hereafter I refer to this collection as A, and abbreviate my references as follows: large Roman numerals = series number, small Roman numerals = volume number, Arabic numerals = page number.

metaphysics developed more or less directly out of his account of truth.[3] As Russell neatly makes the point: "No candid reader ... can doubt that Leibniz's metaphysics was derived by him from the subject-predicate logic." [4] Russell used his impressive philosophical and scholarly skills to survey a wide range of Leibniz's texts. Given Russell's own philosophical interests, it should not come as a surprise to learn that he almost exclusively studied the "scientific" writings and ignored the other "culture." He thereby set a precedent in Leibniz studies.[5]

In my *Leibniz's Metaphysics*, I prove that Leibniz had an elaborate metaphysics by the time he left for Paris (that is, fourteen years before the *Discours*) and that the theory of truth developed from that metaphysics. While it is true that his account of substance as a logical subject with a complete concept (most famously articulated in *Discours* § 8) evolved subsequent to the theory of truth, it remains beyond doubt that he developed major parts of his metaphysics of substance several years before the account of truth. In brief, the logical work of 1676-83 could not have motivated the metaphysics.[6]

There are good reasons to see Leibniz's work in logic as part of a more general concern with the acquisition, teaching, and presentation of truths. Leibniz moved to Hanover in late 1676 to be court advisor to Duke Johann Friedrich. During the years 1679-83, he studied chemistry, and made detailed proposals about administrative matters, including the expansion of mining in the Harz mountains. Encouraged by the duke and inspired by the multi-volume *Encyclopedia* of Johann Heinrich Alsted, Leibniz

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[3] For Louis Couturat's position, *La logique de Leibniz d'après des documents inédits* (Paris, 1901), and especially "Sur la métaphysique de Leibniz," *Revue de métaphysique et de morale*, 10 (1902), 1-25. For the most concise statement of Bertrand Russell's interpretation, see the preface to the second edition of his book, *A Critical Exposition of the Philosophy of Leibniz* (Northhampton, 1967). For recent books that approach Leibniz's thought and its development in this traditional fashion, see Nicholas Rescher, *On Leibniz* (Pittsburg, 2003), and Garrett Thomson, *On Leibniz* (Belmont, CA, 2001).

[4] Russell, *Leibniz*, v.

[5] This approach and main parts of the standard story continue to be endorsed among some historians. E.g., see Rescher, *On Leibniz*, and Thomson, *On Leibniz*. But it has become much more common for scholars to examine Leibniz's thought through a somewhat wider lens. For recent examples, see two fine introductions to Leibniz's thought: Nicholas Jolley *Leibniz* (London, 2005), and Massimo Mugnai, *Introduzione alla filosofia de Leibniz* (Turin, 2001).

[6] Christia Mercer, *Leibniz's Metaphysics: Its Origins and Development* (New York, 2001), see especially chapters 3, 4, 7, and 8.

planned a large encyclopedia project at the very time he was occupied with logical topics. In the midst of his logical papers, we find texts like *Praecognita ad Encyclopaediam sive scientiam universalem*, written in the winter of 1678-79 (A VI iv [A] 133-4). Here Leibniz discusses organizing all knowledge in encyclopedic form. There is no reason to consider his logical work in isolation from these other projects.

(4) Concerning the fourth part of the traditional story, it has become a commonplace among Leibniz scholars to highlight the development of his notion of force in 1679 and to assume that this major discovery must have influenced his account of substance. That Leibniz radically changed his thinking about the nature of force and motion in 1678 is clear. As a young man, he had embraced mechanical physics, according to which the features of bodies are to be explained in terms of the broadly geometrical properties of their parts—whether these are tiny indivisible atoms or infinitely divisible stuff—whose configurations shift and change through motion, and whose motion changes through collision. When he published his two-part *Hypothesis physica nova* in 1671, Leibniz's "abstract" account of motion is offered in terms of the Hobbesian notion of conatus, defined here as "an indivisible, nonextended part of motion" and as "the beginning and end of motion" (A VI ii 264-65). In 1671, Leibniz agreed with Descartes that "all power in bodies depend on speed"(A VI ii 228). By the time Leibniz met Spinoza in The Hague in the autumn of 1676, he had begun to question features of this mechanical account, and in particular, Descartes' law of the conservation of motion. In the winter of 1677-78, Leibniz took some observations made by the Dutch mathematician, Christiaan Huygens, about impact, and transformed them into a notion central to his thought. He decided that force or power of action (rather than speed) must be conserved in collision between bodies. By January 1678, he had hit upon the proper account of this force: $mv^2$ (mass times velocity squared). Given the importance of this insight, it is odd that Leibniz did not publish any part of his findings until 1686, and even then, in his *Brevis demonstratio erroris memorabilis Cartesii et aliorum circa legem naturae*, he merely criticized Descartes' conservation principle and hinted at his own account.[7] Over the next few

[7] *Brevis demonstratio* was published in the *Acta Eruditorum* in March 1686. See A VI iv [C] 2097.

years, he was to work out the details of his dynamics, especially in response to Newton's *Principia mathematica* (of 1687).

The account of force is a dramatic break with Leibniz's earlier physics. But it did not entail a break with his metaphysics. The theory of force may be easily added to the metaphysical foundations built during the early period.[8] Leibniz was clever enough to design his notion of substance to accommodate comfortably different accounts of motion and activity. Once he had hit upon the fundamental structure of his conception of substance as an active and unified self-sufficient thing (which he did in 1670-71), it would be sensible to conceive it as something that could ground slightly different accounts of activity. And once we situate Leibniz's insight within his fundamental assumptions, namely, that physics is a science or kind of knowledge "secondary" to metaphysics, it is not surprising that a breakthrough in physics would *not* require a dramatic shift in metaphysical doctrines. In an essay of 1679-81, Leibniz begins with a definition of physics as "scientia attributorum corporis" and then goes on to explain that even "distinct" knowledge of such an attribute must be reduced to "Metaphysics and Mathematics," since physics is a "subordinate" science (A VI iv [C] 1981-2). Despite its genuine significance, the development of his account of force did not require a break with his past metaphysical claims.

(5) According to the fifth part of the tradition story, the *Discours* of 1686 is the first presentation of Leibniz's metaphysics. In 1686, while overseeing the construction of mining machines he had designed for use in the Harz Mountains, Leibniz was caught in a severe snow storm and took the opportunity to write a summary of his metaphysics for "the great" Antoine Arnauld. While the snowstorm might have encouraged the first thorough-going

[8] Scholars have long noted the importance of Leibniz's development of the notion of force in the late 1670s, and most have taken this to be the first major step in the evolution of his metaphysics. See, e.g., Robinet, *Leibniz*, pp. 128-38; Adams, *Leibniz*, p. 236; and Garber, "Leibniz's Physics," passim. Subsequent to my discovery of Leibniz's original metaphysics, scholars have been inclined to see the break-through in physics as less the beginning of his metaphysical evolution as an important shift in emphasis. This is the position, e.g., taken by Daniel Garber in his Oxonian *Isaiah Berlin Lectures* in 2004. It has long been my contention, however, that if we take seriously the fundamentally active nature of Leibniz's original metaphysics, then it becomes easy to see that the account of force (in fact, virtually any mathematically describable account of activity) can easily be added to his original account of substance. See Mercer, *Leibniz's Metaphysics*, chapters 2, 4, and 7.

summary of Leibniz's views, it did not contribute significantly to its creation. Many of the doctrines contained in the *Discours* appear in the early metaphysics. Thus, the *Discours* does not mark the *creation* of a metaphysical system, but rather a new willingness to make the system public.

(6) According to the final part of the traditional story, the *Theodicie* and *Monadologie* are uniquely important as the most accurate summaries of Leibniz's mature views about theological and metaphysical matters. These works are important, because they were produced at the end of Leibniz's long life, but neither work by itself is radically new as a presentation of his views.

Leibniz's study in Paris of the problem of evil foresees many of the ideas of the *Theodicie* and the metaphysics of the *Monadologie* uses slightly new terminology but also bears a striking similarity to many earlier views. The *Theodicie* has a uniquely important status as the largest single philosophical text that Leibniz chose to publish during his lifetime, but it is neither his first nor absolute last word on the problem.[9] The *Monadologie* as a canonical text is even more problematic. Leibniz did not publish it, nor did he seem to think of it as the most accurate account of his philosophical ideas. Its canonical status has more to do with its use by eighteenth-century Leibnizians and the need of subsequent generations to create a stable Leibnizian philosophy than with any supreme importance that, as far as we know, Leibniz attached to it.[10] The assumption has been that because it appeared at the end of his life, the text must be the final statement of a long progress to philosophical clarity. In fact, there is much in the text that is better explained and more thoroughly explored in earlier writings. In brief, if we put aside our assumptions about the cumulative nature of Leibniz's development, there is little reason to attach quite so much importance to the *Monadologie*.

We have arrived at a Leibnizian puzzle. Once we cease to project our own assumptions about Leibniz's scientific "culture," there appears to be much more diversity to his intellectual life. That is, once we place his "scientific productions" within the

[9] See R.C. Sleigh, Jr., *Confessio Philosophi: Papers Concerning the Problem of Evil, 1671-78* (The Yale Leibniz) (New Haven, 2006), Introduction.

[10] On the publication of the *Monadologie*, see Antonio Lamarra, Roberto Palaia, and Pietro Pimpinella, *Le Prime Traduzioni della Monadologie di Leibniz (1720-21)* (Florence, 2001).

elaborate complex of his theological concerns, political activities, and modes of intellectual exchanges, his story and the scientific contributions within it form a much less coherent and tidy tale. On the one hand, stands one of the greatest scientists of early modern Europe, someone who made contributions in logic, mathematics, physics, philosophy, and mechanical engineering. On the other hand, looms a somewhat enigmatic figure, someone who was court advisor, historian, city planner, librarian, engineer, expert in jurisprudence, and politician obsessed with religious peace, a thinker always prepared to present and contemplate his ideas from different perspectives. Where is the harmony in this diversity?

In the introduction to this volume, Cifoletti claims that once we "expand" our sense of rhetoric to match its use in the early modern period, it becomes "an important tool by which to dissect significant episodes in the history of early modern science." I would now like to use this tool as means to examine the relation between Leibniz's mathematics (generally conceived) and his methodology, and thereby to solve our Leibnizian puzzle. In the remainder of this paper, I take Cifoletti's advice to heart and consider Leibniz's thought within the larger methodological context of early modern rhetoric. Leibniz did not make explicit use of classical rhetorical devices, but he did practice what we are calling here "the art of thinking." Once we expand our sense of rhetoric to include the constant exploration of ideas and their relations, then the nature of Leibniz's life and its intellectual products look significantly different. As Cifoletti puts it in our introduction: as a tool, rhetoric "allows us both to enter more thoroughly the intellectual context of early modern agents and to situate ourselves at the level of the scientific work itself." The "scientific work" that interests me here is Leibniz's mathematical work in the Paris period, namely, the period of the development of the calculus. In order "to situate ourselves at the level" of that work, we need to do two things: first, to explicate Leibniz's rhetorical methodology, and second, to review the metaphysical doctrines that underlie his mathematical work.

## *Rhetoric in the Pursuit of Peace*

In the aftermath of the Thirty Years War (1618-48), whose battles were fought mostly on German soil, a methodology of peace

was extremely attractive, especially to German thinkers, many of whom had witnessed the devastation and horrors of the war first-hand. Born in Leipzig in 1646, Leibniz was raised in the aftermath of the war. He was educated in Leipzig and Jena whose professors were committed to the construction of a philosophical methodology that would generate intellectual harmony. For Leibniz's professors—philosophers like Jakob Thomasius, Johann Adam Scherzer, and Erhard Weigel—every intellectual tool that could be used in the pursuit of the intellectual harmony should be employed.

As a young man, Leibniz endorsed a rhetorical methodology and intended to develop a philosophy that would effect intellectual, religious, and even political peace. In this section, I display the rhetorical features of Leibniz's philosophy.[11] His rhetorical approach has (at least) four aspects worth noting: (1) from the beginning of his philosophical career, he sees himself as a synthesizer of ideas and traditions, and identifies with those philosophers who are similarly committed; (2) he is concerned with the consideration and comparison of various distinct intellectual sources as a means of arriving at his own philosophical insights; (3) he is prepared to formulate and reformulate these insights as a way of understanding them more thoroughly and connecting them to other ideas; and (4) he is keen to engage his readers and interlocutors so that they will join him in his conciliatory effort. I treat each of these features of Leibniz's thought in turn.

As a student in Leipzig, Leibniz acquired a conciliatory methodology and began to identify himself with those philosophers who attempted to find a unity among various philosophical doctrines.[12] He seems to have consumed ideas with a ferocious appetite and was happy to borrow from them whenever possible. The authors

[11] Compared to other early modern philosophers who were wedded to more traditional views of rhetoric (e.g., those of Cicero), Leibniz seems to have forged his own approach. Until more research has been done on this part of his thought, we will have to be satisfied with these somewhat vaguely defined "aspects." I discuss features (1), (2), and (4) in *Leibniz's Metaphysics* (49-59). Thanks to the work of Cifoletti, however, I have acquired a broader understanding of these features.

[12] Particularly important here are Leibniz's professors in Leipzig, Jakob Thomasius and Johann Adam Scherzer. For more on their influence on the young Leibniz, see Mercer, *Leibniz's Metaphysics*, passim. For Leibniz's comments on the importance of conciliation, see, e.g., A VI ii 114, II i 176.

who interested him extend to ancient, medieval, Renaissance, and early modern figures, as well as to proponents of the new mechanical philosophy. The young man saved his most flattering remarks, however, for those intellectuals who promoted conciliation, and he criticized contemporaries like Descartes and Hobbes who did not.[13] As a synthesizer of ideas, the young Leibniz was eager to collect and compare ideas from a variety of sources. His works make it abundantly clear that the young Leibniz showed a keen interest in (what I have called) *conciliatory eclectics*, both past and present.[14]

The second aspect of his rhetorical approach is his concern to arrive at his own philosophical insight through the consideration and comparison of diverse intellectual sources. This is the source of his ideas and reveals one of the main roles of mathematics in his "art of thinking." As such, it deserves our full attention. Consider some comments that Leibniz made on a German scholastic text. In 1663/64 he took notes on Daniel Stahl's *Compendium metaphysicae*. Stahl (1585-1654) had been a well-respected professor in Jena, and his writings display philosophical acumen of a sort often not found in the textbooks of the period.[15] Leibniz's notes reflect his propensity to collect ideas (see A VI i 21-41). Although Stahl's book is a commentary on Aristotle's metaphysics, Leibniz brings an impressive range of authors and doctrines to the text. For example, he compares the views of Aquinas and Hobbes regarding Stahl's discussion of *ens* and *essentia* (A VI i 39). He thus compares ideas from a very wide range of sources.

Another example of the young man's early tendency to collect and combine ideas is the *Specimen quaestionum philosophicarum ex jure collectarum* of 1664. As the title suggests, Leibniz argues that students of jurisprudence cannot ignore metaphysics because in order to answer questions fundamental to law one must be acquainted with both divine and human matters. The young man gives a brief history lesson about jurisprudence, and then

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[13] See, e.g., A VI ii 123, 433; II i 13.

[14] In my *Leibniz's Metaphysics*, I say that, for Leibniz, "the true metaphysics will be constructed from the underlying truths in the great philosophical systems, will be consistent with Christian doctrine and the claims of the revelation, and will explain the phenomena (including the new experiments)" (53).

[15] For a brief discussion of Stahl, see Max Wundt, *Die deutsche Schulmetaphysik des 17. Jahrhunderts* (Tübingen, 1939), 126-29. Stahl's *Compendium* is a very brief account of the components of the philosophy of Aristotle.

proceeds to discuss some of the great philosophical "mysteries" that are relevant to issues in jurisprudence. In his discussions, Leibniz collects ideas from the ancients (e.g., Protagoras, Plato, Galen), the late scholastics (e.g., Soto, Sanchez, Zabarella), Renaissance thinkers (e.g., Giovanni Pico della Mirandola), early modern conciliatory eclectics (e.g., Kircher, Alsted, and especially Grotius), and moderns (e.g., Hobbes, Gassendi). Leibniz constructs his answers from a wide range of sources and, through his methodological example, encourages the reader to seek a harmony beneath the intellectual discord and to build a firm metaphysical foundation for the study of jurisprudence. Nor is the *Specimen* Leibniz's only attempt during the period to speak to questions about education and learning. He proposes to reorganize the learning and teaching of jurisprudence. In his *Nova methodus discendae docendaeque jurisprudentiae* of 1667 he develops a philosophy of education that includes an analysis of the philosophical basis for law. In brief, he wants to reorganize the presentation of legal and ethical topics, make more perspicuous the underlying philosophical assumptions, and thereby promote knowledge and conciliation (e.g., A VI i 261-364).

Leibniz's early methodological assumptions are nicely exemplified in an edition of a text by the sixteenth-century humanist Mario Nizolio (1488-1567). He wrote a lengthy introduction to Nizolio's 1553 book, *De veris principiis, et vera ratione philosophandi contra pseudophilosophos*, in which he aligns himself with other conciliatory philosophers. Both Nizolio's text and Leibniz's introduction discuss the proper way of philosophizing. As part of his introduction, Leibniz attached a slightly revised version of a letter to his Leipzig professor and mentor Jakob Thomasius. The letter thereby became the young man's first published text on a contemporary metaphysical topic. In the letter, Leibniz insists that he is not just another philosopher "lusting for novelty," but desires to find the "interconnections among doctrines" (A VI ii 426). He intends to combine elements from diverse intellectual sources into a philosophy of conciliation, one that would effect peace and capture the "glory" of God's world. Nor did Leibniz waver from his conciliatory attempt to arrive at his own philosophical insights through a consideration of diverse philosophical traditions. In his *Nouveaux essays sur l'entendement humain*, written in the early years of the eighteenth century in response to John Locke's *Essay Concerning Human Understanding* of 1690, he

offers a summary of his philosophy and the methodology that produced it. He writes:

> This system appears to unite Plato with Democritus, Aristotle with Descartes, the Scholastics with the moderns, theology and morality with reason. Apparently it takes the best from all systems and then advances further than anyone has yet done.... I now see what Plato had in mind when he talked about matter as an imperfect and transitory being; what Aristotle meant by his 'entelechy'; how far the sceptics were right in decrying the senses.... How to make sense of those who put life and perception into everything .... I see everything to be regular and rich beyond what anyone has previously conceived.... Well, sir, you will be surprised at all I have to tell you, especially when you grasp how much it elevates our knowledge of the greatness and perfection of God (A VI vi 71-73).

The third aspect of Leibniz's rhetorical approach to philosophy is his readiness to formulate and reformulate, try and retry his views as a means to unify and understand them more thoroughly. For much of the twentieth century, historians of early modern philosophy approached Leibniz as one of the great rationalist philosophers and sought to discover the ultimate truths of his system from which all the others could be deduced. They were not successful, and the result has been a reconsideration of the allegedly deductive structure of Leibniz's philosophy. Benson Mates was one of the first historians to make the point clearly. In his words:

> Contrary to what many commentators seem to have supposed, [Leibniz] does not treat his philosophical principles as a deductive system within which certain propositions are to be accepted without proof and the rest are to be deduced from these..... He deduces the various principles from one another in different orders and combinations. Often he gives alternative definitions of the same concept, sometimes even showing how to derive these from one another. It is obvious that he has no particular order of theorems and definitions in mind.[16]

In my *Leibniz's Metaphysics*, I make much of this feature of Leibniz's philosophical works in an attempt to highlight the difficulty of grasping the complications of his thought. Whereas our other early modern heroes—Descartes, Galileo, Spinoza, Hobbes, Malebranche—produced brilliant explications of their philosophies, there is no single exposition of Leibniz's metaphysics replete with extended arguments and details. What makes matters worse is that he often used different language and took diverse approaches

[16] Benson Mates, *The Philosophy of Leibniz: Metaphysics and Language* (Oxford, 1986), 4.

to the same topic. As Mates saw so clearly, Leibniz seems keen to place core doctrines in very different logical relations to one another.[17]

The most important aspect of Leibniz's rhetorical methodology given our concerns is his tendency to reformulate his philosophical opinions. Because he assumed that greater and greater knowledge would come through the persistent formulation and reformulation of his core doctrines, he was constantly eager to recombine the elements of his thought. Once he came to a position or had an insight, it did not remain a stable object. He seemed always inclined to review and reexamine. The most striking early example of this third aspect of his rhetorical approach is a series of notes he wrote between 1668-71, entitled *Elementa juris naturalis*. These notes are significant because they contain his original statements about universal harmony and his original use of the image of the mind as a mirror. What is especially important for us here is that they contain lists of definitions of key metaphysical, theological, and ethical notions, which are often arranged and rearranged. Similar definitions are reformulated in related texts. For example, there are various closely related proposals about how an individual created mind is related to its thoughts and to God, and subtly different accounts of justice and blame. We find various accounts of wisdom, love, and the pleasure associated with both. Often the same phrases appear in slightly different relations.[18] For example, Leibniz defines the mind and harmony in one manner and then slightly varies his account a few pages later (compare A VI i 438 and 444). Not only is Leibniz working out his views, he is playing with their interrelations.

Notes like these—which he made for most of his life—are large intellectual puzzles whose pieces can be reshuffled to produce different perspectives on the whole. Underlying the definitions in

[17] However, neither Mates nor I are prepared to see this tendency as more than a difficulty that scholars must face. Leibniz's tendency to reinvent and reconsider ideas and their logical relations now seem a part his larger rhetorical strategy.

[18] At A VI ii 283, he writes: "Necesse est in cogitabilibus ipsis rationem esse cur sentiantur, id est cur existant, ea non est in singuloruom cogitatione, erit ergo in pluribus. Ergo omnibus. Ergo in Mente, id est uno in multis. Ergo in Harmonia id est unitate plurimorum, seu diversitate identitate compensata. Deus autem est unus omnia." Compare this formulation to others in the period, esp. those at A VI ii 487.

the *Elementa juris naturalis* we glimpse an account of knowledge according to which each part leads to knowledge of all the others. Leibniz explains: "What it is to have real knowledge, what is called in Latin *intelligere*, is to read the inner natures." For those who have "real knowledge," it is the good they ultimately seek. But what is this "real knowledge?" There is no "singular" knowledge without "universal knowledge." "The suggestion is that one must see the interconnections among things before any single thing can be known. It is not surprising therefore that he engages in a constant process of reviewing the logical relations and connections among things. Such engagement is the means to knowledge and ultimately to wisdom (and the good) (see A VI i 485).

The final feature of Leibniz's rhetorical methodology is that he intends to attract his readers and interlocutors to this conciliatory process of discovery. There are two assumptions here: the truth cannot be directly taught, and moreover, it will not be properly pursued unless the truth-seeker is engaged in the right way. Leibniz develops a strategy to entice the reader to consider the underlying (and often unstated) assumptions of his proposals. These he considers to be true and hopes that they will eventually lead his interlocutor to philosophical enlightenment and intellectual peace. In engaging his reader, Leibniz's first concern is to attain attention in the right sort of fashion.[19] In an unpublished note of 1669-70, he writes: "The power of persuasion consists sometimes in exhibiting reasons, sometimes in moving the affections; but at the heart of all these [means of persuasion] is of course the art of obtaining attention" (A VI ii 276). Along similar lines, he explains in 1668-69 that one of his theological demonstrations "has a three-fold use—to confirm those who think rightly, to attract the rest, and to prove philosophy to be a useful and necessary beginning for theology" (A VI i 514). The success of the true conciliatory philosophy to promote peace depends on its ability to *attract* students in a manner that will lead them to see the interconnections among the doctrines of their school and those of others. As Leibniz puts it to Hermann Conring, he extols the philosophical virtues of Aristotle to the Cartesians so

[19] Of all the aspects of Leibniz's rhetorical approach, this final one is classical. For example, see Cicero, *De inventione* 1, 23, on the importance of attaining attention in the right way.

as "to release them from the limitations of their teacher."[20] And as he explains in a letter to Duke Johann Friedrich of 1679:

> There are many sides to everything, and the way it [a philosophical proposal] is first seen determines much. The most harmless proposals have often been rejected on false suspicions, and the most scabby ones accepted through the ability of their supporters. People often do not take pains to examine matters thoroughly, and however acceptable views may be, they are sometimes rejected at once on a false prepossession (A II i 491).

During an unusually frank moment in 1676 he summarizes the point:

> A metaphysics should be written with accurate definitions and demonstrations, but nothing should be demonstrated in it apart from that which does not clash too much with received opinions. For in that way this metaphysics can be accepted; and once it has been approved then, if people examine it more deeply later, they themselves will draw the necessary consequences. Besides this, one can, as a separate undertaking, show these people later the way of reasoning about these things. In this metaphysics, it will be useful for there to be added here and there the authoritative utterances of great men, who have reasoned in a similar way; especially when these utterances contain something that seems to have some possible relevance to the illustration of a view" (A VI iii 573-74).

Cifoletti has shown that it was common for sixteenth-century thinkers to avoid putting their mathematical innovations front and center. Rather, they chose to introduce their new ideas by other means and to lead readers to insights by a slower method. Once we see Leibniz and his "scientific productions" in this tradition, it is not surprising that he often presents his ideas in such a tentative and conciliatory manner. Even this brief account of Leibniz's rhetorical tendencies offers us significant insight into the unity within the diversity of his intellectual pursuits. His concerns were as broad as the truth itself. His tentative conclusions, tendency to reconsider his ideas, and concern to capture "attention" in the right way are all features of his rhetorical approach. It is now time to turn our attention to the relation between his mathematics and this rhetorical process.

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[20] G. W. Leibniz, *Die Philosophischen Schriften*, 7 vols., ed. C.I. Gerhardt (Berlin, 1875-90; repr. Hildesheim, 1978), I: 198. Hereafter G.

*Rhetoric, Mathematical Knowledge, and God*

The chronology of the relative development of Leibniz's major innovations in mathematics and metaphysics is now clear. Russell and his followers were mistaken in claiming that the mathematics and logic inspired the development of the metaphysics. If there is any influence from the one to the other, it must be the other way round. However, we need to be skeptical about the assumption that there is a neat progression even here. Assuming a relation between all the (apparently) disparate parts of Leibniz's thought, we might hypothesize that the mathematics and logic played a role in the on-going construction and then constant tinkering of his system. That is, the metaphysics encouraged his mathematical and logical works, and these "scientific" productions informed his metaphysics.

I would now like to look at some of Leibniz's mathematical and logical ideas in an attempt to situate accurately their place within the harmonized diversity of his thought. Leibniz turned to a variety of historical sources as a means of accessing the truth. Similarly, he approached mathematics for help in the construction of some of his most fundamental philosophical ideas. In the same way that he turned to traditional sources like the Aristotelian and Platonist philosophies for insights, he considered mathematics and logic as crucial tools in the discovery of the underlying truths in God's world.

When Leibniz arrived in Paris in 1672, he was relatively unfamiliar with recent mathematical findings and quickly set himself the task of catching up. It is all the more striking that he would soon make significant progress in the development of the differential calculus. At the very time that he was working so energetically on the calculus, he was making each part of the world infinitely complex. The simultaneous invention of the calculus and the infinite complexity of the world of creatures is an obvious point. The relations among the calculus, the related problem of the continuum, and the ontological "folds" of the world have been noted by others.[21] But our rhetorical tool al-

[21] Although more work needs to be done, real progress has been made recently on this part of Leibniz's intellectual development. See Richard Arthur, *The Labyrinth of the Continuum: Writings on the Continuum Problem, 1672-86* (New Haven, 2001). Arthur's Introduction is particularly helpful on the relation between the attempt

lows us to discern something more profound underneath this obvious connection.

When we consider the rhetorical methodology underlying Leibniz's philosophical work in Paris, we glimpse its unity. His concern with theological matters (in particular his commitment that the world be a proper expression of God) encouraged his mathematical work, while his keen interest with infinitesimals and related matters informed his conception of divinely harmonized minds. It is not just that working on infinity in one place inclined Leibniz to apply it in another. Rather, as the rhetorical thinker he was, he thought it was a good thing—the methodologically right approach—to take a set of insights derived in one sphere and insert them directly into another. The point of the correct "art of thinking" is to find the connections among areas of study and extend those connections into new areas. To make the point another way, given his assumption about the unity of knowledge, it would have been perfectly reasonable to take an insight acquired in one area of knowledge and assume its relevance in another.

Once we realized that Leibniz was keenly interested in finding the unity among all the areas of knowledge and that he considered this goal the means to knowledge of God, the parts of his texts and his intellectual productions that have seemed disparate for so long suddenly seem much more unified. The parts are not, however, neatly arranged in a row. The world that God created is not, for Leibniz, *that way*. Rather, the world is a beautifully arranged, constantly changing expression of the divine attributes whose eternal natures may be glimpsed when the most focused rational minds make the relevant connections and find harmony among the diverse parts. Ultimately, it is the attributes that we hope to discover; and ultimately, it is the attributes that will lead us to God. But in the meantime, the attributes are best approa-

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to solve the continuum problem and the metaphysics. Also see especially Samuel Levey, "Leibniz on Mathematics and the Actually Infinite Division of Matter," *The Philosophical Review*, 107 (1998), 49-96; Michel Fichant, *Gottfried Wilhelm Leibniz, La réforme de la dynamique: de corporum concursu (1679) et autres texts inédits* (Paris, 1994). Gilles Deleuze offers a playful though insightful account in his *Le Pli: Leibniz et le baroque* (Paris, 1988). Even less historically sensitive historians like Nicholas Rescher are aware that the "idea of creation as maximization, and the conception of an infinite comparison process along the lines afforded by the calculus." See Rescher, *On Leibniz*, 158.

ched by conceiving the interconnections and unities among the diverse parts of the created world.

As a conciliatory eclectic seeking a philosophy of peace, it makes sense to see Leibniz's mathematical and logical developments as contributing to that goal. And once we acknowledge that he embraced an emanative account of the relation between God and the world, according to which each creature in the world and the totality of creatures are manifestations of divine goodness and unity, it becomes easier to make out the exact place of mathematics in that system. Thus, before we turn to the connection between the rhetoric and the mathematics, we need to say a bit more about God.

### *God and Creatures, Harmony and Truth*

Like other prominent thinkers of the seventeenth century, Leibniz believed in a perfectly good Supreme Being who created and maintained the world and whose existence could be proven. Like many of his contemporaries, Leibniz owed a number of his assumptions about God as creator of the world to an ancient (mostly Platonist) tradition. From prominent professors at the University of Leipzig, Leibniz acquired a solid education in Platonism. The Platonist Plotinus (204/5-270 AD) was the primary inspiration behind the version of this ancient philosophical "sect" taught in Leipzig in the mid-seventeenth century. These are the Platonist assumptions particularly relevant here:

*God and Emanation*: There is an ultimately good, perfectly self-sufficient, and thoroughly unified Supreme Being, on which everything else depends and which itself depends on nothing. God's mind contains a number of Ideas or attributes (say, the Idea of Justice), which are the perfect essences of things (these are roughly based on Plato's theory of Ideas) and which are used as models for created things. The Idea or attribute of God is emanated to a creature in such a way that neither God nor God's attribute is depleted in any way, while the creature acquires the attribute, though in an inferior manner. The emanative process is continual so that a creature instantiates a divine attribute if and only if God emanates the attribute to the creature. For many Platonists, a corollary of this causal theory of emanation is that every product of the Supreme Being contains all the attributes (and hence the essence) of God, though the product instantia-

tes each of those attributes in a manner inferior to the way in which they exist in the Supreme Being. Justice as conceived by God is perfect; justice as instantiated by Socrates is not. Leibniz summarizes the position in § 14 of the *Discours*: "it is evident that created substances depend upon God, who preserves them and who even produces them continually by a kind of emanation."

*Plenitude and Sympathy*: The divine essence is emanated to each creature and to the whole of creation. The principle of plenitude develops from the idea that the more of the divine essence in the world—and hence of being and goodness—the better. Although the principle of plenitude suggests that there will be as much diverse being as possible (the more being, the better the world), this diversity of being must also be properly unified (the more unity, the better the world). One of the results of this unity among the parts of the world is a cosmic sympathy. Here the idea is that each part of the world is "in sympathy" with all the others. In other words, the principle of plenitude was supposed to imply that God fills creation with as much being as possible and unifies those diverse beings as much as possible. Such a diverse and unified world was supposed to engender wonder, delight, and awe in human observers. At the end of his life, in the *Monadologie*, Leibniz agrees with the ancient philosopher Hippocrates who claimed that all things are in sympathy with one another: everything "is affected by anything that happens in the universe, to such an extent that he who sees all can read in each thing what happens everywhere, and even what has happened or what will happen, by observing in the present what is remote in time as well as in space" (§ 61).

These ancient Platonist assumptions about emanation, plenitude, and sympathy inform much of Leibniz's thinking about the world. They inspire his theory of universal harmony, many of his views about mind, and his views about the mirroring (and expressing) of created substances. Leibniz agreed with many of his theist predecessors that the created world is an effect that bears the appropriate markings of its perfect, divine cause. But he also goes beyond the standard theist by employing mathematical means to add significantly to the unity and diversity of the world. More than any other major figure in the history of philosophy, he made use of mathematical notions to maximize the goodness of God's world. It is now time to see exactly how Leibniz's work and interests in mathematics influenced the development of his

metaphysics by giving him new means to capture the grandeur and beauty of God's world. He takes his work on infinitesimals and related mathematical notions, and attempts to fill the world with as much good as possible. For Leibniz, more than for any previous philosopher, the world is best *because* it is maximally infinite. There are not just worlds within worlds *in infinitum*, but each of these worlds contains an infinity of minds or substances, each of which perceives all the others at each of the infinity of moments in its eternal existence. By such means, Leibniz added impressively to the harmonized perfection of God's world. The art of thinking mathematically helped him do so.

## *The Young Leibniz on God, Logic, and Knowledge*

In the construction of his own conciliatory philosophy, Leibniz differed from many of his German predecessors and contemporaries in the way he took mathematical notions and wove them into the fabric of his metaphysical thinking. On the one hand, he assigned logic and mathematical reasoning an important role in his system. He was surely committed to the proper use of logic and "mathematical reasoning" as a means to describe precisely the structure and nature of truth. On the other hand, he warned against relying on the "mathematical disciplines" too much. It is now time to consider the interrelationship between Leibniz's mathematical and logical research and the evolution of his metaphysics. As a preface to his work in Paris, it will be helpful to make a couple of points about the early connections between logic and metaphysics.

Scholars have often treated Leibniz's account of logic and truth independently of his views about God and emanation, but the two parts of his philosophy are intimately related. The divine Ideas are the source of all truths, human minds contain these Ideas innately, and so the analysis of truth will involve these Ideas. Leibniz begins the *Dissertatio de arte combinatoria* with a demonstration of the existence of God, and begins the next section with: "To begin at the top, Metaphysics treats being and the affections of being"(VI i 169-70). In what follows, he characterizes mathematics and arithmetic as a means of analyzing such affections. The assumption that underlies this original publication on logic and the combinatorial art is that such logical tools ultimately rest on more fundamental metaphysical truths.

As he makes the point in the *Elementa juris naturalis*, that with the help of mathematical tools, we have become "conquerors of the world." But despite our power in manipulating the world, we have neither "real knowledge" nor its accompanying happiness (A VI i 485). Nor will we have real knowledge until the mind understands that the attributes or Ideas of God are contained in our minds as objects of knowledge and in the world as features of created things. Logic and mathematics are important tools to use to discover these Ideas and the truths that derive from them. This set of epistemological assumptions persists in Leibniz's thought until the very end. In the *Monadologie* he observes that our mind contains "knowledge of eternal and necessary truths . . . thus in thinking of ourselves we think of being" and "of the immaterial and of God himself" (§ 29-30). Logic is a tool to decipher and unlock some of those truths.

### *Method and Minds in Paris*

Leibniz's Paris period (March 1672—October 1676) was enormously productive. In the fall of 1672 he met Christiaan Huygens, who immediately recognized the young man's talent and guided his mathematical studies. Leibniz devoted himself to study and by the fall of 1675 had begun to lay the foundations of his differential calculus. During the period of this intensive work on mathematics, Leibniz found little time for philosophy. It is therefore significant that one of the few philosophical essays of the period is a summary of his views about methodological matters and the role of mathematics in the pursuit of ultimate knowledge.

In this essay, *De vera methodo philosophiae et theologiae ac de natura corporis*, composed in the period 1673-1675, Leibniz describes in detail both his philosophical intentions and his methodological strategy. In the process he presents the secondary position he assigns to "the mathematical disciplines." He begins this essay as follows: "As I turned in my zeal for knowledge from the serious study of the sacred texts and of divine and human law to the mathematical disciplines, and was soon delighted by the thoroughly luminous teachings of the latter, I came near to being caught on siren cliffs. For some wonderful theorems were revealed to me." When one approaches such theorems "with a purified mind," one experiences a wonderful harmony. But despite the thrill of

mathematical matters, Leibniz soon realized that it is essential to use the mathematical disciplines in the right way. For example, although the mechanical philosophy with its geometry has effected greater control of nature, it has "conveyed little" about the ultimate "nature of things" (A VI ii 329). Leibniz summarizes his concern:

> For I reflected as follows: Geometry clarifies configurations and motions; as a result we have discovered the geography of lands and the course of the stars, and machines have been made which overcome great burdens.... But the science that distinguishes the just man from the unjust and through which the secrets of the mind are explained and the path to happiness is paved is neglected. We have demonstrations about the circle, but only conjectures about the soul; the laws of motion are presented with mathematical rigor, but nobody applies a comparable diligence to research on the secrets of thinking (A VI iii 155).

The seeker of knowledge will be successful only if mathematical matters are treated with the right degree of care. Indeed, the wrong attitude toward mathematics will incline the mind to atheism: "I saw dangerous expressions slipping into men's souls; they are a sort of mathematical larva from which arises a false philosophy" (A VI iii 156-7).

In order to acquire genuine knowledge, philosophers must combine the search for theological insights with the care and precision of mathematics. For Leibniz, the "true method" in theology is to be constructed out of the insights of the scholastics along with the approach of the mathematicians—unlike the new philosophers who have too long ignored theological questions and who would allow "the whole of scholastic doctrine" to be "rejected," and unlike the scholastics whose "admirable reflections" are in need of clarification "by a mathematically schooled mind" (A VI iii 156). Leibniz wants to combine the theological insights and "marvelous subtlety" of scholastics like Aquinas and Gregory of Rimini with "mathematical rigor" (A VI iii 155). His goal is to effect a philosophical revolution by combining the best of all current strategies. As he sees it, neither the scholastic nor the mathematical approach is adequate, and the failure of each has encouraged confusion. Leibniz calls his philosophy a "religious" one and promises that it will lead wayward souls to the truth.

For the purposes of this paper, it is important that, according to Leibniz during his Paris years, the primary importance of mathematics is its contribution to the proper understanding of universal harmony and God. He summarizes the point:

> Mathematical studies will be used partly as an example of more rigorous judgment, partly for the knowledge of harmony and of the idea of beauty, experiments on nature will lead to admiration for the author of nature, who has expressed an image of the ideal world in the sensible one, so that all studies finally will lead to happiness" (A VI iii 157)

According to Leibniz, God has expressed the divine nature in the world with the result that the world is a harmonized, beautiful whole; mathematics is crucial as a means to acquire knowledge of that harmony. Once Leibniz describes the "true method," he is prepared to discuss the nature of substance and body. That is, in *De vera methodo philosophiae et theologiae ac de natura corporis*, after presenting the proper use of mathematical reasoning and tools, he is ready to present the core of his metaphysics on the basis of which he intends to effect theological and philosophical peace. He writes:

> There are certainly many and important things to be said ... about the principle of activity or what the scholastics called substantial form, from which a great light is thrown on Natural Theology and ... the mysteries of faith. The result is that not only souls but all substances can be said to exist in a place only through the operation of their active principle, that souls can be destroyed by no power of body; and that every power of acting [*omnem agendi vim*] exists from the highest mind whose will is the final reason for all things, the cause being universal harmony; that God as creator can unite the body to the soul, and that in fact, every finite soul is embodied, even the angels are not excepted, in which the true philosophy is in agreement with the teaching of the church fathers; finally, that the appearances differ from a substance (A VI iii 158).

In my book, *Leibniz's Metaphysics*, I explicate the details of the notion of substance here as well as the account of God and the relation between the creator and created. For our purposes, however, we need only to highlight three features of the active principles of nature (what he sometimes calls *mens*, sometimes *forma substantialis*). These features are: their dependence on God, their place in universal harmony, and their indestructibility. We will consider each of these briefly.

It follows from the theory of emanation that each created mind or soul depends entirely on God. Moreover, every product of the Supreme Being contains all the divine attributes (and hence the essence) of God, though the product instantiates each of those attributes in a manner inferior to the way in which they exist in the Supreme Being. From the beginning of his philosophical career, Leibniz associates activity with mind. Whether he calls these principles of activity minds, substantial forms, or monads, the idea is always that the only sources of activity in the world

are divine-like principles that have the power to generate unity, self-sufficiency, and vitality. In a note of 1671, he argues: "Just as God thinks things ... because they follow from his nature, so does Mind.... Mind and God do not differ except that one is finite and the other infinite" (A VI ii 287-88). In the *Monadologie*, he notes "that souls, in general, are living mirrors or images of the universe of creatures, but that minds are also images of the divinity itself, or of the author of nature, capable of knowing the system of the universe...each mind being like a little divinity in its own realm" (§ 83). We also find there a neat summary of the relation between God and creatures:

> Thus God alone is the primitive unity or the first [*originaire*] simple substance; all created or derivative monads are products, and are generated, so to speak, by continual fulgurations of the divinity from moment to moment, limited by the receptivity of the creature, to which it is essential to be limited (§ 47).

Leibniz first articulates the doctrine of universal harmony in the *Elementa juris naturalis*. As he summarizes the idea for Arnauld in 1671: "I define ... harmony as diversity compensated by identity" (A II i 173-74). By the time he wrote the *Discours* in 1686, he had come to formulate the doctrine in terms of hypotheses, though the underlying idea is still the same. In § 6 of the *Discours*, he explains: "God has chosen the most perfect world, that is, the one which is at the same time the simplest in hypotheses and the richest in phenomena." According to Leibniz, the single, unified, and perfect Supreme Being freely chooses to emanate the divine attributes to creatures; God remains transcendent while all creatures become an imperfect instantiation of God's attributes. Because God emanates the divine essence to all its products, Leibniz describes God as the reason (*ratio*) of the world and the one (*unum*) in it.

Universal harmony entails that God relates to the world and to each creature in it in two ways. God is the multiplicity in the world insofar as the divine essence is variously manifested in the vast diversity of creatures and in the diversity of the perceptions of each creature, but God is also the unity insofar as each created thing is a unified instantiation of the divine essence (although a manifestation of the essence far inferior to that of God) and therefore related to and reflective of all the others. The world is full of various perceptions of the world or 'phenomena', because the world contains an infinity of different expressions of the divine essence. Leibniz's notion of universal harmony forms

the basis for his mature theory of preestablished harmony. At the center of that account stands a (harmonized) diversity of active and perceiving minds.

For a short period in 1670-71, Leibniz distinguished between the momentary minds in nature and the persistent minds of conscious, rational beings. His two-part published treatise, the *Hypothesis physica nova* of 1671, employs momentary minds as the cause of the motion in bodies to great effect. By 1676, he has decided to make all minds eternal: "every mind is of endless duration" and "is indissolubly implanted in matter.... There are innumerable minds everywhere" which "do not perish"(A VI iii 476-7). All minds act constantly and constitute self-sufficient beings that are eternal and indestructible by anything but God. Human minds are created by God and then exist eternally. Nonhuman minds exist from the beginning of the world to its end. Despite appearances to the contrary, the dog does not die, but shrinks down to "an invisible core" of substance from which it activates another substance, and so on for all of eternity. This remained Leibniz's view. As he writes in 1716: "there is never total generation nor, strictly speaking, perfect death, death consisting in the separation of the soul. And what we call *generations* are developments and growths, as what we call deaths are enfoldings and diminutions" (*Monadologie* § 73).

In brief, during the last several months of his stay in Paris, Leibniz is both engaged with his mathematical work and committed to the three features of minds just noted, namely, that minds are causally dependent on God, the source of harmony in the created world, and naturally indestructible.

## *Plentitude*

Soon after making his breakthrough in the invention of the differential calculus, Leibniz applied his energies once again to metaphysical matters. It is here—in the period 1675-76—that we find the most significant examples of the interplay between his work in mathematics and his insights in metaphysics. During this time, each informed the other, resulting in a more unified and brilliant philosophical whole.

In the development of the differential calculus, Leibniz is keen to understand how to use the notion of infinity in the construction of mathematical entities such as the infinitesimals. The insight

here encouraged him to reconsider the construction of metaphysical entities. From 1676 on, Leibniz is increasingly explicit about the significance of the principle of plenitude. In a series of notes written in Paris, entitled *De summa rerum*, he emphasizes its importance. For example, he writes: "I take as a principle ... that the greatest amount of essence that can exist does exist" (A VI iii 472). He never wavers from this commitment to plenitude. In *De rerum originatione radicali* of 1697, he explains that God is the "reason" or source of things and argues that "there is a certain urge for existence or (so to speak) a straining toward existence in possible things or in the possibility of essence itself; in a word essence in and of itself strives for existence" (G VII 303).

For Leibniz, the world is not just very full, it is as full of being as it can possibly be, consistent with harmony. In 1676, Leibniz claims that every part of the world, regardless of how small, "contains an infinity of creatures" which is itself a kind of "world" (A VI iii 474: Pk 25). He emphasizes the same point later in *Primae veritates* of 1689-90: "*every particle of the universe contains a world of an infinity of creatures*" (A VI iv [B] 1647-48). For Leibniz, there is an aesthetic aspect to this elaborate harmony among the infinity of creatures. As he puts the point in the *Monadologie*:

> The author of nature has been able to practice this divine and infinitely marvelous art, because each portion of matter is not only divisible to infinity, as the ancients have recognized, but is also actually subdivided without end, each part divided into parts having some motion of their own; otherwise, it would be impossible for each portion of matter to express the whole universe" (§65).

### *Mirrors and Expressions*

In *De summa rerum* of 1676, Leibniz develops his growing commitment to plenitude in a number of directions. By such means, Leibniz goes beyond the plenitude and sympathy of his Platonist predecessors. He does not just maximize creatures and the assumed sympathetic relations among them, he heightens their connections by making each substance a mirror of all the others, because each mind is (unconsciously) aware of all the others. [22]

[22] The image of the mind as a mirror is a permanent fixture of Leibniz's mature thought. He first develops this idea in the *Elementa juris naturalis* of 1670-71: "Since every mind is like a mirror, there will be one mirror in our mind, another in other

In *De summa rerum*, each mind eternally mirrors the entirety of the world, and each does so from its own perspective. For Leibniz, it is important that each mind has a unique view of the world for "in this way a wonderful variety arises" (A VI iii 524). As he summarizes the point in 1676: "A most perfect being is one that contains the most. Such a being is capable of ideas and thoughts, for this multiplies the varieties of things, like a mirror" (A VI iii 475). Forty years later, Leibniz sets out the same claims, employing the same analogies, in the *Monadologie*: "This interconnection or accommodation of all created things to each other, and each to all the others, brings it about that each simple substance has relations that express all the others, and consequently, that each simple substance is a perpetual, living mirror of the universe" (§ 56). As such quotations suggest, there are close connections between the mirroring activity of minds and Leibniz's mature doctrine of expression. In various texts and in various ways, Leibniz claims that each substance expresses God, each substance expresses the world, and each substance expresses every other substance. *De summa rerum* reveals the underlying motivation behind the doctrine. Each substance is an emanation of God's essence and in this sense each shares the same essence. Each emanation will differ from every other by *expressing* the divine essence differently: "The essence of all things is the same," and they differ "only in the manner of their expression"(A VI iii 573). Each substance—whether a human or snake—is a more or less clear expression of the divine essence. Leibniz concludes: "so do things differ from each other and from God" (A VI iii 519).[23] For Leibniz in 1676, each substance expresses God insofar as it expresses the divine essence; each expresses the world insofar as the world just is the totality of expressions of God; and finally, each substance expresses every other insofar as each is a more or less clear expression of the same thing. The *Discours* of 1686 also employs this notion of expression to great effect: "Every substance is like a complete world and like a mirror of God or

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minds. Thus, if there are many mirrors, that is, many minds recognizing our goods, there will be a greater light, the mirrors blending the light not only in the [individual] eye but also among each other. The gathered splendor produces glory" (A VI i 464).

[23] To explain his point in the Paris years, Leibniz often uses an arithmetical analogy. See e.g. A VI iii 512, 519.

of the whole universe, which each one expresses in its own way, somewhat as the same city is variously represented depending upon the different positions from which it is viewed" (§ 9). He goes on to add that substances are "different expressions of the same universal cause, namely, God," where "the expressions vary in perfection" (§ 15).

*Marks and Traces*

The eternity of all mind-like active things is not an obviously plausible theory. Leibniz endorsed it because the eternity of minds adds significantly to the plenitude and harmony of the world. While developing his opinions about plenitude in *De summa rerum*, Leibniz hit upon the idea that each mind-like creature eternally perceives the entirety of the world. Each mind "senses all the endeavors" of all the other minds in the whole history of the world: "no endeavor in the universe is lost; they are stored up in the mind, not destroyed"(A VI iii 393). He came to believe that plenitude requires that each moment in the eternity of the world contain its whole history, past, present, and future. Minds not only sense all the present activities of all the minds in the world, they also retain a memory or "trace" of them: "it is not credible that the effect of all perceptions should vanish" (A VI iii 510). Each mind "retains the effect of what precedes it" and also "has a quality of such a kind as to bring this [state or effect] about" (A VI iii 491).

Thus, in 1676, Leibniz develops a version of his doctrine of marks and traces according to which each mind at every moment includes an effect or trace of all it has done as well as a quality or mark of all it will do. In § 8 of the *Discours*, he offers the soul of Alexander as an example: "there are vestiges of everything that has happened to him and marks of everything that will happen to him and even traces of everything that happens in the universe, even though God alone would recognize them all." By making minds eternal, allowing them to sense all endeavors, and assigning them traces of all that has gone before and marks of all that will occur, Leibniz makes each mind a mirror of the entire course of the world at every moment in time. That is, each mind reflects or mirrors the entire world at every moment of the mind's eternal existence. In *Discours* §15, he summarizes the point in terms of expression: each substance is of "infinite

extension insofar as it expresses everything" (A VI iv [B] 1646). By such means, he agrees with Plato "who taught that our soul expresses God, the universe, and all essences"(§27).

*Conclusion*

Once we put aside our assumptions about Leibniz's scientific "culture" and place his scientific contributions within the wider context of his life and works, we begin to glimpse the harmony at the center of his intellectual life. That is, once we place his "scientific productions" within the elaborate complex of his theological concerns, political activities, and modes of intellectual exchanges, the story of his philosophical development becomes more elaborate than the traditional account would have us believe.

First and foremost, Leibniz was a rhetorical thinker: he intends to access the truths through the analysis and consideration of a wide variety of philosophical doctrines and then to persist in the reformation and reconsideration of the insights so attained. He does not intend to offer his insights too aggressively. Rather, he hopes to attract and then engage the seeker of truth in his "art of thinking." Mathematics and logic are a part of his rhetorical methodology because they constitute one set of tools that he uses to excavate the truth. Mathematical and logical insights are thus a part of his "art of thinking."

Leibniz's metaphysics did not develop out of his interest in mathematics and logic; nor did the mathematics and logic develop out of his metaphysics. Rather, his work in mathematics and logic developed hand-in-hand with his metaphysics. The core doctrines of the metaphysics are in place before he begins serious study of mathematics, and metaphysics was always more fundamental to his thinking than mathematics. But it remains true that each *informs* the other. In keeping with his conciliatory methodology, he took some of the mathematical ideas that most interested him – about the infinite and the construction of mathematical entities like infinitesimals – and applied them to his Platonist views about universal harmony, plenitude, and minds. In other words, the pursuit of mathematical insights is just another means to access the unity within the divinely arranged truths. In the same way that he uses other philosophical sources (e.g., the Platonist notions of emanation and sympathy), he uses mathemat-

ics as a means to knit together God's truths. In the same way that the Aristotelian and Platonist philosophies offer insights, mathematics and logic are crucial tools in the discovery of the underlying truths in God's world. Mathematics in general and the study of infinity and infinitesimals in particular give Leibniz a new way to capture the grandeur and beauty of God's world. The result is a brilliant melding of elements to form "the best of all possible worlds."

In some notes written during his stay in Venice in 1690, Leibniz summarizes his underlying assumption about the unity of knowledge:

> Each thing is so connected to the whole universe, and one mode of each thing contains such order and consideration with respect to the individual modes of other things, that in any given thing, indeed in each and every mode of any given thing, God clearly and distinctly sees the universe as implied and inscribed.

Due to this connection among things, "the more perfectly I perceive one thing, the better I come to know many properties of other things from it. And from this perfect consonance of things there also arises the greatest Harmony and beauty of the Universe, which exhibits to us the power and wisdom of the highest maker" (A VI iv [B]1668).[24]

[24] I would like to thank Giovanna Cifoletti for teaching me so much about rhetoric. Also thanks to Eric Brian for his kind support and good humor.