

The Origins of Descartes' Concept of Mind in the *Regulae ad directionem ingenii*

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THE ORIGINS OF DESCARTES' CONCEPT OF MIND
IN THE *REGULAE AD DIRECTIONEM INGENII*

a dissertation

by
NATHAN D. SMITH

submitted in partial fulfillment of the requirements
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THE ORIGINS OF DESCARTES' CONCEPT OF MIND IN THE *REGULAE*

by Nathan D. Smith

Adviser: Richard Cobb-Stevens

The dissertation is primarily an historical and philosophical analysis of Descartes' early, unpublished treatise on scientific method, the *Regulae ad directionem ingenii*. Ever since it first appeared—as a manuscript passed among a small circle of intellectuals—in the 1660's, the text has been shrouded in mystery. When was it written? Why was it abandoned? What was the character of the original draft? We will attempt to answer these questions, but more importantly, our concern will be whether or not this text stands on its own as a significant contribution to the Cartesian corpus. Does it present a coherent picture of Descartes' philosophical thought at a crucial point in its development? Recent commentators have made it clear that Descartes' *Regulae* is a foundational text in his scientific career. It most fully develops Descartes' early insights into scientific method and the nature of explanation. These insights ultimately provide the basis for Descartes' theory of matter: that the physical world is nothing but extension; and wherever there is extension, there is matter. These insights will play a central role in the development of my thesis. In effect, what I will try to show is that when Descartes addresses the issues of method, epistemology, and scientific explanation, he does so in such a way that the answers to these questions prejudice Descartes toward a dualistic concept of mind. Though the *Regulae* cannot account for a concept of mind, Descartes' mature concept of mind fits central elements in that work like a missing puzzle piece.

Descartes' mature concept of mind is grounded in two claims: that the mind is a substance whose existence cannot be doubted, and that it is entirely distinct from material

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substance. For Descartes, the mind has one principle attribute, thought, of which ideas and acts of consciousness are its modes. These claims, like the claims addressed in contemporary philosophy of mind, are metaphysical. They answer the questions: what is a mind and what can be attributed to it? By contrast, the *Regulae* is primarily concerned with epistemological questions surrounding the scientific method: what counts as truth in science? How do we discover true principles? What techniques allow us to discern those principles? And how do our mental faculties confirm those discoveries? Moreover, the *Regulae* is firmly set on discarding or overturning the classical, Aristotelian scientific method—one that was intimately connected to Aristotle's metaphysics. Consequently, the *Regulae* is opposed to metaphysics in general and never develops a metaphysics of its own. Thus, Descartes' concept of mind in the *Regulae* is absent exactly that metaphysical foundation. In it, the mind appears solely as an engine of epistemological constraints, rather than a product of a metaphysical thesis (i.e., dualism). We do not see the missing piece of the puzzle, but we can study its absent contours. When we do, we perceive a very different Cartesian mind: not a disembodied soul, but an interface that mediates the subject's most precise (scientific) knowledge of the world.

In order to elaborate on this concept of mind, I propose to concentrate on three topics that demonstrate the nature of such a concept of mind: the *mathesis universalis*, the account of perceptual cognition, and the account of simple natures. These three topics certainly do not exhaust the important topics covered in the *Regulae*, but I do think that they are each central to the foundations of what we have been calling his science, but

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what may be more appropriately called “natural philosophy.” These three topics, then, tell the story of why and how Descartes arrived at the principles of his natural philosophical system. It is my claim that Descartes' concept of mind grows out of and is naturally fitted to embrace those principles.

With the *mathesis universalis*, we will find an elaboration of a method that is the basis of Descartes' analytic geometry. Descartes came to see that arithmetical techniques could be applied to geometrical problems in order to discover their solutions. This is the source of the algebraic geometry that became Descartes' pivotal contribution to mathematics in 1637, with the publication of *La Géométrie*. Yet the *Regulae*, and Descartes' earliest writings on physico-mathematics, make it clear that the *mathesis universalis* was not only a technique for solving purely mathematical problems, but was also the foundation of an applied mathematics that would, at least in part, form the basis of Cartesian science. Indeed, it is in the application of mathematical techniques to understanding physical phenomena that modern physics is born. Descartes was perhaps not the most adept practitioner of this application, but he understood what was philosophically at stake. He understood that in order to apply mathematical techniques to solving problems in natural philosophy (or physics) one had to be able to conceive of any physical object entirely in terms of mathematical representation. According to Descartes of the *Regulae*, all physical entities are to be understood only insofar as they admit of order and measure, i.e., either discrete or continuous (numerical or geometrical) mathematical representation. Thus, there is an implicit metaphysical commitment

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embedded in Descartes' proposed method: he conceives of all physical entities as admitting of mathematical representation, and only considers them insofar as they are mathematically represented. Such a conception rules out the possibility that, for instance, sensible qualities, substantial forms, or living souls have any explanatory, or possibly even causal, role to play in science. With the idea of the *mathesis universalis*, we see that the epistemological concerns of method and exactness drive Descartes' basic metaphysical theory of matter in general.

This implicit metaphysical commitment in natural philosophy has an indirect implication for Descartes' concept of mind. Descartes selects mathematical representation as the rubric by which all physical entities can be known because he understands the essence of thought to be intuition, or as he also calls it in the *Regulae* certain and evident cognition. Nothing is more certain and evident than the principles and products of mathematical calculation, so the mathematical representation of physical entities renders natural philosophy utterly clear and distinct. Moreover, once the objects of pure mathematical representation are identified with the essence of material objects, they are easily detached from the sensory impressions of the mind. Thus, in an effort to found physical science on certainty, Descartes effectively dissociates the mental from the physical. He will admit that our sensory impressions are the effect of underlying material (or mathematically represented) causes, but the character of those sensory impressions plays no explanatory role in the underlying material cause. So, the material world is

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explained through a mathematical physics together with a metaphysical theory of matter, which is independent of the sensory impressions that compose our mental life.

Though Descartes' early insights into applied mathematics show a disposition toward substance dualism, the epistemological justification for dualism lies in a brief account of perceptual cognition. In Rule XII, Descartes outlines the principles of his later scientific theory of perception. In this text, we lack many of the details guiding the later theory, though its core principles are already outlined. The theory of perception serves two purposes in the *Regulae*: first, it provides an epistemological foundation for Descartes' theory of natural philosophy; second, it justifies the use of certain methodological heuristics by relating them to physical capacities of the brain. The first objective is accomplished by accounting for a causal link between our faculties of perception and the external world. Thus, Descartes provides a reasonable physical explanation for why we ought to trust the evidence provided by our senses. This justifies the use of experiment and observation (broadly encouraged in the early Descartes) in order to discover the nature of physical phenomena. The second objective will be accomplished by attending to the nature of our cognitive faculties of representation and imagination, their limitations and strengths. Descartes thinks that we will be assured of arriving at truth if we guard against the weaknesses and harness the strengths of our cognitive faculties. These strengths and weaknesses are construed physiologically. Thus, Descartes' method of scientific explanation determines the powers and limitations of the mind. Nevertheless, Descartes maintains that the active power of the intellect, its capacity

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to voluntarily move the body and brain, is a wholly spiritual power and cannot be reduced to any property of the brain, i.e., it admits of no such physiological explanation. This spiritual power is clearly the forerunner of the *ego*. We see that it plays an essential role in the composition of Descartes' method and its nature is known as something separate from and in contradistinction to physical matter. This account of perception suggests (without proof) that the active power of the mind is primary and independent. Thus, we can understand the wholly spiritual, active power of the mind to provide the basic justification for a natural philosophy based on mathematical representation, experiment, and observation.

Finally, we will examine what is perhaps the core of the *Regulae*, the categorical bases of Cartesian science, the simple natures. Again, we find that Descartes distinguishes intellectual simples from material simples, which suggests that he considers mind and matter to be two different regions of scientific investigation. Moreover, we will note that simples are regarded as basic for scientific explanation because of their epistemic simplicity. That is, the principles of Cartesian science conform to the epistemological character of inquiry. We will illuminate the unique nature of this epistemic priority by comparing Descartes' use of the simple natures to Francis Bacon's. We will see the common search for simple bases of mechanistic science from entirely different perspectives. And we will examine how these simple natures function in the scientific method, both as bases of explanation, and desiderata of investigation. Given the idea that simple natures provide the basis for explaining mental and physical phenomena,

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one might be tempted to turn to the intellectual simple natures for a sketch of Descartes' early philosophy of mind. Unfortunately, Descartes does not elaborate in any detail on the nature of intellectual simples. It is clear that his primary focus, in the *Regulae*, is to develop an interpretation of the physical world, of natural philosophy, rather than the intellectual world. Yet, he holds that intellectual domain apart from the natural world of mechanical interaction. This, again, shows a fundamental commitment to dualism, if not a developed dualistic theory.

Considering these three topics will, I hope, convince the reader that Descartes' dualism grows out of his earliest writings on scientific method. I believe that the reason for this is the central, active role that the mind plays in setting out the parameters of scientific knowledge and pursuing science methodically. Descartes finds this power to be primitive, not yielding to a reductive explanation. One might wonder if it is not the fact that the mind sets up the very principles of natural scientific explanation that renders it intractable under those principles. In any case, we can see that what appears to be a mere metaphysical postulate in the later Descartes (the substantial independence of the mind) is in fact a necessary consequence of the natural philosophical method employed by the early Descartes.

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Introduction

Thesis

Most broadly construed, this dissertation is an historical and philosophical analysis of the *Regulae ad directionem ingenii*, Descartes' early, unfinished, and unpublished manuscript of a treatise on scientific method. The text itself has a controversial history that makes commentary on it difficult. We do not know when it was written; we do not know what it would have looked like had it been completed; and we do not know why it was abandoned. Though we will make our best effort to address these specific questions, the overriding concern of the dissertation will be whether or not the *Regulae* stands on its own as a central text in the career of Descartes. Is it a real contribution to Descartes' philosophy that presents a coherent picture of the Cartesian program at critical time in its development?

I believe it is, but perhaps not for the suspected reasons. Recent commentators have made it clear that Descartes' *Regulae* is a foundational text in his scientific career. It most fully develops Descartes' early insights into scientific method and the nature of explanation. These insights ultimately provide the basis for Descartes' theory of matter: that the physical world is nothing but extension; and wherever there is extension, there is matter.¹ These insights will play a central role in the development of my thesis. In effect, what I will try to show is that when Descartes addresses the issues of method,

¹ John A. Schuster, *Descartes and the Scientific Revolution*, Daniel Garber, *Descartes' Metaphysical Physics*, Stephen Gaukroger, *Descartes: An Intellectual Biography* each develop an argument along these lines.

epistemology, and scientific explanation, he does so in such a way that the answers to these questions prejudice Descartes toward a dualistic concept of mind. Though the *Regulae* cannot account for a concept of mind, Descartes' mature concept of mind fits central elements in that work like a missing puzzle piece.²

Descartes' mature concept of mind is grounded in two claims: that the mind is a substance whose existence cannot be doubted, and that it is entirely distinct from material substance. He says that this substance has a principle attribute--thought--and that ideas and acts of consciousness are modes of this substance. These claims, like the claims addressed in contemporary philosophy of mind, are metaphysical. They answer the questions: what *is* a mind and what can be attributed of it? By contrast, the *Regulae* is primarily concerned with epistemological questions surrounding the scientific method: what counts as truth in science? How do we discover true principles? What techniques allow us to discern those principles? And how do our mental faculties confirm those discoveries? Moreover, the *Regulae* is firmly set on discarding, or overturning, the classical, Aristotelian scientific method—one that was intimately connected to Aristotle's metaphysics. Consequently, the *Regulae* is opposed to metaphysics in general and never develops a metaphysics of its own. Thus, Descartes' concept of mind in the *Regulae* is absent exactly that metaphysical foundation. In it, the mind appears solely as an engine of epistemological constraints, rather than a product of a metaphysical thesis (i.e., dualism). We do not see the missing piece of the puzzle, but we can study its absent contours.

² More recently, Lilli Alanen, *Descartes's Concept of Mind* and Jorge Secada, *Cartesian Metaphysics: the Late Scholastic Origins of Modern Philosophy*, have each indicated that the origins of Descartes' concept of mind, epistemology, and substance dualism lie in the *Regulae*.

When we do, we perceive a very different Cartesian mind: not a disembodied soul, but an interface that mediates and determines the nature of the subject's most precise (scientific) knowledge of the world.

In order to elaborate on this concept of mind, I propose to concentrate on three topics that demonstrate the nature of such a concept of mind: the *mathesis universalis*, the account of perceptual cognition, and the account of simple natures. These three topics certainly do not exhaust the important topics covered in the *Regulae*, but I do think that each is central to the foundations of what we have been calling his science, but what may more appropriately be called “natural philosophy.” While the *Principia Philosophia* is surely the most mature and complete elaboration of Descartes' natural philosophy, the *Regulae* plays an indispensable role in developing the science of discovery underlying that natural philosophical system. These three topics, then, tell the story of why and how Descartes arrived at the principles of his natural philosophical system. It is my claim that Descartes' concept of mind grows out of and is naturally fitted to embrace those principles.

With the concept of the *mathesis universalis*, we will find an elaboration of a method that is the basis of Descartes' analytic geometry. Descartes came to see that arithmetical techniques could be applied to geometrical problems in order to discover their solutions. This is the source of the algebraic geometry that became Descartes' pivotal contribution to mathematics in 1637, with the publication of *La Géométrie*. Yet the *Regulae*, and Descartes' earliest writings on physico-mathematics, make it clear that the *mathesis universalis* was not only a technique for solving purely mathematical

problems, but was also the foundation of an applied mathematics that would, at least in part, form the basis of Cartesian science. Indeed, it is in the application of mathematical techniques to understanding physical phenomena that modern physics is born. Descartes was perhaps not the most adept practitioner of this application, but he understood what was philosophically at stake. He understood that in order to apply mathematical techniques to solving problems in natural philosophy (or physics), one had to be able to conceive of any physical object as something that could be entirely captured by mathematical representation. That is, one had to allow the complete abstraction of any given natural body from its sensible qualities. All physical entities were to be understood only insofar as they admit of order and measure, i.e., either discrete (arithmetical) or continuous (geometrical) mathematical representation. Thus, there is an implicit metaphysical commitment embedded in Descartes' triumph of method: he conceives of all physical entities as admitting of mathematical representation, and only considers them insofar as they are mathematically represented. Such a conception rules out the possibility that, for instance, sensible qualities, substantial forms, or living souls have any explanatory, or possibly even causal, role to play in science. With the idea of the *mathesis universalis*, we see that the epistemological concerns of method and exactness drive Descartes' basic metaphysical theory of matter in general.

This implicit metaphysical commitment in natural philosophy has an indirect implication for Descartes' concept of mind. Descartes selects mathematical representation as the rubric by which all physical entities can be known because he understands the essence of thought to be intuition or, as he also calls it, certain and

evident cognition. Nothing is more certain and evident than the principles and products of mathematical calculation, so the mathematical representation of physical entities renders natural philosophy utterly clear and distinct. Moreover, once the objects of pure mathematical representation are identified with the essence of material objects, they are easily detached from the sensory impressions of the mind. Thus, in an effort to found physical science on certainty, Descartes effectively dissociates the mental from the physical. He will admit that our sensory impressions are the effect of underlying material (or mathematically represented) causes, but the character of those sensory impressions plays no explanatory role in the underlying material cause. So, the material world is explained through a mathematical physics together with a metaphysical theory of matter, which is independent of the sensory impressions that compose our mental life.

Though Descartes' early insights into applied mathematics show a disposition toward substance dualism, the epistemological justification for dualism lies in his brief account of perceptual cognition in the *Regulae*. In Rule XII, Descartes outlines the principles of his later scientific theory of perception. In this text, we lack many of the details guiding the later theory, though its core principles are already outlined. The theory of perception serves two purposes in the *Regulae*: first, it provides an epistemological foundation for Descartes' theory of natural philosophy; second, it justifies the use of certain methodological heuristics by relating them to physical capacities of the brain. The first objective is accomplished by accounting for a causal link between our faculties of perception and the external world. Thus, Descartes provides a reasonable physical explanation for why we ought to trust the evidence provided by our senses. This justifies

the use of experiment and observation (broadly encouraged in the early Descartes) in order to discover the nature of physical phenomena. The second objective will be accomplished by attending to the nature of our cognitive faculties of representation and imagination, their limitations and strengths. Descartes thinks that we will be assured of arriving at truth if we guard against the weaknesses and harness the strengths of our cognitive faculties. These strengths and weaknesses are construed physiologically. Thus, Descartes' method of scientific explanation explains the powers and limitations of the mind. Nevertheless, Descartes maintains that the active power of the intellect, its capacity to voluntarily move the body and brain, is a wholly spiritual power and cannot be reduced to any property of the brain, i.e., it admits of no physiological explanation. This spiritual power is clearly the forerunner of the *ego*. We see that it plays an essential role in the composition of Descartes' method and its nature is known as something separate from and in contradistinction to physical matter. This account of perception suggests (without proof) that the active power of the mind is primary and independent. Thus, we are invited to see the wholly spiritual, active power of the mind as the basic justification for a natural philosophy based on mathematical representation, experiment, and observation.

Finally, we will examine what is perhaps the core of the *Regulae*, the categorical bases of Cartesian science, the simple natures. Again, we find that Descartes distinguishes intellectual simples from material simples, which suggests that he considers mind and matter to be two different regions of scientific investigation. Moreover, we will note that simples are regarded as basic for scientific explanation because of their epistemic simplicity. That is, again the principles of Cartesian science conform to the

epistemological character of mental inquiry. We will illuminate the unique nature of this epistemic priority by comparing Descartes' use of the simple natures to Francis Bacon's. We will see the common search for simple bases of mechanistic science from entirely different perspectives. And we will examine how these simple natures function in the scientific method, both as bases of explanation, and desiderata of investigation. Given the idea that simple natures provide the basis for explaining mental and physical phenomena, one might be tempted to turn to the intellectual simple natures for a sketch of Descartes' early philosophy of mind. Unfortunately, Descartes does not elaborate in any detail on the nature of intellectual simples. It is clear that his primary focus, in the *Regulae*, is to develop an interpretation of the physical world, of natural philosophy, rather than the intellectual world. Yet, he holds that intellectual domain apart from the natural world of mechanical causes. This, again, shows a fundamental commitment to dualism, if not a developed dualistic theory.

Considering these three topics will, I hope, convince the reader that Descartes' dualism grows out of his earliest writings on scientific method. I believe that the reason for this is the central, active role that the mind plays in setting out the parameters of scientific knowledge and pursuing science methodically. Descartes finds this power to be primitive, not yielding to a reductive explanation. One might wonder if it is not the fact that the mind sets up the very principles of natural scientific explanation that renders it intractable under those principles. In any case, we can see that what appears to be a mere metaphysical postulate in the later Descartes (the substantial independence of the mind) is

in fact a consequence of the the limitations Descartes imposes on his early, natural philosophical method.

Methodology

This dissertation will take an historical approach. We are interested in where Descartes' ideas came from, how they developed over time, and what historical figures could have influenced them. Fortunately for students of early modern philosophy, there has been a considerable and substantive debate in the literature concerning historiographical approaches to philosophy. Though these discussions have been advanced as a general debate concerning the methods and practices of "history of philosophy," the principal players have nonetheless (and perhaps not accidentally) been scholars of modern philosophy.³ I will not try here to advance any programmatic response to the question of methods in the history of philosophy. That would be a project in its own right. Here, I only want to provide the reader with some indication of the methodological decisions I have made in the course of writing this dissertation. I do not think that anything I say here can justify the work that follows, but I think that one should make one's assumptions apparent at the start of any philosophical argument. Methodological decisions involve substantive philosophical assumptions and for that reason alone they should be made explicit.

³ *History of Philosophy and Analytic Philosophy*, Tom Sorrell and G. A. J. Rogers eds. and *Philosophy and Its History*, Jorge Gracia ed.

It is my belief that for most philosophers prior to the twentieth century (and in an increasingly diminishing subset of contemporary authors), there is no distinction between history of philosophy and philosophy proper. That is not to say that seminal works like Descartes' *Meditations on First Philosophy*, Hume's *Treatise on Human Nature*, or Kant's *Critique of Pure Reason*, are instances of the kind of philosophy that we would today call history of philosophy. Indeed, it is patently obvious that these works introduce radically new and influential philosophical ideas, announce original philosophical programs, and engage in *sui generis* philosophical argumentation. What I mean is that intrinsic to these works is an engagement with a set of issues and concerns advanced by historically prior authors. These works are dialectically historical: they are engaged in a dialogue with the history of philosophy. Today, contemporary philosophers are engaged in a contemporary dialogue. This is less true on the European Continent, where one still finds many contemporary philosophers in dialogue with the history of philosophy. However, the vast majority of contemporary philosophers follow the style of what has been called "analytic" or "Anglo-American" philosophy. In other words, contemporary philosophers are, by and large, interested in philosophical problems that are generated and addressed in contemporary philosophy journals. If one is interested in pursuing philosophical research in a contemporary setting, it is unavoidable that one engage in these contemporary debates, and consequently it is unacceptable for one to be engaged in a lengthy (private) historical debate with authors of the past without indexing this debate and its conclusions to the contemporary landscape.

Fortunately, the historian of philosophy stands at a unique and (perhaps) crucial crossroads, at the intersection between the contemporary concerns of today's philosophers and the historical trajectory of philosophical thought. As a consequence, the historian of philosophy must meet the competing demands of history and philosophy. As it is usually understood, these demands amount to answering two questions: Is this interpretation historically accurate? And is this interpretation philosophically true? Because most history of philosophy is the history of great philosophical works prior to the twentieth century, I believe that the answers to these questions are interdependent. If we grant that the greatest works of philosophy have had some purchase on the truth (conceived in some non-deflationary sense), then getting our interpretations historically accurate will entail getting our interpretations right. The reality, however, is not so clear. What counts as "true" in contemporary philosophy is a defensible position on any of the problems that are considered central to contemporary debates. What counts as "historical accuracy" amounts to satisfying a broad range of conditions: textual, sociological, historical (proper), and philosophical. The historical work is broadly hermeneutic: the task is to provide an interpretation of historical figures that is consistent with the background beliefs of their time. Ordinarily, the historian of philosophy succeeds by addressing specific philosophical problems in a very narrow range of historical time, so that the broad historical conditions can be satisfied. This is the nature of specialization in the field of history of philosophy.

With respect to the present dissertation, then, we ought to be concerned with the issues that are raised in contemporary epistemology, philosophy of science, and

philosophy of mind, since these are the issues that are of direct relevance to the *Regulae* and to Descartes' (or anybody's) concept of mind. Descartes' mature philosophical positions on these issues are all too well known (and for that reason perhaps not well understood). He founded an enormously influential research program based on a mechanistic theory of physical science that was mathematical in nature; he is the prototypical substance dualist (though dualism about substances was hardly a foreign concept to the medieval scholastics); he is an internalist or individualist about mental content; he holds a doctrine of innate ideas and endorses a kind of Platonism about at least some concepts; and finally he is one of the founding rationalists of the modern era. Clearly, these positions place Descartes at one extreme of most contemporary debates in epistemology, philosophy of mind, and philosophy of science. Indeed, Descartes is often invoked in contemporary literature as a foil for differentiating one's own views. However, the present dissertation considers a period of time in Descartes' life *before* he had arrived at his substance dualism, his doctrine of innate ideas, his proof of the existence and nature of the *cogito*, and his proofs for the existence of God. Quite remarkably, then, we need not assume that Descartes held any of the aforementioned positions commonly attributed to him!

In fact, however, we will find a good deal of what might be called 'precursors' or 'foreshadowings' of these later doctrines in his early work. Still, by focusing on the earlier thought, we can remain methodologically agnostic about some of Descartes' most radical theses and instead search for a more nuanced perspective on the very same issues. Indeed, we will discover that Descartes' substance dualism is very closely connected to

his philosophy of science. We find that though Descartes is an internalist about some knowledge (and perhaps the most fundamental concepts), he readily accepts that there are limits to what can be known internally and outlines a number of techniques for justifying our beliefs that proceed on independent grounds. He even outlines a program of experimental natural philosophy that is downright Baconian! Chapters 3 and 4 will be the primary places for addressing these issues, and I hope to show that Descartes' views come from a much more moderate position than many think. In this way, I hope to question the historical accuracy of Descartes' most famous propositions about mind. Evaluating Descartes' concept of mind ought to involve the assessment of issues in epistemology and philosophy of science.

Our historical time period can also be suitably restricted to Descartes' early unpublished work up to around 1630, with reference to historical authors with whom Descartes may have been in contact during that time. Fortunately, we have a very good idea about this set of authors and thus the boundaries of our historical research is quite clear. We know that, while at La Flèche, Descartes would have been exposed to (on the philosophical side) a fairly orthodox scholastic philosophy, drawing principally from St. Thomas Aquinas and John Duns Scotus, with an awareness of the issues presented by Nominalism, Neoplatonism, Skepticism, and Stoicism. The textbook commentaries, written by the Spanish Jesuits, Francisco de Toledo and a group of authors at the College of Coimbra, provide a very good estimation of this philosophical perspective. However, we also know that students at La Flèche, being the best and brightest, were also exposed to a fair amount of heterodoxy, in the form of the new Gallilean natural philosophy and

the anti-Aristotelianism of the Renaissance Humanists. From La Flèche, Descartes went on to study law at Poitiers, where he may have been exposed to the works of the learned in France, people like Montaigne. Along these lines, we know that Descartes was given a copy of Pierre Charon's *La Sagesse*, which was nearly as ubiquitous as Montaigne's *Essais* and would have introduced Descartes to a broad range of Renaissance thought: Skepticism, Stoicism, Epicurianism and the like. Finally, it is obvious that Descartes was a gifted mathematician (in both pure and applied mathematics). Beginning at La Flèche, we can be confident that he cut his teeth on Christopher Clavius' *Algebra*, though the influence of mentors like Isaac Beeckman, Johann Faulhaber, and Claude Mydorge clearly broadened that base of knowledge. With these teachers, we can assume that by the mid 1620s Descartes was well apprised of the cutting edge of mathematical thought in his day. Fueling Descartes' critical appraisal of his education at La Flèche, we can indicate that Beeckman's mentor was a known Ramist, and that Ramus' attempt to reform Aristotle's *Organon* was well known in both Germany and Holland (where Descartes spent many of his formative years). Again, when Descartes arrived in Paris c. 1623-1625, we can be assured that he was introduced to a burgeoning intellectual minority that was, by and large, anti-Aristotelian and earnestly seeking a new philosophical system that would support the emerging mechanistic natural philosophy.

Having outlined these broad historical parameters, I must say that not all topics will receive equal attention. I focus on a number of Renaissance authors in order to develop a theory of method, but in the areas of metaphysics and epistemology I will spend much more time dedicated to canonical late scholastic authors, especially Aquinas

and, even, returning directly to Aristotle's texts. I think that this is altogether legitimate with respect to understanding the background for Descartes' philosophy. Aristotle, as interpreted by the canonical scholastic authorities, was the *de facto* basis for the 16th century commentaries that were the textbooks of the educated class. Moreover, even though my historical references cannot pretend to be comprehensive, my aim is to provide the contemporary philosopher with an adequate understanding of the history of late scholastic philosophy in order to facilitate interpreting Descartes. Indeed, I take this to be a very good rule of thumb in the area of historical analyses in philosophy. It is utterly necessary to have some idea of the historical context within which an author is writing. This context provides the characterization, however minimal, of the absent interlocuter of the author's writing. At the same time, it is nearly impossible, and where possible entirely contingent, to prove a direct influence of any prior text on the writing of a later one (especially when the texts have different authors). I will frequently refer to historical authors without any proof that Descartes was aware of the texts that I invoke to help explain his thought. I urge the reader to consider my historical analyses as canvassing a broad range of opinions, no doubt missing some critical viewpoints, no doubt betraying my own biases, but nonetheless providing a backdrop against which an interpretation of Descartes can gain some relief.

In general, I have tried to discover the roots of the philosophically relevant issues that I have come upon. However, I have also recognized a great deal of resources that I could not possibly investigate, for lack of time or expertise. In the end, I hope that my philosophical instincts have guided me to genuinely interesting areas of investigation,

that I have uncovered some potentially enlightening material in these areas, and that I have made this material relevant to a study of Descartes. It is in the spirit of a shared, and ongoing, investigation that I write this dissertation and offer it to you, the reader.

The Early Descartes: Dating the *Regulae* and Placing it in the Context of Descartes' Development

The *Regulae ad directionem ingenii* is a very strange text among the corpus of René Descartes. It is never published, yet was always retained among Descartes' personal papers. On its own, this fact may not seem so unusual, since Descartes chose not to publish several of his treatises, most famously his natural philosophical series *Le Monde* (including *La Traité de la lumière* and *L'Homme*). However, unlike these texts which are frequently discussed in correspondence and whose dates can be reasonably well fixed, Descartes apparently never mentions the *Regulae* by name or topic in any of his extant correspondence, and its dates of composition remain heavily disputed.⁴ Thus, before we can engage in an interpretation of the text, we need to be clear about the controversies surrounding the composition and content of it. This is especially critical in the case of the *Regulae* because there are those who claim that the *Regulae* is a heterogeneous collection of notes. In particular, several commentators have considered certain passages as entirely outside the rest of the treatise. My thesis views the work as a whole and makes use of passages throughout the text to illuminate the early connections between Descartes' concept of method and science and his concept of mind. Consequently, some historical and textual background is necessary.

⁴ Crapulli, *Regulae*, xiv.

Introduction to the text: historical obscurities

The *Regulae* first becomes known to the public in the 1660s when it was under the care of Claude Clerselier, a friend and frequent correspondent of Descartes' who was responsible for initially publishing two volumes of Descartes' correspondence. Clerselier offered the manuscript to many prominent intellectuals and promised to publish it, though he did not accomplish his goal before his death in 1684. He had received the manuscript from Descartes along with a trunk full of Descartes' personal papers and correspondence. Before his death as a consequence of a respiratory infection, Descartes had shipped those papers from Stockholm, Sweden to Clerselier, under the supervision of his brother-in-law Pierre Chanut. The items are listed in an inventory, among which is item F: "Nine notebooks bound together, containing part of a treatise of clear and helpful rules for the direction of the mind in the search for truth" (AT X, 9). In the years following Descartes' death, the "rules" quickly became a topic of discussion among intellectuals who knew that there was more to the story of Descartes' general scientific method than the abbreviated account revealed in the *Discours*. Even though a published account of the *Regulae* was not forthcoming, several texts of the period bear the influence of the unpublished text. The second edition of *La Logique ou l'Art de penser*—the so-called Port Royal Logic—of Arnauld and Nicole, notes that some additions were taken directly from the manuscript (AT X, 352). Nicolas Poussin also mentions the *Regulae* in his *Remarques sur la Method de M. Descartes* (1670), while Nicolas Malebranche's *Recherche de la Verité* (1674-1675) bears an uncannily similar title.

We know that Leibniz diligently studied the text, likely after his visit to Paris in 1676, since a copy of the manuscript was found among his papers in Hanover with handwritten corrections. There is a Dutch translation published in 1684. And Descartes' biographer, Baillet, certainly had the original manuscript in hand when he composed sections of the first volume of *La Vie de M. Des-Cartes* (1691). These works could be appended by a much longer list of works in the seventeenth and early eighteenth centuries that were clearly focused on the issue of outlining a clear and useful method for supporting the mind, or the mental faculties, in the discovery of truth and for that reason may bear some similarity to the *Regulae*.⁵

Though it seems to have inspired a great deal of interest, the manuscript enjoyed a very short life. Three copies from the period exist: the Dutch translation published by J. H. Glazemaker (called **N**); in 1701, Charles de Rey publishes a Latin edition in the *Opuscula Posthuma Physica et Mathematica Cartesii* (called **A**). After the publication of the *Opuscula*, no trace of Descartes' original manuscript remains. Much later, Foucher de Careil discovers a copy among Leibniz's personal papers in the library at Hanover (called **H**). It was initially thought to have been the lost manuscript (a theory now discredited) when it was published along with many other papers in the two-volume set, *Lettres et opuscules inédits de Leibniz* (Paris: 1854).⁶ Thus, the obscure reference in the Stockholm inventory to a now-lost Cartesian manuscript on method opens speculation into the nature, content, and importance of these "rules" of method for the Cartesian project. In

⁵ I am thinking, principally, of Spinoza's *Treatise on the Emendation of the Intellect* (c. 1662) and Mary Astell's *A Serious Proposal to the Ladies* (1694-97).

⁶ For a time, it was thought that **H** was the original copy because many handwritten notes in the margins. These were later found to be the hand of Leibniz (Crapulli, *Regulae*, introduction).

contemporary commentary on the *Regulae*, mention of the historical obscurities surrounding the text is *de rigueur*, though it was long thought that the text was not worthy of serious scholarly attention because central questions about its composition and the relevance of its content remained unanswered.⁷

For instance, when in 1952 J. L. Beck's published his classic, *The Method of Descartes: A Study of the 'Regulae'*, the first monograph commentary on the text, he chose to ignore the historical questions and instead clearly explicated the philosophical content of the *Regulae*, showing it to be essential to Descartes' mature philosophical thought. The study prompted one prominent reviewer, J. N. Wright, to complain: "Mr. Beck is silent on the very points that this reviewer, for one, wants to know, before he can decide whether, for example, the *Regulae* is a 'rough draft' and the *Discourse* 'masterpiece' as Adam would have us believe, or whether one is justified in turning to the *Regulae* for information about what Descartes really meant by intuition and *les plus simples* of the *Discourse*."⁸ In other words, Wright was unsatisfied by Beck's conceptual analysis of the *Regulae*; he demanded an historical justification of the text's importance as well. By 1964, Wright and others like him would get what they had wished for. In that year, Jean-Paul Weber published the first comprehensive textual and historical analysis of the *Regulae* with his *La Constitution du texte des Regulae*. This microscopic investigation of the *Regulae* advanced the thesis that there is an underlying stratification of Descartes' thought preserved in the unpublished text. Following the indices of these

⁷ For instance, Charles Adam's *Descartes: sa vie et son oeuvre*, 79, does not even discuss it among Descartes' works, mentioning only that the rules of the method in the *Discourse* had been developed previously in a small work, the *Regulae*.

⁸ J. N. Wright "The Method of Descartes," 78.

strata, like a careful archeologist, Weber depicts a detailed development in Descartes' ideas on method from 1618 to 1628.⁹ With Weber's efforts, the textual and historiographical issues of the *Regulae* suddenly came to the fore. This book and the debate it provoked made the *Regulae* an acceptable subject of scholarly attention, though it simultaneously placed it under considerable controversy.

In a limited way, the issues raised in Weber's book are evident to any careful student of the text: it is a difficult and incomplete treatise that is at once repetitive and vague on central points. When one adds to these conceptual difficulties, the textual difficulties and the lack of any firm historical context for the text, interpretation may seem intractable. But the historical obscurity of the text coincides with content and claims that are provocative and potentially central to understanding Descartes' scientific project. So one is nonetheless compelled to attempt an interpretation.

Main themes and the plan of the treatise

The project appears to have been intended as a treatise on method and the organization of the sciences. It remains the most complete elaboration of Descartes' method, which according to his own testimony is at the heart of his philosophical innovation (*Discours*: AT VI, 16-18; CSM I, 118-120). Throughout, however, one can discern a serious consideration of the nature of the mind and what has been translated as "native intelligence" (*mentis, ingenium*). The first rule tells us that the overriding aim or

⁹ Jean-Paul Weber, *La consitution du texte des Regulae*.

goal of the study is to direct the native intelligence to be able to make solid and true judgments on whatever matter may be presented to it (Rule I, title: AT X, 359; CSM I, 9). That rule goes on to identify this goal with the achievement of human wisdom (*humana sapientia*) and in conjunction with this claim Descartes signals his fundamental departure from the Aristotelian tradition of science. Whereas the tradition had distinguished the sciences according to their subject-matter, considering each science separately, Descartes thinks this is a clear error. Instead, he says, the sciences “consist entirely in the knowledge acquired by the soul” (AT X, 359; CSM I, 9). Moreover, the second rule tells us, all science or pure knowledge is simply “certain and evident cognition” (AT X, 362; CSM I, 10). Thus, the sciences are unified by the mind and scientific knowledge is attained by satisfying certain cognitive conditions. If these first two rules are considered indicative of the general thrust of the treatise, then they clearly point to a fundamental connection between the nature of the scientific method and the concept of mind.

I take these first two rules to represent the purpose and theme of the work accurately. However, it is difficult to reconcile this stated purpose with what Descartes clearly describes would be the content of the treatise. While drafting the twelfth Rule, he apparently settled upon a plan for the work. According to that Rule, the treatise was intended to have three parts, containing twelve rules each. The first set of twelve rules, which is largely complete, was to explain some of the basic propositions concerning the method and provide a detailed analysis of the two mental operations necessary for conducting any scientific research, intuition and deduction (Rule III: AT X, 368; CSM I, 14). The second and third parts were intended to apply these rules to all types of

problems, divided into two classes: perfect and imperfect. This distinction is defined in Rule XIII, where Descartes states that every philosophical problem must contain some elements that are known and others that are unknown. Perfect problems are determined in every respect by data given, whereas imperfect problems involve some inherent obscurity in the nature of the problem in question (AT X, 430-31; CSM I, 51-52). He also suggests in Rule VIII that the distinction might be understood in terms of complexity: “we divide natures of the latter sort [i.e., composite natures which are put together by the intellect] into two further classes, viz., those that are deduced from natures which are the most simple and self-evident (which we will deal with throughout the next book [Book II]), and those that presuppose others which experience show us to be composite in reality. We shall reserve the whole of the third book for an account of the latter” (AT X, 399; CSM I, 32). Even where we have a clear plan of the work, it is not clear exactly what Descartes meant by the proposed divisions.

Before we entertain some hypotheses on the matter, we ought to review what Descartes means by solving problems and how he had hoped to direct the mind better to solve different sorts of problems. Descartes’ notion of problem solving bears some relation, he says, to the classical syllogism—“this is the sole respect in which we imitate the dialecticians” (AT X, 430; CSM I, 51)—since the forms of the syllogism are given and the nature of some particular thing can be understood by determining which of the syllogistic forms is pertinent. This process is described in detail in Aristotle’s *Prior Analytics*. However, Descartes is not concerned with terms of a syllogism and the familiar problem of “finding the middle term.” Instead, he sees these problems in a much

more general, algebraic way. Thus, the formal constraints dictate that problems be represented in equations of constants, which designate known quantities, and variables, which designate unknowns or dynamic quantities. This type of reasoning applies to both of what he calls perfect and imperfect problems, but in perfect problems, he says, “we want [the problem] to be determinate in every respect” (AT X, 431; CSM I, 52). It is unclear at this stage what is meant by the distinction between fully determinate and partially indeterminate problems. Nonetheless, this “algebraic” problem-solving method is central to the *Regulae* and is perhaps even a precursor of his later metaphysical method that he calls analysis. Though in a different sense than Aristotle’s “analytics,” Descartes’ algebraic method is also analytic.

Even though it is clear that algebra ought to play a central role in the scientific method, it is not clear how to distinguish perfect problems from imperfect ones. In Rules XIV-XVIII, Descartes provides examples of perfect problems mainly derived from the fields of arithmetic and geometry. It seems that these would be the kind of problems that could be determinate in every respect, since one would be dealing with a determinate, abstract subject-matter, i.e., number or extension. In Rule XIV, he makes this point explicitly: “At this point we should be delighted to come upon a reader favorably disposed toward arithmetic and geometry . . . [f]or the Rules which I am about to expound are much more readily employed in the study of these sciences (where they are all that is needed) than in any other sort of problem” (AT X, 442; CSM I, 58). But Descartes also suggests that other kinds of problems could be entirely determinate: “For example, someone may ask me what conclusions are to be drawn about the nature of the

magnet simply from the experiments which Gilbert claims to have performed, be they true or false” (AT X, 431; CSM I, 52). This historical investigation into Gilbert’s claims, “be they true or false,” seems to be distinct from the real nature of the magnet, which is one notable example of an imperfect problem in the *Regulae*. That is, when one looks at the body of Gilbert’s work, a determinate field of inquiry, the investigation has a determinate character, while an investigation into the magnet’s true nature is indeterminate.

One possible explanation of the distinction between perfect and imperfect problems is suggested by the distinction between “direct” and “indirect” problem solving (Rule VI: AT X, 386; CSM I, 24 and Rule XIX-XX: AT X, 468-69; CSM I, 76). Even this distinction is ambiguous, however. The titles to Rules XIX and XX, which were never completed, suggest that direct problems are those for which there are as many equations as variables, whereas indirect problems have more variables than equations. On the other hand, Rule XVIII suggests that finding the root of a given magnitude is like division, but requires an “indirect and reverse movement of the imagination” (AT X, 467; CSM I, 75). It is not clear how root extraction and division are analogous to problems with more variables than equations, but it does suggest that all problems addressed in the *Regulae* would be mathematical in nature. On this reading, the third book of the *Regulae* would have been devoted to more difficult sorts of mathematical operations, e.g., root extraction and solving equations with multiple unknowns.¹⁰ Another possibility is that

¹⁰ This appears to be the position of Henk Bos, *Redefining Geometrical Exactness*, 228, who holds that the failure of the *Regulae* amounted to Descartes’ incapacity to resolve problems of higher degree than plane and solid problems and to find a suitable geometrical representation

perfect problems are problems in pure mathematics, while imperfect problems are those in mixed or applied mathematics. This interpretation works well with the historical conception of the *mathesis universalis*, which was typically divided into *pura mathesis* and *mixta mathesis* along the lines of the classical distinction between pure and mixed mathematics. The former would include only arithmetic and geometry, while the latter would include optics, astronomy, mechanics, harmonics, etc. If one takes this route, then it may be possible to conceive of the *Essais*, published along with the *Discours*, as the accomplishment of what was originally intended in the third book of the *Regulae*.¹¹

In the completed portions of the *Regulae*, Descartes makes some progress in detailing perfect kinds of problems: he provides the solutions to many kinds of geometrical and arithmetical problems in Rules XIV-XVIII, and outlines the contents of Rules IX-XXI, meant to expand upon this procedure. These are quite useful for understanding how the method ought to be applied to mathematics, but Descartes does not develop its application to imperfect problems, whether to mathematical problems of a higher degree or physical problems, as would seem to be the aim according to Rule XIII. And he certainly does not fulfill his promise—what would be the real *pièce de résistance* of the work—to show “how imperfect problems can be reduced to perfect ones.” However, he suggests that this would have something to do with the universal relations of order and measure: “We can also see how, by following this Rule, we can abstract a

of root extraction. He also claims that it is possible, on the basis of Rule XVIII, to conceive root extraction as an “imperfect problem” insofar as it requires an “indirect movement of the imagination and treatment of its solution is deferred” (ibid., 267).

¹¹ This is the thesis of Bret J. L. Doyle’s dissertation, *The Logic of Descartes’ Method*, which proposes to complete the second book by referring to the *Géométrie* and the third book by referring to the *Dioptrique*.

problem which is well understood from every irrelevant conception and reduce it to such a form that we are no longer aware of dealing with this or that subject-matter but only with certain magnitudes in general and the comparison between them” (AT X, 431; CSM I, 52). When Descartes claims that he can “abstract” from a problem every “irrelevant conception” and effectively reduce it to what he calls a perfect problem, it is not clear how he would choose to go about it. Is it as simple as saying that every physical problem can be abstracted and reduced to a problem in arithmetic and geometry? If I am considering, for instance, a magnet, what are the relevant arithmetical and geometrical features of the magnet that can be abstracted from that physical object? In order to resolve these questions, we will have to turn to Descartes’ conception of the relationship between mathematics and the natural world. What kind of world does mathematics represent and how does it represent that world to us?¹² These are some of the questions that will have to be addressed as this dissertation proceeds.

It is likely that Descartes could not complete the project as it was described in Rule XII and that as a consequence there is no definite meaning to the perfect and imperfect distinction. Nonetheless, it is clear that the scope of the *Regulae* is ambitious and suggestive. In one form or another, this project of determining the nature of all mathematical and physical problems continued to occupy Descartes throughout his life,

¹² This is why I am quite skeptical of the general thrust of Doyle’s thesis. Though simple problems in mechanics and harmonics seem to permit the sort of reduction that Descartes is talking about, more complex problems will not be so easily reduced. Descartes requires a fair bit of metaphysics in order for him to conceive of nature in such a way that it fits his mathematical representation of it. He does not come to this until he writes *Le Monde*. So as a historical interpretation about the *Regulae*, I do not think this will work. Nonetheless, this general skepticism should not detract from the excellent work that Doyle has done on the *Regulae*, nor should it undermine his admirable effort to understand the *Regulae* as if it were a complete, coherent treatise.

whether in *Le Monde*, the *Discours* and the *Géometrie*, or the *Principia Philosophia*. By this I mean that mathematical techniques applied to a certain representation of the natural world appears to pave the way for the characteristic Cartesian metaphysical principles of God, the thinking self, and extended matter. These later concepts are quite foreign to the *Regulae*, but the way that Descartes employs these metaphysical principles appears to be informed by his early work on method.

One of the aims of the thesis will be to show that when Descartes' early mathematical and methodological writings are taken as informative of his later metaphysical concept of mind, that metaphysical concept takes on a different character. While the content of the *Regulae* is largely devoted to solving mathematical and physical problems, the method for solving those problems betrays Descartes' commitment to a certain theory of mind. Conversely, when Descartes' theory of mind is understood in terms of those methodological motivations, I hope that the concept of mind will find some purchase in Descartes' broader and arguably more prominent scientific pursuits. In particular, I hope that Descartes' real distinction between the mind and body will in no way appear to be a "splendid non sequitor,"¹³ or the product of dogmatic dualism, but rather it will appear to emerge out of a desire to clearly delimit the range of exact knowledge (*scientia*). This desire prevails in the *Regulae*, and I think the later concept of mind ought to be understood as originating in that desire.

The controversy over Rule IV and the composition of the text

¹³ Richard Rorty, *Philosophy in the Mirror of Nature*, 62n34.

My hypothesis concerning the overall aim and cohesion of the *Regulae* is hampered by questions surrounding the text.¹⁴ In particular, I have already made use of the first two rules in order to explain the content of the rest of the rules and I have referred to the *mathesis universalis* as a key component of my interpretation. This word appears in only one passage in the *Regulae*, in Rule IV. Many commentators see these first four rules as expressing an early and outdated notion of method that was later revised and thus should not be considered informative of the rest of the text. How could there be such radically opposing views of what I claim to be such important texts? Mustn't a coherentist reading of the *Regulae* defend it against incoherence? We have already seen the historical obscurities surrounding the text of the *Regulae*: the lack of an extant manuscript and different versions that exist. Now we need to explain how this affects the passages in question. In order to do that, we will need some more precise information about the nature of the text.

Textual Discontinuities

Adam and Tannery have compiled what has become the definitive edition of Descartes' complete works.¹⁵ Though all three extant copies of the *Regulae* (**N**-the 1684 Dutch translation; **A**-the 1701 Amsterdam edition; and **H**-Leibniz's copy) were available

¹⁴ See Marion, *Sur l'ontologie grise*, 13-23, for an engaging and thorough historical summary of the questionable status of the *Regulae*.

¹⁵ The original edition in 11 vols (1886-1894) has seen many editions and is now available in a paperback set (11 vols. Paris: Vrin, 1996).

to them when they produced vol. X—the volume that contains the *Regulae*—Adam and Tannery chose to follow **A** with few emendations. Charles Adam regards this text as authoritative for several reasons: it was published under the supervision of Jean de Rey, a well known Cartesian and one who would have taken the utmost care with unpublished texts; Leibniz had his copy of the original along with the published 1701 edition, **A**, and never protested the authenticity of that text; and **H** is an inferior copy—missing pages, and sometimes lines, including many errors that betray a copy hastily made by someone who was not trained in mathematics (AT X, 351-7). Thus, Adam and Tannery republish **A** with only a few emendations provided by **H**. However, the two texts are substantially different. Most notably, a section from Rule IV (AT X, 374.16-379.14) and another from Rule VIII (AT X, 393.22-396.26) are displaced in **H**. The section from Rule IV, an autobiographical segment treating the *mathesis universalis*, appears as an appendix, while the section from Rule VIII, which gives two examples of the method, is annexed to the end of that Rule in Leibniz’s copy. The similarity between the two segments of Rule IV has prompted several to suggest that one is the draft of the other, though one need not conceive of them as such.¹⁶ Additionally, Rule VIII at 396.15, Rule XII at AT X, 428.20 and Rule XIII at AT X, 434.6 contain obvious lacunae, suggesting that Descartes may have been in the habit of writing a partial draft and continuing to another section with the aim of returning to develop his ideas further.

¹⁶ It is entirely possible to consider the two sections to be two independent, working drafts of the same concept, called a “universal method” on the one hand and a “mathesis universalis” on the other. The most thorough treatment of the drafting thesis is provided by Pamela Kraus’ “From Universal Mathematics to Universal Method: Descartes’ “Turn” in Rule IV of the Rules,” 159-74, though her reasoning is dubious. Marion, *Sur l’ontologie grise*, 145 argues for parallelism between the two sections and claims that they refer to essentially the same topic.

Moreover, in several places Descartes seems to repeat material already covered. Rule VIII is again characteristic of this. In the section that is annexed to the end of the Rule in Leibniz's copy, Descartes undertakes to explain the method by way of "the finest example of all [*omnium nobilissimum exemplum*]" (AT X, 395.17-396.25). In this example, he suggests that one undertake to "examine all truths for the knowledge of which human reason is adequate," a practice everyone should undertake at least "once in his life [*semel in vita*]." This topic is broached again in the following two paragraphs (AT X, 396.26-397.26), "we ought once in our life carefully to inquire as to what sort of knowledge human reason is capable of attaining"; and it is illustrated by analogy with the blacksmith, who must first fashion the tools he will subsequently use in his craft. The same subject occupies the final four paragraphs of the Rule (AT X, 397.27-400.11): "But the most useful inquiry we can make at this stage is to ask: What is human knowledge and what is its scope? We are at present treating this as one single question, which in our view is the first question of all that should be examined ... This is a task which everyone with the slightest love of truth ought to undertake at least once in his life."¹⁷ Chapter 2 §3 will treat the interpretation of these issues in detail.

¹⁷ This repetition is noted in Adam and Tannery, Appendix B to the *Regulae*, AT X, 485-86. They conclude that, "Assez souvent Descartes, après avoir exposé une première fois sa pensée, la reprend ainsi, et la développe point par point avec insistance: il n'y aurait donc pas lieu de s'étonner, dans le cas particulier." What they do note as surprising, however, is that the final section, which most closely develops the themes of the first, contains "une différence capitale," namely, that in the first case Descartes describes only two faculties pertaining to the intellectus, imagination and sense-perception, but in the second case, he adds memory. I might append to this remark what is noted a bit further down, namely, that the latter section in Rule VIII repeats a distinction that is articulated in Rule XII, suggesting that this section might have been embellished with Rule XII in mind.

In other places, Descartes repeats some of the basic tenets of the method. Rules V-VII treat the fundamental heuristics of the method—reducing complex things to their simple components, recomposing these simples in an orderly way, and then enumerating these components to be certain of completeness—yet these same components are again reiterated in Rules IX-XI. Moreover, Rule VII ends with the claim that “the remainder of the treatise will be confined almost entirely to explicating in detail what we have so far covered in general terms” (AT X, 392; CSM I, 28). Yet Rule XII begins by repeating the same phrase, “This Rule sums up everything that has been said above, and sets out a general lesson the details of which will be explained as follows” (AT X, 410-1; CSM I, 39).¹⁸ Are these sections additional examples of redrafting?

Rule XII also repeats the terminology of the “simple natures,” previously mentioned in Rule VI, but gives them a very different meaning. In Rule XII, the simple natures are said to divide among intellectual, material or composite (AT X, 419; CSM I, 44), while in Rule VI they are those terms that are “absolute” and “simple in the highest degree” as distinct from other, relative, natures (AT X, 383; CSM I, 22). This difference in definition suggests a development in Descartes' terminology. Notably, Rule VIII refers to a “natural power” as the “final and most absolute term of a series” (AT X, 395; CSM I, 29) as well as to “simple natures” which “must all be either spiritual or corporeal, or

¹⁸ In my translation, I follow Crapulli and the Hanover and Glazemaker editions, which correct Adam and Tannery, reading *erunt explicanda* for *erant explicanda*. J-L Marion, *Règles*, 224 outlines the two sides of the issue, but chooses to follow Adam and Tannery, interpreting the inverted claim as an indication of “le caractère pédagogique de lent exercice.” While Marion's claim is reasonable as a general comment about the *Regulae*, it seems clear to me that Rule XII is in fact the most explicit and detailed enumeration of Descartes' general categories of investigation. Thus it makes sense to read the claim, *quae in particulari erunt explicanda, hoc pacto* as a description of what follows.

belong to each of these categories,” referring the former to Rule VI and the latter to Rule XII (AT X, 399; CSM I, 32). Rule VIII also states the thesis that we can successfully enumerate all of human knowledge according to two categories, “for the question ought to relate either to us, who have the capacity for knowledge, or to the actual things it is possible to know” (AT X, 398; CSM I, 32), which is repeated in Rule XII (AT X, 411; CSM I, 39). It is possible that Rule VIII is a piecemeal combination of material, some composed at the time of Rules V-VII, others composed at the time of Rule XII.¹⁹

Given that the treatise was never completed, it is possible that its draft form preserves a progression of Descartes’ thought. For instance, it is clear that Rules IX-XI relate the heuristics of the method to particular examples, reinforcing and clarifying what was already covered in Rules V-VII. Sometimes this reference is explicit: “when we think of the process of deduction as we did in Rule Three, it does not seem to take place all at once . . . [b]ut if we look on deduction as a completed process, as we did in Rule Seven, then it no longer signifies a movement but rather the completion of a movement” (AT X, 407-8; CSM I, 37). Again, that Rule continues: “Rule Nine dealt only with mental intuition; Rule Ten only with enumeration. The present Rule explains the way in which these two operations aid and complement each other” (AT X, 408; CSM I, 38). It is clear from these passages that Rule X attempts to develop and refine the kernel of method

¹⁹ These are only a fraction of the many textual breaks that Weber proposes, but in my mind they are the only relatively definitive ones. Weber, *La constitution*, suggests breaks at virtually every topical change. This may be useful for the purposes of outlining the material, but it is hyperbolic for the purposes of dating. For comparison, J-L Marion, *Règles*, contains extensive internal and external annotations to the *Regulae*, highlighting all potential internal references.

described in Rules V-VII.²⁰ In these ways, the rough nature of the text does admit of internal reference from which one could potentially see a development in Descartes' thought, which could imply stages of composition.

Giovanni Crapulli (1966) is the most recent commentator to have carefully reviewed the extant manuscript editions, in preparation for his critical, bilingual edition of the *Regulae*, which presents both the original Amsterdam edition and the Glazemaker translation side by side. Crapulli's judgment is instructive, though it is not uncontested. He does not think that it is possible, on the basis of the text alone, to conclude that it was written in stages. But he also claims that none of the three manuscripts we currently have was copied directly from the original: "three manuscripts . . . but none of them depends directly on the original." Crapulli reasons that this is the case based on a large number of errors that the three texts have in common.²¹ Whatever the status of the three extant manuscripts—whether copies or copies of copies of the autograph edition—the most important question is obviously whether or not the *Regulae* can be conceived of as a

²⁰ There are many such internal references throughout the *Regulae* and it would be instructive to examine each of them carefully to determine how and in what way they demonstrate a development in Descartes' thought on method, during the composition of the text.

²¹ Crapulli, *Regulae*, xxii. Furthermore, Crapulli concludes that the Hanover manuscript bears many traits of a copy hastily made from the original by a copyist who may not have known Latin very well (ibid., xxv-xxviii). Adam has argued that the Hanover manuscript was copied directly from the original, while he suggests that the Amsterdam edition and Dutch translation were produced off of a common copy (AT X, 353). Heinrich Springmeyer, in his commentary on the Latin text of the *Regulae*, prefacing the German translation, *Regeln*, xii-xvii, poses several important questions of Crapulli's assertion here: It is possible that the many common mistakes one finds in the three manuscripts were not that of a forth copy, but of Descartes himself, who never properly revised the text for publication. On the other hand, it is entirely possible that Clerselier, the authors of the Port Royal Logic, or someone else may have modified the text in some way that affected the extant copies. Finally, Baillet's free paraphrase of the text does not allow us to make any inference back to the original despite the fact that Baillet surely had a copy of the original before him. Thus, Springmeyer doubts the necessity to posit a fourth text between the original and the three we now possess.

coherent whole even though it is so obviously fragmented. More specifically, the dislocated sections from Rules IV and VIII naturally prompt one to ask whether these excerpts were originally separate notes that Descartes appended to the treatise after having written it or whether Leibniz's copy is an aberration from the original. Some twentieth-century authors have sided with **H**, against Adam and Tannery, judging the sections from Rules IV and VIII to have been separated in the original.

The Weber Thesis

In 1964, Jean-Paul Weber's *La consitution du texte des Regulae*—apparently the achievement of decades of research—proposed that the extant manuscripts reveal a progression of thought that can be discerned through scrupulous textual analysis. Weber takes the prerogative to dissect the text of the *Regulae* at every change of topic and theme in order to leave no rock unturned. In effect, Weber unravels the text of the *Regulae*, leaving only strands of thought without coherence, and then he tries to build that coherence back into the text through a story about the “development” of Descartes' thought. The textual divisions are too numerous to list, but when Weber pieces those strands back together, he concludes that there are ten (10) distinct stages of thought preserved in the text, spanning the period from October 1619 to 1628, from Ulm, Germany to Holland, through Paris and contemporaneous with Descartes' many travels. He labels each of these stages and lists the Rules that correspond to them.²²

²² See Ch. 9, Weber, *Composition*, 194-206, for a review of the history of the *Regulae*.

On the face of it, Weber's textual analysis may seem thorough and perhaps justified by the questionable status of the text. Weber begins with the premise that the text has to be unraveled to be understood, combined with a belief that the various strands of the text will correspond to historical stages of development. We can imagine Weber as the meticulous archeologist of the text, carefully holding apart each delicate strand, stretching it out, and indexing it to a time-line of historical events. Most commentators since have recognized that Weber is forced to stretch the limits of his interpretation farther than the text can reasonably support. Nonetheless, when John Schuster revised the Weber thesis for his dissertation (Princeton-History of Science), something approximating the Weber thesis became a fairly standard reading of the composition of the rules.²³

At its core, Weber's thesis hinges on his interpretation of the term, *mathesis universalis*. Weber regards the *mathesis universalis* as equivalent to what he calls "universal mathematics."²⁴ This fact remains unchanged in Schuster's revision.²⁵ That

²³ Most notably, Gaukroger, *Descartes*, 89-131, offers a detailed biographical sketch of how the Weber thesis fits into Descartes' early intellectual development. Cf. Garber, *Descartes' Metaphysical Physics*, 12-6 and 30-44, and "Descartes and Method in 1637" in *Descartes Embodied*, 33-84, where, again, the Weber thesis is criticized for being "too fine-grained," but the essential claims are upheld. Stephen Menn, *Descartes and Augustine*, 212n criticizes the Weber/Schuster thesis (again in a footnote), claiming that this reading relies too heavily on "the principle of charity," confusing what Descartes ought to have thought for what he actually did. Detractors seem to prevail in the Francophone literature, following Jean-Luc Marion, but these critiques are somewhat hushed: Jean-François Courtine, *Suarez et le système de la métaphysique*, 484-95; Gilles Olivo, *Descartes et l'essence de la vérité*, 59-60 and 70-1n1; and, as an instructive example, Geneviève Rodis-Lewis, *Descartes, biographie*, nowhere mentions Weber though her account of Descartes' life and works maintains 1625-1628 for dating the *Regulae*.

²⁴ I think this translation fails on purely linguistic grounds: 'mathesis' is not equivalent to 'mathematica' either in its use or its definition. It is a transliteration of the Greek, meaning the act of learning or a way of acquiring knowledge. In Latin, it is closely related to 'scientia'

this term hardly makes any sense already prejudices the reader against the *mathesis*. What would it mean for mathematics to be universal if it isn't already? How could one differentiate *universal* mathematics from ordinary mathematics? And what does mathematics, even a universal mathematics, have to do with the broader scientific method? Weber takes the extreme position that: "at the moment that one turns to philosophy [which he identifies with the 'méthode universelle'] it is necessary that one breaks from, distances oneself from, 'universal mathematics' [mathesis universalis]." ²⁶

Thus, according to Weber, whatever universal mathematics is, it is not the same thing as a universal method. The latter, Descartes tells us in the *Discours* (Pars 2), he discovered while shut in his stove-heated room during the onset of winter, 1619. Weber coordinates this discovery with the historical event of Descartes' famous three dreams of November 19, 1619, and claims that the three dreams announce a kind of epiphany, a new path to follow in establishing science on firm foundations. Since the *mathesis universalis* must be discarded or surpassed upon the discovery of a universal method, Weber reasons,

(Liddell and Scott, *A Greek-English Lexicon*). Thus, 'mathematics' and 'mathesis' seem to be two strictly distinct concepts: the former a subject of study, while the latter includes a concept of the technique or mode of studying that is potentially broader than mathematics itself. Frederick Van de Pitte, "Dating Rule IV-B," 387, suggests that the confusion over mathema, as a mathematical science, amounts to a category mistake. David Rapport Lachterman, *The Ethics of Geometry*, on the other hand, takes the well-formulated position that mathesis is "the measure of scientia, of epistêmê. That is, how it is we can come to know something, how we learn or ought to learn, determines the character and claims of the science we come to know" (175). In either case, they seem to be two distinct terms. This is corroborated by the fact that Descartes employs both terms independently in certain passages.

²⁵ John Schuster, "Descartes' *Mathesis Universalis*", 43: "Universal mathematics [mathesis universalis] somehow subsumes and is superior to properly mathematical fields only. There is no claim to mathematicize all knowledge (whatever that might mean) and subordinate it to universal mathematics; nor is it even hinted that in some metaphorical sense all knowledge is to be rendered 'mathematics-like' and commanded through a suitably extended notion of universal mathematics."

²⁶ Weber, *La constitution*, 10.

Descartes must have written the passage containing the *mathesis universalis* before having had his three dreams.²⁷ In other words, Weber's claims regarding the constitution of the text of the *Regulae* seem to be driven by a prior interpretation of what the text means.²⁸ This argument is the cornerstone of Weber's book. However, it is obviously circular.

On its own, that ought not entirely disqualify Weber's thesis. The hermeneutics of textual interpretation suggest that such a circular relationship between philological or historiographical and philosophical issues need not be vicious. Indeed, it is impossible to arrive at a firm historical account of a text without engaging in interpretation, and *vice versa* (I believe). However, the historical facts do not demand the reading that Weber proposes. Indeed, I will claim that specifically mathematical issues are intertwined with questions about a universal method in the sciences throughout the 1620s. Though Descartes clearly envisioned something analogous to the *mathesis universalis* as early as 1619, this concept finds its first, definite, and recorded articulation only in 1628, again in conversation with Beeckman. Throughout the intervening period, according to Descartes' testimony and his extant writings, issues of method and mathematics continued to be at the forefront of his mind. Thus, even if '*mathesis universalis*' means something like 'universal mathematics,' this would not imply that it preceded or was discarded after Descartes' discovery of a universal method.

²⁷ Cf. *Discours de la méthode* AT VI, 11-12; CSM I, 116-117.

²⁸ Frederick Van de Pitte, "Descartes' Mathesis Universalis," 155-156 calls Weber's reasoning circular, for just this reason.

Moreover, subsequent research into Descartes' early mathematical and scientific studies has forced a modification of Weber's claims. In Rule VIII, Descartes provides "one or two examples" to illustrate the method, the first example treats the method for finding the angle of refraction in the anaclastic, the second example is called the "finest example of all" and describes someone who undertakes to investigate every truth that can be known by the human intellect, an endeavor that Descartes claims anyone with a real interest in science should undertake "once in his life" [*semel in vita*].²⁹ The discovery of the anaclastic line—or the curve that refracts all parallel rays of light to a single point—is a critical moment in the history of Descartes' scientific work. The discovery of this line was a significant achievement with potential applications to optics, where it would eventually lead to grinding lenses for telescopes and glasses. It is essentially based on the discovery of the sine-law of refraction. In Rule VIII, this discovery is championed as a paradigm for the method of scientific discovery. Interestingly, this passage, like the one in Rule IV, is inverted in Leibniz's Hanover manuscript, appearing at the end of the Rule.³⁰

²⁹ The locution "semel in vita" is a central concept for Descartes. It is repeated three times in Rule VIII (AT X, 395.20, 396.29 and 398.2), each time in reference to the one who truly desires scientia undertaking an examination of the sciences as a whole. In later writings (*Meditatione* I, AT VII, 17.5; *Principia* I §1, AT VIII-A, 5.5), this trope recurs in reference to the need to doubt all previously held opinions. Clearly there is a relationship between these diverse uses across Descartes' corpus (see D. Garber, "Semel in vita: The Scientific Background to Descartes' Meditations" in *Essays on Descartes' Meditations*, 81-116). Weber reasons that the three references in Rule VIII occur in sections that he dates to successive periods: 81-108, especially 107. However, it seems that such a chronological distinction lacks a foundation in the text.

³⁰ This fact suggests to me that the displacement of the passage was due, not to notation of Descartes', but to the direction of Leibniz, whose interest in the concept of mathesis preceded his acquaintance with Descartes, as is evident in his *De Arte Combinatoria* (1668), and continued to be a recurring theme in his writings up to the mid 1690s.

Though the passage ought not to be understood as an accurate record of the process by which the sine-law was discovered, it was probably written during the time that Descartes discovered that law.³¹ Fortunately, we have a number of sources to corroborate the time of this discovery. The subject is taken up in Descartes' conversations with Beeckman in the fall of 1628 upon arrival in Holland, and a solution to this problem is subsequently recorded in Beeckman's journal (October 8, 1628), so it is certainly prior to that date. The result also appears in Descartes' *Dioptrique* and, perhaps most importantly, in a letter from Mydorge retained in Marin Mersenne's correspondence. This letter, in particular, establishes that Descartes' optical achievement occurred in Paris, with Mydorge, between 1625-1626.³² Descartes' resolution of the anaclastic problem and his discovery of the sine law of refraction are directly related to Mydorge's own proposed solution. Though Pierre Costabel presents several stages to Descartes' understanding of this problem, suggesting that it was not entirely resolved until after discussions with Huygens and Golius in 1635, it appears that Descartes' initial forays into the question, of which the passage from Rule VIII is an example, date to Descartes' work with Mydorge in Paris around 1626. Costabel's argument reinforces what is found in Descartes' letters, in a marginal note to his letter to Golius, 2 February 1632 (AT I, 239), and in the letter to Huygens, December 1635 (AT I, 335-6), both of which refer the work in optics back to 1625-26 with Mydorge. Weber identifies the passage in Rule VIII with phase three of the

³¹ In this vein, Schuster's calling it a "cover story" is overblown, "Descartes' Mathesis Universalis," 58.

³² Costabel, *Démarches originales de Descartes savant*, 63-76; see *Correspondance du P. Marin Mersenne*, v. I, 404-414.

universal method (phase one including Rule IV-A) and suggests a date of 1621 for its writing.³³ This is obviously incorrect.

Furthermore, Weber's thesis seems strained when one considers not only the words '*mathesis universalis*' but also recurrences of its definition as a general science of order and measure. There are two other occurrences of this trope in the *Regulae*. When Descartes demonstrates the application of his method to general relations between things in Rule XIV, he proposes that problems will be most easily solved if they can be clearly represented by figures. He continues, "if we are to explain which of all the available figures we are going to make use of here, we should know that all the relations which may possibly obtain between entities of the same kind should be placed under one or other of two categories, viz., order or measure [*nempe ad ordinem, vel ad mensuram*]" (AT X, 451; CSM I, 64). Again, in Rule XVI, the same categorization recurs, this time in relation to solving geometrical problems. In that rule, Descartes proposes to simplify geometrical problems by reducing square and cubic roots to the relations between lines. However, this kind of abstraction can also be reversed, he says, if the problem may be solved easier using the numbers themselves, rather than their relations as represented by line segments. This is possible, Descartes argues, because of the transitive relation that exists between numbers and their relations, i.e., "the dual function which numbers have, which is, as we have already mentioned, sometimes to express order, sometimes measure [*modo ordinem, modo mensuram*]" (AT X, 457; CSM I, 68). This passage refers directly back to the first and it seems to indicate that the general relations of order and measure,

³³ Schuster, "Descartes' *Mathesis Universalis*," 58-59.

i.e., *mathesis universalis*, underlie Descartes' application of the method to solving "perfect" problems in Rules XIV-XVIII.³⁴ Weber sees these passages as having been written between March and April, 1623. He sees this as a period during which Descartes develops the ideas on method, discussed in Rule VIII. The fact that Descartes is still considering *something* equivalent in definition to the *mathesis universalis* at the time he is working out his universal method seems to undermine Weber's thesis. But if we consider that Rule VIII dates to 1626-1627, then we cannot see these passages as having been written in 1623. Weber's entire time-line must be pushed back, even farther from the original insight into the *mathesis universalis*? Does this stretch the text beyond its breaking point?

If Weber's proposal is to be retained, it ought to bear the weight of our best historical evidence. Unfortunately, that evidence seems to strain and bend Weber's thesis. His reconstruction, though detailed in its dissection of the text of the *Regulae*, is cursory at best in reference to external historical events, other early works, or potential external influences on Descartes' thought. He relies heavily on Descartes' autobiographical account in the *Discours*, Baillet's paraphrase and reconstruction of the three dreams as reported by Descartes presumably in 1619, and Descartes' correspondence with Beeckman, also in 1619. These reference points are insufficient to make the claims that Weber wishes to make. Furthermore, the story of those pivotal years in 1619-1620 can be

³⁴ Again, Schuster seems aware of the problem, concluding that Descartes takes up the proposal of a "universal mathematics" in a more rigorous and systematic way, aimed at legitimizing and founding a mechanistic natural philosophy. See below.

explained without dragging the *Regulae* into the mix.³⁵ I believe that what Weber gains in explanatory power by splitting the *Regulae* so finely is far outweighed by what he loses in not conceiving of the text holistically.

Nevertheless, we should be cautious not to throw out the proverbial baby with the bathwater. Weber's analysis calls attention to a crucial period in Descartes' intellectual development, roughly from the time he meets Beeckman in 1618 to his retreat from the Paris intellectual scene in 1628. Moreover, the imperfect text that remains shows a progressive construction, which alludes to some of the decisive changes in Descartes' thought in the 1620s. This development is central to understanding the ultimate trajectory of his mature thought of the late 1630s and 40s: with respect to the present thesis, specifically the discovery and articulation of the metaphysical nature of the mind.

From Descartes' intellectual crisis, 1619-1620, to the Regulae

The thesis that many of the Rules date to the period of 1619-1620 does not begin with Jean-Paul Weber. Gaston Milhaud (1921) notes that, following the publication of Adam and Tannery's edition of Descartes' complete works, several commentators began to hypothesize about the dating of the *Regulae*, suggesting that much of it was composed around 1619.³⁶ The reasons for this are fairly straightforward: Adam and Tannery's volume X of the *Oeuvres complètes* finally presented scholars with Descartes' early

³⁵ See the informative and comprehensive historical work by Edouard Mehl, *Descartes en Allemagne (1619-1620)*.

³⁶ Milhaud, *Descartes savant*, 47-63.

unpublished works in a complete volume and in context (they include the longer unfinished treatises, elements from the biographies of Baillet and N. Poisson, Nicole and Arnauld's Port-Royal logic, Van Schooten's explication of Cartesian algebra, Leibniz's notebooks, and Descartes' correspondence, all of which lend to an overall picture of Descartes' early work). These elements enable one to judge for oneself about the historical connections between these works. Second, Baillet had already provided the narrative that incorporated Descartes' autobiographical account of his discoveries in method and science from the *Discours* with the critical events early in Descartes' life. Thus, it is a natural step to follow Baillet's interpretation, using the texts provided by Adam and Tannery to reconstruct a textual picture of what Descartes could have written during that crucial turning point from 1619-1620.

Beeckman and the scientia penitus nova

When John Schuster took up the Weber thesis again, he distanced himself from Weber's textual methods of interpretation and turned to a much more conceptual argument about the progressive composition of the *Regulae*. His reading formed the basis for a thorough and impressive dissertation on the historical emergence of Descartes' natural-philosophical theory from 1618 to 1634. In that work, Schuster recognized the historical difficulties discussed earlier, regarding the passage from Rule VIII and the discovery of the sine-law of refraction. Principally for this reason, Schuster plucks the passages from Rule VIII out of their context in Weber's analysis and joins them to what

Schuster considers to be Descartes' more mature consideration of method in Paris, 1625-1628. Schuster supposes that the first two paragraphs of Rule VIII were written during the early period, but he sees the discussion of the sine-law of refraction and the repeated attempts to articulate the method as self-reflective examination one ought to undertake "once in his life" as associated with a much later project that would legitimize Descartes' mathematical method of discovery with a new teaching on epistemology.³⁷ According to Schuster, Descartes came to Paris in 1625 with a draft of his treatise, containing Rules I-XI, excepting the passages already mentioned from Rule VIII. In Paris, he confronted a different set of problems that forced a new direction.

In order to understand why Schuster sees these periods as so different, we will first have to look at Descartes' work with Beeckman and the influence of this work on his nascent natural philosophy. When Descartes meets Isaac Beeckman in 1618, he begins to apply himself to problems in natural philosophy (or the physical sciences) where he could put his mathematical acumen to use. We know that Descartes first met Isaac Beeckman in Breda, November 10, 1618, where they developed a close working relationship and a mutual admiration.³⁸ After their chance meeting, Descartes was introduced to the potential physical applications of mathematics. According to Schuster, "Beeckman was virtually the first man in Europe to dream of what was to become the new 'mechanical philosophy' of the seventeenth century, a combination of classical atomism with the

³⁷ Schuster, "Descartes' *Mathesis Universalis*," 58-59.

³⁸ Their meeting is recorded in Baillet, *La Vie*, I, 42-44, "à sa façon" (AT X, 48) through an improbable story where Descartes is able to solve a classical mathematical problem posted in the streets of Breda. Another less dramatic though equally coincidental story about their meeting is provided by Lipstorp in his *Specimina Philosophiae Cartesianae* (1653) (see AT X, 47-8).

belief that atoms (or corpuscles) move according to mathematical-mechanical laws.”³⁹ As a monument to Descartes’ admiration for Beeckman, he offered him his *Compendium Musicae* on New Year’s Day, 1619, which contained Descartes’ resumé of a classical area of applied mathematics.⁴⁰ During their time together, in Breda in the fall and winter of 1618, Beeckman proposed to Descartes two physical-mathematical problems which he subsequently solved and which Beeckman recorded in his journal: one of these concerned the continuous acceleration of a free-falling body, the other treated the “hydrostatic paradox,” which shows that fluid bodies can exert a pressure on the bottom of a container that is greater than their total weight.⁴¹ These two texts are quite interesting from the standpoint of the history of ideas, being the first recorded attempt by Descartes’ to apply mathematically determined mechanics to specific problems of natural philosophy, though at times they also demonstrate the young mathematician’s carelessness.

In the beginning of January 1619, Beeckman returned to Middleburg from Breda, where Descartes remained until April of that year. During this period, there are six letters between the two men (five from Descartes and one from Beeckman).⁴² The most suggestive of these letters is Descartes’ letter to Beeckman, March 26, 1619 (AT X, 154-

³⁹ Schuster, “Descartes’ Mathesis Universalis,” 48. Gaukroger, *Descartes*, 70 contains a virtually identical sentiment, which seems to be supported by the judgment of Cornélis de Waard, editor of Beeckman’s *Journal*, though it must be remarked that Descartes was in no way an “atomist.”

⁴⁰ Gaukroger, *Descartes*, 74. Rodis-Lewis, *Descartes*, 29 suggests that Descartes received in return the little parchment notebook, noted as “element C” in the Stockholm registry, from Beeckman (that notebook bearing the date January 1, 1619).

⁴¹ AT X, 67-78; Gaukroger, *Descartes*, 80-9. Rodis-Lewis, *Descartes*, 29-30, proposes that Descartes worked out the solutions to these problems in early 1619, after Beeckman had departed for Middleburg.

⁴² The whole relationship between Beeckman and Descartes, including a detailed discussion of their correspondence is found in Cole, *Olympian Dreams*, 114-128.

60; CSM III, 1-3), where Descartes proposes that with the aid of his “new compasses,” he has found a way to divide an angle equally into three parts and has devised a way to solve three types of cubic equations.⁴³

Let me be quite open with you about my project. What I want to produce is not something like Lull's *Ars Brevis*, but rather a completely new science [*scientia penitus nova*], which would provide a general solution of all possible equations involving any sort of quantity, whether continuous or discrete, each according to its nature. . . . This is of course a gigantic task, and one hardly suitable for one person; indeed it is an incredibly ambitious project. But through the confusing darkness of this science I have caught a glimpse of some sort of light, and with the aid of this I think I shall be able to dispel even the thickest obscurities.⁴⁴

These discoveries prompt Descartes to exclaim that he will inaugurate a “completely new science [*scientia penitus nova*].” In the margin, Beeckman writes “a general art that would find the solution to any inquiry [*Ars generalis ad omnes quaestiones solvendas quaesita*].”⁴⁵ The compasses that prompt Descartes’ enthusiasm are indeed important since they allow Descartes to derive the roots of cubic equations by determining the “mean proportionals” between given line segments (or, in contemporary language, the geometrical mean of a given series of numbers) and they allow for the trisection of any angle. These two fundamental discoveries, which were vexing problems in classical

⁴³ The compasses and their use are recorded in Leibniz’s notes, the *Cogitationes Privatae*: AT X, 238-241, cf. *La Géométrie*, AT VI, 388-392.

⁴⁴ AT X, 156-158. I have omitted some very important mathematical claims from this letter, but these will be addressed in detail in the following chapter.

⁴⁵ This statement suggests that at least Beeckman equated the *scientia penitus nova* with an *ars generalis*, which would indeed be close to a *mathesis universalis*. Weber, Schuster and Gaukroger see this *scientia penitus nova* as the precursor of the *mathesis universalis*, which in turn, they claim, is surpassed by the universal method, of which the three dreams are harbingers. The argument here is not whether these texts bear traits that link them to a *mathesis universalis*. Indeed, I will argue that this concept is in many ways a long-standing focus of Descartes’. Rather these links are not sufficient to warrant dividing the *Regulae* as they do.

mathematics, remain essential to Descartes' ultimate solution of n th degree polynomials in the *Géométrie*.

Schuster and Gaukroger see in the proportional compass the core of the *ordo et mensura* that define the *mathesis universalis*: "Descartes' enthusiastic desire to transcend the immediate geometrical or algebraic statement of problems, and to reduce them to common forms of relation among proportional magnitudes, was to have great significance for the genesis of universal mathematics [*mathesis universalis*] and for its content."⁴⁶ It is true that these issues can be linked to the *mathesis universalis*, and indeed doing so will illuminate how Descartes conceived his method for finding truth in the sciences in its earliest stages.⁴⁷ If these compasses provided acceptable constructions (which they would not), then Descartes had potentially solved every vexing classical problem save squaring the circle.⁴⁸ However, there is no good reason simply to identify the solution to two mean proportionals with the compasses mentioned in Descartes' letter to Beeckman of March 26, 1619. In fact, there is good reason to suggest that these compasses are only the most rudimentary beginnings of Descartes' response to those

⁴⁶ Schuster, "Descartes' *Mathesis Universalis*", 51; cf. Gaukroger, *Descartes*, 95-9.

⁴⁷ Sasaki, *Descartes' Mathematical Thought*, Vol. 237 in the Boston Studies in the Philosophy of Science (Boston: Kluwer, 2003), Ch. 3, 95-157, provides an excellent summary of Descartes' mathematical work during this time and its relation to his broader vision of discovering a general method for the sciences.

⁴⁸ Ibid., 242-43. It seems that Descartes' initial discovery in 1619 would have followed upon his careful study of Simon Stevin's *Arithmetica*. In fact, the mesolabe compass appears to be closely related to some classical constructions reported in that work. For instance, Eratosthenes had proposed a machine for solving the problem of duplicating the cube (or finding the first of two mean proportionals). This machine involved a series of squares and their diagonals, which would slide along a frame and the diagonal would cut the side of the square in a proportion to the previous side (see Heath, *A History of Greek Mathematics*, 258-60). However, Eratosthenes' compass worked very poorly since it was difficult to maintain a constant ratio of movement between the moving parts. Descartes' compass remedied this problem.

questions and that the passages treating this issue in the *Regulae* display a more advanced understanding of the issue.

These nascent insights, combined with the three dreams, undoubtedly provide the reason why Descartes of the *Discours* relates his discovery of method back to the period of time, in late 1619, when he quietly reflected on his thoughts in the stove-heated room. However, these letters and notes are far from Descartes' final word on the translation of geometrical problems to algebraic equations, solving mean proportionals, or the significance of proportional magnitudes for geometrical problem solving. It appears that Descartes' thought on these matters remains unresolved until after he is able to determine a general solution to the Pappus locus problem, c. 1632. Thus, there is no reason to date Descartes' comments in the *Regulae* that refer to these issues back to 1619. Indeed, after the dreams, Leibniz records that Descartes had promised on February 23, 1620 that "before the end of November I shall head for Loreto [Italy, home of the Santa Casa di Loreto].... At all events I will complete my treatise before Easter, and if I can find publishers, and I am satisfied with what I manage to produce, I shall publish it" (AT X, 218; CSM I, 5).⁴⁹ Descartes does not actually complete the pilgrimage until 1623 and clearly no treatise was published, so this passage provides some indication that Descartes' youthful promises were frequently unfulfilled.⁵⁰ It is known that Descartes

⁴⁹ Rodis-Lewis, *Descartes*, 49-56, disputes Adam's correction of the Foucher de Careil text, reading along with Careil September 23 instead of February 23. I do not find her arguments on this convincing.

⁵⁰ Rodis-Lewis, *Descartes*, 58, dates the pilgrimage to 1623, on the occasion of the death of Descartes' godmother's husband, M. Sain, in Châtelleraut. This is why Descartes travels across the Alps to reach Italy. As for the "treatise," it is difficult to tell. Element C of the Stockholm inventory contained: the *Parnassus*, a text on mathematics; the *Olympica*; some writings on algebra; some writings on the sciences; *Democrita*; *Experimenta*, which is at least

traveled to the Duchy of Pfalz-Neuburg, where he spent much of the winter of 1619-1620.⁵¹ By the summer, Descartes is in Ulm where he meets with the eminent mathematician Johann Faulhaber and probably spends June through September working on algebra, with close attention to Peter Roth's *Arithmetica Philosophica*.⁵² It is quite probable that Descartes' marginal note to the *Olympica* on November 11, 1620, the anniversary of his three dreams, indicates his growing understanding of algebraic equations, courtesy of his work with Faulhaber.

Schuster takes some of these biographical details as justification for his characterization of Descartes' philosophical discovery in 1619-1620. His proposal has gained more currency in the literature since he reduces Weber's many proposed strata of the text of the *Regulae* to three decisive periods: one prior to November 10, but after April 23, when Descartes' first entertained the idea of a "universal mathematics" [*mathesis universalis*], the second during the winter of 1619-1620, after the three dreams

partially preserved in Baillet, *La Vie*, II, 102-3; and *Praembula*, an introduction to wisdom and the fear of God. Many of the mathematical and physical fragments are preserved by Leibniz in the *Cogitationes Privatae*, and any one of these works or all of them together could have been conceived of as a draft of a "treatise."

⁵¹ Frédéric de Buzon, "Un exemplaire de la Sagesse de Pierre Charron offert à Descartes en 1619," has shown that Descartes received a dedicated copy of Pierre Charron's *La Sagesse* (1607 edition) from an older member of the Society of Jesus, P. Molitor. The inscription indicates a close familiarity and supports Descartes' pious reaction to his three dreams. *La Sagesse* was a work that was as popular as Montaigne's *Essais* during the beginning of the 17th century, see Michel Adam, "René Descartes et Pierre Charron," 467-83. It is interesting that none of the proponents of Weber's thesis refer to this fact, since Charron's influence is apparent on the *Regulae*. It is quite possible that Descartes carefully studied this text during the winter of 1619-1620 and may have written notes reflecting on how it might apply to his own thought. However, Charron was a central figure of discussion in Paris in the 1620's and these earlier thoughts were probably reinvigorated at that time and then incorporated into the *Regulae*.

⁵² Manders, "Algebra in Roth, Faulhaber and Descartes," 186. See also, Ivo Schneider, *Johannes Faulhaber, 1580-1635: Rechenmeister in einer Welt des Umbruchs* (Basel: Birkhäuser, 1993); and Manders, "Descartes et Faulhaber," *Archives de philosophie*, 58 (1995), *Bulletin cartésien* XXIII, 1-12.

when Descartes attempts to work out a universal method, and a final period in Paris from 1625-1628 when Descartes' interest in optics moves him toward a natural-philosophical grounding for and expansion of a real conception of "universal mathematics."⁵³ He argues essentially that Descartes' initial foray into universal mathematics coincides with his work on physico-mathematical issues with Beeckman. On his reading, the three dreams of November 10, 1619 interrupt this project with a sudden vision of the universal method, which reaches beyond the scope of his earlier mathematical work. During the period of 1619-1620, Descartes is supposed to have composed the vast majority of Rules I through XI, devoted to mapping out a plan of the universal method. However, after Descartes' arrival in Paris, Schuster claims, he returns to the early mathematical concerns, this time fueled by a challenge to skepticism and an expanded account of the epistemological function of the mind (which Schuster rightly links to Descartes' research in optics). This final version of the "universal mathematics" includes "the main lines of his dualist metaphysics," presented in Rules XII through XXI, and, Schuster claims, "the composition of his first system of corpuscular-mechanical natural philosophy *Le Monde* (1629-33)."⁵⁴ Thus, Schuster reasons, the section of Rule IV, containing the phrase 'mathesis universalis' and annexed to the end of Leibniz's Hanover manuscript, stands alone as an early expression of the universal mathematics; he then claims that Rules I-III, IV-A, and most of V-XI were composed shortly after the three dreams, in the winter of 1619-20 in order to articulate the program of a universal method; finally, Schuster

⁵³ John A. Schuster, "Descartes' Mathesis Universalis: 1619-28," see especially p. 81n4 where Schuster outlines the claims relevant to Weber's thesis that he upholds.

⁵⁴ Ibid., 41-42, quoted text from 42, see also 55-57. Cf. Gaukroger, *Descartes*, 111-112.

concludes that Descartes undergoes a “massive shift” in his thought, while reworking sections of Rule VIII in conjunction with his experimental work on optics, in order to arrive at an account of “mental function and perception, which—in the first instance—would ground an elaborated version of universal mathematics.”⁵⁵ While Schuster’s account is certainly more straightforward than Weber’s, his reading ultimately implies a much more drastic chronological break in the writing of the Rules (a hiatus of five or six years) and concentrates an enormous amount of the text into the winter of 1619-20. It appears that Descartes would have had plenty of projects underway during that time (see element C of the Stockholm inventory), some of which may have developed the basic principles of the *Regulae*, but should not be considered to be identical with that text. So it is unlikely that Schuster’s story adds much historical credence to Weber’s theory of a serious discontinuity in the text of the *Regulae*.

The famous three dreams (November 10, 1619)

The only surviving account of Descartes’ three dreams and the short work that they provoke is Baillet’s. Baillet consistently interprets the early events in Descartes’ life through the lens of the *Discours* and the case of the three dreams follows this method.⁵⁶

⁵⁵ Schuster, *ibid.*, 59. Stephen Menn, *Descartes and Augustine*, 212n15 criticizes Schuster for not sufficiently justifying a conceptual distinction between “universal mathematics” and “universal method” in the early Descartes.

⁵⁶ For instance, when discussing Descartes’ enthusiasm for reading classical texts at La Flèche, Baillet paraphrases the *Discours*, “Il s’était persuadé que la lecture des bons livres est comme une conversation avec les plus honnête gens des siècles passés qui en ont été les auteurs” (Baillet I, 20; cf. *Discours*, AT VI, 5); or when it concerns the study of philosophy, “Dès ce temps-là [the winter term 1609-1610], il s’aperçut que les syllogismes et la plupart des autres

This is problematic for a couple of reasons: First, Descartes himself states that his autobiographical account is “only a story, or if you prefer, a fable” meant to provide some “examples worthy of imitation” (AT VI, 4; CSM I, 112). Second, the *Discours* is written in 1637, as a prelude to Descartes’ first published works, presenting the merits of his method for finding truth in the sciences (as the full title states).⁵⁷ The autobiographical account that opens the *Discours* must be seen in the context of this aim, i.e., as a justification of the validity of the method, grounded in Descartes’ own life experiences. For these reasons, it would be difficult to read too much of this account back into Descartes’ actual biography. In particular, there is almost no credibility in reading Descartes’ claim that, all in one day, while meditating in his stove-heated room, he conceived of the necessity to radically doubt his prior beliefs and then to reconstruct these beliefs according to a four-step method.

This well-known reference to the small stove-heated room (*la poêle*), where he stayed during the onset of winter is a central point of reference for Baillet (AT VI, 11; CSM I, 116). Descartes tells us that he had returned from his stint with the volunteer gentleman’s army to participate in the festivities surrounding the coronation of the Emperor—Ferdinand II, which took place in Frankfurt from July 20 to September 9. Baillet claims that, from the middle of October 1619, Descartes retained winter lodging

instructions de la logique de l’école servent moins à apprendre les choses que l’on sait, ou même à parler sans jugement de celles qu’on ignore, qui est l’effet qu’on attribue à l’art de Raimond Lulle” (Baillet I, 24 ; cf. *Discours*, AT VI, 17); this is followed immediately by quoting at length the four maxims of the method (Baillet I, 24-25; AT VI, 18-19) and the maxims of provisional morality (Baillet I, 25; cf. *Discours*, AT VI, 23-25). Indeed, the theme of moral maxims guiding the events of Descartes’ life is one that resounds throughout Baillet’s story about the young Descartes.

⁵⁷ *Discours de la méthode pour bien conduire la raison et chercher la vérité dans les sciences. Plus la dioptrique, les météores, et la géométrie, qui sont des essais de cete méthode.*

in the Duchy of Pfalz-Neuburg, on the border of Bavaria in an area north of the Danube.⁵⁸ According to Descartes' own account in the *Discours*, which is summarized in Baillet, this period of time afforded him adequate solitude and freedom from distraction in order to reflect on his thoughts. From this time of introspection, he tells us, he discovered several important things: First, most structures are more beautifully and orderly constructed if they are "the works of one man" (AT VI, 11; CSM I, 116). This suggests to Descartes that, like other architectural works, the sciences themselves ought to be designed with a unified vision. Second, he "reflected that we were all children before being men" and during that formative period we were variously ruled by our appetites and our teachers, "which were often opposed to each other, and neither of which, perhaps, always gave us the best advice" (AT VI, 13; CSM I, 117). In other words, opinions rest on dubious foundations, which suggests to Descartes that in order to achieve an ordered and perfected understanding of truth in the sciences, "I thought I could not do better than undertake to get rid of them, all at one go, in order to replace them afterwards with better ones, or with the same ones once I had squared them with the standards of reason" (AT VI, 13-14; CSM I, 117). What follows is Descartes' account of how to reconstruct those demolished opinions, using the insights he has gleaned from arithmetic and geometry and following the four-part method he has outlined for himself.

⁵⁸ Baillet I, 77-78. It was widely thought, following C. Adam, *Descartes*, 18, that Descartes' poêle was in fact in Ulm (cf. Cottinghams' notes in CSM I, 4n1 and 116n1), but Frédéric de Buzon has provided documentary evidence that places Descartes in Neuberg at the time, in agreement with Baillet (de Buzon, "Un exemplaire de la Sagesse de Pierre Charron offert à Descartes en 1619," *Bulletin cartésien* XX, 1-3).

Baillet links this period of introspection in the *poêle* to Descartes' three dreams, recounted in the short work, the *Olympica*, and dated November 10, 1619 (AT X, 179 and 216). It is not clear in the *Discours* what link exists between the *poêle* and the three dreams, except that they occur within the same period time in the fall and beginning of winter, 1619.⁵⁹ However, Baillet recounts Descartes' three dreams in a way that weaves them intimately into his reflections in the *poêle*. Notably, the conceptual apparatus supporting this interpretation is Descartes' own physiological theory of passions and their influence on thought. Baillet begins Bk. II, Ch. 1 with the following account of that day:

We have noted that after having left for the city of Fankfurt at the end of September, 1619, where he had attended the coronation of the Emperor, he stopped on the border of Bavaria for the month of October, and that he began his stay in the countryside by locating winter lodging. . . . Thus, having secured lodging he remained the entire day, alone, shut in the stove-heated room, where he had complete leisure to reflect on his thoughts. At first, it was nothing but the preludes of imagination: but it progressed by degrees, by passing from one thought to another, just as he felt an increase in the pleasure his mind found in the train of his thoughts.⁶⁰

Here, Baillet sets up a scenario in which Descartes is affected only by his own internal thoughts; and he places this time of self-reflection in its historical locale. The period of self-reflection will not only lead to the discovery of a method in the sciences, but it also

⁵⁹ John R. Cole, *Olympian Dreams*, 61-64, argues in an interesting fashion that because Saint Martin's Eve, which occurs on the 10th of November, traditionally inaugurates the "onset of winter," which detained Descartes in his quarters where he "stayed all day shut up alone in a stove-heated room" (AT VI, 11; CSM I, 116), there is a chronological link between that fateful night and the time of solitary contemplation. Scholarly consensus tends to follow Baillet (see Gilson, *Discours: Texte et commentaires*, 156).

⁶⁰ Baillet I, 78: Nous avons remarqué qu'après avoir quitté sur la fin de Septembre de l'an 1619 la ville de Francford, où il avoit assisté au couronnement de l'Empereur, il s'arrêta sur les frontières de Bavière au mois d'Octobre, et qu'il commença la campagne par se mettre en quartier d'hiver.... S'étant ainsi assurée il demeura tout le jour enfermé seul dans un poêle, où il avoit tout le loisir de s'entretenir de ses pensées. Ce n'était d'abord que des préludes d'imagination: et il ne devint hardi que par degrés, en passant d'une pensée à une autre, à mesure qu'il sentait augmenter le plaisir que son esprit trouvait dans leur enchaînement.

represent the preludes to an imagination (the dreams themselves). Baillet tells us that these thoughts augment through a kind of intellectual pleasure. The connection between pleasure and imagination can be made by way of Descartes' theory of the passions. In the *Passions de l'âme*, Descartes distinguishes two kinds of imagination, one which is the product of our will, and the other which comes from the body, either through real perceptions or mere fantasy. In the case of mere fantasy, Descartes describes the "illusions of our dreams and also our day-dreams" as arising simply "from the fact that the spirits, being agitated in various ways and coming upon the traces of various impressions which have preceded them in the brain"(Part I, §21: AT XI, 344; CSM I, 336). These agitations recall former images, whose trace remains on the flesh of the brain, in turn producing the images of dreams. Baillet understands these traces in terms of a chain of thought (*enchânement*) and thus justifies uniting this theory of the passions with the image of a "chain of reason," that step by step movement of the mind, which is so central to Descartes' method (cf. definition of "deduction," Rule III: AT X, 369-70; CSM I, 15).

We find some reinforcement for this theoretical background in Descartes' *Cogitationes Privatae* (the notes and aphorisms recorded in Leibniz's notebooks, which were probably written by Descartes in 1619-1621) where he claims: first, that "in the minds of all of us there are certain elements which once aroused, however slightly, produce strong emotions [*sunt quaedam partes in omnium ingeniis, quae, vel leviter tactae, fortes affectus excitant*]" ; and, later in the same paragraph, "In moving from one passion to another, we move through intermediate passions [*transitus a passione in*

passionem, per vicinas]” (AT X, 217; CSM I, 4). Here one can see a rudimentary theory of the passions and the suggestion that passions could be linked to one another. In effect, Baillet provides a very “Cartesian” interpretation of the dream events and their significance.⁶¹

By framing Descartes’ period of introspection in the *poêle* in terms of this theory of imagination and the passions of the soul, Baillet provides some theoretical justification for linking the three dreams of the *Olympica* with the vision of a universal method in the sciences. If this were the case, then we could tie the discover of a universal method to a specific date, to quote Baillet: “He tells us that on the 10th of November, 1619, having gone to sleep *filled with enthusiasm*, and completely preoccupied by the thought *of having found that day the foundations of a wonderful science*, he had three consecutive dreams that were extraordinary enough for him to imagine that they had come from above.”⁶² The italicized phrases translate text presumably written by Descartes and

⁶¹ However, the Cartesians were not at all happy with Baillet’s interpretation, fearing that it was “bound to render [Descartes] and his philosophy ridiculous,” according to Malebranche. Apparently, Huygens and Leibniz concurred, fearing that, “The passage in which he relates how his brain was over-stimulated and in a fit state for visions, and his vow to Our Lady of Lorette, shows great weakness; and I think it will appear so, even to Catholics who have rid themselves of superstition.” Quoted in J. Maritain, *The Dream of Descartes*, 16.

⁶² Baillet *La Vie* I, 81: “Il nous apprend que *le X de novembre 1619 s’étant couché tout rempli de son enthousiasme, et tout occupé de la pensée d’avoir trouvé ce jour-là les fondements de la science admirable*, il eut trois songes consécutifs, mais assez extraordinaires pour s’imaginer qu’ils pouvaient lui être venus de haut.” Gaukroger, *Descartes*, 105, equates Descartes’ discovery of a marvellous science with his engagement with the Rosecrucian mathematician, Johannes Faulhaber: “It is, I believe, this vision [Faulhaber and Descartes’ shared vision of the broader applications of mathematics], which marks the beginning of [Descartes’] general theory of ‘method,’ to which Descartes is referring in the statement that he has discovered the ‘foundations of a marvellous science’ (*mirabilis scientiae fundamenta*).” Cole, *Olympian Dreams*, Appendix III, 214-26 provides the clearest refutation of Paul Arnould’s 1957 thesis of a Rosecrucian influence on Descartes’ account of the three dreams, on which Gaukroger’s conjecture is based. Even the still broader thesis that Descartes’ dreams emerged out of his

earlier quoted in Baillet when he describes the physical presentation of the *Olympica*. That text, he says, begins with the phrase “November 10, 1619: I am full of enthusiasm and I am working out the foundations of a wonderful science [*X Novembris 1619, cum plenus forem Enthousiasmo, et mirabilis scientiae fundamenta reperirem*]” (AT X, 179). Leibniz records the brief note that “In November 1619, I had a dream involving the Seventh Ode of Ausonius which begins *Quod vitae sectabor iter*” (AT X, 216; CSM I, 4). This refers to the third dream and confirms the date. A marginal note, which is indicated in Baillet and also recorded by Leibniz, suggests that the anniversary of that event also had significance for Descartes: “In the year 1620, I began to understand the foundation of a wonderful discovery [*Anno 1620, intellegere coepi fundamentum inventi mirabilis*]” (AT X, 216; CSM I, 3).⁶³ What is the foundation (*fundamentum*) of this wonderful science? What is this wonderful science? And why does Descartes claim to have only begun to understand its basis a year later? Moreover, what is the relationship between the dreams, the method, and this wonderful discovery?

These questions have been the fodder for countless pages on Descartes’ dreams and their interpretation.⁶⁴ The text of the *Olympica* is now lost, though it is clearly listed

work with Faulhaber is contradicted by Manders, “Algebra in Roth, Faulhaber and Descartes,” 186, who concludes that “The evidence, taken together, suggests (pace Schneider) that Descartes was in Ulm and in extended contact with Faulhaber, probably from June to September 1620.” It is possible that Faulhaber had some influence on the anniversary comment that Descartes was “beginning to understand the basis of his wonderful discovery,” but not on the dream episode itself.

⁶³ Only this second marginal phrase is included in the Stockholm inventory, AT X, 7; Baillet inverts the words “coepi” and “intelligere” with no consequence for its meaning (AT X, 179; Baillet, *La Vie* I, 50).

⁶⁴ Henri Gouhier, *Les premières pensées de Descartes* was the first extended study of these dreams. More recent studies have been proposed by proposed by J-L Marion, *Questions cartésiennes*, I, 7-36; Gregor Sebba, *The Dream of Descartes*; and Cole, *Olympian Dreams*,

as part of the Stockholm manuscripts (element C: AT X, 7). Baillet's text is generally believed to have been paraphrased from the original.⁶⁵ I have shown that Baillet presents this material in such a way that links it to the discovery of method, related in the *Discours*. But the dreams, when read on their own, are highly allegorical, written in a stylized fashion and contain no indication of a "universal method" for the sciences.⁶⁶ Nonetheless, Weber, for one, takes the November 10th date as a cornerstone for his interpretation, maintaining that in the brief period from the spring of 1619 to the end of that year, Descartes moved successively through three distinct stages, conceiving first an "entirely new science" based on proportional relations that Descartes had proposed to easily solve using compasses. Weber then claims that this receives some minor modifications before producing the text on the *mathesis universalis* of Rule IV-B in the weeks before the dreams. But that stage is quickly abandoned after those dreams reveal

especially 6-11 which contains a good review of the literature, much of which is not cited here.

⁶⁵ Cole, *Olympian Dreams*, offers a good appraisal of Baillet's authority in this regard, Ch. 2 and Appendix II. The basic argument is that "Adrien Baillet's work is bad history by almost any standards. . . . Paradoxically, this bad historian's badness is the good fortune of working scholars. Baillet swallowed the *Olympica* whole, but he neither chewed much nor digested at all" (43). In the Appendix II, Cole examines many passages in Baillet that are also represented in extant texts, such as the *Cogitationes Privatae* and the *Regulae* where we can compare Baillet's paraphrase with the original Latin. In these cases, Baillet proves to be a reliable paraphraser. In a somewhat confused way, Adam and Tannery caution that Baillet "à une façon à lui de traduire les textes, en les amplifiant toujours et y ajoutant force défauts de so crû," yet they conclude that the "*Olympica* renferme des circonstances si particulières et des détails si singuliers, qu'il [Baillet] ne semble pas avoir rien inventé" (AT X, 175).

⁶⁶ Milhaud, *Descartes Savant*, 54 warns against accepting Baillet's judgment: "On ne trouve évidemment rien dans les songes des *Olympica* qui autorise à parler de synthèse ou d'analyse, d'énumération complète, d'induction, de natures simple, et plus généralement on ne saurait penser à ces règles savantes, à ces démarches compliquées, qui seront formulées avec plus ou moins précision soit dans le *Discours de la Méthode*, soit dans les *Regulae*." The third dream, with its obscure references to a "way of life [*vitae iter*]" and the dictionary that presents the sciences in an orderly way but then changes its form, have suggested some connections to the "method." But this hypothesis requires a great deal of charitable interpretation on the part of the reader.

the possibility of a truly universal method. Ultimately, Weber claims that the first four rules would have been completed almost immediately after the three dreams, rendering them a “complete treatise” in their own right. By early 1620, he has Descartes finishing almost all of Rules I-VIII and parts of Rule XIII.⁶⁷ Weber reinforces this interpretation by indexing each of the three stages to specific passages in Descartes’ interpretation of his dreams in *Olympica*: the *mathesis universalis* and *scientia nova* correspond to the past, the universal method corresponds to the present, and the enthusiasm of Rule IV-A corresponds with Descartes’ vision for the future.⁶⁸

When taken as a whole, the dreams do clearly record a pivotal point in Descartes’ life where, as Gregory Sebba paraphrases the words of Descartes, “the spirit of Truth descended upon him to give him the mission to philosophize.”⁶⁹ This seems to be the one point on which most commentators agree: the dreams convince Descartes of the value of a life spent pursuing philosophy. It is possible that this pivotal event was a “mystical crisis” and an experience of sudden religious conviction. This might in turn demonstrate something more general about philosophical discoveries, namely, that they represent “a search for a system of rational thought that satisfies the memory of a unique physical

⁶⁷ Weber, *La constitution*, 42ff., cf. the complete resume of the stages in Ch. 9, 194-206. Another slight complication for the Weber thesis is found in the fact that Weber claims Rule IV-A clearly indicates the enthusiasm that would have followed Descartes’ dreams. However, as noted above, Descartes says that the night before the dreams he was “full of enthusiasm [cum plenus forem entusiasmos],” not after the dreams. Indeed Baillet records, “Son enthousiasme le quitta peu de jours après; et quoique son esprit eût repris son assiette ordinaire, et fût rentré dans son première calme” (AT X, 187). If we follow Weber’s logic relative to the “tone” of the text, Rule IV-A should have corresponded to the time before the dreams.

⁶⁸ Weber, *La constitution*, 41-4.

⁶⁹ Respectively: Milhaud, *Descartes Savant*, 47-63 and Sebba, *The Dream of Descartes*, 5.

experience of the same form.”⁷⁰ Or perhaps these dreams emerge out of a moment of indecision, where Descartes is caught between two opposing forces: “Isaac Beeckman was trying to lure him into a scholarly retreat; Joachim Descartes [his father] was trying to force him into the law.”⁷¹ If not a personal dilemma, it may have been a professional dilemma: “the tension between the audacity of ambition and the fear of not being able to succeed alone corresponded to an excitement no longer limited to mathematics but embracing his model of a unification of all science.”⁷² It might even be the case that “What the dreams reveal in 1619 would result in the awakening of the *cogitatio*.”⁷³ In some measure, the dreams represent a crisis in Descartes’ life and intellectual development. They coincide with his first glimpse of the possibility of unifying the sciences, which becomes the focus of his philosophical vocation. Yet all hypotheses are in fact sustainable without positing that any of the actual text of the *Regulae* was written at this time. It seems most likely that the shorthand of Descartes’ autobiographical account in the *Discours* points to this period of time during which he likely discovered the principles of his method, though the maturity of the text of the *Regulae* and its contents mitigate against positing that the text of that work was actually written during this turbulent period.⁷⁴

⁷⁰ Sebba, *The Dream of Descartes*, 7-8.

⁷¹ Cole, *Olympian Dreams*, 170.

⁷² Rodis-Lewis, *Descartes*, 33.

⁷³ Marion, *Questions cartésiennes*, I, 32: “La révélation des rêves de 1619 aurait donc pour résultat l’éveil de la *cogitatio*.”

⁷⁴ This is essentially the conclusion of Rodis-Lewis, 37-8: “There has been much discussion about that exciting discovery and much thought about the method. It could not have been the articulation of the rules, since Descartes said he needed ‘enough time’ to seek them out [Discours, AT VI, 17]. It was rather the principle of such rules, the subordination of all sure knowledge to a self-evidence such as existed in mathematics.” Cf. Chikara Sasaki, Descartes’

The beginnings of Descartes' algebra and the mesolabe compass

One of the most important problems in the early development of Descartes' mathematical thought was the problem of finding two "mean proportionals" between given line segments. This problem came from antiquity because it was known that a general method of constructing two mean proportionals would allow one to double the area of a cube, the length of whose side is known.⁷⁵ Geometrically, we can think of mean proportionals as the mean of a geometrical series, where the relationship between each term is multiplicative. For this reason, mean proportionals can also be understood as the roots of equations with variables of a power greater than one. When we look at Descartes' approach to this problem, we see marked differences between the *Regulae* and the 1619 letter to Beeckman.

In Rule VI, Descartes introduces this problem as an instance of the general problem of determining "the proportions or relations between things," which, he says, "encompasses the essential core of the entire science of pure mathematics [*quod unum totius scientiae purae mathematicae summam complectitur*]" (AT X, 385; CSM I, 23). As

Mathematical Thought, 149-57. Though Sasaki does not think any of the *Regulae* was composed in 1619, he does suggest that Descartes "could have already possessed his plan of a reformed algebra capable of serving as an algebraic analysis," which is why he calls these dreams "mathematical."

⁷⁵ The reduction of the problem of duplicating the cube to the problem of finding two mean proportionals is attributed to Hippocrates of Chios (470-410 BCE). The reduction is explained as follows: "if for a given line segment of length a it is necessary to find x such that $x^3 = 2a^3$, line segments of lengths x and y respectively may be sought such that $a:x = x:y = y:2a$; for then $a^3/x^3 = (a/x)^3 = (a/x)(x/y)(y/2a) = a/2a = 1/2$ " (from Francois Rivest and Stephan Zafiroff: <http://www.cs.mcgill.ca/~cs507/projects/1998/zafiroff/>)

we will see in the following chapter, the *mathesis universalis* would have been understood to govern the principles of pure mathematics, i.e., arithmetic and geometry, while mixed mathematics, or applied fields of mathematics, would depend on those. Yet, when Descartes refers to the proposed solution to mean proportionals, does he refer to his compasses? No. Instead, he demonstrates how a series of proportional magnitudes can be constructed easily by multiplying each member of the series by the proportion: “For example, say the thought occurs to me that the number 6 is twice 3: I may then ask what twice 6 is, viz., 12; I may, if I like, go on to ask what twice 12 is, viz., 24, and what twice 24 is, viz., 48, etc.” (AT X, 385; CSM I, 23). This establishes the nature of the relation between each number in the series, but the problem of finding the mean proportional requires that, given the numbers 3 and 12, for instance, one is able to determine that the magnitude in equal proportion larger than 3 and smaller than 12 is 6. Finding the solution to this sort of problem is “indirect” (AT X, 386-87; CSM I, 24); this language clearly recalls that of Rule XVIII (see above) where finding the intermediate mean proportional is a kind of division that requires an “indirect movement of the imagination.”

Lachterman has suggested that the notion of a serial arrangement of simples is connected to the serial movement of the mind along a sequence of intuitions, i.e., the mental process of deduction, which would serve to connect this passage with Descartes’ understanding of the two main functions of the intellect in solving problems.⁷⁶ Clearly, the connection to Rule XVIII suggests that Rule VI is hinting toward some multiplicative understanding of the roots of equations, such that this might be an oblique way of

⁷⁶ *Ethics of Geometry*, 182.

explaining his algebraic method. However, when Descartes refers to the possibility of splitting up the problem of finding three mean proportionals into three problems of finding one mean proportional each, he realizes that there might be a shorter method: “the thought immediately strikes us that this problem can be split up and made easier: first we look for the single mean proportional between 3 and 48, viz., 12; then we look for a further mean proportional between 3 and 12, viz., 6; then another between 12 and 48, viz., 24” (AT X, 386; CSM I, 24). This heuristic suggestion does not seem to coincide with a general algebraic method for finding roots, like what one finds in book three of the *Géométrie*. However, one thing that is clear is that Descartes has already transitioned from conceiving of the solution to geometrical problems through mechanical means, i.e., compasses and the like, to thinking of the solution to these problems in arithmetical means. The thought in Rule VI betrays an attention to what we might call number theory and its application of the problem of mean proportionals. It suggests that Descartes was working out an arithmetical, or numbers-based, solution to a classical geometrical problem. This is the crucial insight of the *mathesis universalis*, i.e., to think of magnitude in general and thus equally applicable to both arithmetical and geometrical magnitude. Therefore, it appears that these rules mark an intermediary stage, somewhat more advanced than the compasses proclaimed to Beeckman in 1619, but somewhat less sophisticated than the method proposed in the *Géométrie*.

During the period in which Descartes was apparently working out the specifics of his algebraic method for solving geometrical problems (such as the mean proportionals), he also seems to have discovered, with the help of Claude Mydorge, a geometrical

solution to the problem of finding two mean proportionals. By geometrical solution in this case, I do not mean a reversion to the compasses devised in 1619, but I mean an acceptable geometrical construction, using only a straight line and the conic sections. This solution is reported in Beeckman's journal after their meeting in the fall of 1628 (AT X, 342-44). This rather ingenious solution proposes finding two mean proportionals by the intersection of a circle and a parabola. The classical mathematician, Menaechmus, had proposed a solution involving the intersection of two parabolas, which appears to be most closely related to Descartes'.⁷⁷ By the time of the *Géométrie*, the parabola becomes Descartes' favored means of construction. Pierre Costabel has shown that this construction owes its discovery to Descartes' work with Hardy and Mydorge in Paris c. 1625, since Mydorge provides a proof of the construction in correspondence with Mersenne.⁷⁸ Though Beeckman presents the solution in his journal using the Greek analysis and synthesis to describe the stages of solution, his use of these terms indicates the rather loose sense in which they were understood. In the next chapter, when I refer to analysis, I generally understand this to be identical to algebra, whereas synthesis corresponds to geometrical construction. However, in Beeckman's journal the "analysis" provides the construction, albeit using as its point of departure the well-known *sit jam factum*, while the "synthesis" provides a proof of the construction. If modern algebra, the techniques of which Beeckman was relatively unfamiliar, were used, then the proof would be supplied in the algebraic analysis and would not need to be restated.

⁷⁷ See Heath, *A history of Greek Mathematics*, II, 253-55.

⁷⁸ *Demarches originales de Descartes savant*, 49-52. Mersenne goes on to reproduce a proof of this construction, which was proposed by Roberval, in his *Harmonie Universelle* II, VI, 408-11 (see Marion and Costabel, *Les Règles*, Annexe III, 309-13).

Nonetheless, the continued interest in this problem, from Descartes' letter to Beeckman up to Mersenne's *Harmonie Universelle* (1635) and Descartes' *Géométrie* (1637), demonstrates its centrality as a mathematical discovery and application of algebra as well as the continued development and refinement of the solution. In fact, Costabel has suggested that Descartes was quite late to arrive at a real solution to the problem, suggesting that it only occurred to him after his solution of the Pappus problem.⁷⁹

Whatever the exact date of Descartes' true discovery of the solution to the problem of finding two mean proportionals, his statements in the *Géométrie* state conclusively that he had not found a satisfactory solution in 1619, despite the enthusiasm expressed to Beeckman. Though he may have tried to arrive at a satisfactory solution by way of the mesolabe compass, he rejects this as a possibility in the strongest language.

While commenting on the curves generated by that compass, Descartes says:

However, because the curved line AD is of the second degree, and one can find two mean proportionals by the conic sections [i.e., by the intersection of a circle and parabola], which are of the first degree; and moreover because one can find four or six mean proportionals by lines that are not as complex as are AF and AH, *it would be an error* in Geometry to use them there. And it is also an error, from the other side, to apply oneself uselessly wanting to construct some problem by lines more simple than their nature permits. (AT VI, 443-44, my emphasis)

At the time of the *Géométrie*, Descartes recognizes that even if he had been able to provide an algebraic equation for the curve described by the mesolable compass, this solution would not even be acceptable. Instead, only those solutions provided in the simplest means possible, and in the *Géométrie* he means by that “using the lowest possible degree of equation or curve,” are admissible (I will discuss the notions of

⁷⁹ *Demarches originales de Descartes savant*, 52 and Marion and Costable, *Les Règles*, 312.

simplicity and acceptability in detail in Chapter 2 §2). Later in that treatise, he articulates this restriction in algebraic terms: “when considering these difficulties [of two mean proportionals or the trisection of an angle] they may always be understood by equations that are only as great as the square of the square or the cube”(AT VI, 471). Thus, by the time of the *Géometrie*, not only has Descartes found a real solution to the problem of finding two mean proportionals and trisecting the angle, but he has also disqualified as inadmissible the use of the compasses proposed to Beeckman in 1619. We should thus not see these as adequate instruments for finding the solution to these problems.

Nevertheless, this does not entirely dismiss the importance of the letter to Beeckman. Indeed, what is so remarkable about that letter is that it very much frames the central mathematical problems that will preoccupy Descartes for at least the next 15 years. Indeed, what Descartes does in that letter is he links the solution to the problem of finding mean proportionals to a project of determining an “entirely new science, which would provide a general solution of all possible equations involving any sort of quantity, whether continuous or discrete, each according to its nature.” What is more, this science of a “*mathesis universalis*,” as he will later identify it, ought to entail a proper division in kind between the various problems involving continuous quantities. This division in kind already seems to bear the traits of the distinction between “geometrical” and “mechanical” curves, which is articulated in the *Géometrie*. All of this will be discussed in detail in the following chapter. It is sufficient to note here that though Schuster and Gaukroger rightly associate the issues related to the *mathesis universalis* with the letter to Beeckman of March 26, 1619, this no more suggests that Descartes wrote the passage on

the *mathesis universalis* from Rule IV at that time than it would suggest that Descartes wrote significant portions of the *Géométrie* at that time.

Optics and epistemology

In a related way, Schuster argues from Descartes' discoveries in optics to the claim that there is a "massive shift" or dramatic break between the later rules and the earlier ones. He states that, in Rule XII, Descartes presents his first elaboration of the nature and operation of the mental faculty in direct opposition to a particularly prevalent interpretation within the Aristotelian tradition. Schuster claims that Descartes simplifies the traditional picture somewhat by positing "first, the natural light of reason, or *vis cognoscens*, which is the unique and purely spiritual agency of the cognitive apparatus and which carries out intuition and deduction" to which he contrasts "certain loci in the brain where mechanically delivered corporeal impressions or patterns are registered, thus providing the content of sensation, imagination and memory."⁸⁰ He concludes that this basic epistemology now founds the previously incomplete vision of a *mathesis universalis* and provides the possible link to a complete metaphysical system.

Since there is good prima facie reason to think that an achieved mechanization of the theory of vision lies behind the physiology of rule 12 and is implicitly maintained as their complement ... Descartes' entire teaching in rule 12, both explicit and implicit, will be termed the 'optics-psychology-physiology nexus', or 'o-p-p nexus' for short. It is on the basis of the o-p-p nexus that the truth of the operations of universal mathematics [*mathesis universalis*] will be grounded, as well as the ontological reference of its objects.⁸¹

⁸⁰ Schuster, "Descartes' *Mathesis Universalis*," 59.

⁸¹ Ibid., 62. While it is true that in many ways Rule XII substantiates what was only sketched in

As we have seen in other cases, Schuster's historical reasoning turns out to be a bit two-dimensional. I will discuss the nature of Descartes' theory of perception and its relation to an epistemological justification for the project of the *Regulae* in Chapter 3. For now, I want to take note of Schuster's tendency to locate all of Descartes' optical work in Paris, 1625-1628. First of all, while Descartes was traveling in Germany, he probably made his way to Prague in order to visit the one-time home of Tycho Brahe and Johann Kepler. It is likely that at this time, Descartes first became acquainted with Kepler's optics, Kepler being the first to teach him about optics, according to his own testimony.⁸² Secondly, the physiological claims that are central to Descartes' developed account of perception depend on anatomical observations and a theory of the circulation of the blood and animal spirits that were both heavily indebted to Harvey, and thus would not have been part of Descartes' body of knowledge until after 1629, i.e., after his return to Holland and

earlier Rules and "by the time he composed rule 12 Descartes had already devised the core of his mature mechanistic theory of light as a mechanical impulse instantaneously conveyed through a continuous optical medium," it is a much different thing to suppose that this is roughly the same as what is presented in *Le Monde* or the *Dioptrique* (ibid., 61). It is clear that Descartes begins to understand the sine-law of refraction in 1626 while working with Mydorge. See Pierre Costabel, *Démarches originales*, 63-76, on the anaclastic line and its relation to the *Dioptrique*. However, it is one thing to understand that mathematical relation and another to have a workable mechanistic theory of light. This kind of project only finds expression in the letters of the early 1630's and is subsequently incorporated into the *Discours* and the *Dioptrique*. Again, if Descartes possessed the basic elements of his theory of light and refraction while he was working with Mydorge in Paris, then why did the leaked copy of his *Dioptrique* in 1636 cause such a stir with Mersenne and Fermat? See letters October 5 1637 (AT I, 450-4); November 1637 (AT I, 463-74); and January 25, 1638 (AT I, 499-504). This debate over the nature of refraction, prompted by Mersenne giving Fermat a copy of the *Dioptrique* would seem strange if the core of Descartes' theory of light were established with Mydorge in 1625-1628.

⁸² "Kepler a esté mon 1er maistre en Optique" (AT II, 86). This claim occurs in the context of a letter to Mersenne, March 31 1638, in which Descartes vehemently denies that his discovery of the sine-law of refraction derives from his reading of Kepler. For the relation between this claim and Descartes' biography see Milhaud, *Descartes Savant*, 102 and Rodis-Lewis, *Descartes*, 51.

his cessation of work on the *Regulae*. Thirdly, as I have remarked above, Descartes does not seem to have resolved the problem of designing lenses that would use the sine-law of refraction in order to magnify images until c. 1632. Schuster's tendency to identify Descartes' mature conclusions with his initial insights is apparent again. While I agree that Rule XII provides the first sketch of a Cartesian epistemology and metaphysics tailored to the nature of the method central to that work, I cannot support Schuster's conclusions. Moreover, if Schuster believes that "[i]n rule 12 Descartes develops a theory of psychology and perception that will provide the basis for the logical machinery [worked out in detail in rules XIV-XVIII] of universal mathematics," then it is difficult to understand why he does not advocate a coherentist reading of the *Regulae*.⁸³ It would seem, according to Schuster's own conclusions, that universal mathematics *is* the general method of the *Regulae*.

It seems that the real rationale behind Schuster's position in support of Weber is encapsulated in his claim that "the reason Descartes devised the elaborate machinery of lines and rectangles in rules 12 to 18 was legitimacy and not procedural or heuristic."⁸⁴ Schuster's reasoning is driven by a theory about the history of science (likely influenced by Paul Karl Feyerabend), which would hold that an author's explicit claims about method are to be seen as rhetorical schemes devised to legitimate scientific practice. In contrast, he claims that the real, implicit, structure of science often runs counter to these claims and cannot be legitimized by methodological theory.⁸⁵ While the legitimacy thesis

⁸³ Ibid. 59ff., see also 64-9.

⁸⁴ Ibid. 71.

⁸⁵ Cf. Schuster, "Whatever Should We Do with Cartesian Method? Reclaiming Descartes for the

itself is doubtful, it certainly does not justify adopting Weber's thesis. Though it is inevitable that theoretical commitments will influence one's interpretation of history, this prejudice should not explicitly inform one's historical interpretation. Philosophical history must be philosophical, but it must still be historically accurate.

Descartes' Notebooks, 1619-1623

When one examines the period of 1619-1621, after Descartes' last communication with Beeckman, during his travels through Germany, the time surrounding his three dreams, and his work with Faulhaber, it appears that Descartes is grappling with a number of issues related to mathematics and method. The chief texts that can be confidently dated to this era are given curious titles (*Preambula: Initium Sapientia Timor Domini, Democritica, Experimenta, Parnassus, and Olympica*). Leibniz has recorded most of the philosophical and mathematical writings from this period in his *Cogitationes Privatae*.⁸⁶ There one also finds several cryptic aphorisms that refer to more general concerns. For instance, Descartes says, "Knowledge is like a woman: if she stays faithful to her husband, she is respected; if she becomes common property, she will be despised [*Scientia est velut mulier: quae, si pudica apud virum maneat, colitur; si communis fiat,*

History of Science," in Voss, *Essays on the Philosophy and Science of René Descartes*, 195-223.

⁸⁶ Some commentators make divisions in this text according to Descartes' titles (especially, Cole, *Olympian Dreams*), but I cannot verify these with the Adam and Tannery text. Perhaps Foucher de Careil's edition contains some more divisions not recorded there. Adam and Tannery were unable to find the original text and thus were forced to employ a great deal of effort to remedy the many defects of de Careil's edition, AT X, 207-12. So it would seem difficult to come to any definitive conclusion about the original breaks in the text.

viliscit]” (AT X, 214; CSM I, 2). He also writes, “The sciences are currently masked; by which I mean that if their masks were removed, they would appear in their full beauty [*Larvatae nunc scientiae sunt: quae, larvis sublati, pulcherrimae apparerent*]” (AT X, 215; CSM I, 3). In addition to these curious reflections on the nature of knowledge, Descartes puts forward some statements that seem to presage the *Regulae*. He writes, “In my youth, when I was shown an ingenious discovery, I used to wonder whether I could discover its principles before reading the author’s account. This practice made me realize that I was using certain rules [*Iuvenis, oblatis ingeniosis inventis, quaerebam ipse per me possemne invenire, etiam non lecto auctore; unde paulatim animadverti me certis regulis uti*]” (AT X, 214; CSM I, 2). Again, he writes, “The pronouncements of the wise can be reduced to the fewest so-called general rules [*Dicta sapientum ad paucissimas quasdam regulas generales possunt reduci*]” (AT X, 216; CSM I, 4). Likewise, in what appears to be a proposed treatise, Descartes adopts a pseudonym, Polybius, that he will use again in the dialogue, *La recherche de la vérité*. The text is called *Thesaurus Mathematicus* (A Mathematical Treasure Trove), and it begins with the claim that it will treat “the true means for resolving all the difficulties in this science [*vera media ad omnes huius scientiae difficultates resolvendas*]” (AT X, 214; CSM I, 2). This claim is clearly consistent with Descartes’ enthusiasm for his *scientia penitus nova*, which he proclaimed to have embarked on in March 1619, and it will prefigure similar claims that Descartes will make to Beeckman in 1628 regarding his algebra.

In another passage, Descartes claims, “For each of us there is a set limit to our intellectual powers which we cannot pass. Those who, through lack of intelligence,

cannot make discoveries by employing first principles, will still be able to recognize the true worth of the sciences, and this will enable them to arrive at a correct judgment of the value of things” (AT X, 215; CSM I, 3). The first part of the passage seems to be consistent with the prescription of Rule VIII, that we not extend our knowledge beyond the limits of our intellectual capacities (AT X, 396 and 399-400; CSM I, 30 and 32-33). But the second part seems to contradict his warnings against accepting the authority of others, which renders it a somewhat ambiguous antecedent to the *Regulae*. In the same vein, the unity of the “light of reason” or the “pure cognitive power,” which are the focal points of Rule I and XII respectively, are only vaguely and ambiguously foreshadowed by the following aphorism: “There is a single active power in things: love, charity, harmony” (ibid.). These texts provide some indications that during the time just before and after his three dreams, Descartes was perhaps concerned with devising rules for resolving problems in mathematics, that he saw the broader implications of these rules for a general theory of science, and that he sought a unified explanation of that science.⁸⁷

However, other passages from the same notebooks demonstrate a rather sophomoric way of thinking when compared to the *Regulae*. Descartes seems at this time to be entranced by the power of metaphor and mystical insight to reveal the truth of the sciences. In a segment apparently intended to introduce the account of his three dreams Descartes writes:

It may seem surprising to find weighty judgments in the writings of the poets rather than the philosophers. The reason is that the poets were driven to write by enthusiasm and the force of imagination. We have within us the sparks of knowledge, as in a flint: philosophers extract them through reason, but poets force

⁸⁷ Milhaud, *Descartes Savant*, 60-61.

them out through the sharp blows of imagination, so that they shine more brightly. (AT X, 217; CSM I, 4).⁸⁸

This high praise of the imagination as a vehicle for truth is consistent with Descartes' "enthusiasm" surrounding his three dreams, but the *Regulae* presents a much more measured assessment of that mental faculty. Indeed, the above passage seems difficult to square with Descartes' sharp criticism of merely probable knowledge. In these passages, Descartes was not in the mood for critical reflection, he was enchanted by the possibility that "the things which are perceivable by the senses are helpful in enabling us to conceive of Olympian matters." He clarifies:

There are more wet things than dry things, and more cold things than hot, because if this were not so, the active elements would have won the battle too quickly and the world would not have lasted long. (AT X, 218; CSM I, 5)

Again:

Man has knowledge of natural things only through their resemblance to the things which come under the senses. Indeed, our estimate of how much truth a person has achieved in his philosophizing will increase the more he has been able to propose some similarity between what he is investigating and the things known by the senses. (AT X, 218-9; CSM I, 5)⁸⁹

These statements do not seem consistent with, for example, Rule VI—a rule that contains "the main secret of my method"—which "instructs us that all things can be arranged serially in various groups, not in so far as they can be referred to some ontological genus (such as the categories into which philosophers divide things), but in so far as things can

⁸⁸ A paraphrase of the same text is found in Baillet, *La Vie*, I, 85; AT X, 187.

⁸⁹ It is true that at the end of his *Principia Philosophia*, Descartes triumphantly proclaims to have explained all phenomena of nature that can be perceived by the senses, as if this were the aim of the entire treatise (see Part IV, §199: AT IX-B, 323; CSM I, 285-6). But it is a long way from here to there, and this aphorism implies a much more naïve view of that aim. Whereas here Descartes speaks of knowledge based on a "resemblance" of things as they come under the senses, the nature of things in the *Principia* is based on Descartes' metaphysical principles and their combination to produce perceived phenomena.

be known on the basis of others” (AT X, 381; CSM I, 21). But the ontological genera of the “philosophers” are divisions based on the categories of things according to the elements (fire, water, earth, and air) and secondary qualities, i.e., on analogy with things perceived by the senses.⁹⁰ In the *Regulae*, Descartes insists that scientific knowledge is to be founded on “simple natures,” which are the basic intuitive starting points of scientific all demonstrations (AT X, 381-2; CSM I, 21). Simple natures have no analogy with sensory experience and are fundamentally different than perceived qualities. This distinction is even more vivid if one turns to Rule XII, where Descartes talks about the perception of colors “in abstraction” from the way they appear in objects, but only insofar as they are present in some “shape” (AT X, 413; CSM I, 40-41). It appears that in 1619-1620 Descartes still entertained the possibility that the basic metaphysical components of the world could be made intelligible through perception. This belief would have been discarded and surpassed in the composition of the *Regulae*, a text which is infused with an ontology very different from what could be derived from sense-perception.

The reference to simple natures is also useful for dating the composition of the *Regulae*. Descartes refers to simple natures in three places in the *Regulae* that indicate at least two different concepts of the meaning of the term. In Rule VI, he refers them to a “series” of absolute and relative terms and in Rule XII, he divides them into intellectual, corporeal and common notions. A passage in Rule VIII (a passage that also uses the term ‘mathesis’ and can be confidently dated to c. 1626) also employs the language of absolute and relative terms of a series: the simple term arising after a series of questions related to

⁹⁰ See Aristotle, *Categories* Bk. 4-5, 8 on the definition of secondary qualities or secondary substances as that which is differentiated by sense perception.

the nature of the angle of refraction, Descartes says, but “he must know what a natural power in general is—this last term being the most absolute in the series” (AT X, 395; CSM I, 29). Now, it is quite probable that Descartes begins using the terminology of the “simple natures” following his introduction to Francis Bacon’s *Novum Organon* published in 1620 (though it is also possible that he may have picked up the term elsewhere; it is used in a passing way in both Francisco Toletus’ commentary on *De Anima* and in the Coimbrian commentaries on Aristotle’s *Physics*—these issues will be treated in detail in Chapter 4).⁹¹ The more likely source, however, is Bacon, since it is Bacon who makes the simple natures a thematic concept in scientific inquiry. For the moment, it is sufficient to establish that Descartes probably encountered Bacon’s writings via Mersenne, whose *La Vérité des sciences* of 1624 engages with Bacon’s critique of the Aristotelian syllogism.

But even if the influence of Bacon, via Mersenne, were doubted, the *Cogitationes Privatae* show that while Descartes may have conceived of a method of reducing things to their causes by way of an ordered and serial relation between terms, he had not yet sufficiently established a concept of orders and relations that was independent of the classical ontological genera and elements. Proof of this hypothesis can be found in Descartes’ critical review of Lambert Schenkel’s *De arte memoria* where he objects to Schenkel’s “profitable nonsense [*lucrosas nugas*]” and posits his own method, the “true art of memory,” based on the correct order [*recto ordine*]:

⁹¹ Etienne Gilson, *Index Scholastico-Cartésien*, 201.

This order consists in the following: that the images formed should be reciprocally dependent on one another. If he omits this here, I do not know [what is the use of his art]; or rather, I consider that this is the key to all mysteries.

I have thought out another way: either out of images of interconnected things new images can be obtained which are common to all images, or at least one can make one image out of all images like it. One should not only consider the relation to the proximate image, but also to other images, such that the fifth is related to the first by means of a stake driven into the ground, the image in the middle by means of a ladder by which they descend, the second by means of an arrow fired towards it and the third in some analogous way reasonably related either truly or falsely by means of signification. (AT X, 230)

This strange passage reflects a serious reflection on Schenkel's *De arte memoria* and, though it is critical of that treatise, it demonstrates that Descartes is still convinced by the idea that the true order of things could be obtained through the relations between symbolic images. Indeed, Descartes' interest in classical mnemonic techniques and their relation to Ramon Llull, beginning in 1619, will play a significant role in forming his concept of the *mathesis universalis* (this will be discussed in Chapter 2). It is quite likely that Descartes' response here to Schenkel with his suggestion that his method would provide the *clavis totius mysterii*, provides the germ of the *artis secretum* of Rule VI. However, it is equally important to understand the differences between this formulation and that of the *Regulae*. Here Descartes relies on a vague, symbolic and allegorical relation between images as a means to disclose the true order of things, whereas Rule VI insists on the inference obtained between logical terms (absolute and relative terms, and their dependence relation). Indeed, Descartes' focus here on images and their symbolic relations resembles his admiration of poetic enthusiasm and symbolic allegory in the *Cogitationes Privatae* for disclosing the nature of things.

Nevertheless, Descartes does seem to be consistently preoccupied with practical issues in physics, mathematics, optics, and music during this time. In addition to the problem of free-falling bodies and the hydrostatic paradox, which were copied into Beeckman's *Journal* and also appear in the *Cogitationes Privatae* in a slightly more developed form (AT X, 219-22 and 228), Descartes records other physical-mathematical problems (AT X, 222-26 and 230-31), applications of his treatise on music (AT X, 227), a treatment of gnomons (AT X, 229-30), an explanation of the use of several compasses for solving various problems (AT X, 232-42) and some experiments treating the nature of light and its refractive properties (AT X, 215-6 and 242-3). Just these issues seem to be the focus of Descartes' studies during his stay in Germany. And he clearly augments his understanding of them while working with Faulhaber; remnants of this debt also appear in his notes. His *Thesaurus Mathematicus* contains a strange dedication to "learned men throughout the world and especially the celebrated brothers of the Rose-Croix [*totius orbis eruditis & specialiter celeberrimis in G. (Germania) F. R. C. denuo oblatus*]" (AT X, 214; CSM I, 2); and he refers a series of mathematical and navigational concepts to Peter Roth's *Arithmetica Philosophica* and to Benjamin Bramer, also a German mathematician whom he undoubtedly met through Faulhaber (AT X, 241-2). It is clear that this time was important for Descartes' development, his thoughts on mathematics and science, and the relationship between mathematics and knowledge more generally.

Perhaps even more importantly, as a prelude to the *Regulae*, sometime between 1620 and 1623, Descartes writes the *De Solidorum Elementis*, a study of solid bodies and their geometrical properties (Element M in the Stockholm inventory, a copy of which was

also found among Leibniz's notes).⁹² That text includes a proof of the so-called Euler characteristic of solid geometrical bodies, which is a topological invariant establishing the ratios of between vertices, edges, and faces of solid geometrical objects. This would indicate a continuation of Descartes' attempt to resolve problems in mathematics by applying his method; and it would also indicate a certain measure of success in this endeavor. During the period from 1620-1623, Descartes probably composed another, now lost, treatise simply called *Algebra* (Stockholm inventory, item D, AT X, 8). This may have been the source of the "specimen" that Beeckman records in his *Journal* in 1628, but it likely also served as the foundation for, particularly, Rules XV-XVIII, which show how to illustrate and solve simple algebraic problems with geometrical representations. It is likely that these mathematical writings mark the end of Descartes' work on "pure mathematical problems" and the beginning of his research into the foundations of those mathematical discoveries. This development in Descartes' thought would seem to be confirmed by a noteworthy letter to Mersenne, written in the midst of a series of letters clarifying the contents of his *Géométrie* and *Dioptrique*, where he recalls, "as you know, it has already been over 15 years since I claimed to have abandoned Geometry, and I would not take the time to solve any problem unless it were at the request of a friend" (AT II, 95). Such a claim may refer to the completion of the lost treatise on algebra, the beginning of the *Regulae*, or the solution of the problem of

⁹² See Costabel ed. *Exercice des éléments solides*, preface. Sasaki, *Descartes' Mathematical Thought*, 145-148 treats the issue of dating this manuscript extensively and concludes that it must have been composed between 1619-1623. He also proposes that this work is tied to issues prompted by Faulhaber (ibid., 124).

finding two mean proportionals.⁹³ In any case, the reference to 1623, along with the textual pieces I have cited, make Weber's thesis that a universal theory of mathematics was dispensed with and surpassed in November 1619 highly improbable.

It is much more likely that these historical considerations explain why Rule IV-B is framed in the language of an autobiographical retrospective upon an earlier time, even though the Weber thesis would have it written earliest. Descartes opens the passage with, "When I first applied my mind to the mathematical disciplines," and continues, "Later on I wondered why," "But I have come to think," and "I began my investigation by inquiring," etc. (AT X, 374-6; CSM I, 17-9). The key phrase, "It was these thoughts that made me turn from the particular studies of arithmetic and geometry to a general investigation of *mathesis*" (AT X, 377; CSM I, 19) echoes the sentiment of Rule IV-A. That section clearly describes Descartes as moving away from purely mathematical interests: "if one attends closely to my meaning, one will readily see that ordinary mathematics is far from my mind here, that it is quite another discipline I am expounding, and that these illustrations are more its outer garments than its inner parts" (AT X, 374; CSM I, 17). It is quite probable that these references to a time of completing pursuits in mathematical problem solving and beginning an investigation into the philosophical core of those mathematical insights point to the time c. 1623 when Descartes' had completed *De Solidorum Elementis*, drafted a treatise on algebra, and began his pilgrimage to

⁹³ Sasaki, *Descartes' Mathematical Thought*, 3-4, takes this to refer to the core principles of Descartes' *Géométrie*, citing the importance of the lost treatise on Algebra. Baillet, *La Vie*, I, 111-12, identifies this with the commencement of the *Regulae*, specifically, Descartes' claim to have moved beyond the largely useless "bagatelles" (trifles) of problem-solving in Arithmetic and Geometry, as declared in both sections of Rule IV.

Loreto. Though not decisive, it is instructive that Baillet uses this very historical context to introduce his paraphrase of Rule IV.⁹⁴ In that same passage, he relates Descartes' abandonment of specifically mathematical studies with the discussion of a '*mathesis universalis*.' Crapulli takes this to indicate that Rules IV-A and IV-B were actually unified as a common rule in the autograph edition that Baillet had before him at the time.⁹⁵ Thus, it seems that Descartes' testimony would reason against his having abandoned mathematics (even a "universal mathematics") in 1619. Moreover, the possibility that Baillet's representation of Rule IV is consistent with the original autograph copy strikes at the very heart of the Weber-Schuster thesis that Rule IV-B should be considered heterogeneous to the rest of the Rule, composed before the three dreams in 1619.

Little is known about Descartes' exact whereabouts from the end of 1621 to the beginning of 1625. In 1622, he is certainly back home in Rennes, where he authorizes his brother to sell an inherited estate, from which he had gained the title "du Perron" (AT I, 1-2). After that, he is in Paris on March 21, 1623 (AT I, 3) and then he probably undertakes the pilgrimage to Loreto, which he had promised himself to do on February 23, 1620. In late 1624, he returns to France and moves to Paris, where he will stay, with few interruptions for the next three years. Thus the extant manuscripts from the period of 1619-1623, when coupled with biographical information about Descartes' whereabouts cast serious doubt on the Weber-Schuster thesis that the vast majority of the *Regulae* was

⁹⁴ Baillet, *La Vie*, I, 111-115.

⁹⁵ Crapulli, *Regulae*, 86n11.

composed during that time. In the next section, I will propose an alternate hypothesis about the dates and composition of the rules.

A case for the composition of the Regulae during Descartes' stay in Paris, 1625-1628

While it is possible that Descartes began work on the *Regulae* as early as 1623 and it is quite likely that he made ample use of his personal notebooks, some written as early as 1619, I propose that we return to the original, judicious reasoning of Adam and Tannery, when they suggest that the *Regulae* was composed between 1625 and 1628, marking only its termination c. 1628 with any certainty (Appendix C, AT X, 486-88). By dating it to this time period, we are able to suggest that it represents a certain development in Descartes' thought, which originally provided the impetus for Weber's thesis, but we can also maintain that there are no drastic chronological breaks in the composition of the rules. This judgment would align itself with Crapulli's scrupulous review of the extant manuscripts: "Did Descartes draft the treatise of the *Regulae* several times? Neither the examination of variations, nor the form of the treatise allows us to respond affirmatively to that question. . . . The author seems, in effect, to have used some fragments and notes from a prior time without arriving at a complete and unified draft."⁹⁶ Moreover, I believe that we ought to adhere to a kind of Hippocratic principle of hermeneutics: in interpreting a text (and the date of its composition), first, do no harm! Indeed, it is evident that the Weber thesis has done a great deal of harm to the

⁹⁶ Crapulli, *Regulae*, xxi.

interpretation of the *Regulae*. I do not mean to say it has done more harm than good, since it is the first and one of the most careful studies of the text. Yet, it is incontestable that Weber's thesis has prevented most commentators (with a few notable exceptions⁹⁷) from advancing a coherent and complete reading of the *Regulae*, erring on the side of a cautious appraisal of the unity of the text. When I advance my own proposal in this section, it will be my expressed aim to maintain as much continuity as possible in the text and to refrain from asserting more than I can reasonably support historically and textually.

Mersenne's intellectual circle in Paris, c. 1625

Apart from the discrepancies between the philosophical outlook of the *Regulae* and Descartes' early notes, observed in the previous section, there is good reason to think that the entire thrust and aim of the treatise grows out of Descartes' engagement with the intellectual climate in Paris, where he lived from 1625-1628. The treatise presents itself as an attempt to legitimate scientific knowledge in a way that sharply diverges from Aristotelian syllogistic reasoning as the vehicle for its legitimacy. This is a distinct characteristic of the climate in Paris in the 1620s and part of the reason why I think it is most plausible that the *Regulae* was written there. While Schuster acknowledges an influence of Mersenne's circle on Rules XII through XXI, this influence can be seen from the very first rules.

⁹⁷ Most notably, Marion, *Sur l'ontologie grise*, and more recently, Bret J. L. Doyle, *The Logic of Descartes' Method*.

In the 1620s, Mersenne was concerned primarily with combating naturalism and panpsychism, while legitimizing the rising mechanistic conception of the world in terms of a Christian natural theology. Though not a systematic philosopher, Mersenne was intimately involved in the scientific and philosophical community of 17th century such that his works stand as a kind of encyclopedic compendium of contemporary views.⁹⁸ His first work *Questionnes celeberrimae in Genesim* (1623) represents just this kind of thinking. Its primary aim is to prove the existence of God against the disbelief of the atheists. Even Mersenne's proofs for the existence of God are closely aligned with mathematics and mechanical philosophy, arguing for instance that the proportion and elegance of numbers, as well as the many properties of geometrical objects demonstrate intelligent design.⁹⁹

In 1624, with *La Vérité des science contre les sceptiques ou pyrrhoniens*, Mersenne set his aim more directly at Pyrrhonism which had gained some traction as a philosophical theory following Montaigne's *Essais* and Charron's *La Sagesse*, both of which revived many elements of Hellenistic natural and moral philosophy.¹⁰⁰ Again, Mersenne's 1624 work collects a variety of mathematical and scientific results that he claims are so certain they withstand the skeptics' attacks on truth. Indeed, for Mersenne,

⁹⁸ Consider this assessment from Robert Lenoble, the eminent commentator on Mersenne, *Mersenne ou la naissance de la mécanique*, 4: "Si Mersenne, en effet, n'a pas été un philosophe de premier plan, il est éminemment représentatif de la pensée moyenne du public instruit de son temps, et son itinéraire philosophique est celui de toute cette génération, qui quitte la Scolastique pour le Mécanisme."

⁹⁹ Of the 35 proofs for the existence of God in *Quaestiones in Genesim*, proofs 15-22 are based on knowledge attained through the sciences.

¹⁰⁰ Other examples of a concerted religious attack on the kind of skepticism one finds in Charron and Montaigne, cited in Michel Adam, "Réné Descartes et Pierre Charron," 74, are: P. Garasse, *La doctrine curieuse des beaux esprits de ce temps* (1623) and *La somme théologique des vérités capitales de la religion chrestienne* (1625).

the truths of mechanical natural science, mathematics, and philosophy are not really distinct from the truth revealed by faith. For him, the truths of science reinforce Christian belief. Thus, his project of Christian apologetics is consistent with his defense of mechanism. As Lenoble succinctly puts it, for Mersenne, “the first heresy is error.”¹⁰¹ Nonetheless, for Mersenne, science is not merely propaedeutic to faith, but exists in its own right, according the empirical and mathematical strength of its demonstrations: “... the science of which he speaks is no longer a speculation on natures [as in Aristotle] but a science of phenomena and constructive laws.”¹⁰² Another philosopher of that circle, Pierre Gassendi, whom Mersenne would meet in 1623, published *Animadversiones contra Aristoteles* in that same year. This treatise employs the resources of skepticism and mechanical philosophy to argue against the authority of the Aristotelians. Thus, the direct confrontation with Aristotelianism, an engagement with skepticism and an effort to legitimate the emerging mechanical philosophy were all features of Mersenne’s circle in Paris, to which Descartes would be introduced as early as 1623, but certainly after 1625.

It is noteworthy that Rule IV-B, the controversial starting point for Weber’s thesis, bears a marked resemblance to a passage from Mersenne’s *La vérité des sciences*, which discusses the necessary prerequisites for gaining knowledge in geometry. There, Mersenne lists some thirty-one books all of which, he claims, contribute to our knowledge of “analysis,” the true method of mathematics. Chief among these works are Pappus, Diophantus, Simon Stevin and Viète. With the possible exception of Viète, each of these authors plays an important role in the *Regulae*, particularly in the contentious

¹⁰¹ Lenoble, *Mersenne*, 234.

¹⁰² Ibid. 273.

passage of Rule IV-B, where Pappus and Diophantus are named as providing “traces of the true mathesis.” In this passage, however, Descartes claims that this true mathesis was later suppressed by its inventors who “feared that their method, just because it was so easy and simple, would be depreciated if it were divulged”(AT X, 376; CSM I, 19).¹⁰³ Descartes notes that this original method, which would have elaborated how to discover scientific principles, has begun to be revived under the name “algebra,” though he immediately criticizes this science for its barbaric name and its incomprehensible figures.¹⁰⁴ At the end of the passage in *La Vérité des sciences*, Mersenne appeals to God for “certain new Archemedes” who would carry the mathematical sciences “to their final perfections.”¹⁰⁵ According to the judgment of Cornélis de Waard, Descartes is intended as one of those “new Archimedeans.”¹⁰⁶ De Waard follows Baillet who determines that Descartes had first traveled to Paris for a few months in early 1623 where he supposes that he met Mersenne, who was so impressed by his mathematical acumen that he referred to him in the book he was then working on.¹⁰⁷ The passage in question, which

¹⁰³ This discussion surely recalls Descartes’ statements elsewhere concerning the method of analysis, in contrast to synthesis, which is the true geometrical method, but was begrudgingly concealed by its first practitioners, Second set of replies to the *Meditationes*: AT VII, 155-6; CSM II, 110-1.

¹⁰⁴ The reference to “algebra” here is probably a reference to Christopher Clavius, *Algebra* (1608) and Descartes’ studies with Faulhaber rather than to Viète, whom he denies having read, see letter to Mersenne February 10, 1639: AT I, 524. In fact, analysis is generally taken to be identical with the method of algebra. Viète’s algebra being distinguished between “analysis infinitorum” and “analysis finitorum.”

¹⁰⁵ Mersenne, *La Vérité des Sciences*, 750.

¹⁰⁶ *Correspondance du P. Mersenne*, I, 287-304.

¹⁰⁷ Baillet, I, 106ff. Baillet, however, claims that Descartes and Mersenne had initially met at La Flèche (ibid., 21), though this has been proven to have been impossible: Rodis-Lewis, Descartes, 57. Charles Adam suggests that Descartes could have met Mersenne in 1620, while in Paris, *Descartes*, 20. This is also improbable because it appears that Descartes was in Germany in 1620. Cornélis de Waard suggests that Descartes meets Mersenne in 1623. This is

presents analysis as the true method of mathematics, surely bears traits similar to Descartes' discussion of *mathesis* in Rule IV-B. It would not be unreasonable to suggest that Descartes' own thought on the subject would date to the same period, though this is purely conjectural.¹⁰⁸

We should not conclude from these observations that Descartes agrees with Mersenne or Gassendi, or that he is simply echoing their writings. Instead, it is during this time and engaging with this set of issues that Descartes seems to find his own philosophical voice. For instance, while Mersenne parades various mathematical proofs and scientific results in front of the reader as if the sheer mass of demonstrations were enough to establish their certainty, Descartes will not accept this kind of utilitarian basis for truth. Instead, the central criterion for truth, from the *Regulae* onward, is clarity and distinctness of intuitions. This criterion rests on a philosophical claim about the nature of human knowledge and its sources, rather than the beneficial results of human industry. Nonetheless, the topics of concern are the same, even if their treatment is different. This would seem to suggest that Descartes wrote his *Regulae* as a way of articulating his own philosophical voice in response to the pertinent issues to which he was introduced in Paris.

based on a letter posted from Paris and preserved by Baillet, March 21, 1623 (AT I, 3-4). Baillet records that Descartes was in Paris for several months before departing for Italy. During this time he could have met Mersenne, but it is certain that by 1625 Descartes knew Mersenne.

¹⁰⁸ In fairness, Beeckman's *Journal* does contain reference to many of these same writers in connection with Mathesis, see AT X, 29. Apparently the professor at Leyden, Rudolf Snellius—not to be confused with Willebrod Snell van Rolien who discovered the sine-law of refraction—gave Beeckman these references. Though Beeckman may have conferred some knowledge of that tradition, Descartes would not have known Snellius since he died in 1613.

Nowhere is Descartes' unique engagement with Aristotelianism and the foundations of modern science in the *Regulae* more evident than in Jean-Luc Marion's groundbreaking work, *Sur l'ontologie grise de Descartes*. Marion takes the strange textual and historical situation of the *Regulae*, what he calls a "texte sans texte," as an opportunity to consider Aristotle as its putative interlocuter.¹⁰⁹ Though Descartes certainly could have gained a perspective critical of Aristotle in reaction to his schooling at La Flèche, this does not seem to be the focus of his work with Beeckman or Faulhaber. Without summarizing the details of Marion's work, one can easily see that the topics of the first few rules are oriented in direct confrontation with Aristotelianism. Rule I introduces a general idea of knowledge [*scientia*], and asks whether there are various kinds of knowledge and how knowledge in general is to be acquired.¹¹⁰ In direct contrast to the prevailing Aristotelian understanding, Descartes claims that the sciences should not be distinguished by the different kinds of objects they study, rather, "the sciences as a whole are nothing other than human wisdom, which always remains one and the same, however different the subjects to which it is applied, it being no more altered by them than sunlight is by the variety of the things it shines on" (AT X, 360; CSM I, 9).¹¹¹ The

¹⁰⁹ Marion, *Sur l'ontologie grise*, 13. Marion's suggestion is aided by the fact that there is in fact no trace of reference to the *Regulae* in Descartes' correspondence. In short, the text appears, long after Descartes' death, without any historical point of reference. Though Marion's work is practically canonical at this stage, it is obvious that the present effort is precisely to determine the historical point of reference for the *Regulae*.

¹¹⁰ The verb 'scio' from which 'scientia' is derived, is simply "to know" in its most general sense. However, when used in a philosophical context it means "knowledge in the strict sense" and is thus close to what we mean by "science." However, it is not necessary for 'scientia' to be a body of knowledge, or a field of knowledge, as distinct from a way of knowing. That is why Descartes says that scientia "consists wholly in the cognition of the mind [*scientias, quæ totæ in animi cognitione consistunt*]" (AT X, 359; CSM I, 9).

¹¹¹ Marion, *Sur l'ontologie grise*, sees in this first rule two important features of the entire

Aristotelian picture of many different kinds of sciences is derived from, Descartes claims, an inappropriate analogy between the sciences, which depend only on the intellect, and the arts, which require habituation of bodily faculties. This rule demonstrates, in a preliminary way, the characteristic Cartesian response to the proliferation of scientific disciplines, disputations and philosophical argumentation, namely, that nothing matters more than “good sense [*bona mente*]” (AT X, 360; CSM I, 9) for the advancement of wisdom and for giving human beings the capacity to judge well about any of life's contingencies (cf. *Discours*, AT VI, 1-2; CSM I, 111). Furthermore, this good sense is cultivated by being aware of the generality and purity of scientific knowledge, which is determined only by the clarity of the intellectual light.

Rules II and III continue this line of reasoning by distinguishing the method advocated in the *Regulae* from the syllogistic reasoning of the “scholastics.” Rule II aims at discrediting all probable cognition, preferring instead only “what is perfectly known and incapable of being doubted” (AT X, 362; CSM I, 10). Descartes sees the “probable syllogisms” of the “schoolmen” as only useful in training young men to sharpen their wit, but not in expanding scientific knowledge. This sentiment is echoed by the better-known passage of Rule X:

But to make it even clearer that the aforementioned art of reasoning contributes nothing whatever to knowledge of the truth, we should realize that, on the basis of their method, dialecticians are unable to formulate a syllogism with a true conclusion unless they are already in possession of the substance of the conclusion, i.e., unless they have previous knowledge of the very truth deduced in

Regulae: first, that the certainty of the sciences is founded on “l'unique producteur de certitude ... l'intellect même,” 30; second, in its divergence from the Aristotelian classification of the sciences by their objects, he sees “la destruction entière et systématique du primat aristotélicien de l'ousia,” *ibid.*, 31-2.

the syllogism. It is obvious therefore that they themselves can learn nothing new from such forms of reasoning, and hence that ordinary dialectic is of no use whatever to those who wish to investigate the truth of things. Its sole advantage is that it sometimes enables us to explain to others sophisms which are already well known. It should therefore be transferred from philosophy to the sophists themselves. (AT X, 406; CSM I, 36-37)¹¹²

This is a strong objection to the syllogistic justification of knowledge prominent in the schools. In contrast to this, Descartes reinforces the claim that perfect knowledge is indubitable, which is why disputatious arguments should not be pursued and it is the reason why “out of all of the sciences so far devised, we are restricted to just arithmetic and geometry if we stick to this rule” (AT X, 363; CSM I, 11). Descartes continues to differentiate his own project from the Aristotelian one in Rule III, where he claims that “we ought to investigate what we can clearly and evidently intuit or deduce with certainty, and not to what other people have thought or what we ourselves conjecture” (AT X, 366; CSM I, 13).¹¹³ This warning announces Descartes’ preliminary attempt to undermine arguments from authority. First, he claims that “we would always be uncertain which [ancient writer] to believe, for hardly anything is said by one writer the contrary of which is not asserted by some other” (AT X, 367; CSM I, 13), a claim that is echoed in the *Discours* (AT VI, 2; CSM I, 114-5). Second, the knowledge obtained from authority would be useless if one were not able to reproduce the arguments that legitimate it.

¹¹² The heritage of Peter Ramus should be evident in this statement.

¹¹³ The word ‘intueri’ literally means “to look, gaze at,” which is why Marion takes the bold step to translate ‘intueri’ by ‘régarder’ (Marion and Coastabel, *Les Règles*, Annexe I, 295-302). Marion, *Sur l'ontologie grise*, goes on to claim that “intuitus mentis reprend du *nous tes psyches*” of Aristotle in three ways “extrêmement précis”: first, intuition is a sense closely aligned with touch; second, and as a consequence, intuition apprehends its object directly and before any predicative possibility of true or false, i.e., intuition by definition cannot be false; and third, the appropriate objects of intuition are first principles. Nonetheless, Marion concedes that this analogy does not imply a complete semantic symmetry between the two words, 48-49.

Philosophical arguments only have historical value, unless they can be sustained by the very same intuitions and deductions that once demonstrated them to be true (AT X, 367; CSM I, 13). In these two rules, one sees Descartes argue against the legitimacy of traditional authors, in favor of a concept of knowledge in general, on analogy with mathematics, that is sustained by intuition and deduction, and concerns only what can be known with certainty. In fact, he foreshadows a central argument of the *Meditationes*, that the only sure way to defeat skepticism is by attending to what is simple, easy, and evident: “Men of learning are perhaps convinced that there is very little indubitable knowledge, since, owing to a common human failing, they have disdained to reflect upon such indubitable truths, taking them to be too easy and obvious to everyone. But there are, I insist, a lot more of these truths than such people think—truths which suffice for the sure demonstration of countless propositions which so far they have managed to treat as no more than probable” (AT X, 362; CSM I, 10-1). This sentiment is again echoed in Descartes’ discussion of the *mathesis universalis*, which he claims had previously been disdained because “everyone thinks the subject too easy” (AT X, 378; CSM I, 20). It is also repeated in Rule V with the reduction of complicated terms to simples (AT X, 379; CSM I, 20) and in Rule X, which advocates that one ought to “first tackle the simplest and least exalted arts, and especially those in which order prevails” (AT X 404; CSM I, 35). One can see that these themes are present throughout the *Regulae* and remain paramount throughout Descartes’ writings. Such observations only confirm that these Rules should be read together, as advancing a clear and mature vision that is characteristic of Descartes’ thought.

Additionally, the mathematics of Rules XV-XVIII show a clear influence of Viète's modern algebraic notation of letters with raised powers for unknowns, which would imply that these were not written between 1618-1623, when Descartes was still accustomed to using the German Cossic notation (which is preserved in the *Cogitationes Privatae*, the *Physico-Mathematica*, etc.). This was the notation used by Beeckman and the German mathematicians. Though Descartes denies having even seen the cover of Viète's book (AT I, 524) it is likely that his work with Mydorge and Hardy introduced him to Viète's technical innovations. Moreover, if, as I have suggested in the previous section and will further discuss in the following Chapter, Rules XV-XVIII are closely connected with the idea and definition of the *mathesis universalis*, then it is likely that we can conceive of the *Regulae* as presenting Descartes' new theory of mathematics, informed not only by his work with the German mathematicians, but also the Parisian mathematicians. It is also likely that for this reason the treatise on algebra was abandoned in favor of its updated version, the *Regulae*. These historical observations serve to reinforce the original judgment of Charles Adam, that the *Regulae* was composed in Paris, from 1625-1628.

A proposed schema for the composition of the text

With this evidence in favor of dating the composition of the *Regulae* to the period of Descartes' stay in Paris, 1625-1628, let us return to the text in order to examine its distinct elements and try to establish, by a merely probable conjecture, in what order they

might have been composed. In this section, I will draw on some of the textual difficulties discussed at the beginning of the chapter. My aim now is to try to impose a bit of order on the chaos. In order to do that, I need to outline the distinct elements of the *Regulae*.

First, we can confidently begin with the block of text from Rule I to Rule IV-A (AT X, 359-374.15), which even Weber maintains was written as a whole.¹¹⁴ These first four Rules announce the plan of a universal method in the sciences. The method is to be based on the “certain and evident” cognition of the natural light of reason. Its paradigm is the certainty of arithmetic and geometry, consisting “entirely in rationally deduced arguments” (AT X, 365; CSM I, 12), which is identified with the basic cognitive operations of intuition and deduction. The entire thrust of these first Rules is to establish a method that is sure to be free from error and to allow the cognitive capacities to arrive at truth. Next, we should set apart the text of Rule IV-B (AT X, 374.16-379.14). This portion introduces the concept of a *mathesis universalis*, which is the name of the new science that will treat problems only insofar as they can be represented in terms of relations of order and measure. Rules V-VII, Descartes tells us, “ought not to be separated, since we ought to think of all of them together and as all equally contributing to the perfection of the method” (AT X, 392; CSM I, 27). These Rules outline a more concrete vision of the method as a process of reducing complex problems to simple elements and ordering and arranging those simples according to the way that they are known. Rule VIII must be divided into three distinct sections, though the first two paragraphs may also be considered apart from the rest of the Rule (VIII-intro, 392.10-

¹¹⁴ *La Composition*, 47.

393.21; VIII-A, 393.22-396.25; VIII-B, 396.26-397.26; VIII-C, 397.27-400.11).¹¹⁵ Next, I believe that there is no reason to separate Rules IX-XI because these three Rules focus on the nature of the method and the application of the mind to solving problems. Moreover, Rule XI is explicitly aligned with the previous two Rules: “Rule IX dealt only with mental intuition; Rule X only with enumeration. The present Rule explains the way in which these two operations aid and complement each other; they do this so thoroughly that they seem to coalesce into a single operation...” (AT X, 408; CSM I, 38). While we should consider Rule XII alone, I see no reason to separate it topically as Weber does.¹¹⁶ The only passage that could easily be set apart from the rest of the Rule is the concluding passage, after the lacuna, where Descartes announces the proposed plan of the work (Rule XII-plan, AT X, 429-430; CSM I, 50-51). Otherwise, the topics addressed in Rule XII are announced at the beginning (especially, the division between an examination of “ourselves the knowing subjects” and “the objects of knowledge,” AT X, 411; CSM I, 39). Thus, there is no reason to separate these topics from each other for the purposes of understanding the chronology of composition. I will refer to the entirety simply as Rule XII. Rules XIII, XIV, and XV-XVIII can be considered each on its own, or they can all be considered together. I think it makes little difference, since these Rules clearly set out the program of abstracting the relations between variables in a given problem, depicting those relations clearly before the mind, and then arriving at a solution. Rule XVII makes this explicit, referring to the “preceding four Rules (XIII-XVI)” as sharing a common

¹¹⁵ This Rule is the first instance of Weber’s hyperbolic dissection of the text. Paragraph divisions and changes in topic are not sufficient to warrant the claim, which Weber makes, that they are composed at different times.

¹¹⁶ *La Composition*, Ch. 7 and 8.

purpose, to show us “how to abstract determinate and perfectly understood problems from particular subjects” (AT X, 459; CSM I, 70). These Rules represent the most mature formulation and concrete implementation of the method; they are the ripened fruits of the entire *Regulae*.

We are thus left with about 11 reasonable divisions in the text. Now we must try to draw some tentative conclusions about the possible chronological relations between them. First of all, we should examine the explicit internal references made to previous Rules. Unfortunately, Rules I-VII make no explicit reference to previous Rules, so we are unable to clearly distinguish a chronology for I-IV-A, IV-B, and V-VII on that basis. Rule VIII, however, makes a number of references to Rules V-VII. In VIII-intro, Descartes refers to “the preceding three Rules” (AT X, 392; CSM I, 28), while VIII-A refers to Rules V and VI by name (AT X, 394; CSM I, 29). That section also refers to Rules I and III, so we can confidently date VIII-intro and VIII-A *after* I-IV-A and V-VII. Likewise, Rules XI refers to Rules III and VII (AT X, 407-408; CSM I, 37), suggesting that Rules IX-XI were composed *after* I-IV-A and V-VII. Rule XII-plan divides the plan of the work into three sections of twelve Rules each, so we can be fairly confident that when Descartes wrote that section as part of the twelfth completed Rule. It is possible that it was composed some time after the rest of Rule XII, or it is also possible that Descartes wrote this section first and then worked out the details of Rule XII. Rule XII also makes explicit reference to Rule VIII with respect to the notion of “simple natures,” which is likely a reference to Rule VIII-C, but this connection will be better explained in what follows. Rule XIII refers to Rules V, VI, and VII, while Rule XIV refers to Rule

XII. I think we can be confident that Rules XIII-XVIII were written *after* Rule XII, and also *after* Rules V-VII. This leaves us with the following certainties: Rules I-IV-A and V-VII were written *before* Rule VIII-intro, VIII-A, IX-XI, XII, and XIII-XVIII; Rules XIII-XVIII were written *after* Rule XII. We are still unclear about the relationship between Rules I-IV-A and V-VII and Rules IX-XI to Rules XII-XVIII. Moreover, we have little insight into the chronology of Rule IV-B, VIII-B, and VIII-C.

In order to address these lingering uncertainties, we should turn to the content of the Rules and ask whether there are any clear topics that unite certain Rules to others, or any implicit references to other Rules that would help fix their chronology. In particular, we are looking for a way to determine the chronological relations between Rules I-IV-A, IV-B, V-VII, VIII-intro, -A, -B, -C, and IX-XI. Both conceptually and on the basis of internal references, it seems that Rules XII-XVIII were probably composed last, and there is no need to doubt that the order of composition is any different than the order in which they are presented.¹¹⁷ The following chapters will make ample use of these Rules in order to demonstrate Descartes' most technically sound conception of his algebraic method of discovery, its relationship to the mental processes of intuition and imagination, and the connection between solving problems in pure mathematics and applying those solutions to problems in natural philosophy. There is no hard and fast argument for this thesis, but I think it is a reasonable and relatively uncontroversial interpretation.

If we start backward, from Rule XII, to determine the contextual and topical references to other Rules, we find an interesting connection. While I have described the

¹¹⁷ In this regard, I agree with Schuster's analysis, "Descartes' *Mathesis Universalis*," 55-73, especially 58.

explicit reference to Rule VIII in the body of Rule XII as ambiguous, I think that a careful look at this reference will yield an important distinction. When Descartes explicitly refers back to Rule VIII, he claims that now he has shown what are the simple natures, which were only mentioned in the prior Rule:

... [T]here are no other ways accessible to human beings to arrive at certain cognition of the truth than evident intuition and necessary deduction. Thus, in the same way, [we have shown] what the simple natures are, which Rule VIII mentioned. (AT X, 425; CSM I, 48)

This reference is difficult to analyze because of the nature of Rule VIII, to which it refers. As I have mentioned, Rule VIII appears to be composed of an introduction and three sections, each treating roughly the same topic. Moreover, Rule VIII-A was displaced in Leibniz's copy of the text, provoking the idea that perhaps it had been discarded in favor of a more mature formulation. Adam and Tannery initially proposed the thesis that Rule VIII was a redrafted Rule, culminating in VIII-C. They note a number of parallel topics discussed. In particular, an enumeration of the cognitive faculties and the application of those faculties to different kinds of problems (Appendix B to *Regulae*, AT X, 485-86). VIII-C states that one may divide any question into two parts "for the question ought to relate either to us, who have the capacity for knowledge, or to the actual things it is possible to know" (AT X, 398; CSM I, 32). When Descartes turns to "us, who have the capacity for knowledge," he claims, "while it is the intellect alone that is capable of knowledge, it can be helped or hindered by three other faculties, *viz* imagination, sense-perception, and memory." Adam and Tannery note that this list adds memory to a similar list from VIII-A, a difference of "capital" importance (AT X, 486; cf. AT X, 395-96). If we continue to examine that section of text, however, we will discover another aspect of

capital importance. When Descartes turns to “the things themselves,” he notes that they can be divided into “simple and complex or composite natures”:

Simple natures must all be either spiritual or corporeal, or belong to each of these categories. . . . All these points will be explained at greater length in Rule XII, where it will be demonstrated that there can be no falsity save in composite natures which are put together by the intellect. (AT X, 399; CSM I, 32)

Indeed, Rule XII follows this outline so exactly that it seems impossible to conceive that this section of Rule VIII was not composed at the same time as Rule XII.

Given the clear evidence of a chronological link between Rule VIII-C and Rule XII, what should we conclude about the other sections of Rule VIII? To begin with, Rule VIII-intro is so closely aligned with the “preceding three Rules” that it seems difficult to separate it from them chronologically (AT X, 392.14; CSM I, 28). In effect, the first paragraph of Rule VIII simply elaborates the plan of Rules V-VII, while the second paragraph integrates those heuristics with the overriding aim of the treatise, outlined in Rules I-IV-A. Rule VIII-A introduces two examples that are said to illustrate the application of the method to particular problems. The first example is the discovery of the sine-law of refraction as the solution to the problem of how to construct a lens that refracts all rays of light to a single point. This example uses the term ‘mathesis’, contrasting it with the empirical knowledge of the physical sciences. For this reason, it ought to be closely linked to Rule IV-B. The example also utilizes the technique of “reduction to the most simple term,” which it refers explicitly to Rule V and describes the relation between those terms as “absolute” or relative, referring back to language from Rule VI. The fact that Descartes applies the very same language used in previous Rules to a concrete problem, whose solution we know Descartes discovered c. 1626, should be the

clearest indication that these Rules were composed during roughly the same period of time. I will not insist that Rule IV-B and Rule VIII-A were composed at the same time as Rule V-Rule VIII-intro, but I will insist that they were composed at *nearly* the same time and that they ought not be separated drastically.

Finally, Rule VIII-B introduces a very interesting analogy in order to describe the relationship between the method and the mental faculties. He claims, “our method in fact resembles the procedures in the mechanical crafts, which have no need of methods other than their own, and which supply their own instructions for making their tools” (AT X, 397; CSM I, 31). This short section surely stands out as a vivid example of the nature of method, but it is difficult to relate to the other Rules chronologically. I propose that it is closely aligned with Rules IX-XI, each of which also expand on the nature of the method by comparing components of it to the various mechanical and educational arts. Rule IX finds that “mental intuition” can be compared to “ordinary vision,” and just as “craftsmen who engage in delicate operations . . . acquire through practice the ability to make perfect distinctions between things” so, too, our mental intuition should be trained to make fine distinctions between things and not to attempt to focus on problems that are too complex or too general (AT X, 400-01; CSM I, 33). Rule X elaborates on this theme of training our minds well. In that Rule, he contrasts the puzzles and mathematical games that interested him as a young man with the syllogisms of dialecticians. Whereas the former are certainly trivial, “nothing in these activities remains hidden and they are totally adapted to human cognitive capacities, they present us in the most distinct way with innumerable instances of order, each one different from the other, yet all regular” (AT X,

404; CSM I, 35). In contrast, the dialecticians prescribe certain “forms of reasoning” that encourage our mental powers come to rely on them and take a break “from considering a particular inference clearly and attentively.” As a consequence, “truth often slips through these fetters, while those who employ them are left entrapped by them” (AT X, 405-06; CSM I, 36). Finally, Rule XI describes the way that enumeration can shore up the deficiencies of deduction, which is “a kind of movement of the mind” that “in a sense depends on memory” (AT X, 407-08; CSM I, 37). This Rule describes enumeration as a mechanical exercise, like learning your multiplication tables, that actually helps you perceive the true relations between things. It also refers back to the problem of determining the relations between different magnitudes in a series, the central topic of Rule VI. Descartes says that, while these relations are sometimes difficult to perceive initially, “we acquire the habit of distinguishing at a glance what is more, and what is less, relative, and by what steps the relative may be reduced to the absolute” (AT X, 409; CSM I, 38). I suggest that these three Rules were composed, along with Rule VIII-B in order to explicate and expand on the heuristics of method developed in Rules V-VII. Again, I believe this suggestion makes the most sense of the passages in question without any hard and fast evidence to come to a certain conclusion.

If my analysis is correct, then it seems that Rules IV-B-XI demonstrate the greatest variability in composition. Rules I-IV-A show a clear and unified plan for the entire treatise, while Rules XII-XVIII go the furthest to actually working out the details of what Descartes’ method would look like. By contrast, Rules IV-B-XI show that Descartes had considerable difficulty squaring his lofty, thematic vision with the

technical details of the proposed method. As a consequence, these Rules preserve the “drafts” or “layers” of Descartes’ effort to work out that connection. It does appear that by the time Descartes writes Rule XII he has a fairly clear conception of how the method ought to be united with an epistemological and metaphysical view of the world that would support the lofty goals set in the first four Rules. I believe that this is why he took the effort to try to reintegrate the most mature vision of the method into Rule VIII. This would also indicate the centrality of Rule VIII for understanding the entire project. (A point I will rely on in the next chapter.)

To sum up this historical schema for the composition of the Rules let me propose seven stages of composition. In the first stage, Descartes sets out a plan for a universal method that would provide a foundation of the sciences on the paradigm of mathematics, Rules I-IV-A. Next, Descartes sets out the basic heuristics of this method, Rules V-VII and VIII-intro. At this stage, Descartes makes a series of false starts, in an attempt to advance that ambitious project. The whole treatise is geared toward the application of an algebraic technique to solving problems in natural philosophy, but in trying to get from his grand vision of a universal method to the technical application of it, Descartes hesitates. I suggest that at some point Descartes redrafts Rule IV-A with an explicit reference to the *mathesis universalis*, hoping this concept will do the trick of uniting the technique with the vision. In Rule VIII-A, he tries to demonstrate the utility of the methodological heuristics by championing his discovery of the sine law of refraction. That section also mentions the word ‘mathesis’, so it can be reasonably correlated with Rule IV-B. Next, Descartes tries a different tack, this one more analogical than technical.

Here, Descartes drafts Rule VIII-B and Rules IX-XI with a view to explaining the nature of method and its heuristics on analogy with the crafts and mechanical sciences. These efforts are not conclusive; they do not really unify the treatise yet. The treatise is finally unified when Descartes discovers the preliminary epistemological and metaphysical bases of his method in Rule XII. Now, Descartes redrafts Rule VIII, resulting in Rule VIII-C in order to align that Rule with the new foundation for the method. Sometime near the drafting of Rule XII, Descartes outlines a plan of the whole treatise, confirming that indeed this Rule is the long sought-after linchpin. Once Rule XII is in place, the rest of the Rules are written as a fairly straightforward explication of the discoveries announced there.

This theory is completely conjectural, though it is my best guess. The single point that I want to emphasize right now is the central importance of Rule XII, VIII, and IV. Others have noticed the importance of Rule XII, but it is particularly central to my thesis. Chapters 3 and 4 will be entirely based on an exposition of themes in Rule XII. Those chapters reflect my belief that this Rule is *the* linchpin of Descartes' *Regulae*. Indeed, I think that Descartes could not have conceived of the *Regulae* as a treatise before having discovered the epistemological and metaphysical insights in Rule XII. These insights are foundational for the real, technical developments of the work.

After the Regulae: its relevance for scholarship

Having outlined what the treatise is about, its purpose, contents, and discontinuities, I now need to address its incompleteness. Why did Descartes abandon the *Regulae*? Indeed, if they are so central to his development, why aren't they completed and published? There is no definitive answer to this question. Descartes' choice to move on to other projects could have arisen from some fatal flaw in the design of the *Regulae*. It could have been the result of a technical difficulty, like the completion of his algebra or the application of his mathematical method. Or, as Descartes himself suggests in a letter to his friend Mersenne, perhaps he simply had arrived at additional insights, so rewarding that he thought it would be more fitting to simply make a fresh start (AT I, 137-38; CSMK, 21). Since this dissertation is interested in exploring the philosophical content of the *Regulae* as it relates to Descartes' mature work, we ought to pause for a moment to consider what happened when Descartes abandoned his treatise on method. Why did he do so? And how will this affect our reading of the text?

Descartes' retreat from Paris to Holland

Even though Descartes clearly profited from his stay in Paris, through his collaboration with Mydorge and Mersenne, he ultimately preferred the solitary life. This is no doubt one of the reasons why he retreated to Holland in 1628. In 1631, he writes to Balzac, an acquaintance and correspondent, that even in his small retreats to the countryside around Paris, he could not find a comfortable mode of life: "there I always lacked an infinite number of conveniences that one only finds in the city; and even the

solitude that I sought there, I never found wholly perfect.” By contrast, in Holland, everyone else was so occupied with commerce that “I would go out walking every day amidst the confusion of so many people, with as much freedom and relaxation as you could find in your private garden. I consider the men that I see there as no more than the woods and trees that one encounters in your forest, or the animals there that one passes by” (AT I, 203). In Holland, Descartes enjoyed not only the liberty of solitude, but also, he tells us, freedom from war and the pure and fresh air which he thought increased his mental productivity. He claims these benefits in a prelude to his *Discours* and *Essais*, where he concedes a great obligation to the king for living “under the aegis of his military power [*à l'ombre de ses armes*]” (letter to Huygens, June 12, 1637: AT I, 638; CSM III, 59-60).¹¹⁸ Aside from a couple of months’ return to Paris and the final few months of his life in Sweden, he would remain in the Netherlands the rest of his life.

Before leaving Paris, however, Descartes would experience an event that not only had an impact on his life, but also certainly fueled the legend that surrounded his name. Likely in November of 1627, Descartes would join a group of well known scholars outside Paris at the Cardinal Pierre de Bérulle’s residence, the former founder of the Augustinian order of Oratorians (of which Mersenne was a member). These scholars were gathered on the occasion of a speech to be given by a M. de Chandoux, who was apparently a mechanistic natural philosopher, professing knowledge of chemical

¹¹⁸ This letter accompanies a previously written letter in which Descartes asks Huygens, friend of the royal court in Holland, to present his *Discours* and *Essais* to the King, the French Ambassador and the Cardinal of Richelieu (AT X, 636).

alchemy, who incidentally was beheaded in 1631 for selling counterfeit money.¹¹⁹ It was not so much the buffoonery of this speech that impressed the attendants—in fact, Baillet reports that the speech was universally well received—but it was the eloquence of Descartes’ rebuttal that deserved the greatest mention. Apparently, Descartes announced that the foundations on which everything Chandoux had proposed could be easily undermined by posing some simple skeptical questions. It is not clear that he had yet stumbled upon the power of hyperbolic doubt because Baillet reports that he criticized “a dozen other similar arguments that carried its listeners to recognize it as a merely probable truth,” an argument which is consistent with the *Regulae*’s interdiction against “probable syllogisms.”¹²⁰ Nonetheless, Descartes’ eloquence and the reasoning behind his speech greatly impressed everyone in attendance, especially the Cardinal, who subsequently requested a personal meeting with Descartes and suggested to him to publish something on the subject.¹²¹ While the specifics of this discussion are not known—most of what is recorded had been passed along by word of mouth—there is no doubt that the episode in a certain sense defines Descartes’ departure from Paris: it sets the

¹¹⁹ Rodis-Lewis, *Descartes*, 68.

¹²⁰ Baillet, *La Vie* I, 162. Gaukroger, *Descartes*, 183-86, doubts that Descartes had any interest in skepticism at this time.

¹²¹ See Baillet, *La Vie* I, 160-166; and Rodis-Lewis, *Descartes*, 67-69, doubts that the Cardinal was very interested in Descartes working on “mechanics and medicine” as reported by Baillet. It is Rodis-Lewis who presents a cogent argument for dating the episode to November 1627, Baillet records August 1628. Menn, *Descartes and Augustine*, 46-50, describes this as the real philosophical turning point in Descartes’ career. I think that he places too great an emphasis on the distinction between the early and late writings of Descartes and concedes too much real influence on Descartes’ later writing from the Cardinal Bérulle. This concession operates in support of Menn’s general thesis that Descartes’ turn toward providing a metaphysical foundation for physics coincides with his incorporation of Augustinian philosophy, since Bérulle was instrumental in the revival of Augustinianism in the seventeenth century.

stage for his celebrity, and the sanction of his ideas by the Papal nuncio could certainly have encouraged his metaphysical speculations that occupy his first year in Holland.

While the date of the event at Cardinal Bérulle's is disputed, it is known that Descartes was in Holland by October of 1628, since Beeckman records his conversations with Descartes in his journal, dating them October 8, 1628 (AT X, 331). These conversations record a very different kind of interest, also characteristic of this period in Descartes' intellectual life. In his conversations with Beeckman, Descartes returns to many of the same issues that had occupied their earlier work together, from 1618 to 1620. Descartes tells Beeckman that in Paris he had discovered a general form of algebra, "by which he arrives at a perfect knowledge of Geometry, and with which it is possible to complete all human understanding" (AT X, 331-32). As I have noted above, sections of this specimen of Descartes' algebra are also found in Rules XV and XVIII, where Descartes conceives of numbers as line segments and their multiplication as parallelograms. Beeckman records the algebraic notation using Cossic signs in his journal, whereas the *Regulae* show that Descartes had already adopted the simpler, modern alphabetical system with raised powers for designating knowns, unknowns and their multiplication. Beeckman's journal also records Descartes' account of the sine-law of refraction, to which he makes reference in Rule VIII. There are some notes on musical chords and the properties of an ellipse are also explained. On February 1, 1629, at Dordrecht, Beeckman records a method for discovering mean proportionals using the intersection of a circle and a parabola (AT X, 342-44). This solution is featured in the *Géométrie* Bk. III (AT VI, 469), where Descartes deduces his real coup de grâce of that

work, a general form for solving quadratic equations of any degree. All of this suggests that Descartes had returned to Holland from Paris with some important discoveries in the area of mathematics and the sciences. He seems to suggest to Beeckman that these fruits of his labors might actually constitute what he had set out to discover in 1619, namely, “a completely new science.” To the extent that these results match up with the *Géométrie* and *Dioptrique*, Descartes may have not been far off the mark in his self assessment.

The early metaphysical thoughts (c. 1630) and the beginnings of a system of natural philosophy

Apart from the task of relaying his recent accomplishments in geometry and optics to Beeckman, Descartes tells Mersenne in 1630 that for the first nine months of his time in Holland, he had done nothing other than to establish the foundations of his physics on metaphysical truths (AT I, 144; CSM III, 22). This famous remark comes in response to a theological question posed by Mersenne, from which Descartes demurs, on grounds that it “is beyond [his] mental capacity.” Though he resists entering into theological questions, he claims that it is “rather metaphysics that ought to be examined by human reason” (ibid.). Furthermore, he states, “I would not have been able to discover the foundations of physics if I had not looked for them along that road.” And he concludes that he has “found how to prove metaphysical truths in a manner which is more evident than the proofs of geometry” (ibid.). Adam and Tannery index these comments to Descartes’ letter to Gibeuf, on July 18, 1629, where Descartes mentions “a

little treatise” that he has begun while in Holland and hopes to finish in two or three years, though “perhaps in the end I shall decide to burn it, or at least not let it out of my hands or those of my friends without giving it careful scrutiny: If I am not clever enough to produce something worth while, I shall at any rate try to be astute enough not to publish my shortcomings” (AT I, 17; CSM III, 5-6). There is no indication of the contents of this “little treatise” in the letter to Gibeuf, but the caution expressed at the end of the letter indicates that it would cover a controversial subject.¹²²

It is possible that Descartes had been emboldened by the affirmation he had received from the Cardinal Bérulle and allowed himself to contemplate metaphysical questions upon his retreat to Holland. The claim that he has found “how to prove metaphysical truths in a manner which is more evident than the proofs of geometry” bears a trope that will recur in the *Discours de la méthode*, where he concludes that “it is at least as certain as any geometrical proof that God, who is this perfect being, is or exists” (AT VI, 36; CSM I, 129). Does this suggest that by 1628 Descartes had arrived at a proof for the existence of God, understood as the foundation of physics? Perhaps. This would be one of the key elements that would move Descartes beyond his work in the *Regulae* and on to other projects.

In Descartes’ April 15, 1630 letter to Mersenne, he also notes that he had begun to study Chemistry and Anatomy together, the combination of which would lead to Descartes’ theory of matter, which was in turn fundamental to his *Traité de la lumière*

¹²² Rodis-Lewis, *Descartes*, 78-83, takes this occasion to hypothesize about the contents of the treatise. Her conclusions are instructive. It seems most likely, pace the editors of CSMK, that the “little treatise” was *Le Monde*, some of the contents of which were expanded and published in the *Dioptrique* and *Météors* (CSMK, 21n1).

and *Traité de l'homme*. After announcing these pursuits, Descartes writes the following very illuminating passage:

Perhaps you find it strange that I have not persevered with some other treatises I began while I was in Paris. I will tell you the reason: while I was working on them I acquired little more knowledge than I had when I began them, and when I tried to take account of this I was forced to start a new project, rather larger than the first. It is as if a man began building a house and then acquired unexpected riches and so changed his status that the building he had begun was now too small for him. No one could blame such a man if he saw him starting to build another house more suitable to his condition. (AT I, 137-38; CSMK, 21)

Given the insights of this chapter, we can confidently assess this passage. The treatises are likely the *Regulae* and perhaps the *Algebra* or other lost treatises. The fact that Descartes claims, “while working on them I acquired little more knowledge than I had when I began them” would confirm his testimony from the *Discours* that locates all of his methodological and mathematical insights to the period of 1619-1620. We have seen how this time can indeed be understood as the origin of much of the *Regulae*, even though it is most likely that the treatise itself was composed while in Paris. Given the new insights into the nature of matter and the workings of the human body, Descartes is convinced that the *Regulae* would be better discarded in favor of a grander project on the nature of all matter in the universe and its relation to human cognition, *Le Monde*, which would include *La Traité de la lumière* and *La Traité de l'homme*. The *Regulae* makes only the most vague appeals to the nature of matter and its effects. Certainly, empirical observations, like those indicated to Mersenne in 1630 would have greatly enhanced Descartes’ relatively superficial understanding of issues in natural philosophy in the *Regulae*. (This notwithstanding the enormous importance of that text for understanding the principles of Descartes’ natural philosophy.) Thus, Descartes’ return to Holland

marks not only a turn toward the metaphysical foundations of his natural philosophy, but also a turn to more sophisticated empirical observations.

If that is the case, these letters confirm Descartes' testimony in the *Discours*. At the end of Part Three, Descartes claims that he would not have embarked on this project of achieving his vision of unifying the sciences through a universal method if "I had not noticed that some people were spreading the rumor that I had already completed it." He claims ignorance for the cause of this rumor: "If I contributed anything to it by my conversation, it must have been because I confessed my ignorance more ingenuously than is customary for those with a little learning, and perhaps also because I displayed the reasons I had for doubting many things which others regard as certain." Is it possible that the "rumor" to which Descartes refers is the aftermath of the Chandoux interrogation, when Cardinal de Bérulle urged him to publish something on the subject? If so, it locates the historical time of Descartes' first expression of his method of doubt and the effectiveness of this method for arriving at a solid foundation for his physics. In the *Discours*, Descartes continues:

But as I was honest enough not to wish to be taken for what I was not, I thought I had to try by every means to become worthy of the reputation that was given me. Exactly eight years ago [from 1636/7, i.e., 1628/9] this desire made me resolve to move away from any place where I might have acquaintances and retire to this country, where the long duration of the war has led to the establishment of such order that the armies maintained here seem to serve only to make the enjoyment of the fruits of peace all the more secure. Living here, amidst this great mass of busy people who are more concerned with their own affairs than curious about those of others, I have been able to lead a life as solitary and withdrawn as if I were in the most remote desert, while lacking none of the comforts found in the most populous cities. (AT VI, 30-1; CSM I, 126)

These words clearly recall the letters to Huygens and Balzac regarding Descartes' assessment of his expatriation to Holland. If these testimonies are thus taken at face value, then the opening statement of Part Four, concerning "the first meditations that I had there [in Holland]" might in fact be accurate. In this case, it seems that in the winter of 1628-1629, Descartes discovered the power of doubt for arriving at the proofs for the existence of the soul, the independence of the mind from the body, and the existence of God, which in turn were to serve as the foundations of his physics.

It is not an incredible leap of reasoning for Descartes to have discovered these metaphysical foundations of his physics at that time. In Rule XII, when he is working out how to link knowledge of simple natures in order to arrive at an understanding of the nature of physical things, he provides several examples of necessary conjunctions of simple natures. A conjunction is necessary, he says, "if one of them [the simples] is somehow implied (albeit confusedly) in the concept of the other so that we cannot conceive either of them distinctly if we judge them to be separate from each other" (AT X, 421; CSM I, 45). The necessary conjunction of simple natures is what we might call, *pace* Kant, an analytic a priori inference. This is then precisely the kind of reasoning that one finds in geometrical proofs. Among Descartes' examples, he cites "that 4 and 3 make 7, the composition is a necessary one, for we do not have a distinct conception of the number 7 unless in a confused sort of way" (AT X, 421; CSM I, 46).¹²³ He continues:

This necessity applies not just to things which are perceivable by the senses but to others as well. If, for example, Socrates says that he doubts everything, it necessarily follows that he understands at least that he is doubting, and hence that

¹²³ In point of fact, Kant calls this kind of combination synthetic a priori for his own reasons, *Critique of Pure Reason*, 144, B15-6. I bracket this issue entirely for the moment.

he knows that something can be true or false, etc.; for there is a necessary connection between these facts and the nature of doubt.... Again, there are many instances of things which are necessarily conjoined, even though most people count them as contingent, failing to notice the relation between them: for example the proposition, “I am, therefore God exists,” or “I understand, therefore I have a mind distinct from my body.” (AT X, 421-2; CSM I, 46)¹²⁴

These roughly sketched examples are clearly not the same as the proofs for the existence of the self, the mind’s distinctness from the body, or the existence of God found in the *Discours*, but they serve to show that Descartes’ thought in the *Regulae* had advanced to such a stage that it was not impossible for him to discover those proofs as early as 1629, in his first few months in Holland.¹²⁵

These are critical discoveries for Descartes and they constitute the beginning of his mature metaphysics. Nonetheless, they should not be taken to be utterly distinct from his mathematical and physical investigations. It must be remembered that Descartes spends considerable time, at least between October 8, 1628 and February 1, 1629, explaining his discoveries in geometry and optics to Beeckman. Furthermore, despite the well-known letters to Gibeuf and Mersenne that mention his newly discovered metaphysical principles, the vast majority of Descartes’ correspondence, which far

¹²⁴ These comments echo those of Rule III, which provides the following examples of intuition and deduction: “everyone can mentally intuit that he exists, that he is thinking, that a triangle is bounded by just three lines, and a sphere by a single surface, and the like. . . . The self-evidence and certainty of intuition is required not only for apprehending single propositions, but also for any train of reasoning whatever. Take for example, the inference that 2 plus 2 equals 3 plus 1: not only must we intuitively perceive that 2 plus 2 make 4, and that 3 plus 1 make 4, but also that the original proposition follows necessarily from the other two” (AT X, 368-9; CSM I, 14-5).

¹²⁵ For confirmation of the claim that there is a marked difference between Descartes’ passing remarks that ‘everyone can mentally intuit that he exists’ and that ‘I understand, therefore I have a mind distinct from my body,’ see Descartes’ letter to Clovius (AT III, 247-48), where Descartes distinguishes his concept of the ‘I’ from St. Augustine’s on the basis of its role in his metaphysical system. Such a distinction could be just as easily extended to the early Descartes of the *Regulae*.

exceeds these minor remarks, remains focused on explaining issues in optics, mathematics, and physics. Ferdinand Alquié was perhaps the first to outline the development of Descartes' thought in terms of a sharp distinction between his early investigation into mathematical exercises and his later metaphysical discoveries.¹²⁶ This line of interpretation has been repeated often by some of the most eminent commentators on Descartes' intellectual development. Daniel Garber evokes a kind of dualism between Descartes problem-solving in mathematics and system-building in metaphysics: "When Descartes ceased to be a problem-solver and became a system-builder, it is not surprising that the method, central to his early thought, would become obsolete."¹²⁷ Even Gary Hatfield suggests that there is a rather sharp distinction between Descartes' early mathematical and methodical writings and his later metaphysics.¹²⁸ Stephen Menn follows Garber, regarding the change in Descartes' philosophy as one from "preparatory mathematical exercises" to "philosophical construction." He seems to read this change along the lines of Descartes' project in *mathesis universalis*, arguing that Descartes had originally sought an avenue to the unification of the sciences from the mathematical disciplines, but then realized that this was insufficient and pursued a metaphysical ground for this unification instead.¹²⁹ Stephen Gaukroger presents a much more integrated account of the period of 1629-1630, viewing the metaphysical discoveries, on which Descartes exercised most of his thought, in the context of his work on optics and

¹²⁶ Ferdinand Alquié, *La découverte métaphysique de l'homme chez Descartes*.

¹²⁷ Garber, *Descartes' Metaphysical Physics*, 50. Cf. Garber, "Descartes and the Method in 1637," in *Descartes Embodied*; and Peter Dear, "Method and the Study of Nature."

¹²⁸ Gary Hatfield, *Descartes and the Meditations*, 16.

¹²⁹ Menn, *Descartes and Augustine*, 50.

mathematics. However, this line of reasoning seems to operate to the detriment of Descartes' metaphysics, when it leads to Gaukroger's claim that "Descartes' [metaphysical] project is ultimately directed towards metaphysical legitimation of his natural philosophy, which is resolutely Copernican."¹³⁰ As with all of the preceding cases, it is easy to see Descartes' metaphysical discoveries as radically heterogeneous from his earlier work on mathematics and method.¹³¹ Indeed, we have seen that Descartes' own testimony is vastly weighted in favor of that interpretation. Yet, the *Discours* also presents both of these critical periods in Descartes' life, one beginning in 1619 with the discovery of a universal method in the sciences, the other in 1629 with the discovery of metaphysical principles, as ingredient to that work. The rules of the method, introduced in Part Two are meant to provide the procedure for rebuilding the edifice of knowledge after its destruction. If one brackets for a moment the importance of the provisional morality, Part Four then presents the metaphysical principles discovered in 1629 as the cornerstones of this new structure. Thus, even in 1637, Descartes presents his project of methodical problem-solving as intimately related to the "system-building" or "philosophical construction" that is meant to follow the demolition rendered by hyperbolic doubt. More to the point, however, even if the *Regulae* is the house abandoned in favor of the castle, the construction certainly utilizes the same plot of land, and to extend the metaphor, the same topological survey. It is the *Regulae* that advances a

¹³⁰ Respectively, Gaukroger, *Descartes*, ch. 6: "A New Beginning, 1629-1620," 187-224 and 355. It is a bit shocking to read Gaukroger's "intellectual biography" of Descartes and to find only 10 pages devoted to a discussion of the *Meditations*.

¹³¹ J. L. Beck, *The Method of Descartes*, offers a notable exception, reading Descartes' method as generally continuous from the *Regulae* to the *Meditations*.

theory of science fitted to our cognitive capacities, defines the nature of matter as that which can be expressed in clearly perceived figures, and outlines an algebraic method of comparing unknown entities to known entities. These elements are instrumental in the production and completion of the system, the castle so to speak.

While it has been noted that the *Discours* cannot be taken as an entirely accurate portrayal of Descartes' intellectual development, it should be taken as a sketch of Descartes' own vision of his philosophical project. In other words, Descartes sees his philosophical project in the *Discours* as one that abandons the particular disputations of the schools in favor of a complete eradication of former philosophical principles, a process that lays the ground bare for a new philosophical paradigm. This philosophical paradigm is governed by three principle discoveries: one is the four-step method for achieving truth in the sciences, the second is the provisional moral code for human action and the third is the discovery of the metaphysical principles of the existence and nature of the self and God. However, acknowledging that Descartes' vision of a unified project for attaining truth in the sciences does not alleviate the responsibility of making precise distinctions about Descartes' actual philosophical claims.

Though the *Regulae* is a treatise composed in order to outline the basic method for achieving scientific truth and it is the most explicit discussion of its kind, there is no single "method" in Descartes' philosophy.¹³² The method of hyperbolic doubt which thrusts the cogito into the foreground as that which legitimates Descartes' metaphysics is absent from that early work. Second, it is not clear whether Descartes' proposed method

¹³² Daniel Flage and Clarence A. Bonnen, *Descartes and Method*, presents a very clear outline of these distinctions.

of geometrical analysis, which is said to govern the *Meditationes*, is the same as the art of discovery or “true analysis” that is treated in the *Regulae* as ingredient to the *mathesis universalis* (though I think that they are probably related). Third, the very specific methods applied to mathematics and natural philosophy—on the one hand, a method of solving algebraic equations that transposes them into geometric constructions, on the other hand, an experimental and inductive method—must be distinguished from a general sense of method. Finally, even the four-step method discussed in the *Discours* finds no articulation as clear and precise in the *Regulae*, though it does seem to point back to that work. These issues must be treated carefully when discussing Descartes’ “method.” Thus, when the *Regulae* is considered as an antecedent to the later work, particularly in terms of our present concern--Descartes’ concept of mind--the nature of this antecedence must be made precise. What aspects of the method, elaborated in the *Regulae*, function to generate the priority that Descartes’ later metaphysical writing gives to the mind? What is the connection between method and mind in Descartes?

The fact that Descartes’ discovery of the metaphysical principles of physics did not impede his research into optics, mathematics, and natural philosophy suggests that these concepts could be more or less seamlessly interwoven with his early conception of the method appropriate to those scientific investigations.¹³³ It does not appear that Descartes completely abandoned those early thoughts on method; rather, they were retained and incorporated into the mature writings. The task of the dissertation will be to develop a concept of the mind in the *Regulae* that itself fits seamlessly into Descartes’

¹³³ This is the sense in which Descartes’ natural philosophy is a “metaphysical physics.”

mature metaphysical writings. I will argue that this concept of mind is governed by Descartes' attention to scientific truth, which is achieved through careful adherence to a *mathesis universalis*. This notion of scientific truth coordinates Descartes' insight into the metaphysical and epistemological importance of his theory of cognition. In the end, the notion of the *cogito* as a fundamental metaphysical principle originates in the concept of scientific knowledge that he articulates in Rule I: "For the sciences as a whole are nothing other than human wisdom, which always remains one and the same, however different the subjects to which it is applied, it being no more altered by them than sunlight is by the variety of the things it shines on" (AT X, 360; CSM I, 9).

***Mathesis Universalis*, Method, and Mathematics: The Origins of Descartes' Theory of Matter and its Distinction from Mind**

In the preceding chapter, we found that the central concern of Descartes' early work is with developing a technique to solve mathematical problems, which would apply to problems in natural philosophy. Initially, he imagined a universal method that would unite the various sciences. We have already heard intimations that this method will somehow relate to Descartes' concept of mind. In this chapter, we begin to be more specific about the connection between this early focus on mathematics and method and the origins of Descartes' concept of mind. This chapter will approach that issue much more directly from the perspective of the 'mathesis universalis' as it relates to Descartes' method of discovery in the sciences. Though the term has been widely debated and has received many different interpretations, I will argue that 'mathesis universalis', for Descartes, is essentially connected to the development of a method that applies the intellectual powers to solving problems that are mathematical in nature. Descartes seems to operate under the assumption that a kind of mathematical or algebraic method is the paradigmatic method for science in the general sense (*scientia*). This method is, in essence, Descartes' idiomatic response to what was a general theme of the 16th and 17th centuries, i.e., a rediscovery of the classical dialectic, "method of analysis," or "art of discovery" in the sciences. He weaves this historically contemporary search for a universal art of discovery in with his knowledge of mathematics to propose a workable

technique for solving problems in natural philosophy with the use of arithmetic and geometry.

At first blush, there does not appear to be any reason to claim that Descartes' investigation into the method appropriate to the mathematical disciplines—even when it is given the glossy title of a 'mathesis universalis'—would inform Descartes' concept of mind.¹³⁴ First of all, at least for the mature Descartes, the mind is a thing, a *res cogitans* and, what is more, a distinct and independent substance. Neither mathematics, arithmetic, geometry, or method could be considered a "thing" in this sense. These are subject matters, disciplines, or modes of investigation. While the ontological status of the objects they study may be an interesting question, they themselves are not things. Second, the mind would seem to have a privileged status relative to method or mathematics, since in some way they are activities or operations of the mind. Thus, the concept of mind would seem to operate on a different ontological level than mathematics or method, both of the latter depending on the former. Why would they, rather than any other mental activity or objects of thought, be particularly illuminating with respect to the metaphysical nature of the mind? Moreover, what kind of analogy could exist between this substance, mind, and its activity or operation? Though it is often assumed that Descartes' notion of method and

¹³⁴ I concede this difficulty despite the testimony, for example, of Beck, *The Method of Descartes*, 111: "The rules we are in search of, that is, the Method, are found by a careful reflection upon the human mind in its natural unperverted state, by a study of its procedure when it functions purely and its natural power of grasping the truth is not corrupted or hampered by 'prejudices'. The human mind, so far as it functions in accordance with its nature, cannot fail to think truly. If then we wish to acquire knowledge, the one vital condition is that our thinking should be the thinking of the human intelligence in so far as it is functioning according with its own nature.... For to reflect upon the procedure of the human intellect, in so far as it follows its own nature in its thinking, is to reflect upon the conditions of truth."

his preference for the mathematical sciences bears some relation to his concept of mind, this assumption ought to be justified.

This chapter attempts to outline such a justification by way of a historical investigation into the use and meaning of the *mathesis universalis*. This historical overview will furnish a narrative, describing the origins of the term ‘*mathesis universalis*’, its connections to Renaissance theories of method, and its implications for seventeenth century mathematics, in order to inform the interpretation of Descartes’ use of that term. The observations noted in the first section will demonstrate that Descartes’ interest in the *mathesis universalis* is part of a larger engagement in a tradition of logic, memory art, encyclopedism, and an investigation of the true method of discovery in the sciences. This tradition sought to recover the lost method of discovery in Plato and Aristotle, what they called simply ‘*dialectic*’. Prior to the time when Descartes began working on the *Regulae*, however, algebra presented itself as a new influence on discussions of scientific method. Around the turn of the seventeenth century, it was thought that this *mathesis universalis*, which was frequently identified with algebra, could provide that hidden key to the scientific method. Descartes’ response to the enthusiasm about existing algebraic methods is measured, but his devotion to the basic epistemological tenets of that tradition is central to the *Regulae*. I will examine the particular places where Descartes uses the term ‘*mathesis universalis*’ and thus propose an interpretation of how this concept is understood in the context of Descartes’ philosophy. (One claim will be that, in fact, Descartes’ understanding of ‘*mathesis*’

changes over time.) To understand the central features of Descartes' *mathesis universalis*, Leibniz will offer an important point of comparison.

The second section will then apply the discussion of the *mathesis universalis* to a general understanding of Descartes' method in the *Regulae* and the relationship between method and the genesis of Descartes' concept of mind. There is an important sense in which the 'mathesis universalis' is the central concept governing the *Regulae*: it determines the basic principles of the method. Furthermore, that work provides a crucial link between Descartes' initiation into philosophical research in 1619 and his first published treatise, the *Discours* and *Essais* (1637). With the *Discours* and the *Essais*, Descartes locates his method at the heart of his natural philosophy and metaphysics. There, he substantiates some of the provisional theses of the *Regulae* through his demonstration of the existence and nature of the mind as well as the existence of God. We see in the *Discours*, for instance, that the method bears an intimate relation to the mind as the first principle of Descartes' metaphysics; and we see that the conception of the physical world as subject to geometrical measurement yields Descartes' unique vision of mechanistic natural philosophy. These doctrines of the *Discours* and *Essais* bear a direct lineage to the *mathesis universalis* of the *Regulae*. However, Descartes' vision of the possible scope of a purely mathematical method is not entirely commensurate with his natural philosophical practice: we will see that he is forced to make certain fundamental assumptions about the nature of the physical world (that prove to be unjustified) and he implicitly imports an empirical method of observation without formally integrating this method into his philosophy of method.

Mathesis universalis: a brief history of the term

Part of the reason for the great deal of confusion that surrounds the interpretation of the ‘mathesis universalis’ in Descartes’ work is that he rarely mentions the concept and describes its meaning only once in his entire corpus, in the infamous Rule IV-B. As I have described in previous chapter, this passage has been questioned for its relevance to the work as a whole. Apart from this historically contentious passage, Descartes gives the reader few resources with which to understand the concept. Additionally, the historical roots of this concept reach as far back as Plato and Aristotle, though the term ‘mathesis universalis’ only emerges as a thematic subject of study in the 16th century. By the 17th century, it seems to achieve some prominence as a description of the general application of the method of algebra to resolve problems in both arithmetic and geometry, serving as the title for at least two Cartesian textbooks on geometry. Leibniz finally makes it one of the real focal points of his philosophy; and it is Leibniz’s understanding that has had the most enduring influence on subsequent philosophical treatments of the term. For this reason, I think it is necessary to survey, in the broadest way possible, the general history of the term, from its classical beginnings to its contemporary interpretation, in order to glean a coherent philosophical concept of what ‘mathesis universalis’ means.¹³⁵

¹³⁵ The principle studies of the ‘mathesis universalis’ are the following: L. Liard, “La méthode et la mathesis universale de Descartes,” the earliest treatment of the concept, which essentially sees it as integrated with a concept of universal method; Jean-Paul Weber, *La Constitution*, especially Ch. 1, which lays the groundwork for interpreting the mathesis universalis as a ‘universal mathematics’ and consequently understands this to be strictly distinct from a

Though the “historical survey” seems to trace an elliptical path, it will illuminate the broader philosophical context within which one can understand Descartes’ project in the *Regulae*. There are several important threads of this history that must be disentangled in order to appreciate the precise ways in which Descartes’ concept of method and mathesis emerge from a historical context but also inaugurate something new. I take the view that the mathesis univiersalis is one of the primary ways that Descartes’ articulates his concept of method in the *Regulae*. Though there are others, this concept seems best to capture the technical aspects of the method; though it is certainly not a comprehensive articulation of ‘method’ in the *Regulae*, it holds a place of prominence among many different presentations of “the” method.¹³⁶ One of the benefits of construing the mathesis

universal method; Giovanni Crapulli, *Mathesis Universalis*, provides a complete survey of the 16th century use of the term, together with very helpful appendices including excerpts from sources that are otherwise difficult to find; Jean-Luc Marion, *Les Règles*, Annexe II, 302-9, which claims that the passage in Rule IV-B represents Descartes’ answer to a specific contemporary problem that pertained directly to his current research on method and also provides a number of classical and early modern source references; Frederick Van de Pitte, “Descartes’ *Mathesis Universalis*,” and more recently, “The Dating of Rule IV-B and Descartes’ *Regulae ad directionem ingenii*,” in both cases Van de Pitte argues that Descartes makes a clear distinction between mathesis and mathematica, the former closely related to the method; Pamela A. Kraus, “From Universal Mathematics to Universal Method: Descartes’ ‘Turn’ in Rule IV of the *Regulae*,” who argues for an early dating of Rule IV-B, principally on the basis of her interpretation of the metaphor of the seed and fruit, which recurs in both sections; and Jürgen Mittelstrass, “The Philosopher’s Conception of the ‘*Mathesis Universalis*’ from Descartes to Leibniz,” which takes the broad historical conception of the mathesis universalis as a general science, on analogy with arithmetic and geometry, but with broader applications; John Schuster, “Descartes’ *Mathesis Universalis*,” whose interpretation is treated extensively in Ch. 1; and Chikara Sasaki, *Descartes’ Mathematical Thought*, Part II, 287-417, who takes a broad historical view and understands the mathesis universalis to be intimately connected with algebra and with Descartes’ concept of a method of discovery in the sciences.

¹³⁶ For instance, Dan Garber, “Descartes’ Method in 1637,” 38-39n8 holds that such an identification is not warranted. His comment appears to be directed toward Marion, *Les Règles*, 144-47n18, who argues that the ‘mathesis universalis’ of Rule IV-B is convertible with the ‘methodus’ of Rule IV-A. My claim is most precisely in contradistinction to the theses of Weber, Schuster, and Kraus, op. cit. To be clear, mathesis universalis is not a

universalis in light of Descartes' method and his early discoveries in mathematics is that one will be able to understand how each of these three concepts serves to highlight the primacy of self-conscious thought, or mind, in determining the nature and extent of scientific knowledge. The justification for this claim depends on the historical resources from which Descartes' concept of method emerged. First, Descartes' focus on the appropriate method for scientific investigation reflects a 16th century focus on dialectic and the method of discovery as it related to education and the appropriate categorization of the sciences. However, that once venerated tradition had lost its lustre in by the late Renaissance period for two reasons: (1) it had become identified with rhetoric in the Ciceronian tradition and (2) the political context in which rhetorical virtue was praised had gradually disappeared. Thus, when the 16th century reformers sought to reinvigorate a true method of discovery—dialectic—they saw their project as radically diverging from the Aristotelian tradition. Coincidentally, the 16th century also saw a resurgence of the Galenic empirical method of scientific investigation and a deepening interest in solving classical problems in geometry. As a consequence, the mathematical and scientific methods began to become intertwined; the 'mathesis universalis' is one of the fruits of this union. In mathematics, Christopher Clavius and François Viète championed algebra as the true art of discovery that had been hidden for so many centuries. In this way, the 'mathesis universalis' also came to be roughly identified with algebra, both as a method of discovery and a domain of study. Thus, by the time of Descartes' *Regulae*, he states

methodus any more than it is a mathematica. Nonetheless, there is an important synthesis of these three concepts in the *Regulae* such that Descartes' understanding of each depends on the others.

his purpose as a search for the true method in the sciences, but he discards traditional dialectic as “merely probable syllogisms” whose conclusions, he claims, are disputed and whose demonstrations produce no new knowledge. Instead, Descartes’ hails a new method of comparison (essentially algebraic), which he distinguishes from other contemporary algebraic efforts. In order to understand this tension in Descartes’ writings—his simultaneous search for a method of discovery and his neglect of dialectical reasoning—it is necessary to reexamine the historical development that precedes Descartes’ *Regulae* and makes possible his claims in that work. Ultimately, Descartes’ interpretation of the mathesis universalis as a general method of discovery in the sciences rests on an epistemological claim about what counts as scientific truth.

Dialectic and rhetoric in classical philosophy

When Descartes refers to dialectic, dialecticians or their principle tool, the syllogism, in the *Regulae*, it is—with one notable exception—negative. He uses some variant of dialectic six times (AT X, 365, 372, 405-406 and 430; CSM I, 12, 16, 36-37 and 51) and syllogism five times (AT X, 363, 389, 406, 430 and 439; CSM I, 11, 26, 36-37, 51 and 57). Dialectic is said to be “of little use” or “useless,” while syllogisms are thought not to produce new knowledge, but only to sharpen the wit while failing to advance the search for truth. The two principal passages in which Descartes treats dialectic and the syllogism are found in Rules II and X. In Rule II, Descartes’ primary target is “probable syllogisms.” These, he charges, are “made for controversies,”

uncertain, and produce disputed conclusions. On the basis of this assessment of dialectic, he discards all syllogistic reasoning and claims to rely only on “arithmetic and geometry,” which are by contrast “so pure and simple that they make no assumptions that experience might render uncertain” (AT X, 363-66; CSM I, 11-12). Rule X adds to the claim that dialectical syllogisms are uncertain a further claim that even when one does demonstrate by means of the syllogism, this type of demonstration offers nothing new. He says, “to make it even clearer that the aforementioned art of reasoning contributes nothing whatever to knowledge of the truth, we should realize that, on the basis of their method, dialecticians are unable to formulate a syllogism with a true conclusion unless they are already in possession of the substance of the conclusion” (AT X, 406; CSM I, 36-37). Thus, according to Descartes, dialectical syllogisms are either uncertain or trivial; this is why he repeatedly claims that they are of no use to the present investigation.

There is one passage in which Descartes refers to dialect and syllogistic reasoning in a somewhat favorable light. In Rules XIII and XIV, he compares his “method of comparison” to the syllogistic method of “finding the middle term.” The sense in which this analogy works and the sense in which it breaks down will be treated in a subsequent section. Briefly, the “method of comparison” that Descartes acknowledges is similar to the syllogistic method is essentially Descartes’ algebraic method, given a broad application to both mathematical and physical problems.

Dialectic in Aristotle

On the basis of the *Regulae* alone, a careful reader might be persuaded by Descartes' forceful rejection of the syllogism as an invalid method of discovery. However, there is an important sense, at least in Aristotle, in which the dialectical syllogisms do produce new knowledge and are, in fact, one means of arriving at first principles for scientific demonstration. In order briefly to explain the nature of syllogistical reasoning and the sense in which it produces scientific knowledge, it will be helpful to return to Aristotle's *Prior* and *Posterior Analytics*, *Topics*, and *Sophistical Refutations*. First of all, dialectic is but one kind of syllogistical reasoning for Aristotle. One common misunderstanding of Aristotle's dialectic—one that Descartes propagates when he pejoratively refers to "probable syllogisms"—is that dialectic presumes to reason from what is merely probable to what is necessary. Of course, this would be invalid. However, it is not what Aristotle has in mind either. He differentiates dialectic from demonstration by the fact that dialectic makes an appeal to an interlocuter or to common or reputable opinions (*endoxa*) in order to establish its premises, whereas a demonstration makes no such appeal, but simply "lays them down." The result is that, whereas the veracity of dialectical deduction depends on the veracity of the solicited opinions, demonstration demonstrates absolutely (*Pr. An.* I, 1 24a 21-4; cf. *Pos. An.* I, 2).

The paradigmatic case of dialectic is one of a scholastic disputation—a kind of cross-examination procedure—where one student attempts to demonstrate the falsity of another's claim by showing that the premises that his opponent holds lead to a contradiction. This disputatious sparring can be extended to more general kinds of

investigation where, for instance, one appeals to common or reputable opinions (*endoxa*) in order to reason to puzzles (*aporia*). This is precisely the sense in which dialectic is useful for scientific investigation: “it is through reputable opinions about [the sciences] that [syllogisms] have to be discussed, and this task belongs properly, or most appropriately, to dialectic; for dialectic is a process of criticism wherein lies the path to principles of all inquiries.”¹³⁷

One could construe Aristotle’s *Organon* as a textbook intended to prepare young philosophers in the art or skill of dialectic so that they could go on to engage in true scientific investigations. Indeed, the *topoi* of the *Topics* catalogue the various forms of argumentation commonly used in this sort of rhetorical exercise.¹³⁸ The numerous forms would be difficult to employ without rigorous and consistent training. In this sense, these mental exercises seem designed to pass on a kind skill (*technê*) for investigating scientific truths that must be learned through practice rather than understood by means of demonstration. Thus, scientific investigation, insofar as it utilizes dialectic, depends on a prior assumption of technical expertise on the part of the scientist, i.e., a practical skill rather than just the understanding of a formal system. With this arsenal of arguments, forms of inference, and a catalogue of common and reputable opinions on a variety of subjects, Aristotle proposes to arrive at first principles by way of dialectical reasoning.¹³⁹

¹³⁷ Aristotle, *Topics* I.2, 101b 1-3: trans. by W. A. Pickard-Cambridge in *The Complete Works*.

¹³⁸ The variety of *topoi* are far too numerous to list here, even provisionally. H.G. Zekl’s “Ausführliche Inhaltsübersicht,” cviii-cxvi, lists hundreds of variations.

¹³⁹ Some classical examples of the use of a dialectical-type reasoning in order to arrive at scientific truths are found in the following texts: (concerning natural philosophy) *Physics* I and IV; and *De Anima* I and II, 1-2; (concerning first philosophy) *Metaphysics* I, IV; and (concerning practical philosophy) *Rhetoric* I, 1-2; *Nicomachean Ethics* I and IX, 4; and *Eudemian Ethics* VII, 6.

From a post-Cartesian critical perspective—one which we take for granted in contemporary philosophy—it seems impossible to reason dialectically, beginning with beliefs or opinions (no matter how commonly held and no matter how “skillful” the scientist) to arrive at any sort of scientific first principles. In contemporary science, there is no putative connection between ordinary opinion and scientific truths. Though it may be possible (and perhaps even desirable) to link scientific truths to “folk” beliefs, we certainly do not begin from what the folk suppose to be the case in order to arrive at first principles of scientific demonstration.

Thus, the question remains, how does Aristotle accomplish the move from opinion to truth, where the former depends on the testimony of the senses or of the opinions of others and the latter is intended to be necessarily true? By and large, commentators adopt the strategy, *pace* G.E.L. Owen, of understanding *endoxa* as another sort of *phainomena* and they claim that, like all elements of experience, opinions admit of degrees of certainty and thus are applicable to scientific reasoning insofar as they suit the matter under investigation.¹⁴⁰ The advantage of construing opinions as general features of experience is that the process of moving from opinion to first principles is just the process of induction—not that this frees it from difficulty. Sifting through puzzles to find principles is not unlike sifting through the range of everyday experience in order to arrive at some general lessons about that experience. Of course, for Aristotle, the former is no

¹⁴⁰ G.E.L. Owen's classic paper, “Tithenai ta phainomena” [Reprinted numerous times]. T. Irwin *Aristotle's First Principles* has been the gold standard of a response to this issue, but the proposed contemporary solutions to the problem are too numerous to list.

less dependent on a certain kind of training and the acquisition of a certain skill than the latter. It is the *Topics* that are meant to furnish the exercises for acquiring that skill.

The art of discovery in Aristotle's science depends on an epistemological faith in perceptions and in the opinions passed down through a particular linguistic tradition.

While these are some of the general features that define Aristotle's "scientific method," he appropriates the terminology of dialectic and method from Plato, for whom the *methodos* is that by virtue of which one can be said to have a sound knowledge of any skill, and it is through the *methodos* that the skill is taught to others. For Plato, the one who masters analysis (*diarexis*) and synthesis (*synagôgê*) is called the dialectician.¹⁴¹

While Aristotle uses the Greek *methodos* sparingly, its sense is derived from its much more common root, *hodos* (literally, 'way or path'), according to which the *meta-hodos* indicates that which is 'after the way' or, perhaps more idiomatically, 'in pursuit of the way' or 'in pursuit of truth'. In Aristotle, as I have noted above, there is a connection between *methodos* and *technê*. This is reflected most notably in the Stoic conception of method, expressed by Zeno when he defines *methodos* as *technê estin hexis hodopoiêsis*.¹⁴² In this sense, *methodos* is clearly an acquired capacity of the human being that enables a certain kind of production. The stoic conception of the *methodos* highlights the sense in which there is a system of rules governing the appropriate direction of the mind such that, when exercised together, they direct one toward ends useful in life.

Though there is an implicit sense of 'utility' and even 'production' in *hodos*, since the

¹⁴¹ The principal text in this matter is the *Phaedrus*. See Gilbert, *Renaissance Concepts of Method*, 40.

¹⁴² Quoted in Gilbert, *Renaissance Concepts of Method*, 43.

way seems to be tied to an ‘end’, the Stoics seem to have made this sense an explicit feature of the method. They framed a set of informal rules or prescriptions that enabled one to achieve *katalepsis*, i.e., the strong sense impressions that defy doubt. Cicero translates *katalepsis* by *perceptio* and the linguistic similarity between *perceptio* and *praeceptio* (‘a set of rules’) created some confusion, which historically served to reinforce the prescriptive or rule-bound nature of the methodical technique.¹⁴³

Dialectic in the Latin world

Most of the Latinate philosophers eschewed transliterating *methodos* by *methodus*, preferring instead the Latin expressions *ars*, *via* et *ratio* to describe the rational technique by which one arrives at scientific demonstrations.¹⁴⁴ Only Galen, in the Hippocratic medical tradition, and Boethius, in his commentary on Aristotle’s *Topics* (where he describes its contents as providing a *methodum invenire*), prefer the transliteration, *methodus*. For Galen, the method concerned primarily a ‘method of healing’ by which the doctor would arrive at a diagnosis of the disease and a prescription of the cure by means of a progressive distinction between like and unlike qualities. He thus divides method into three components, analysis (the reductive stage of dividing like from unlike), synthesis (where these elements are coordinated with a systematic understanding of the human body and disease), and definition (by which the essence is

¹⁴³ Ibid. 11-13.

¹⁴⁴ Massimiliano Savini, *Le développement de la méthode cartésienne dans les Provinces-Unies (1643-1665)*, contains a very nice summary of these issues in section 2.1.

named).¹⁴⁵ Unfortunately, Galen's eclectic and rather loose use of terminology did not lend his conception of method any lasting influence in medieval philosophy. Cicero was the preferred source such that, for instance, Aquinas continues to employ the *via*, *ratio*, and *processus* in favor of *methodus*.

Without a coherent and well-defined 'method of discovery' with which to comprehend Aristotle's dialectical techniques expounded in the *Topics*, the mere rhetorical application of those techniques held sway. Moreover, the crucial concept that does the work in scientific discovery for the Latinate commentators seems to have been the *hexis* or *dispositio* brought about in the soul of the student, rather than the logical structure of the syllogism. Thus, dialectical deduction, or dialectical reasoning, was gradually pushed to the periphery of scientific discovery. The syllogism seems to have been thought to be useful in education, since it organized the premises and conclusions in a clear manner, but did not reflect the true nature of discovery. Thus, much of the tradition would have agreed with Descartes' assessment that one is "unable to formulate a syllogism with a true conclusion unless [one is] already in possession of the substance of the conclusion," though this is clearly not an accurate depiction of the use of deduction in Aristotle. When, in the Late Middle Ages, the humanists would again take up Aristotle's *topoi* and *methodus* with renewed vigor, they vehemently rejected the eristic use of dialectic in disputations: "The aim of disputation, so the Humanists argued, was simply the 'silencing of one's opponent', and the gaining of glory for the winner. Of what

¹⁴⁵ Gilbert, *Renaissance Concepts of Method*, 13-24; see also Wilhelm Risse, "Zur Vorgeschichte der cartesischen Methodenlehre," 272.

possible use could this practice be to other arts?”¹⁴⁶ On a deeper philosophical level, Descartes will reject any dialectical reasoning out of hand, not because it employs a faulty form of reasoning but because it relies on the authority of others. In Rule III, he claims

[E]ven though we know other people’s demonstrations by heart, we shall never become mathematicians if we lack the intellectual aptitude to solve any given problem. And even though we have read all the arguments of Plato and Aristotle, we shall never become philosophers if we are unable to make a sound judgment on matters which come up for discussion; in this case what we would seem to have learnt would not be science but history. (AT X, 367; CSM I, 13)

This characterization of science, namely, that it rests on the capacity to make sound judgments on whatever matter presents itself as opposed to relying on the opinions of others, is a central feature of Descartes’ rejection of dialectical reasoning. His claims neglect the role of developing a technical expertise such as was required for Aristotelian dialectic. Certainly, for Aristotle, developing technical expertise in argumentation is not merely a matter of rehearsing the arguments of others. Nonetheless, Descartes’ preference for the mind’s grasp of truth and its capacity to make true judgments as the basis for scientific knowledge would mitigate against a method founded in any way on the opinions of others (whether reputable or authoritative).

Order and method in the 16th century: an ars brevis

Some sixteenth century renaissance humanists saw fit to return to the concept of *methodos* as a real method of discovery even though others rejected the “barbaric”

¹⁴⁶ Gilbert, *Renaissance Concepts of Method*, 77.

transliterations of Greek in favor of a truly Latinate rendering of Aristotle's meaning.¹⁴⁷

However, these Latinate purists were fighting a losing battle as the philosophical importance of the concept of method necessitated a word to identify it. In this context, Peter Ramus emerged as a controversial but central figure of reform in scholastic education who returned to the Galenic use of *methodus* as a means to describe the true nature of reasoning about scientific matters.

Peter Ramus, 1515-1572

Unlike Galen's tripartite division Ramus proclaimed the unity of the method of dialectic, as the "art of arts" and the "science of the sciences." The reason for this is that Ramus believed dialectic to describe the structure of reasoning of the mind itself. For him, dialectic could be divided into two categories: invention and judgment. The latter involved the use of the syllogism, the collocation of various experiences (this is where he locates method), and the conjunction of these with a true understanding of God's nature. Insofar as Ramus believed dialectic to describe something essential about the way the human mind thinks and judges, he considered his project to be one of reforming the tedious and burdensome tradition of scholastic education in favor of a simple, clear, and concise art that would illuminate the true categories of things without the proliferation of forms of deduction.

In understanding the purpose of dialectic to provide a concise method of instruction, Ramus is echoing a tradition of Aristotelian commentary, such as what one

¹⁴⁷ Ibid. 60-63.

finds in Augustinus of Nifo and Albert the Great. These commentaries identify dialectic as an *ars brevis*, or concise compendium of learning, intended to lead one to discover scientific truth.¹⁴⁸ Additionally, Ramus follows both Johann Sturm and Agricola whose reforms of logic suggested a reform of Aristotle's *Organon* as a project that would supply the basic method of investigation in the sciences. Whether or not these reformers actually improved upon the existing scholastic textbooks is up for question, but it is their vision with which we are concerned, insofar as this ushers in a new perspective on method and the science of discovery.

Ramus' anti-Aristotelianism, which would eventually lead to the interdiction of his lectures by the faculty of the Sorbonne, seems to have arisen out of practical, pedagogical concerns.¹⁴⁹ His most influential work, the *Scholae dialecticae* (1569), was a textbook of sorts for the young student in the schools (*scholae*). Ramus seems to have understood his project in terms of distinguishing the true nature of dialectic as the method of discovery appropriate to reason from its unfortunate confusion with rhetoric and grammar. He claims, "Aristotle caused the greatest confusion when he made invention the first part of rhetoric, which is false, because invention belongs to dialectic [*Aristoteles summae confusionis author fuit: inventionem rhetoricae partem primam facit, falso ut antea docui, quia dialecticae propria est*]." For Ramus, Quintilian only made matters worse: "It is amazing how ignorant Quintilian was of the nature of dialectic: he confounded dialectic and rhetoric; he did not realize that invention, disposition, and

¹⁴⁸ See Savini, *La Développement de la méthode cartésienne*, 35-36.

¹⁴⁹ Walter J. Ong, *Ramus, Method, and the Decay of Dialogue*, 39, writes, "Ramus was getting down to the business of teaching after his degree, and his anti-Aristotelianism developed as a result of a practical pedagogical situation rather than as a result of intellectual insight."

memory belong to dialectic, and that rhetoric is concerned only with elocution and action [*miror Quintilianum dialecticia tam nudum esse, qui dialecticam ipsam cum rhetorica hic confusum non potuerit agnoscere, cum dialecticae sunt inventio, dispositio, memoria; rhetorica tantum elocutio et actio*].”¹⁵⁰ Walter J. Ong identifies the antecedent of this distinction between rhetoric and dialectic with Agricola’s “humanistic” logic that would supplant Peter of Spain’s formal logic by the middle of the 16th century. According to Peter of Spain, there was only one logic, namely, dialectic, “the art of arts and the science of sciences.” By contrast, Agricola pronounced a more definite restriction, distinguishing the use of *loci*—the *topoi* of Aristotle—as dialectical, while rhetoric was concerned only with “ornamentation.” Ong writes, “This limitation of loci to dialectic is the critical Renaissance divorce in the chronologically uneasy union of rhetoric and dialectic.”¹⁵¹ Above all, Ramus’ concern seems to be to dissociate the true method of discovery from all of the “useless” rhetorical trappings that only serve to ornament arguments and cloud the organization of Aristotle’s system. Clearly, this project represents a return to the Stoic ideal of method as something useful for life; and this same concern motivates Descartes’ criticism of dialectical syllogisms as “of little use.”

Ramus also exhibits another renaissance trend in the interpretation of Aristotle’s dialectic, i.e., to internalize the process of dialectical reasoning so that it is understood psychologically. He alters the notion of “natural dialectic” to govern principally a way of thinking, even though the classical notion of dialectic was fundamentally connected with

¹⁵⁰ Petrus Ramus, *Rhetoricae distinctiones in Quintilianum* (Paris, 1559), 43, quoted in Rossi, *Logic and the Art of Memory*, 99.

¹⁵¹ Ong, *Ramus*, 102.

speech and “dialogue.” Correlatively, the “art of dialectic” becomes “teaching of discourse” (*doctrina dissendi*), teaching a way of thinking rather than a style of public disputation. Ramus characterizes Aristotle’s principles of scientific discovery according to the clarity of their presentation and the ease of apprehension. He does not base his notion of science on the rigors of “proof” but on the sense in which scientific claims follow evidently and methodically from an order. In a certain measure, Ramus’ internalization of dialectic as a method of reasoning rather than a method of disputation ushers in a formally “subjective” method as opposed to the formally “objective” syllogism.¹⁵² Even though Ramus conceived of himself as a great innovator who would overturn Aristotle, he still relied heavily on Aristotle’s categories for his understanding of the proper order in the sciences and his grasp of logic was more significant for its conceptual extension as a general science than for its rigor.¹⁵³ Nonetheless, his

¹⁵² This is the claim of Wilhelm Risse, “Vorgeschichte der cartesischen Methodenlehre,” 281-83. However, I disagree with his much stronger claim that “Damit hat Ramus die vier Regeln des cartesischen Discours formuliert” by virtue of his categorization of Aristotle’s principles of dialectic.

¹⁵³ Ong, *Ramus*, 188, summarizes the complexities of Ramus’ position relative to Aristotelian logic as follows: “What happened here is plain. As a humanist, Ramus wishes to forget about formal logic and to exalt at the expense of formal logic every other type of discourse. He is not, however, the Italianate Rhinelander Agricola, but a Parisian arts professor, heir to the residue of what was once a highly sophisticated tradition of formal logic. Laboring in the wake of this formal logical tradition with a good deal of oratorical vigor but with little or no real insight of his own, he is drawn to think of all discourse as though it consisted of nothing but operations in formal logic. However, what Ramus retains of this formal logic is not real skill as a logician but only a blind drive toward a quantified approach to mental activity. In his case this drive has become a crude mechanistic or diagrammatic view of this activity, warped, moreover, by Agricola’s preoccupation with the individual arguments found in the places to the point where it thinks habitually of concepts only as unit-pieces. The proposition as such is not adverted to, and syllogistic is made to serve the purpose of chucking a unit piece or ‘argument’ into a question.”

reinvigoration of dialectic serves as an important antecedent to the method of discovery that becomes thematic in the seventeenth century.

Giordano Bruno, 1548-1600

Ramus, like other 16th century reformers, saw his reform of education and his introduction of a new method in light of a systematic reform of the disciplines and their organization. Above all, the reform was meant to condense the material for education into easily and quickly comprehended units. This focus on brevity, ease and facility were paramount for the utility of the method.¹⁵⁴ Systematic reform and methodical study are characteristic of another figure of the late 16th century, Giordano Bruno. He appears to be motivated by the same pedagogical concerns of Ramus, namely, to make knowledge of true ideas accessible to anyone willing to exercise their reason and judgment carefully and attentively.

It is our intention, with the approval of the divine will, to follow a methodical path, and one which can correct the defects, fortify the weakness, and aid the natural power of memory, so that anyone (as long as they possess adequate powers of reason and a modicum of judgment) can make progress in it.... This art is not as laborious as those of our predecessors (whose inventions have inspired us to greater efforts), and through our daily meditations we have made significant advances in the art, in terms of its ease, certainty, and brevity.¹⁵⁵

¹⁵⁴ Gilbert, *Renaissance Concepts of Method*, 71-73.

¹⁵⁵ Giordano Bruno, *Opera Latina*, II, I, 215. Intentio nostra est, divino annuente numine, artificiosam meodicamque prosequi viam: ad corrigendum defectum, roborandam infirmamitatem, et sublevandum virtutem memoriae naturalis: quatenus qualibet (dummodo sit rationis compos, et medicris particeps iudicii) proficere possit in ea... Quod quidem ars non habet a seipsa, neque ex eorum qui praecesserunt industria, a quorum inventionibus excitati, promoti sumus diuturnam cogitationem ad addendum, tum eis quae faciunt ad facilitatem negotii atque certitudinem, tum etiam ad brevitatem. Quoted in Rossi, *Logic and the Art of Memory*, 86.

Bruno's Platonic assumptions about the nature of reality enabled him to have a great deal of optimism that this effort would produce the desired results. Yet his belief about the structure of reality often manifests itself in a strange emphasis on symbolism and magic. For Bruno, logic, the intellectual ideas, mental images and symbolism were all connected in what Paolo Rossi has called his "imaginative logic." That is, he transposes the metaphysical substratum or logical *subjectum* from its existence as an independent reality to an "imaginative form." This imaginative form seems to be understood in a way that is analogous to the "formal" property of mental images that inform the *loci* of the mnemotechnical tradition (the topic of the next section). As we will see, Bruno's logic is a logic of the order of things in the same way that the classical memory art conceived of its mnemonic ordering of things to be related to the real order of things by way of a similarity between mental images and the things themselves. Bruno conceived his logic to be broader than formal logic, however, since it bypasses the typical difficulty of correspondence between logical ideas and actual entities. From a taxonomy of imaginative forms or logical places, Bruno conceived of the myriad (some 130) categories that could be generated out of a combination of a few basic elements in a way analogous to alchemical and magical practices.¹⁵⁶

Johann Heinrich Alsted, 1588-1638

These same concerns can be seen in the early 17th century in the writings of J. H. Alsted. Alsted matriculated at Marburg under the direction of the great encyclopedist

¹⁵⁶ See Rossi's, "The Imaginative Logic of Bruno," in *Logic and the Art of Memory*, Ch. 4.

Rudolph Goclenius. He was also a member of the faculty at Herborn, which was a Calvinist reformist school with a Ramist leaning; and he became the teacher of Comenius, who himself would be one of the key figures to introduce the idea of a universal science and universal language to England.¹⁵⁷ His *Encyclopedia* (1630) and *Methodus theologicae* (1614-22), both dense multi-volume texts, represent his massive effort to provide an encyclopedic account of a broad range of disciplines. His first philosophical publication, the *Systema mnemonicum* (1609), is a testament to his prodigious work. Of that work Howard Hotson remarks, “In the dedication of the *Systema mnemonicum*, Alsted claimed to have buried himself ‘from earliest youth to the year of judgment’ in the literature of mnemonics and to have completed the work ‘for my own use by the continual toil of eight years’. The enormous size of the work—over 1,700 pages in all—the prefatory list of 600 authors consulted, and the range of topics it contains jointly support this claim.”¹⁵⁸ When writing on method, Alsted tends to follow Ramus by equating the art of investigation with logic, and a reform of the latter with a pedagogical purpose. Additionally, Alsted represents the influence of Neoplatonism on this period of thought with specific reference to Augustine. He conceives of the faculty of *memoria* in a way analogous to Augustine’s discussion of that faculty in *De Trinitate* Bks. IX-XI (a conception that will also be seen in Llull, see below), namely, that it is one element in a triune representation of the divine in the human being (according to the doctrine of *imago dei*). Alsted refers to Augustine in the context of his *Panacea*

¹⁵⁷ On the influence of Comenius in England see Rossi, *Logic and the Art of Language*, 146, 152-6; and for a general overview of the importance of Alsted for British philosophy, see Howard Hotson, *Johann Heinrich Alsted*, Introduction.

¹⁵⁸ Hotson, *Johann Heinrich Alsted*, 40.

philosophica, where he claims that the human being had perfect access to philosophical knowledge in Eden; but after the fall, he claims, the three faculties, *memoria*, *intelligentia*, and *voluntas*, were each clouded by original sin and thus are in need of artificial support, specifically through the kind of reform of the sciences and application of the memory arts that Alsted proposes.¹⁵⁹ The restoration of these faculties, along with an understanding of the subject matter appropriate to them, is accomplished through the cycle of courses expounded in Alsted's encyclopedia. On the one hand, there are interesting theological implications for Alsted's view. Though Alsted himself was a professed Calvinist, his suggestion that human industry could potentially overcome the deficiencies imposed by original sin suggests that one could overcome one's fallen state, a view that resembles Pelagianism. On the other hand, Alsted's notion of a *panacea philosophica* evokes old magical and alchemical leanings. That tradition held that the cosmic order of elements had a direct bearing on terrestrial events such that there might be a combination of elements, a magic potion or snake oil, capable of resolving any human infirmity. Alsted's *panacea philosophica* suggests that his reform of logic and pedagogy could serve such a purpose, i.e., provide a "panacea" for philosophical education. However, this implication of Alsted's philosophy put him at odds with the prevailing church doctrine.¹⁶⁰ The strange mixture of magical and alchemical superstitions, writings on logic, method, and the reform of the scientific disciplines that one finds in Alsted tokens a long history of vaguely occultist writings on the art of memory, in which one of the central figures was Ramon Llull.

¹⁵⁹ Ibid., 66-69.

¹⁶⁰ Ibid., Ch. 3, 95-143.

The art of memory, method, and Ramon Llull (1232-1315)

In 1666, nearly forty years after Descartes was writing the *Regulae*, Leibniz writes an early sketch of a general philosophical project called *Dissertatio de Arte Combinatore*, which served as the equivalent of his *Habilitationschrift*, i.e., his first major work through which he sought a place in the faculty of the University of Leipzig (though without success).¹⁶¹ That work outlined his plan for codifying a general science, based on mathematics, which would perform a kind of linguistic calculus that Leibniz called an *ars combinatoria*. He indicates that this combinatorial art would relate to all kinds of knowledge, proving to be a general art of scientific discovery. The work opens with reference to Ramon Llull's *Ars Magna*, as the progenitor of this idea and reproduces one of the "Llullian circles," a mechanical device that represented all of the potential predicates pertaining to a particular subject matter. The predicates were to be combined in order to produce concepts corresponding to any possible thing, whose nature would then be identified by the system of classification governing the predicates. This circle seems to have some relevance for Leibniz's *ars combinatoria* which he outlines in the treatise. This short treatise provides the historical point of departure for understanding

¹⁶¹ *Dissertatio de Arte Combinatore in qua ex Arithmeticae fundamentis Complicationum ac Transpositionum Doctrina novis praeceptis exstruitur, et usus ambarum per universum scientiarum orbem ostenditur; nova etiam Artis Meditandi seu Logicae Inventionis semina sparguntur. Praefixa est Synopsis totius Tractatus, et additamenti loco demonstratio Existentiae Dei, ad Mathematicam certitudinem exacta, in Philosophische Schriften, IV, 27-104. See "Introduction," by Gerhardt, 3-5, for the biographical background and a general summary of the work.*

Leibniz's interest in the *mathesis universalis*. When Leibniz acquires a copy of Descartes' *Regulae* and studies algebraic geometry, he begins to link the original combinatorial art to his early ideas of calculus. With this connection, Leibniz articulates a complete notion of the *mathesis universalis* that approaches something like a formal ontology.

Llullian influences on Descartes and Leibniz

Briefly, Leibniz's combinatorial art has as its goal the discovery of complex propositions about number, relation and quantity, the division of the species and their subalternate divisions, and various arguments and propositions related to these divisions.¹⁶² The primary influence for this project appears to come from Llullian sources, such as the 16th and 17th century commentaries of Agrippa, Bruno, Alsted and the esoteric encyclopedist Athanasius Kircher. Additionally, in the introduction to the project (a section Leibniz titles, *Cum Deo!*), Leibniz refers to Descartes and the concept of a 'mathesis universalis', via Franz Schooten's *Principia matheseos universalis* (which he misidentified in the passage as *elementa matheseos universalis*), a mid-17th century textbook introduction to Cartesian geometry.¹⁶³ It does not appear that Leibniz was very well informed on Cartesian geometry at this time (the combinatorial art does not display any signs of Descartes' algebraic method); this influence would become central only after Leibniz's travels to Paris in the 1670s.

¹⁶² See the synopsis of *De Arte Combinatore* in *Philosophische Schriften*, IV, 30, especially, "De arte Combinatoria Lullii, Athanasii Kircheri, nostra, de qua sequentia..."

¹⁶³ *Philosophische Schriften*, IV, 35. At this time, Leibniz could not have been aware of Descartes' *Regulae*, discovering that text only after 1676, upon his visit to Paris.

For the purposes of the *Dissertatio*, Leibniz clearly links together the idea of a universal science with mathematics: he elaborates a technique for determining the nature of all things according to the paradigm of arithmetic and geometry and suggests that this would involve a classification of entities by a symbolic notation and a calculus of combination. To aid in this project, he devises several tables of combination and predication.¹⁶⁴ These tables are organized according to different kinds of combinations, either combining two predicates, three, four and so on (Leibniz writes these as com2natio, com3natio and com4natio).¹⁶⁵ The idea that it was possible to devise a system of classification that would reproduce any possible combination of elements present in things clearly owes its origin to Ramon Llull.

Not incidentally, these issues appear to have been influential for the young Descartes' vision of his philosophical project. In Chapter 1, I showed the importance of the "entirely new science [*scientia penitus nova*]" as it pertained to Descartes' philosophical development and his work with Beeckman.¹⁶⁶ In the letter to Beeckman of March 26, 1619 in which Descartes first expresses the outline of this project, he is careful to distinguish it from the Llull's *Ars Brevis* (AT X, 156; CSM III, 2). Also, in the *Discours de la méthode*, when Descartes refers back presumably to this same period of time, he again suggests that although logic, geometrical analysis and algebra had much to offer his plan of a discovering a general method in the sciences, his would be nothing like

¹⁶⁴ Ibid. 40, 42, 53, 84-5, 91-3, and 99-101.

¹⁶⁵ See Paolo Rossi, *Logic and the Art of Memory*, 177-9, for a concise summary of Leibniz's method in *De Arte Combinatore*.

¹⁶⁶ Sasaki, *Descartes' Mathematical Thought*, 267-269, conjectures that Descartes came to know about Adrian van Roomen's discussion of mathesis universalis while in the Netherlands in 1618-1619. He coordinates this concept with the *scientia penitus nova* of March 1619.

“the art of Lully, for speaking without judgment about matters of which one is ignorant” (AT VI, 17; CSM I, 119).

This negative assessment of Llull appears to be directly related to one of Descartes’ personal experiences, which he also relates to Beeckman in 1619. “Three days ago,” he says, “I had a conversation about Llull’s *Ars Parva* [sic] with a learned man whom I met in an inn at Dordrecht. He boasted that he was able to apply Llull’s method, and to do this so skillfully that he could talk for a whole hour on any subject you cared to mention; and if he was required to talk for a further hour on the same topic, he would find fresh things to say, and could even continue for twenty-four hours at a stretch” (April 29, 1619: AT X, 164-5; CSMK, 4-5). In the letter, Descartes seems to have a measured appraisal of the man, calling him loquacious [*loquax*], possessed of bookish learning [*eruditio utpote a libris hausta*], who seemed to rattle things off the tip of his tongue rather than from within his mind [*in extremis labris potius quam in cerebro versabatur*]. However, Descartes also seems genuinely intrigued, asking Beeckman to look into the matter for him (since Beeckman possessed a copy of Agrippa’s commentary on Llull) and to tell him whether or not there was anything of intellectual substance in the books of Llull or his commentator, Agrippa. In particular, Descartes is searching for certain “keys” to knowledge that Llull’s art is supposed to contain. The so-called ‘keys’ were thought to be like a code that would enable one to translate symbols into elements and thus understand the underlying structure of nature (not unrelated to Cabbalism).

Beeckman does write back to Descartes, though perhaps not in the detail that one would hope for. He tells Descartes that if he would stay a few days in Copenhagen,

talking to the learned men there, he could find out more. Then he proceeds to recite, from memory, what he says he had read superficially several years before. He does not recall having discovered any “keys” such as the old man suggested in Agrippa’s commentary. However, he does describe the structure of the book, and he includes a description of a typical Lullian circle, which he says could enable one, given any topic, to speak for many hours on the subject. In the end, Beeckman does not appraise this technique too highly, suggesting that it could enable one to say many ridiculous things that have little bearing on the matter in question. If there is any value in the technique, he concludes, it lies in the mental powers of the speaker, not the art itself (Beeckman to Descartes, May 6, 1619: AT X, 167-69). It is likely that this exchange is what Descartes refers to in the *Discours*.

At the very least, it is noteworthy that he would recall such a seemingly minor event so many years later as he introduces his first great work. It is clear from Descartes’ letter that the interest in Lull originates with Beeckman, though based on the date of one of Beeckman’s journal entries on Lull, the influence may have gone the other direction.¹⁶⁷ Beeckman’s journal records an entry on Lull’s art, “with which one can cultivate Logic [*cum colata Logica*],” where he outlines the structure of Lull’s *Ars Brevis*, by which, he claims, one could easily be lead to the highest knowledge of all things [*ut breviter doceat summam omnium rerum*]. By the end of his entry, he arrives at a more conservative estimation of the art of Lull, which, he claims, the true logic of Peter Ramus has deprived of any sustained utility [*Logicae vero Ramae alius est scopus*

¹⁶⁷ Adam and Tannery surmise that Beeckman wrote this entry following the receipt of Descartes’ letter, since it falls between two dated entries, the 2nd and 14th of May: AT X, 63nb.

(*esti videri possit hanc arte Lullii aboleri*)] (AT X, 63-5). It ought to be noted that one of Beeckman's teachers, Rudolph Snell, the father of Heerborgh Snell—who would discover the sine-law of refraction—was a Ramist. This may account for Beeckman's quick dismissal of Lull in favor of Ramus.

Though these particular cases do not give one much in the way of an understanding of Lull's art, nor in terms of a substantial understanding of how it relates to Descartes' early work, they do indicate precisely the set of issues to which Lull's art was applied and, moreover, they suggest some philosophical connection between Descartes' understanding of his early project of determining a universal science, an *Ars brevis*, and the mathesis universalis. Additionally, Descartes' interest in another author in the Lullian tradition corroborates these potentially incidental remarks on Ramon Lull. In Chapter 1, I quoted at length an excerpt from Descartes' *Cogitationes Privatae* where he comments on a book by Lambert Schenkl, *De arte memoriae*.¹⁶⁸ In that short commentary, he describes the book as providing a reduction from things to their causes (*per reductionem rerum ad causas*), which are to be known by virtue of the fact that they are passed through the imagination by impressions easily formed there (*Qui enim intelliget causas, elapsa omnino phantasmata causae impressione rursus facile in cerebro formabit*). Even though he reports that the book provides the *clavis totius mysterii*, he ultimately rejects its conclusions and suggests another method whereby images are related in a more simple and easily recalled order. I have contrasted these

¹⁶⁸ The full title, quoted on AT X, 251, is *De Memoria liber secundus: in quo est Ars Memoriae, ex ipso D. Thomas Aquinate, Doctore Angelico, Aristotele, M.T. Cicerone, F. Quintiliano, Philosophorum et Oratorum Principibus, ac huius etima artis fontibus, aliisque, compendiose absoluteque et collecta, et latiore explicatione explicata* (1595).

proposals with the *Regulae* to show that they represent a much more obscure and probably early conception of order and the successive relation between things and their causes. Nevertheless, Descartes' sustained interest in these issues is confirmed in what is clearly a serious engagement with a text in classical memory art. Moreover, I would add that there is likely some connection between the *clavis totius mysterii* sought here and the *ars secretum* of Rule VI (AT X, 381), where the relationship between thing and cause is expressed as a series of absolutes and relatives, beginning with the "most simple natures." This suggests that Descartes conceived of the method of the *Regulae* as a final response to these issues.

Nicolas Poisson, who possessed some of the original manuscripts (some of which now lost) of Descartes' personal writings on method, quotes from one such fragment: "Indeed, here all the sciences are brought together, such that no more perfect combination is possible, from which the others spontaneously follow and the whole of which one can apprehend as if it were an encyclopedia [*Quippe sunt concatenatae omnes scientiae, nec una perfecta haberi potest, quin aliae sponte sequantur, et tota simul encyclopedia apprehendatur*]" (AT X, 255).¹⁶⁹ So, it seems that Descartes was thoroughly engaged in a project of creating a unifying method that would encapsulate the principles of the sciences in a sequential and ordered system throughout the 1620s. The interest and public disagreement he professed in Ramon Llull was part of distinguishing his project from notable historical antecedents.

¹⁶⁹ Quoted from Poisson, *Commentaire ou remarques sur la Méthode de René Descartes* (1670).

Llull and the art of memory

Llull himself (1232-1315), it seems, was a polymath; he wrote in Latin, Arabic and Catalan, and expressed a desire to organize and catalogue knowledge in a variety of different subjects with the objective of grounding this knowledge in the existence of God. His circles and mnemonic techniques were designed to allow the believer a means for convincing non-believers of God's essential connection to natural phenomena. Llull's art, which relied predominantly on an account of the elements and their connection to the divine names or attributes, bore none of the trademarks of classical mnemonics (elaborate images, relation to rhetorical practices, the many rules governing its practice, etc.), however, it did apply a general memory art to a theory of causation and ultimately a metaphysical picture of the world.¹⁷⁰ By indexing the predicates of God, i.e., God's names and attributes, to the elements, Llull grafts his art of memory to an investigation of metaphysical principles.

Whereas Llull emphasizes only meditation and repetition, rather than the elaborate Ciceronian mnemonic techniques involving images and places, he joins this notion of memory art to an ordering of the various categories of being in such a way as to reinforce a parallel between cognition and creation. In order to disclose the principles of the sciences, he employed various mechanical instruments and symbols that catalogue and categorize various domains of knowledge. In the most celebrated instance, Llull designed mechanical wheels, instruments of concentric circles, around which he would designate a series of seven predicates or principle attributes of God: *bonitas optima*,

¹⁷⁰ See Frances Yates, "The Art of Ramon Lull: An Approach to it through Lull's Theory of the Elements" in *Lull and Bruno*, I, 9-77.

magnitudo maxima, veritas verissima, aeternitas aeternalissima, virtus virtuossima, et perfectio perfectissima; these are indicated by the letters of the alphabet B C D E F G H I and K. The three chief elements of these principles are God's goodness, greatness, and truth. These three elements, along with the seven principles and their negations, allow one to combine the various names of God, the combinations of which have direct application to the nature of things through God's causal efficacy in creation. Llull claims of his *Ars Magna*, "And in this way this book will be constructed; in other words, it will be an art for discovering the truth of these predicates [*Et per istum modum liber iste erit artificiatu, sive erit ars ad inveniendum veritates de praedictis*]." ¹⁷¹ The divine names are supposed to relate to the terrestrial, natural world through a theory of astrological causation. For Llull, there seems to be a causal connection between the nature of the planets, their affinity for certain elements, and the existence of specific properties in terrestrial things. This influence of the stars and planets on terrestrial things is based on a doctrine of "similitude," whereby the nature of the celestial bodies is impressed on terrestrial bodies as a seal into wax. ¹⁷² In Llull's system, the principles of causation are a modified list of the divine attributes. In effect, it is this causal dependence of one sphere of being (the heavens) on another (earth and earthly bodies) that enables Llull to propose that the human intellect can attain knowledge of higher grades of being. ¹⁷³

One of Llull's most important contributions to the history of ideas is his effort to categorize the various levels of being and the elements. In addition to the circles of

¹⁷¹ Ramon Llull. *Opera Latina*, I, 334.

¹⁷² Frances Yates, *Lull and Bruno*, "The Art of Ramon Lull: An Approach to it through Lull's Theory of the Elements," 19-20.

¹⁷³ *Ibid.*, 41-42.

predicates, Llull also represented the connection of the sciences in terms of a tree of science (*arbor scientiae*). In his *Arbre de scientia*, which Frances Yates has called the “Forest Encyclopedia,” Llull demonstrates the connection of the sciences by representing the particular sciences, as well as logical relations and real elements, by a tree, or even at times a forest of trees. This taxonomy of the elements of things and the sciences was intimately related to classical rhetorical and logistical devices that were designed to help one memorize and access a wide variety of information easily, since they helped to order that information such that it could accommodate the mnemonic techniques.¹⁷⁴ In essence, the art of memory was intended to bridge the gap between the internal structure of thought (logic) and the external nature of reality (metaphysics). The memory art was meant to apply logical principles to the ordering of things in reality and therefore to lead one to a real knowledge of things in the most expedient way possible.¹⁷⁵

Classical memory art

Thus, the Lullian art of memory represents a revival of the rhetorical practices of the Latin classical authors like Cicero and Quintillian, combined with a resurgent Neoplatonic mysticism that cast this technique in a very different form.¹⁷⁶ As the story

¹⁷⁴ See Rossi, *Logic and the Art of Memory*, 36-55, for a complete discussion of the connection between the tree of knowledge and encyclopedism and the art of memory.

¹⁷⁵ “Sciendum est igitur, quod haec Ars est et Logica et Metaphysica ... sed in duobus differt ab aliis duabus, videlicet in modo considerandi suum subjectum et in modo principiorum. Metaphysica considerat res, quae sunt extra animam, prout conveniunt ratione entis; logica etiam considerat res secundum esse, quod habent in anima ... Sed haec Ars tanquam suprema omnium humanarum scientiarum indifferenter respicit ens secundum istum modum et secundum, illum,” *Introductoris artis demonstrativae*, Mainz. ed., vol. III, p. 1; quoted in Yates, *Lull and Bruno*, 56.

¹⁷⁶ See Frances Yates. *The Art of Memory*, esp. Ch. 1-3.

goes, this ancient art extends back to the Greek poet Simonides. After Simonides had recited a poem at a large banquet, the ungrateful host suggested that while he would pay half the fee for this entertainment, the poet's muses should pay the other half (it seems that Simonides was one of the first poets to have requested payment for his craft). Just at that moment, Simonides received a messenger telling him to meet someone outside the banquet hall. While there was no one to be found outside, Simonides' happened to exit the building just as it collapsed, killing everyone inside. Apparently, the bodies were so badly mangled that Simonides was the only one able to identify them based on his excellent memory of their positions around the table. This surprising capacity for recollection lead the poet to suggest that he had developed a technique to remember things, based on the ordered arrangement of places, to which he could assign names, events, people or images.

Aristotle acknowledges that this art of memory is closely related to the use of dialectic in scientific investigations. For instance, he says, "For just as in a person with a trained memory, a memory of things themselves is immediately caused by the mere mention of their 'places' [*topoi*], so these habits too will make a man readier in reasoning [*logismos*], because he has his premises classified before his mind's eye, each under its number."¹⁷⁷ Aristotle seems to have acknowledged that the activity of remembering, or recollection, is a sort of investigation. This is why he claims that though memory may be shared with animals, recollection is the property of human beings alone, who have the

¹⁷⁷ Ibid. VIII.14, 163b 27-31.

capacity for deliberation, or logical inference, of which recollection is a species.¹⁷⁸ For Aristotle, the nature of recollection as a mode of investigation is also what necessitates an order in the series of things to be recalled, because the recollection is sought through a chain of inferences or a “succession of movements,” beginning from a “starting-point,” which he says “explains why it is that persons are supposed to recollect sometimes by starting from ‘places’.”¹⁷⁹ Additionally, this art of memory seemed to provide a necessary complement to dialectical deduction as something that would aid in scientific discovery. Aristotle makes it clear that induction relies on the capacity of memory and the ordered representation of experience.¹⁸⁰

This seems to be the inspiration for Cicero, whose discussion of the art of memory in his *De Oratore* is instructive:

He [Simonides] inferred that persons desiring to train this faculty would select places [*loci*] and from mental images of the things they wish to remember and store those images in the places, so that the order of the places will preserve the order of things [*ordo rei*], and the images of the things will denote the things themselves, and we shall employ the places and images as a wax writing-tablet and the letters written on it.¹⁸¹

Thus, the technique gives an account of the relation between images and things (like the impressions on a wax writing-tablet) and the order that is given to these images, which in turn facilitates recollection of the true order of the things themselves. Though the actual applications of this mnemonic technique are obscure to the contemporary thinker

¹⁷⁸ Aristotle, *On Memory*, 453a 11-3.

¹⁷⁹ Ibid., 451b 11-452a 17.

¹⁸⁰ *Post. An.* II, 19 suggests a link between perception, memory and induction, while *Pr. An.* II, 23 claims that there are only two ways of acquiring belief, deduction or induction (or enumeration as he also calls it).

¹⁸¹ Cicero, *De Oratore* II, lxxxvi, 351-4, quoted in Yates, *The Art of Memory*, 2.

(sometimes these are related to architectural structures, where different rooms or places in rooms are meant to designate things to be remembered; sometimes bizarre images are conjured up—human representations with symbolic accoutrements—in order to prompt the individual’s memory), it is clear that some art or technique was devised in order to shore up the deficiencies of the memory to make one more apt to reason or speak well. Paolo Rossi supplies many sources which indicate that, in fact, the “places” were to be thought of on analogy with matter, while the “images” were considered the forms. Thus, if someone were familiar with a certain location, say a house or abandoned building, these same *loci* could serve as the template for many different arguments or speeches to be remembered.¹⁸²

As time wore on and the settings in which rhetorical skill and good memory were highly praised disappeared, the art of memory began to lose its relevance.¹⁸³ As a consequence, when for example Thomas Aquinas takes up the issue of memory with reference to Cicero, it is subsumed under prudence, as one of its parts. Though Aquinas refers back to the pseudo-Ciceronian text *Ad Herennium de arte rhetorica*, which was the primary Latin source for the art of memory, it seems that he revives these mnemonic techniques principally in service of moral action. It is useful, Aquinas claims, to train the memory since prudence concerns judgments about contingent things, and thus is

¹⁸² For a clear discussion of the practical techniques of this art see Yates, *The Art of Memory*, Ch. 1, 1-26 and Rossi, *Logic and the Art of Memory*, 6-24.

¹⁸³ Yates, *ibid.*, 53, puts it this way: “In the barbarized world, the voices of the orators were silenced. People cannot meet together peacefully to listen to speeches when there is no security. Learning retreated into the monasteries and the art of memory for rhetorical purposes became unnecessary, though Quintillianist memorising of a prepared written page might still have been useful.”

advanced through experience, which is simply the combination of many memories. Thus the better one remembers, the better will be one's collective experience of many particular events, and thus the better one will be able to apply the rule of reason to any given contingent event.¹⁸⁴ This capacity to remember and to perform the techniques of memory depends, for Aquinas, on the capacity to reproduce an image, or phantasm, that adequately represents the thing to be remembered. In his commentary on Aristotle's *De Memoria*, Aquinas concludes that "it is necessary, if we wish to facilitate the remembering of intelligible reasons to bind them to certain phantasms [which are corporeal in nature], as [pseudo-]Cicero teaches in his *Rhetoric*. Nevertheless memory is placed by some in the intellectual part, insofar as memory is understood to be every habitual conservation of those things which pertain to the intellectual part of the soul."¹⁸⁵ The epistemological implications of this view, as it can be contrasted with Descartes, will be treated in Chapter 3. The important point to realize here is that, while Aquinas retains the psychological and metaphysical account of memory as it is given in Aristotle, he sees the art of memory as generally necessary for acquiring prudence and not for the rhetorical and educational purposes for which it was conceived by Cicero and Quintilian.

The ordered succession of memories and the necessity for a starting-point of investigation all serve to connect Aristotle's theory of memory, the encyclopedic taxonomy of knowledge that emerges with Llull, and the era just prior to Descartes. Because order in one's thoughts aids recollection of the thing sought, Aristotle says, "accordingly things arranged in a fixed order, like the successive demonstrations in

¹⁸⁴ *Summa Theologica*, II, q. 49, a. 1.

¹⁸⁵ *On Memory and Recollection*, Lsn. 2, §326, 15.

geometry, are easy to remember, while badly arranged subjects are remembered with difficulty.”¹⁸⁶ From this, Aquinas concludes in his commentary, “Therefore, to remember or recollect well, we can learn four useful lessons from the foregoing. First one must be careful to reduce to some order what one wishes to retain; then one must apply the mind profoundly and intently to those things; next one must frequently meditate (on them) in order; finally one must begin to recollect from the starting point.”¹⁸⁷ Thus, the classical origins of the art of memory already indicate that the technique for discovering truth in the sciences proceeds most easily when knowledge is reduced to its simple components and these are subsequently ordered and arranged like the demonstrations of mathematics. Clearly, there are important implications of these insights for Descartes’ *Regulae*.

Llullian ontology

While, in a certain sense, the dissociation of dialectic from rhetoric spelled the end of the rhetorical significance of the memory art, that art would reemerge in a different form in the sixteenth century. According to Rossi, “The absorption of memory into logic and the identification of the problem of method with that of memory gave rise to the concept of method as a *classification of reality*, a notion which became vitally important to European thought in succeeding centuries.”¹⁸⁸ Both Bruno and Alsted attempted to bridge the gap between logic and reality by introducing concepts that are really outside the realm of science. In this way, they draw on the metaphysical and

¹⁸⁶ Ibid. 452a 1-3, trans. J. I. Beare in *Complete Works of Aristotle*.

¹⁸⁷ Aquinas, *On Memory and Recollection*, Lsn. 5, §371, 39.

¹⁸⁸ Rossi, *Logic and the Art of Memory*, 101.

alchemical elements of Llull's system. Frances Yates is the most well known commentator to have traced the central elements of Bruno's thought to the Hermetic tradition, occultism, and astrology.¹⁸⁹ Yates has been criticized, in particular, by Rita Sturlese for an overemphasis on the magical and mystical elements in Bruno's thought to the detriment of a focus on its technical utility.¹⁹⁰ Nonetheless, Bruno's philosophical writings show a clear lineage with the writings of Ramon Llull and thus fit within a tradition of Cabalism and occultism. Additionally, Bruno's application of the memory art to scientific understanding utilizes decidedly Neoplatonic themes: the shadows or "ideas" of the mind, an intellectual ascent from darkness into light, a presumed order and unity to all things, and a metaphysical correspondence between ideas perceived by the mind and the nature of reality.

This is all the more evident in Llull insofar as his resurrection of the art of memory coincides with a certain strain of Augustinian and Neoplatonic metaphysics, an influence that Yates understands to come from John Scotus Eriugena.¹⁹¹ Two elements of this connection ought to be noted. First, Llull's emphasis on the centrality of the divine names, or divine attributes, as the first principles and the standard of order for the universe has a clear Neoplatonic heritage, most immediately from Pseudo-Dionysus. For instance, Scotus Eriugena calls the divine names "primordial causes": they are, he says, "what the Greeks call ideas."¹⁹² Second, Llull believed that by means of the divine names and their combinations, an *ars combinatoria* of the sort that Leibniz refers to, one could

¹⁸⁹ Yates, *Giordano Bruno and the Hermetic Tradition*.

¹⁹⁰ Rita Sturlese, "Introduction" to *Giordano Bruno, De umbris idearum*.

¹⁹¹ Yates, "Ramon Lull and John Scotus Eriugena," in *Lull and Bruno*, 78-125.

¹⁹² Cited in Yates, *ibid.*, 85.

ascend the levels of being in order to attain higher knowledge. This notion of ascension through mnemonic technique, according to the interconnection of things in divine creation is variously imagined in terms of a great tree (the *Arbor Scientiae*) or a ladder (the *scalae intellectus* of the *Liber de ascensu et descensu intellectus*). Moreover, ascension up to the vast treasure trove of the memory resembles the famous passage from Augustine's *Confessions*, Bk. 10.¹⁹³ The Augustinian influence is reinforced through Lull's distinction between memory, intellect, and will as a symbolic expression of the persons of the Trinity: the new logic of combination represents the intellect, his mystical writings represent the will, and the mnemotechnical system unites them by means of its vast classification and codification of the elements.¹⁹⁴ Thus, Lull's art, while still a technique to aid the memory, is simultaneously a technique of investigation of the nature of things, understood according to their relations to the elements and the divine attributes; and this technique provides a means for ascending to the most general forms of knowledge by way of the connection between first principles and the things themselves. Moreover, the ascension of knowledge is made possible because, for Lull, the nature of the intellect mirrors the nature of God, and hence the structure of God's creation. In this way, Lull's project represents the aim to develop a total system of knowledge, a "pansophia" as it came to be known in the 16th and 17th centuries, by means of what

¹⁹³ Cf. Augustine, *Confessiones*, X, VIII, 1: "Transibo ergo et istam, naturae meae, gradibus ascendens ad eum, qui fecit me, ubi sunt thesauri innumerabilium imaginum de cuiuscemodi rebus sensis invectarum"; compare to Descartes, Rule V, AT X, 380: "et saepe adeo inordinate difficilimas examinant quaestiones, ut mihi videantur idem facere, ac si ex infima parte ad fastigium alicuius aedificii uno saltu conarentur pervenire, vel neglectis scalae gradibus, qui ad hunc usum sunt destinati, vel non animadversis."

¹⁹⁴ Yates, "The Art of Ramon Lull," in *Lull and Bruno*.

Paolo Rossi calls a “specular” doctrine of reality, i.e., a presupposed “correspondence between words (*termini*) and things (*res*), between logic and ontology.”¹⁹⁵ Clearly this mystical unity of knowledge through the participation of the human intellect in the divine intellect and thereby from the ideas or images in the intellect to the products of creation exceeds what one could legitimately ascribe to Aristotle or Aquinas. Nonetheless, it demonstrates the gradual dissolution of the Aristotelian method in education and as a standard of scientific certainty. These elements together suggest a growing interest in the possibility of a universal method, one that would emerge in explicit contrast to Aristotelian dialectic and would arrange the sciences according to a clear order such as would be fitting for human mental capacities.

Mathesis universalis, algebra and the ars analytica

Though mathematical education had been largely neglected in the Middle Ages, the sixteenth century reformers expressed a renewed interest in the study of and education in geometry. In 1564 Conrad Dasypodius, a teacher of mathematics at Johann Sturm's university, prepared a Greek and Latin edition of Euclid's *Elements* with an accompanying preface and made this a central part of the educational program there, while Ramus endowed a chair exclusively for mathematics at the University of Paris and urged others to do the same. These reformers much preferred the simplicity and

¹⁹⁵ Rossi, *Logic and the Art of Memory*, 61; cf. Augustine, *De Trinitate*, Bk. IX-X.

uncontroversial nature of geometrical proofs to the disputatious syllogisms.¹⁹⁶ Above all, the question of the method of the geometers drove interest in the field. The clarity and utility (especially in medical science) of geometry were obvious, but *how* the ancient geometers were able to arrive at their demonstrations remained obscure. Toward the end of the sixteenth century, Dasipodius and no less than Christopher Clavius attempted (in vain) to render Euclid's *Elements* in syllogistic form.¹⁹⁷ It is, in fact, impossible to render the *Elements* in syllogistic form because Euclid's geometrical proofs depend on the 'auxiliary construction' or 'supposition' of features that are only accidental to the object under consideration. In other words, Euclid's demonstrations are *per accidens* and never *per essendi* as is required for an Aristotelian demonstrative syllogism.¹⁹⁸

It is in this context that the term *mathesis universalis* emerges as a philosophical concept. In a general sense, the terminology is used to describe a novel approach to mathematics that was recognized in classical geometry but not exploited as such. Alsted was one of the key figures of the early 17th century to employ the idea of a *mathesis universalis* in a meaningful way. Alsted introduces his *Methodus admirandorum mathematicorum* (1613) by stating that this book will teach one the wonders of mathematics, containing techniques by which one can attain a universal *mathesis* [*Isagoge in libros admirandorum mathematicorum, continens technologiam, adeoque*

¹⁹⁶ Gilbert, *Renaissance Concepts of Method*, 83-86.

¹⁹⁷ Ibid. 86-92.

¹⁹⁸ I borrow this argument from Bret J. L. Doyle, *The Logic of Descartes' Regulae*. Section 2.3.3 presents a thorough treatment of Clavius' attempt to render geometrical arguments in the syllogism and Descartes' consequent rejection of syllogistic reasoning from scientia.

matheseos universae oeconomiam].¹⁹⁹ For Alsted, “general mathematics is a science that treats of quantity in its common meaning [*mathematica generalis est scientia, tractans de quantitate communiter*].”²⁰⁰ Though this definition of a “general mathematics” suggests that it is only applicable to abstract quantity, for Alsted, mathesis seems to govern a broader range of applications. For instance, he relates mathesis to Aristotle’s *Organon*, suggesting that it is the means by which any philosophical knowledge is discovered.²⁰¹

Aristotle and the idea of “universal mathematics”

While classical mathematics recognized the possibility of designing a general science of mathematics applicable to abstract magnitude, i.e., both discrete (arithmetical) and continuous (geometrical) magnitude, not until the 16th century was this possibility actively explored. It was suggested that the ratio or proportional relation that exists between both kinds of magnitude could make a general science of abstract magnitude possible. Aristotle suggests that some Ancient Greek philosophers held the opinion that there was such a “universal mathematics” in his *Metaphysics*:

One might indeed raise the question whether first philosophy is universal, or deals with one genus, i.e. some one kind of being; for not even the mathematical sciences are all alike in this respect—geometry and astronomy deal with a certain particular kind of thing—while universal mathematics applies alike to all. We answer that if there is no substance other than those which are formed by nature, natural science will be the first science; but if there is an immovable substance, the science of this must be prior and must be the first philosophy, and universal in this way, because it is first.²⁰²

¹⁹⁹ J.H. Alsted, *Methodus admirandorum mathematicorum* (1613) in Crapulli, *Mathesis Universalis*, Appendice IV.

²⁰⁰ Ibid., 19-20.

²⁰¹ Ibid.: “Quia adeo sunt excellentes, ut sine nemo philosophi titulo guaderet possit.”

²⁰² *Metaphysics*, 6.1, 1026a 23-31, trans. W.D. Ross. Cf. *Metaphysics* 9.7, 1064b 6-14: “One

The problem in Aristotle is raised with respect to the possibility of a science of being in general, what Aristotle called first philosophy and would later become ontology. This is the reason for his conclusion that first philosophy will either be a kind of physics or a kind of theology. But the reference to a “universal mathematics” suggests that certain Greek thinkers had entertained the possibility of a general science of mathematics on analogy with which one might conceive of first philosophy. Of course, just as Aristotle poses the question with respect to first philosophy, the central question for a proposed universal mathematics would be: to what does that science apply?

One difficulty immediately presented to any science of magnitude in general is the incompatibility of the supposed principles of the science. Plato suggests a unity between the mathematical sciences in Bk. VII of the *Republic* when he treats the education of the guardians by suggesting that the best kind of education will have something to do with “calculation and number” because these help to determine the one apart from the many (525a). Socrates suggests a further alliance between arithmetic and geometry when he calls geometry “the study adjoining [the science of calculation and number]” (526c). However, Plato also recognizes that the mathematical sciences depend

might raise the question whether the science of being qua being is to be regarded as universal or not. Each of the mathematical sciences deals with some one determinate class of things, but universal mathematics applies alike to all. Now if natural substances are the first of existing things, natural science must be the first of sciences; but if there is another entity and substance, separable and unmovable, the sciences of it must be different and prior to natural science, and universal because it is prior.” St. Thomas Aquinas, *Commentaria in Aristotelem et alios*, “In Libro Metaphysicorum,” p. 446, n. 26, states that the term “universal” here does not really apply to mathematics, since for him mathematical entities always pertain to some particular genre of being. However, Averroës introduces the term *scientia universalis* into his commentary, *Commentarium in Metaphysicorum in Aristotelis Opera Omnia*, Vol. VIII: Metaphysicorum libri XIII (Venetiis, 1562), f. 146v, suggesting to some readers the possibility of a truly universal science of mathematics.

on hypotheses and “are unable to give an account of them” (533c). Aristotle seems to offer some explication for what is meant by those unaccounted for hypotheses of mathematics: “in some cases what a thing is is immediate and a principle; and here one must suppose, or make apparent in some other way, both that they are and what they are (which the arithmetician does; for he supposes both what the unit is and that it is).”²⁰³ Thus, both arithmetic and geometry presuppose certain basic concepts, such as the unit, point, line, or plane, which are axiomatic, or definitional, and cannot be proved.

However, for Aristotle, the starting points of arithmetic and geometry are distinct and as a consequence there can be no universal, or common, mathematics. This follows from the Aristotelian principle that “one cannot prove anything by crossing from another genus.” To illustrate this famous dictum, he says that one cannot prove “something geometrical from arithmetic”: he goes on to explain “one cannot apply arithmetical demonstrations to the accidentals of magnitudes, unless magnitudes are numbers.”²⁰⁴ The reason for this is that, for Aristotle, what is demonstrated must not only depend on the axioms, or premises, from which it follows, but also the “underlying genus” to which it pertains. That is, the extremes—the subject and predicate of what is to be demonstrated—must be of the same genus as the middle term. Otherwise, for Aristotle, the demonstration would not demonstrate what the thing is essentially, but what it is accidentally, or by some adduced property that does not belong to the essence of the thing. In short, the prohibition against a general science of magnitudes follows from the fact that there is no genus of ‘abstract magnitude’ for Aristotle. For him, universal mathematics rests on a

²⁰³ *Posterior Analytics*, II.9, 93b 24-26.

²⁰⁴ *Ibid.* I.7, 75a 38-39.

“category mistake” in the strictest sense of the term because scientific explanations must demonstrate what a thing is by virtue of the category, and more specifically the genus, to which it belongs.²⁰⁵ Moreover, Aristotle was surely aware of the incommensurability problem of numerical and continuous magnitudes. This follows from the existence of irrational magnitudes; and the Pythagoreans were well aware of the existence of these. Consider the diagonal of the unit square ($\sqrt{2}$): it is incommensurable to any rational number, and incommensurable with the unit itself (cf. Plato’s *Meno* 82a-85c).²⁰⁶

Mathesis universalis in the sixteenth century

In the sixteenth century, however, several thinkers appear to have explored this notion of “universal mathematics” as a genuine science (sometimes it is referred to as a ‘*mathematica generalis*’ (Alsted), ‘*aliqua scientia mathematica communis*’ (Benedictus Pererius), ‘*prima mathematica*’ (Adriaan van Roomen), or ‘*scientia communis*’ (Alessandro Piccolomini)) of quantity or proportional relations between magnitudes in general.²⁰⁷ Notably, Adriaan van Roomen’s *Apologia pro Archimede* (1597) describes

²⁰⁵ Now, there remain some important relations between the various mathematical sciences, for Aristotle. For example, he suggests that some mathematical sciences are related as type to token, such as optics to geometry, mechanics to solid geometry, harmonics to arithmetic, or star-gazing to astronomy. Some are united in name or by virtue of their explanation such that it is up to the empirical science to know the fact and the mathematical science to know the reason why: such is the case for mathematical and nautical astronomy, mathematical and acoustical harmonics, optics and the study of the rainbow, and geometry and medicine, *Posterior Analytics*, I.13, 78b 34-79a 16.

²⁰⁶ Doyle, *The Logic of Descartes’ Method*, Chapter 1.3 argues for incommensurability as a driving force behind Aristotle’s rejection of a universal mathematics.

²⁰⁷ Consider the conclusion in Crapulli, *Mathesis Universalis*, 146: “la scienza comune alle discipline matematiche sembra addirittura perdere la sua specifica caratterizzazione matematica, pre per assumere quella più generica di un ordine di considerazione più pertinenti all metafisica.”

exactly what is meant by the *mathesis universalis* in a section in which “An Idea of a Kind of *Universalis Matheseos*, which We Shall Call *Prima Mathesis*, Is Proposed [*Idea quedam universalis Matheseos, quam nos primam vocabimus Mathesin, proponitur*].” As the title of this section indicates, van Roomen understands *Prima Mathematica seu Prima Mathesis* on analogy with first philosophy and he claims, “it is called ‘First’ because under it are assumed the subjects of all the other sciences and further it proves the principles of the others if they need demonstration [*ea dicitur, Prima quia subiecta omnium reliquarum sub se comprehendit scientiarum, quinimo et reliquarum demonstrat principia si demonstratione egeant*].”²⁰⁸ Further, he details the constituent elements of what he calls a “mathesis universalis.”²⁰⁹ He divides “general mathesis [*universa mathesis*]” into “true mathematics [*vera mathematica*]” and “that which is like mathematics [*quasi mathematica*],” the latter of which includes things like architecture and the military arts.²¹⁰ The true mathematics is further distilled into a “pure mathematics [*pura mathematica*]” as distinct from “mixed mathematics [*mixta mathematica*],” which includes Astronomy, Geodesics, Music, and Optics. Pure mathematics is finally reduced to “mathesis universalis,” which is to be distinguished from “mathesis specialis,” i.e., arithmetic and geometry.

²⁰⁸ Translation following Chikara Sasaki, “Descartes as Reformer of the Mathematical Disciplines,” *Descartes et le Moyen Age*, 40.

²⁰⁹ Van Roomen, *Apologia pro Archimede* (1597), Ch. VI-VIII in Crapulli, *Mathesis Universalis*, Appendice III.

²¹⁰ This list of categorization has lead Sasaki to suggest that “in the sixteenth and seventeenth centuries ‘universa mathesis’ was in general distinguished from ‘universalis mathesis’. The former term meant ‘mathematics as a whole’, whereas the latter usually denoted ‘a mathematical discipline common to arithmetic and geometry.’” (“Descartes as Reformer of the Mathematical Disciplines,” 41)

This is the first recorded use of the exact phrase ‘mathesis universalis’ and it suggests that van Roomen conceived of it as an independent science that would capture the essence of the various mathematical disciplines, i.e., a science of mathematics as such on analogy with first philosophy.²¹¹ The table of classification in van Roomen also suggests a hierarchy of the mathematical sciences, where purity is correlated with abstraction from physical applications. For example, mathesis universalis is a component of “pure mathematics,” which also includes arithmetic and geometry but does not include “mixed mathematics” like astronomy, music and optics. In the end, van Roomen appends a kind of calculus to the abstract notion of mathematical science, the mathesis universalis. He calls this technique the *supputatrix*, or *logistikê* or even *Arithmopraxia*. Apparently this technique or calculus would deal not only with numbers, but it would be a very general kind of calculation whose operations would be at the same time readily apparent to anyone.²¹² The term “logistics” refers back to the formal logic of the High Middle Ages, which is what Peter of Spain called his logic.²¹³ In this way, van Roomen’s initial use of ‘mathesis universalis’ appears against the background of a recategorization of mathematical knowledge, the mathematical disciplines, and the method of discovery appropriate to mathematics.

Moreover, van Roomen’s understanding of the mathesis universalis, insofar as it is an abstract science of quantity as such, wrests mathematics free from its association

²¹¹ He says, “Inscribemus autem scientiam hanc nomine primae mathematicae, seu primae matheseos, ad similitudinem primae philosophiae.... Ita et haec prima mathematica versatur circa subiecta omnium scientiarum mathematicum, et puram et mixtum.”

²¹² Sasaki, *Descartes’ Mathematical Thought*, 351, equates this concept with a nascent idea of algebra.

²¹³ Ong, *Ramus*, 55-74.

with a particular genre of being. For Aristotle, as we have seen, mathematics is the study of quantity and measure, but quantity and measure of some particular thing, some underlying substance, whether number, length, or solid bodies. Moreover, for Aristotle, it makes a difference with reference to which kind of thing one is demonstrating. The possibility of a kind of mathematics as such, a universal or first mathematics, suggests that there is a kind of mathematical science that is not tied to some particular substance, but would pertain either to an abstract substance or to a substance that is the super-genus of different kinds of things. In other words, the *mathesis universalis*, in contrast to Aristotle's understanding of mathematics, is the first gesture toward conceiving of mathematics as a formal system.²¹⁴

Barozzi's translation of Proclus

This gradual abstraction and formalization of the science and method of mathematics from particular entities accords well with the introduction of Francesco Barozzi's widely distributed Latin translation of Proclus' commentary on Euclid's *Elements* (1570). This work represents the other side of the coin from van Roomen and Alsted's project, in terms of a general inquiry into a formal system of mathematical knowledge. Frederick Van de Pitte has made this important distinction: in the case of the former, he says, *mathesis universalis* is assumed to be a kind of mathematical science, a

²¹⁴ Benito Pereira, *De communibus omnium rerum naturalium principiis* (Rome, 1576), interprets mathematics as that which is easily abstracted from all material specificity and indeterminacy is thus the most easily understood and clearly comprehended. But it is not, for that reason, the highest scientific knowledge, indeed, for Pereira, it is the lowest, since it is so easily abstracted from the things themselves.

subject matter, under which the various specific mathematical sciences would be incorporated; in the case of the latter, mathesis is linked to a way of learning, an epistemological process. This is apparent, for instance, when Proclus refers back to Plato's doctrine of reminiscence and dialectic, whereby first principles are attained through a kind of inward reflection on the nature of ideas.²¹⁵ Thus, in a historical sense, Proclus is more indebted to Plato's epistemological theory of mathematical truth than to Aristotle's concern for the ontological range of mathematics, understood as a discipline related to a particular subject matter. Nonetheless, the mathematical epistemology of Proclus' commentary is also rooted in an abstraction of the mathematical sciences from their concrete determination by particular substances in much the same way as van Roomen's and Alsted's rejection of the Aristotle's view of mathematics served to liberate mathematics to be an abstract universal science. The former treats the epistemological features of abstraction, i.e., how one comes to know the principles of such a formal system, while the latter describes the metaphysical range of a proposed mathesis universalis.

When Barozzi published his translation, he appended an introduction and commentary that are instructive. In the prologue, he divides the term "universalis mathesis" into "intelligible things [*res mente*] (*ta onta*)" and "thought [*ratione perceptas*] (*dionoêta*)."²¹⁵ Thus, he understands mathesis universalis to refer to the objects of mathematical knowledge as well as the manner of thinking appropriate to mathematical objects. In some sense this mitigates Van de Pitte's strict distinction between Barozzi and

²¹⁵ Frederick Van de Pitte, "The Dating of Rule IV-B," 386-87.

van Roomen, but it does not diminish the importance of recognizing that such a distinction is operative in the tradition of writing on *mathesis universalis*. Indeed, Barozzi will focus greater attention on the “thought” appropriate to mathematics, indicating his epistemological concerns. For Proclus, mathematics is a mediating science between the sensible and the knowable and in this way related to imagination. When Proclus refers to the famous passage in Bk. VI of Plato’s *Republic*, where mathematical “hypotheses” are seen as the “stepping-stones” from images, on analogy with the sensible world, to the intelligible world of ideas, Barozzi comments that “[i]t is thus some kind of universal science of mathematics, according to which all the mathematical disciplines are included ... and to which the other sciences refer as though it were the principle of them [*est autem una quaedam universalis mathematica scientia, sub se comprehendens omnes simul mathematicas disciplinas ... denique ad eam ipsam tanquam principalem referentur*].”²¹⁶

Corrado Dasipodio adds another layer of commentary to Barozzi’s text, saying that the mathematical sciences “hold an intermediary place between the indivisible, simple things, and composite things [*medium obtinere locum inter impartibiles, et simplices, et compositas*].”²¹⁷ Here Barozzi and Dasipodio, by way of their commentary on Proclus, assert that the *mathesis universalis* serves a function in cognition that is akin to the role of mathematics in Plato, namely, to carry the mind from the physical world of sensible reality to a mental world of ideas, from complex physical entities to simple and indivisible ideas. Moreover, when Barozzi classifies the mathematical sciences, now understood as species of the *mathesis universalis*, he divides them according to the

²¹⁶ Dasipodio, *Scritti matematici* (1564) in Crapulli, *Mathesis Universalis*, Appendice I, 166.

²¹⁷ Ibid.

distinction between thought (*noêta*) and perception (*aisthêta*): arithmetic and geometry stand on the side of pure thought, while astronomy, mechanics, optics, geodesics (the science of measuring surfaces and volumes) and logistics (the science that deals with numbering things, not numbers themselves) are all classified on the side of perception.²¹⁸ Here again, van Roomen's classification of the disciplines of mathematics is correlated with the faculties of the intellect as described by Proclus.

Viète, algebra, and the analytic art

While these references indicate a concern for a general science of mathematics at the turn of the 17th century, François Viète, who probably drew his greatest influence from Diophantus and Peter Ramus (though he was also an acquaintance and sometimes adversary of van Roomen), concretized this abstract notion with a workable technique that he called the “new algebra.” For Viète, the new algebra was explicitly and directly related to the ancient notion of “analysis,” the hidden art of discovery that the ancient geometers apparently used to reach first principles of demonstration: “There is a way for Mathematics to inquire and search for the truth, which is said to have been first found by Plato, and which he called “Analysis” (*analypsis*). Here it is defined as the supposition of what is sought as given because of the truth of the given.”²¹⁹ Viète's description of

²¹⁸ Crapulli, *Mathesis Universalis*, Appendice I, 159. See Thomas Heath, *A History of Greek Mathematics*, I, for a clarification of the classical division of mathematics.

²¹⁹ *La nouvelle algèbre de M. Viète*, traduction en Français par J. L. Sieur de Vaulezard (Paris, 1630), Ch. 1. Latin edition, *Fransisci Vietae Opera Mathematica*, ed. By Franz van Schooten (Lugduni Batavorum, 1646), In *Arten Analyticen Isagoge*, Ch. 1: “Est veritatis inquirendae via quaedam in mathematicis, quam Plato primus invenisse dicitur, a Theone nominata Analysis, et ab eodem definita, adsumptio quesiti tanquam concessi per consequentia ad verum concessum.”

analysis here recalls the classical notion, defined by Pappus of Alexandria: “For in analysis we suppose that which is sought to be already done, and we inquire from what it results, and again what is the antecedent of the latter, until we on our backward way light upon something already known and being first in order. And we call such a method analysis, as being a solution backwards (*anapalin lysin*).”²²⁰ It seems that Viète’s reference to Plato is, like the passage from Proclus, a reference to the ascension of mathematical knowledge up to first principles by way of hypotheses, i.e., supposing what is sought as already done. In the *Republic*, Socrates finds that because the mathematical sciences take their hypotheses as given, they are unable to reach metaphysical truths that are only attainable by dialectic.²²¹ Nonetheless, the turn of the seventeenth century mathematicians follow Proclus in outlining a general method of discovery, an *ars analytice*, where the mathematical sciences provoke an ascension of thought from complex, sensible particulars up to simple, intelligible, and abstract concepts.²²² Algebra was understood to provide just that method; it would link arithmetic and geometry by using symbols to denote unknown quantities and a method of transforming equations in order to isolate and determine those unknowns according to what is known.

²²⁰ Pappus, *Mathematical Collection*, quoted in J. Hintikka and U. Remes, *The Method of Analysis*, 8.

²²¹ Plato, *The Republic* (511a): “However, a soul in investigating [the intelligible form] is compelled to use hypotheses, and does not go to a beginning (*archê*) because it is unable to step out above the hypotheses. And it uses as images those very things of which images are made by the things below, and in comparison with which they are opined to be clear and are given honor.”

²²² I am uncertain how either Viète and/or Proclus responded to the issue of the unexamined “hypotheses,” or if they refer to dialectic. Are the elements of mathematics definitional/axiomatic? Is there any awareness of the limitations of this? As a result, what is the scope of this system?

Viète's new algebra produced perhaps the first formal mathematical system: it defined a set of mathematical elements, basically on analogy with geometrical objects, and defined the nature of the operations to be performed on those elements, i.e., addition, subtraction, multiplication, division, and root extraction.²²³ The new algebra was divided into three distinct techniques: "zetetics" was the art of translating geometrical problems into algebraic equations; "poristics" provided the means for transforming equations; and "exegetics" or "rhetorics" developed the means for deriving solutions of unknown quantities. Algebraic symbols and the manipulation of equations allowed Viète to arrive at equations for the desired curves, mean proportionals, or planar points in order to solve classical geometrical problems. However, his science of algebra was fairly restricted because he stipulated that one could only perform operations or transformations on magnitudes of the same degree. The degree of a magnitude was determined by its power (x is of the first degree, while x^2 is of the second). He called this restriction the "law of homogeneity."

Though this law seems strange to a contemporary reader, it is based on an extension of the geometrical principle of multiplying and dividing to algebra. For instance, if a line segment is to be multiplied by another, the result is not a line, but a parallelogram. Likewise, if the parallelogram is multiplied again by a line segment, the result is a parallelepiped. One can see that in dealing with extended magnitudes, the operations of multiplication and division result in a change in *dimension*. While there is

²²³ Henk J. M. Bos, *Redefining Geometrical Exactness*, 2001), 148-51, outlines the formal characteristics of Viète's new algebra. Understanding the ontological status of that formal system depends on how one responds to the issue of hypotheses.

no apparent dimensional change in the arithmetical analogs to these calculations, Viète felt it necessary to prevent the possibility of comparing two magnitudes of different dimensions, thus instituting the law of homogeneity. Viète's adherence to this law reveals the extent to which the ontological status of mathematics is cashed out in geometrical figures and not an independent concept of number.²²⁴ As Henk Bos remarks, "Viète did not see his algebra, which was to be the essential tool in his analysis, as a technique concerning numbers, but as a method of symbolic calculation concerning abstract magnitudes."²²⁵ I take this to mean that, in fact, Viète did not have a rigorous mathematical concept of number, but only a loose concept of "abstract magnitude" (the subject matter of *mathesis universalis*), which he ultimately understood to refer to geometrical constructions.

At the time of the *Regulae*, it seems to me that Descartes too did not have an abstract concept of number as an entity whose existence could be clearly and distinctly perceived without the aid of the imagination. This can be seen for instance in Rule XIV, where Descartes outlines the difference between abstract mental conceptions (which can be conceived by the pure intellect, but have no real, i.e., specific, instantiation) and what he calls "real" or "particular" ideas. The latter are formed through the aid of the imagination. With respect to the concept of number, Descartes says, "[I]f something

²²⁴ Though Descartes eliminates the need for the law of homogeneity by appealing to the generic concept of a unit, he still does not entirely wrest himself from the legitimating force of geometrical magnitude for mathematical objects. This can be seen in his inability to treat equations with imaginary or irrational roots (i.e., those kinds of numbers that cause problems for geometry).

²²⁵ Bos, *Redefining Geometrical Exactness*, 147. Cf. 121, where he defines *mathesis universalis* as "the concept of [abstract] magnitudes [i.e., those that remain undetermined as either number or measure] ... [and] the notion that the operations on such magnitudes could be treated abstractly."

concerning number is sought, we imagine some subject which is measurable by way of many units. The intellect of course may for the moment reflect on only this multitude; nevertheless we must beware that [the intellect] does not on this basis reach a conclusion in which the thing numbered has been excluded from what was considered [merely abstractly]” [*si de numero sit quaestio, imaginemur subjectum aliquod per multas unitates mensurabile, ad cuius solam multitudinem livet intellectus in praesenti reflectat, cavebimus tamen ne inde postea aliquid concludat, in quo res numerata a nostro conceptu exclusa fuisse supponatur*] (AT X, 445; CSM I, 61).²²⁶ Thus, even though the *mathesis universalis* gestures toward a formal theory of mathematics, Viète and Descartes of the *Regulae* are unable to concede something like a formal “concept of number,” even on the vaguest analogy with what Frege, Husserl, or Cantor propose at the turn of the 20th century.²²⁷

Despite its restricted scope, Viète’s algebra remained a real instantiation of the general science of a *mathesis universalis* insofar as it was applied to a concept of “abstract magnitude,” however loosely conceived. Furthermore, his hopes for this science were high. He famously closes his *In Artem Analyticem Isagoge*, his introduction to the new algebra, with the claim that “the analytic art, endowed with its three forms of zetetics, poristics and exegetics claims for itself the greatest problem of all, TO LEAVE NO PROBLEM UNSOLVED [*Denique fastuosum problema problematum ars Analytica,*

²²⁶ Cf. his criticism of “some philosophers” who are “so subtle that they have even distinguished quantity from extension” (AT X, 442; CSM I, 67).

²²⁷ The best argument for this is provided by Henk Bos, “The Concept of Construction and the Representation of Curves in Seventeenth-Century Mathematics,” in *Lectures in the History of Mathematics*, 23-36, where Bos takes geometrical construction to be the essential criterium for adequate solution to mathematical problems as they are envisaged in the 17th century.

triplicem Zeteticas, Poristicas, et Exegeticas formam tandem induta, jure sibi adrogat, quod est, NULLUM NON PROBLEMAM SOLVERE].” This claim is generally consistent with Descartes’ own claims regarding his *scientia penitus nova* and his algebra, even though Descartes was probably in no way acquainted with Vietean algebra until after 1623 and maintained that he had never even seen the cover of that book.²²⁸ He did, however, obtain a copy of Viète’s *Ad Logisticen Speciosam* from Mersenne, which he calls in a letter to Mersenne “book of analysis.” As might be expected, Descartes’ opinion of this book is reserved, to say the least: “Between us, I do not see what would be of any great utility [in the book].” What is perhaps most interesting about his remarks is the way he responds to Viète’s call *nullum non problema solve*:

It’s not that I would only like to truly believe that the authors are truly learned, but I do have enough good spirit to be an accurate judge of the contents of this book, nor to respond to what you have asked me about Pappus. For it would be quite necessary to go beyond the conic sections and solid figures in order to resolve this problem for any number of given lines. Any man who would claim *nullum non problema solve* must solve this as well, and I think that I have solved it. (Letter to Mersenne, 3 May, 1632: AT I, 245)

It is perhaps disingenuous of Descartes not to have recognized the “great utility” of Viète’s proposed translation of geometrical problems into modern algebraic notation. But, with reference to the Pappus locus problem, he is quite right that it is necessary to go beyond solid problems, or the conic sections, in order to derive a solution for the problem for greater than four lines. In fact, to have moved beyond Viète’s capacity to solve this type of problem is precisely the crowning achievement of Descartes’ *Géométrie*. Nonetheless, in the book that Descartes refers to as the book of analysis, Viète articulates

²²⁸ In *Artem Analyticam Isagoge* in *Opera Mathematica*; for Descartes’ denials see AT X, 156-7 and 331-32.

a version of his new algebra as a kind of *logistica speciosa* and defines the operations of the new algebra for adding, subtracting, multiplying, dividing, and finding the mean proportionals (i.e., roots of equations) for abstract quantities. These operations are defined *more geometrico*, given postulates and their corollaries and deducing theorems from these.²²⁹ This is noteworthy because when Leibniz writes his fullest treatment of the *mathesis universalis*, he refers back to Viète's "special logistics" and proposes to expand this into a "general logistics."

With Viète's new algebra, seventeenth century thinkers were presented with an answer to two vexing questions from the history of mathematics: What is the subject matter of a universal method of mathematics? Magnitude in general. What is the method of analysis, or the true method of discovery in mathematics? Algebra. In fact, it seems to me that these answers were so compelling that the algebraic method was a much more promising science for discovering first principles than the confused dialectic of Aristotle and Ramus. The name of dialectic had been sullied by its association with rhetoric, alchemy, mysticism, and magic so that it had no real promise for science. Though the "law of homogeneity" represents a remnant of the problem of incommensurability, the method of the mathematical sciences seemed much more secure with Viète.

Certainty as the standard of truth

²²⁹ *Ad Logisticen Speciosam* in *Opera Mathematica*.

Several commentators have noted one other historical antecedent to Descartes' concept of mathematics and the importance of the mathematical method for universal science that we will turn to briefly. Whereas Aristotle had recognized only the most powerful demonstrations [*potissimae demonstrationes*] as the standard of scientific certainty, some late 16th century philosophers began to question this thesis, suggesting instead the concept of certainty [*certitudine*] as the standard of truth. Piccolomini, in his *Commentarium de certitudine methematicarum* (1547), advanced the controversial thesis, against Averroës, that the dignity of mathematics lies in “*primo gradu certitudinis*” not in “*ratione demonstrationem potissimarum*.”²³⁰ As I have already noted, the requirements of the syllogism for scientific demonstration in Aristotle ensured that it was impossible to render even the a priori, deductive geometry of Euclid in that form. Thus, Piccolomini advocated certainty rather than the syllogistic form as the mark of mathematical truth. The characteristic certainty of mathematics is affirmed by Benedictus Pererius (1535-1610), who agrees that mathematics, by virtue of its abstraction is more certain than any other science. However, according to Pererius, it does not for this reason attain the status of scientific truth. On the contrary, Pererius claims that the mental abstraction of mathematics from the things themselves renders mathematical knowledge empty.²³¹

However, Descartes will arrive at a position closer to Barozzi than Pererius on this

²³⁰ Crapulli, *Mathesis Universalis*, 34 ff. See also Savini, *La développement de la méthode cartésienne*, Ch. 2.2.

²³¹ Savini, *La Développement de la méthode cartésienne*, 55 ff. Jean-Luc Marion, *Descartes' Metaphysical Prism*, trans. by J.L. Kosky (Chicago: U Chicago Press, 1999), 43-47, has also noted the importance of Pererius for Descartes, in the sense that he inverts the Suarezian distinction between first philosophy and metaphysics. For Pererius, as for Descartes, first philosophy represents the most universal science, while metaphysics represents a special science, specifically a study of the nature of God and the soul.

matter, since he will hold that the clear and distinct ideas of mathematics, precisely because they are abstracted from all material nature, constitute the foundations of a universal science. It is, indeed, this concept of mathematical certainty that will make arithmetic and geometry the cornerstones of the universal scientific method in the *Regulae*.

Descartes' use of mathesis in his writings and Leibniz's interpretation

When Descartes approaches the problem of determining an appropriate method to investigate the truth of things, in Rule IV-A, he contrasts his aim with the “blind curiosity” of mortals, who “direct their minds down untrodden paths, in the groundless hope that they will chance upon what they are seeking, rather like someone who is consumed with such a senseless desire to discover treasure that he continually roams the streets to see if he can find any that a passer-by might have dropped” (AT X, 371; CSM I, 15-6).²³² Descartes finds that chemists, even most geometers, and many philosophers are guilty of exhibiting such “blind curiosity.” It is by virtue of this that he rates them “more fortunate than diligent” even if they happen to have discovered some truths. In one

²³² Cf. Kant's *Critique of Pure Reason*, Bxiv: “This is how natural science was first brought to the secure course of a science after groping about [Herumtappen] for so many centuries.” For Kant, it is Francis Bacon who first alighted upon the methodical foundation for the natural sciences. However, Kant finds that Bacon falls short of founding metaphysics on an equally firm foundation. I would suggest that Descartes succeeds where Bacon falls short though we will have a chance to revisit this in the fourth chapter. There, the method of discovering the relations that exist between “simple natures” will be explored in both Bacon and Descartes.

stroke, Descartes has differentiated his science, a methodical science, from the Llullian alchemists, the Aristotelian dialecticians, and preceding geometers.

In contrast to these former efforts, Descartes' *Regulae* can be understood as an attempt to outline a clear and concise universal method, essentially an *algebraic* method, that would treat any kind of subject matter whatsoever. This method is most clearly articulated as the "method of comparison," which in Rule XIII he compares to the dialectical method, though without invoking the relation between the middle term and its extremes:

First, in every problem there must be something unknown; otherwise there would be no point in posing the problem. Secondly, this unknown something must be delineated in some way, otherwise there would be nothing to point us to one line of investigation as opposed to any other. Thirdly, the unknown something can be delineated only by way of something else which is already known. (AT X, 430; CSM I, 51-52)

Presumably, the method Descartes has in mind here is to express the knowns and unknowns in an equation that clearly demonstrates the relation between said terms. However, it is clear by the language in this passage that this method could have a much broader application to scientific investigations in general, rather than strictly mathematical problems. This ambiguity is confirmed when Descartes follows the description above with the claim, "These conditions hold also for imperfect problems" (ibid.). The paradigmatic cases of imperfect problems are physical problems, such as the nature of the magnet, where the relationship between knowns and unknowns cannot be determined sufficiently (AT X, 439; CSM I, 57). The method of comparison, when applied to the combination of physical "natures," which are the causes of perceived effects, Descartes claims, will explain "whatever it is possible for the human mind to

attain in this matter” (ibid.). This is the sense in which I take Descartes’ *Regulae* to express the greatest fulfillment of Descartes’ vision for a *scientia penitus nova*, which he outlined for Beeckman in 1619.

Mathesis in the Regulae

I think that one must understand Descartes’ use of the concept of *mathesis universalis* in Rule IV-B in light of his overarching desire to outline a general method for scientific discovery. Though the literature on Descartes’ use of *mathesis universalis* exhibit a spectrum of opinions on its meaning, the date of composition of the passage in which it appears, and its significance for his philosophy as a whole, one issue that consistently arises is the appropriate translation or definition of the *mathesis universalis* as it is used by Descartes. Those who have looked at the issue from the perspective of mathematics (especially Schuster, Bos, and Sasaki) refer to the *mathesis universalis* as a general mathematical science and identify it with the emerging technique of algebra, an analysis that lends itself to the translation “universal mathematics.”²³³ The reasoning behind their decision is sound, though I would add that the investigation into a general algebraic method of discovery in mathematics, as is seen in Viète, should also be coordinated with a general interest in outlining an *ars inveniendi*, i.e., a method for discovering first principles of science, which is broader than specifically mathematical problem-solving. Moreover, this art ought to be understood in light of a renaissance of the ancient concept of analysis, with all of its connections to the epistemological and

²³³ Schuster, op cit.; Bos, *Redefining Geometrical Exactness*, 121, 125 and 261-3; and Sasaki, op cit.

metaphysical issues raised by Plato's concept of mathematics.²³⁴ Thus, while the *mathesis universalis* has direct pertinence for the mathematical sciences, it is certainly embedded in a grander vision. Moreover, Descartes' own remarks seem to indicate clearly that the method of comparison, algebra, and the *mathesis universalis* could reasonably be extended to include a kind of universal method in the sciences, or a general art of discovery (the *ars generalis ad omnes questiones solvendas quaesita* that Beeckman annotates to Descartes' *scientia penitus nova*). Finally, van Roomen and Alsted, who are the first to describe the *mathesis universalis* in the context of a classification of the sciences, make it clear that this concept is distinct from special mathematics, a distinction that should not be obscured by translation. I think that the similarity between *mathesis* and mathematics demonstrates the extent to which the mathematical method, specifically algebra, had emerged (since Viète) as a legitimate method of discovery in the sciences. Insofar as the dialectical method had become adversely identified with scholastic disputations, a litany of syllogistic forms, and rhetoric, it no longer provided a legitimate method of discovery. Descartes reflects this historical tendency.

Despite the fact that there is good reason to understand 'mathesis' as a distinct though related concept to 'mathematica', the standard English and French translations of the *Regulae* make no such distinction, translating both by mathematics or la *mathématique*. Since these translations give the reader no indication of the subtle changes

²³⁴ Both Jacob Klein, *Greek Mathematical Thought and the Origin of Algebra*, 181-83, and John Schuster, "Descartes' *Mathesis Universalis*," 44, suggest that Descartes' comments on *mathesis universalis* have a direct connect to his reading of Barozzi's translation of Proclus.

in Descartes' vocabulary, they exacerbate the difficulties already inherent in interpreting the controversial passage in Rule IV. The controversial section of that rule begins with a retrospective look back on Descartes' first studies in mathematics. He complains to the reader that though he had read many accounts of problem-solving in classical mathematics, "they did not seem to make it sufficiently clear to my mind why these things should be so and how they were discovered" (AT X, 375; CSM I, 18). This is why he calls these mathematical problems "childish and pointless," "trifles," and having "more to do with our eyes and imagination than our intellect" (ibid.). Indeed, this disdain for ordinary mathematical problem solving seems to echo Rule IV-A, where he claims to no longer be dabbling "in trifles" (the Latin here is identical: *nugara*), and that ordinary mathematics is but the "outer garments" of the true method expounded there (AT X, 373-4; CSM I, 17). In fact, Descartes claims that it is only when he questioned why the "founders of philosophy would admit no one to the pursuit of wisdom who was unversed in *mathesis*" (i.e., in reference to the alleged motto over Plato's academy, "No one ignorant of geometry may enter") that he began to discover a secret art, a true Mathesis, which would provide a real method of discovery. Though Descartes does not mention analysis directly, he does cite Pappus and Diophantus and he states that "the method seems to me to be none other than the art which goes by the barbaric name 'algebra'" (AT X, 377; CSM I, 19).²³⁵ Moreover, this algebraic method, Descartes indicates, is a contemporary attempt to revive the ancient art of discovery that was suppressed by its

²³⁵ Bos, *Redefining Geometrical Exactness*, 97: "Algebra entered geometry through its use in the analysis of problems and from c. 1590 the development of this analytical use of algebra can be identified as the principal dynamics within the early modern tradition of geometrical problem solving." Cf. 10n17

practitioners: “They may have feared that their method, just because it was so easy and simple, would be depreciated if it were divulged; so to gain our admiration, they may have shown us, as the fruits of their method, some barren truths proved by clever arguments” (AT X, 376-7; CSM I, 19). This was the standard view of analysis at the time: namely, that it was a method of discovery that had been suppressed in favor of the clever, but empty, arguments provided by synthesis, which give no indication of how the principles themselves were discovered, and were possible only after one had acquired the knowledge sought. When Descartes complains that the present “algebra” is overwhelmed by a “multiplicity of numbers and incomprehensible figures” (ibid.), he is referring to the German Cossic algebra (rather than Viète's), whose notation is indeed cumbersome, bordering on incomprehensible, at least to the modern reader.

Thus, Rule IV-B introduces the *mathesis univiversalis* alongside algebra, a true reform of which we are told would also enable one to come to possess all of human knowledge (*imo qua ad omnem cognitionem humanam pervenire potest*: Beeckman's journal, October 8, 1628: AT X, 332). However, the identification between Descartes' algebra and *mathesis* should not lead one to identify ‘*mathesis*’ and ‘*mathematica*’.

Rather, I believe that Rule IV-B presents a consistent distinction between the two.²³⁶ Of

²³⁶ For readers of the Cottingham translation, here are the locations of each use of ‘*mathesis*’ in Rule IV and the translated phrase in which it appears: ln. 24: “the founders of philosophy would admit no one to the pursuit of wisdom who was unversed in mathematics [ut primi olim Philosophiae inventores neminem Matheseos imperitum ad studium sapientiae vellent admittere]”; 376, ln. 4: “they were familiar with a kind of mathematics quite different from the one which prevails today [quidam eos Mathesim agnovisse valde diversam a vulgari nostrae aetatis]”; 376, ln. 19: “also enabled them to grasp the true ideas in philosophy and mathematics [Philosophiae etiam et Matheseos veras ideas agnoverint]”; 376, ln. 21: “Indeed, one can even see some traces of this true mathematics, I think, in Pappus and Diophantus [Et quidem huius verae Matheseos vestigia quaedam adhuc apparere mihi videntur in Pappo et

the eleven times ‘mathesis’ is used in the passage, it is twice called “Mathesis Universalis,” once referred to in terms of “a general investigation of things related to mathesis [*generalem quandam Matheseos investigationem*]” in contrast to arithmetic and geometry and three times called the “true mathesis [*vera Mathesis*].” By contrast, “mathematica” is used four times in the passage, three times in the plural and always with reference to the mathematical disciplines, twice with reference to the “parts of mathematics [*partae mathematicae*].” Thus, it seems that Descartes is drawing a relatively sharp distinction between mathesis, which indicates a general science of investigation that is truly at the heart of the various mathematical disciplines, and mathematics, which serves to designate those particular disciplines in a way that is entirely consistent with the use of that term in van Roomen and Alsted. This is again confirmed by the explicit definition of mathesis universalis in that Rule:

I came to see that the exclusive concern of *mathesis* is with questions of order or measure and that it is irrelevant whether the measure in question involves numbers, shapes, stars, sounds, or any other object whatever. This made me realize that there must be a general science which explains all of the points that can be raised concerning order and measure irrespective of subject-matter, and that this science should be termed *mathesis universalis*—a venerable term with a

Diophanto]”; 377, ln. 9: “which I believe the true mathematics ought to have [qualem in vera Mathesi debere esse supponimus]”;³⁷⁷, ln. 11: “It was these thoughts which made me turn from the particular studies of arithmetic and geometry to a general investigation of mathematics [Quae me cogitationes cum a particularibus studiis Arithmeticae et Geometriae ad generalem quamdam Matheseos investigationem revocassent]”; 377, ln. 17: “since the word ‘mathematics’ has the same meaning as ‘discipline’ [nam cum Matheseos nomen idem tantum sonet quod disciplina]”; 377, ln. 22: “what relates to mathematics and what to other disciplines [quidam ad Mathesim pertineat, et quid ad alias disciplinas]”; 378, ln. 1-2: “the exclusive concern of mathematics is with questions of order and measure [illa omnia tantum, in quibus ordo vel mensura examinatur, ad Mathesim referri]”; 378, ln. 8-9, “Mathesis Universalis”; and 379, ln. 4: “Mathesis Universalis.” When Descartes refers to “rapports et proportions” in the Discours de la méthode, a concept parallel to the “ordo et mensura” that identifies mathesis universalis in the Regulae, he distinguishes it from “common mathematics,” though he does not explicitly relate it to mathesis: AT VI, 20; CSM I, 120.

well-established meaning—for it covers everything according to which these other mathematical sciences are called parts [*quod aliae scientiae mathematicae partes appellantur*]. (AT X, 377-78; CSM I, 19)

In this central passage, the only place where Descartes explicitly defines ‘mathesis universalis’, it is clear that he conceives of it as a general science of order and measure of which the specific mathematical sciences, e.g., optics, mechanics, astronomy, geometry and arithmetic, are tokens.

When this passage is related to Rule VIII, a Rule that we have seen is central for interpreting the *Regulae*, it becomes evident that this science of mathesis universalis responds directly to the question concerning the investigation of the nature and scope of all human knowledge. Though it is not the case that all of human knowledge admits of “order and measure” and as a consequence cannot simply be identified with the mathesis universalis, there is some good evidence that Descartes, at least in the *Regulae*, was attempting to reduce all of human knowledge to what could be ordered and measured. In order to illustrate this, I will refer here briefly to a series of citations that will be discussed in more detail in the final section of this chapter. Descartes states in Rule II that, of the sciences devised thus far, “we are restricted to just arithmetic and geometry if we stick to this Rule” (AT X, 363; CSM I, 11). Moreover, his notion of scientific knowledge is founded on intuition and deduction, which themselves rest on the “simplest things” and the necessary inference from these to other propositions (Rule III). One has access to these simple things, he claims, through a “step by step,” orderly reduction of complex propositions to their simple components (Rule V). Finally, Rule VIII states that the limits of human knowledge are coextensive with what can be easily conceived.

Descartes assures the reader that there are limits to human cognition, things that are “beyond the bounds of human knowledge” (AT X, 396; CSM I, 30) or exceed “the grasp of the human mind” (AT X, 400; CSM I, 32-3); an inability to understand these things does not demonstrate a lack of intelligence, but simply the limits of human reason itself. The same Rule introduces the principle that “there is no truth or falsity in the strict sense, except in the intellect” (AT X, 396; CSM I, 30). Insofar as scientific knowledge concerns what is either true or false, then this knowledge would lie wholly within the bounds of what can be conceived clearly and distinctly by the intellect. These passages suggest that Descartes does conceive of the *mathesis universalis*, a general science of order and measure whose principles are utterly transparent to anyone, as roughly coextensive with human knowledge in the strict sense (*scientia*).

It is thus not surprising that Descartes invokes the term ‘mathesis’ in Rule VIII. There it is used in a puzzling way, however, in reference to the example of how one ought to discover the principle of refraction exemplified in the anaclastic line. For the purposes of that example, Descartes introduces someone “whose studies are confined to mathematics.” He claims that though this person will see that “the determination of this line depends on the ratio [*proportione*] of the angles of refraction to the angles of incidence ... he will not be able to find out what this ratio is, since it has to do with physics rather than with *mathesis* [*cum ad Mathesim pertineat, sed ad Physicam*] (AT X, 393-4; CSM I, 28-9). It is possible that Descartes is drawing a distinction between ‘mathesis’ in the narrow sense, as that which applies only directly to the proportions and relations of arithmetic and geometry, and ‘mathesis universalis’, which would extend

such an understanding to other sciences. After all, Rule IV-B does acknowledge that optics and mechanics are “parts of mathematics” (AT X, 377; CSM I, 19); and it appears that the *mathesis universalis* is what allows these various parts to be called mathematical. However, in Rule VIII the key physical notion that cannot be discovered by the mathematician has to do with “the nature of the action of light,” or more generally what a “natural power [*potentia naturalis*]” is (AT X, 394-5; CSM I, 29). Understanding the natural philosophical concept *potentia naturalis* is certainly not within the provenance of a science of “order and measure.” Additionally, it does not seem to be the kind of knowledge that would be “utterly transparent” or available to “intuition.” Rather it is something that can only be inferred on analogy with other intuitions and requires empirical investigation.

When Descartes finally addresses some of the issues concerning the nature of the action of light in his *Optics*, he does so by way of several analogies: the nature of sight is understood in terms of the way a blind man uses his walking sticks to “see” in front of him, the action of grapes in a wine vat demonstrate the instantaneous motion of light through the plenum, and the action of a ball as it bounces off of a wall demonstrates the property of refraction (AT VI, 83-90; CSM I, 153-56). Even more to the point, determining the sine law of refraction requires introducing a constant, called the “refractive index,” that is specified by the kind of material through which light is being refracted. This constant cannot, in principle, be discovered by pure, abstract, mathematical reasoning; it requires experimental observation. Thus, Descartes’ distinction between *mathesis* and physics does not undermine the epistemological claim

that all knowledge, in order to be certain and evident, must be reduced to a proportion between ordered magnitudes. Rather, it simply states that some problems require the introduction of magnitudes or constants that must be determined empirically. The *mathesis universalis* tells us what we ought to look for, but in some cases it cannot also tell us what we will find.

In this way, the passage demonstrates the limitations of the project of a *mathesis universalis* as it is applied to problems in the physical sciences. This same limitation is apparent in Rule XII, where Descartes appears to allow for a kind of scientific knowledge that would be reached by experiments, along the lines of Bacon's method of induction in the *New Organon*. This can be seen most clearly in Descartes' discussion of the "nature of the magnet," where again he undertakes to explain the method for treating this difficult topic with the aim of outlining "the whole of human knowledge" (AT X, 427; CSM I, 49-50). While it was noted above that the nature of the magnet could be disclosed by means of the method of comparison, this passage indicates that experimentation will also be necessary in order to disclose its true nature. Thus, there are two methods implicitly operative here: one that is mathematical, which involves creating a comparison or proportion between knowns and unknowns, and the other that is empirical, which allows one to determine certain knowns empirically.²³⁷

Just as Descartes turned toward establishing the metaphysical foundations of his physics in 1629, he also embarked on a concerted effort to outline his physical science,

²³⁷ We will have occasion to return to this passage in the following chapter and assess in what way it can be taken as a "paradigmatic" case of Descartes' method as Dan Garber, "Descartes and Method in 1637," in *Descartes Embodied*, 33-51, esp. 34-39, claims.

writing *Le Monde*. These efforts lie beyond the scope of what was accomplished in the *Regulae*. Perhaps they lie beyond the scope of what Descartes was able to achieve in terms of the *mathesis universalis*. Insofar as they invoke the techniques of analogy and experimentation, they seem to rely on resources outside the realm of a formal science of abstract magnitude. Indeed, Descartes' investigations into natural philosophy proper will require that he admit of other methods of discovery (principally Baconian in nature). The experimental method does not, however, eliminate the importance of the *mathesis universalis*; rather, the nature of those experiments is determined by the requirements of *mathesis*.

Mathesis in Descartes' mature writings

When Descartes begins his definitive work on metaphysics and the foundation of his physics, the *Meditationes*, he once again returns to the language of *mathesis* in describing at least one aspect of that metaphysical picture. In a letter to Hogelande of February 8, 1640, Descartes identifies *Mathesis* with scientific knowledge, which he says is "the ability to resolve all problems, and moreover to discover by one's own industry [*humano ingenio*] everything that can be known by the human mind" (AT XII, 2). This letter would seem to support the reading of the *mathesis universalis* as united with a general project for outlining all that can be known by the human intellect. In another letter in that same year, however, Descartes refers to *mathesis* in order to distinguish it from physics, though he also claims that the two are operative in putting together arguments that establish scientific knowledge [*Nam certe neque nomen eius a quo Theses*

illae factae sunt, ad me scriptum fuit, neque etiam nomen scientiae quam docet, etsi vel Physicam esse vel Mathesim facile ex argumento conijciam] (to P. Hayneuve, 22 July, 1640: AT III, 98-9). Finally, also in 1640, in a letter to Mersenne of August 30, Descartes refers three times to mathesis. It appears that Descartes wrote this letter in response to an exchange with Fr. Bourdin, who had been critical of his *Géometrie* (see AT III, 105-19). Descartes defends his *Géometrie* against Bourdin by appealing to the very same qualities that had made arithmetic and geometry paradigmatic for *scientia* in the *Regulae*: mathematical reasoning rests on certain experience, it cannot contain any falsity and its demonstrations are easy easily encompassed by the ordinary power and learning of the human mind [*Talia enim sunt ea quae scripsi, ut, cum non aliis quam Mathematicis rationibus, aut certa experientia nitantur, nihil falsi possint continere, quod non facile fit tam ingeniosis et doctis evidenti demonstratione refellere*] (AT III, 173).

Van de Pitte argues that Descartes was introduced to the terminology of the mathesis universalis around 1640 through two texts that he had been given in 1639: Amos Comenius' *Pansophia Prodromus* and Peter Wallis' *Idea Mathematica*, both of which employ that concept.²³⁸ As I have shown in the previous section, these two works by Comenius and Wallis fit within the general project of outlining a true method of discovery in the sixteenth and seventeenth century. As a result, the existence of these texts and Descartes' introduction to them in 1640 do not represent anything novel for

²³⁸ Van de Pitte, "Dating Rule IV-B," 378-82. The key link for Van de Pitte is the Greek spelling of *matheseôs* (with the omega) that is employed by Mersenne in his letter to Descartes, and is also employed by Descartes to Hogelande in his letter of August 8, 1640. On this basis, Van de Pitte argues for dating Rule IV-B to around 1640. To be fair, the primary aim of Van de Pitte's article is to argue against Weber's dating of 1619 for the passage. However, I think he goes too far.

Descartes, rather they fit within a general range of concerns that had occupied him since as early as 1619.

There is another good reason not to accept the most contentious conclusion of Van de Pitte, namely that Rule IV-B was written around 1640 during the preparation for the *Meditationes*: the *Regulae* ought to be read as a coherent text and not as a piecemeal construction over time. There seems to be no better reason to claim that Rule IV-B was written after 1640 than to claim, as Weber does, that it was written before November 10, 1619. The reason for declaring sections of the *Regulae* to have been written at radically different periods of time ought to be supported through textual arguments, and there are none available. Nonetheless, what Van de Pitte's article does demonstrate is the close connection between Descartes' use and understanding of 'mathesis' and that of those contemporary to him, in this case Comenius and Wallis. Indeed, Comenius was a student of Alsted and was instrumental in introducing the ideas of a universal science (a *panacea philosophica*) and a universal code or language to England; Wallis was principally a mathematician (an influence of Newton's), but he also demonstrated an interest in the ideas of a universal science or universal language. Thus, these two works fit into the overall picture of the mathesis universalis that has been outlined above; and it is quite possible that Descartes reincorporates that vocabulary into his later writing as a response to these texts. Moreover, Van de Pitte's research demonstrates a reintroduction of this terminology in Descartes' later work and thus provides an important link between Descartes' youthful vision of a universal science modeled on mathematics and his mature metaphysical system, in which mathematics also plays an important role.

Whatever the motivation behind the references present in Descartes' later work, they link Descartes' concept of a mathesis to his mature thought.²³⁹ In Meditations V and VI, this link is made most definite. There, Descartes refers several times to "the object of pure mathesis [*purae Matheseos objectum*]" or an "abstract mathesis [*abstractam Mathesim*]." In Meditation V, he clearly refers back to his early conception of a mathesis universalis, as it relates to certain and infallible knowledge: "... even before, when I was completely preoccupied with the objects of the senses, I always held that the most certain truths of all were the kind which I recognized clearly in connection with shapes, or numbers or other items relating to arithmetic and geometry, or in general to pure and abstract mathesis [*ad Arithmetica vel Geometria vel in genere ad puram atque abstractam Mathesim pertinetibus*]" (AT VII, 65; CSM I, 45). Later, as he completes that Meditation, wherein he proves the necessary existence of all things of which one has a clear and distinct idea, he concludes: "And now it is possible for me to achieve full and certain knowledge of countless matters, both concerning God himself and other things whose nature is intellectual, and also concerning the whole of that corporeal nature which is the object of pure mathesis [*de omni illa natura corporea, quae est purae Matheseos objectum*]" (AT VII, 71; CSM I, 49). Here, Descartes makes it clear how the mathesis universalis fits into his later metaphysics, i.e., it provides the rubric according to which corporeal nature can be conceived clearly and distinctly. The essence of material things, which can be conceived clearly and distinctly and thus makes possible the existence of

²³⁹ Lachterman, *The Ethics of Geometry*, 124-205, presents probably the most sustained interpretation of the role of the mathesis universalis in linking Descartes' *Géométrie* to his metaphysics.

material things, is understood *qua* object of pure mathesis. A similar concept is again reiterated in the *Principia* II, §64 where abstract mathesis is correlated with geometry and the two fields are determined to be the only acceptable principles of Cartesian physics (AT VIII-A, 78; CSM I, 247).

We will have a chance to explore the philosophical issues raised by these passages in the closing sections of this chapter. For the moment, it is sufficient to note that the mathesis universalis bears a largely continuous relevance for Descartes' philosophical project from its earliest inception in 1619 up to its most mature formulation in the *Principia* (1644, 1647). We see this interest grow out of Descartes' studies in mathematics. In the sixteenth and early seventeenth centuries, mathematics was also closely related to more general project of reforming Aristotle's *Organon*, setting the sciences on a firm foundation, and reordering our knowledge in order to make it useful for instruction and scientific discovery. All of these historical elements ought to be brought to bear on an interpretation of Descartes' *Regulae*.

The mathesis universalis and Descartes' successors, especially Leibniz

If these brief references are not sufficient to demonstrate that what is intended by the mathesis universalis is Descartes' algebraic method, through which he considered it possible to comprehend any physical phenomenon, then the testimony of his successors can help to support my interpretation. Three textbooks on Cartesian geometry appeared in the century following the publication of Descartes' *Géométrie*, each of which refers to their study as a study of 'mathesis universalis'. John Wallis' *Mathesis universalis* (1649),

Franz van Schooten's *Principia matheseos universalis* (1661) and William Jacob's *Matheseos universalis elementa* (1727) all understand the method of Cartesian geometry and its subject-matter to be defined as a 'mathesis universalis'.²⁴⁰ These textbooks indicate a rather widespread interpretation of Cartesian geometry as the fulfillment of that sixteenth and early seventeenth century vision of a universal science of mathematics that would resolve all the classical problems in geometry. Yet Leibniz is the first to truly synthesize the mathesis universalis with a general ontology and a theory of language.

I have already discussed his first major work, *De arte combinatorie* (1666), which refers principally to Lull and the Lullian commentaries as the progenitor of the art of combination outlined there. In that work, Leibniz also refers to Descartes via Franz Van Schooten, but does not really incorporate the Cartesian algebraic geometry into his understanding of mathesis universalis. However, after Leibniz traveled to Paris in 1676, he obtained a copy of the *Regulae*, which we have seen is now known as the famous Hanover manuscript. During his travels to London, Leibniz may have also come into contact with John Wallis' *Mathesis Universalis* (1649), another text on algebraic geometry, but which contains numerous references to the problem of writing in general and of occult writing in particular. Wallis seems to have been interested in algebraic characters as a specific kind of signs, ciphers, and textuality in general.²⁴¹ Whatever sources may have had a primary influence on Leibniz, he clearly understood the mathesis

²⁴⁰ These books are discussed in Sasaki, *Descartes' Mathematical Thought*, 394-98, though Sasaki insists on the purely mathematical nature of the works. I would also emphasize the linguistic interests of Wallis and the physical applications of mathematics in van Schooten as supporting a broader interpretation of the range of the mathesis universalis.

²⁴¹ Rossi, *Logic and the Art of Memory*, 152.

universalis as the application of Cartesian style geometry to a general method of cognition; he saw it as part of the project to create what he called “an alphabet of human thoughts.”²⁴²

This project seems to have exercised a continued influence on Leibniz’s thought, a hypothesis that is confirmed by references in his correspondence to his *Dissertatio*.²⁴³ Indeed, Leibniz’s interest in an art of combination dovetails with his introduction to, for instance, John Wilkin’s *Characteristica Realis*, which expands a theme of Francis Bacon’s. In the *De augmentis scientiarum*, Bacon had suggested devising a true philosophical language based on “real characters,” i.e., words whose meanings precisely mirror things.²⁴⁴ The basic idea is that if one were able to devise a symbolic system of classification wherein the basic elements of every existing thing were identified by a ‘real character’, then understanding and properly naming the essence of any given thing would be a task of simple combination and calculation using real characters. It would be as if the periodic table of elements had semantic content. Wilkin’s expansion of Bacon’s proposed project of developing a truly philosophical language was heavily influenced by Comenius, the student of Alsted, who introduced ideas of universal language and encyclopedism to Britain in the 17th century. These elements are closely related to the mystical and Neoplatonic aspirations of people like Ramon Llull. Though Leibniz would ultimately distance himself from his youthful inspiration by Llull, he continues to express

²⁴² G.H.R. Parkinson, “Introduction,” *Leibniz’s Logical Papers*.

²⁴³ See, for instance, Leibniz to Th. Burnett, *Gesamelte Werke*, III, 216: “J’avois considéré cette matiere avant le livre de Mr. Wilkins, quand j’estois un jeune homme de 19 ans, dans mon petit livre de *Arte Combinatoria*, et mon opinion est que les Caracteres veritablement reels et philosophiques doivent repondre à l’Analyse des pensées.”

²⁴⁴ Rossi, *Logic and the Art of Memory*, 145-50; Leibniz to Th. Burnett, op cit.

an interest in a true combinatorial art of essences. Whereas the earlier treatise conceived of the characters of the combinatorial art to mirror the real world of qualities or elements like Llull's theory of the elements, Leibniz's mature understanding mediates those abstract symbols and their physical counterparts through quantitative measurement. In other words, he designates physical entities with a common measurement in order to translate the real qualities into mathematical relations and then perform the appropriate calculus. In order to understand any real product of two physical things, it would suffice to translate the mathematical result obtained through Leibniz's calculus back into descriptors of physical qualities.

In Leibniz's unfinished treatise on the *mathesis universalis* (begun around 1695), he identifies the *mathesis universalis* with "logistic," i.e., a calculus applied to logical combinations of formal relations.²⁴⁵ Logistics appears to be specifically the process of attaching symbols to arithmetical problems: Leibniz says that logistics is what algebra has come to be called [*Logisticam, quae Algebrae nomine venit*]. Yet he also suggests that this symbolization has a direct bearing on physical qualities, redressing for instance common errors of calculation in dynamics, i.e., the physics of the forces and motion. While the treatise provides a technical outline of the principles of geometrical algebra, in essence providing Leibniz's response to Descartes and Viète, the role of logistics and the importance of symbolic characters stretch its implications beyond merely mathematical problem solving. In the introduction to the treatise, Leibniz conceives of this general

²⁴⁵ "Mathesis universalis," in *Gesamelte Werke*, VII, 49-76.

calculus to have direct application to mechanics and “mixed mathesis,” though he never develops that proposed section.²⁴⁶

Instead, in the first part of the actual treatise (the only part completed), Leibniz affirms a standard definition of mathesis universalis: “Mathesis universalis is a science of quantity in general, or of designated ratios to which limits are determined and between which certain things fall [*Mathesis universalis est scientia de quantitate in univesam, seu de ratione aestimandi, adeoque limites designandi, intra quos aliquid cadat*].”²⁴⁷ But he continues, “[J]ust as metaphysics is a general science of things, mathesis universalis is the general science of created things. And this has two parts: finite science (which is called algebra and which has already been explained) and infinite science, where it determines what comes between the finite and the infinite [*ut Metaphysica est scientia rerum generalis, ita Mathesin universalem esse scientiam creaturarum generalem. Duasque habet partes: scientiam finiti (quae Algebrae nomine venit priorque exponentur), et scientiam infiniti, ubi interventu infiniti finitum determinatur*].”²⁴⁸ The “just as” (*ut ... ita*) analogy to metaphysics certainly lends the mathesis universalis a broader scope than a merely mathematical science and harkens back to Aristotle’s rejection of any analogy between “universal mathematics” and metaphysics. Given these broad overtures, however, one need not get carried away by the language of finite and

²⁴⁶ Ibid., 51-2 (marginal section heading): “De usu huius Scientiae, ut qui eius praecepta tenaeat, ipse per se facilius invenire possit, quae in Geometria et Mechanica et Matesi mista traduntur, paucis tantum privatis cuiusque scientiae ad hanc subalternae principiis cognitiss. Quod nunc magis locum habet, ex quo novum Calculi Algebrae Transcendentis hoc primum libro explicati genus ipsa infiniti scientia subiit, quae partem huius nostrae facit et ad majoris momenti problemata adhiberi debet.”

²⁴⁷ Ibid., 53.

²⁴⁸ Ibid.

infinite sciences (*scientiam finiti, infiniti*). It seems that this distinction is equivalent to the distinction between finite calculus and infinite calculus, i.e., Riemannian integration. Leibniz's notation and its application to particular problems are outlined on the following pages of the treatise. In essence, Leibniz appears to be weighing in on the algebraic geometry of Viète and Descartes (and van Schooten who also plays a significant role). Just as these philosophers identified their algebraic calculus with the ancient art of “analysis,” so too does Leibniz.²⁴⁹

Aside from generalizing the analytic art of mathesis to infinitesimal calculus, reclassifying curves in terms of transcendental and geometrical, and reinterpreting the law of homogeneity (as a rule governing the reduction of equations in order to determine their roots), Leibniz's greatest innovation in this treatise is to determine explicitly the mathesis universalis as encompassed under a broader “combinatorial art.” In so doing, Leibniz extends the art of logistic to both quantity and quality [*scientia generalis de quantitate ad scientiam generalem de qualitate, ut adeo speciosa nostra Mathematica nihil aliud sit quam specimen illustre Ars Combinatoriae seu speciosae generalis*] and he explicitly relates it back to his youthful vision of an *ars combinatoria*.²⁵⁰ In this way, the mathesis universalis is subsumed under what Leibniz sometimes calls the *characteristica universalis* or the combinatorial art applied to the characteristics or formal qualities of things perceived through sensory intuition. The *characteristica universalis* is subsequently subsumed under the pure formal logic of ideas. Thus, one crucial innovation that Leibniz appends to the mathesis universalis is to apply the idea of a universal method

²⁴⁹ Ibid., 54: “unde et Logistica nostra nomine Analyseos Mathematicae passim venit.”

²⁵⁰ Ibid., 61.

of the mathematical sciences to qualities or forms of sensory intuition as well as to quantity or magnitude. Leibniz thought such an extension was possible on the basis of an analogy between the designations “similar” and “dissimilar” applied to quality with “equal” and “unequal” as they are applied to quantity. This seems to be, in some measure, directly related to the concrete applications of the abstract science of mathesis. Whereas the formal features of number or ratio are treated by finite or infinite calculus, the mathesis universalis makes it possible to conceive of their corresponding concrete applications, e.g., as lines, shapes, solid bodies, time, movement, force, sound, light and the like [*Abstractae sunt numeri, vel etiam rationes, quas ipsas (quemadmodum supra dicum) ut numeros tractes concipio. Quantitates concretae possunt esse linea, figurae, solida, tempora, motus, vires, sonitus, lux, et omnia denique, in quibus eiusdem mensurae repetitio intelligi potest*].²⁵¹

Repetition of measure and the unit of measure: the key to a mathesis universalis

The crucial feature that allows Leibniz to move back and forth between the abstract calculus of mathematics and concrete physical qualities is what he calls the repetition of measure (*mensurae repetitio*). This repetition of measure is a kind of unit of measure to which various kinds of measurements can be compared. To stress the importance of this concept, Leibniz compares the mathesis universalis to a kind of

²⁵¹ Ibid.

science of the repetition of measure.²⁵² Thus, it appears that the repetition of measure functions as a focal point around which the mathematical calculus can be conceived either purely abstractly, as numbers and symbols, or concretely, as describing lines, shapes, solid bodies, time, movement, forces, sounds, or light. In this way, Leibniz outlines his understanding of *mathesis universalis* as an analytic and synthetic procedure. The analysis allows one to proceed from a proposed problem (which could be physical or mathematical) to the presuppositions necessary for solving it, but the synthesis, or the art of combination, allows one to move either from one problem to another or from the simple starting points to complex realities with reference to the repetition of measure. Here the *mathesis universalis* is clearly integrated into a method for solving real problems, whether abstractly mathematical in nature or dealing with concrete physical realities.

In fact, Leibniz's appeal to the *mensurae repetitio* echoes Descartes' discussion of the role of the "unit" of measure in the *Regulae*, itself recalling the *famosa mensura* commonly attributed to Regiomantus (1436-1476).²⁵³ The basic idea behind this concept is that measurements of different kinds of things, e.g., weight, motion, or number, can be

²⁵² See Leibniz's definition, *ibid.*, 53: "Quia autem omnis quantitas determinari potest per Numerum partium congruentium inter se seu repetitionem mensurae, hinc fit ut *mathesis universalis* simul sit scientia de *Mensurae repetitione* seu de *Numero*, unde generali calculi nomine venire solet."

²⁵³ See for instance, Michel Varro's *De motu tractatus* (1584), Lemma II, where he applies the *famosa mensura* to the concept of weight: "ponderibus scilicet quibusdam certa quantitate constantibus inditis nominibus, vt essent ponderum omnium communes mensurae, vt sunt librae, vncia, drachmae, &c. quas famosas mensuras vocant." See also Bos, *Redefining Geometrical Exactness*, 148-51 on Descartes' use of the *famosa mensura* to circumvent the "law of homogeneity."

compared if they refer to a common unit of measurement. Descartes introduces this concept in terms of his general method for problem solving in Rule XIV:

... we should note that whenever we deduce something unknown from something already known, it does not follow that we are discovering some new kind of entity [*genus entis*] but merely that we are extending our entire knowledge of the topic in question such that we perceive that thing sought participates in this way or that way [*participare hoc vel illo modo*] in the nature of the things that are given. (AT X, 438; CSM I, 56)

He goes on to describe how this extension of knowledge is made possible by the fact that different things possess “common natures,” though not in an equal degree. What is common to them allows us to deduce the nature of something unknown by means of what is already known by creating an equation or ratio of natures. There is a direct relationship between the concept of a “common nature” and the concept of “magnitudes in general,” since “nothing can be reduced to such a degree of equality except what admits of differences of degree” (AT X, 440; CSM I, 58). This reference to “magnitudes in general” is a clear reference to the *mathesis universalis*. Moreover, it is clear that when Descartes refers to “common natures” he is not restricting his discussion to mathematics alone, since he uses examples of the magnet, of a gold or silver crown, and embarks on a detailed discussion of the nature of the relationship between “extension” and “body.” Indeed, it seems that this notion of common nature is directly related to the simple natures of Rule XII, which are not at all confined to mathematical entities in the strict sense.

Setting the issue of simple natures aside for the moment, Descartes clarifies what he means by the concept of the “unit” in Rule XIV:

Unity is the common nature which, we said above, all the things which we are comparing must participate in equally. If no determinate unit is specified in the problem, we may adopt as unit either one of the magnitudes already given or any other magnitude, and this will be the common measure of all the others. (AT X, 449-50; CSM I, 63)

Thus, the unit is not a fixed point of reference, but an arbitrary point of reference; and it is that common nature through which anything can be submitted to the ‘method of comparison’. This stipulation that one can arbitrarily select the unit of measure will feature in Descartes’ solution to the Pappus problem where any two of the given lines, heeding some pragmatic rules of thumb, are chosen as the principle lines or axes for solving the problem. Though Descartes does not depend on some fixed “common nature,” such as would have been required by Aristotelian demonstration according to genera, the arbitrarily chosen unit acts as the explanatory “middle term” of the demonstration. Descartes says, “But I cannot get to know what the proportion of magnitude between 2 and 3 is without considering some third term, *viz.*, the unit, which is the common measure of both” (AT X, 451; CSM I, 65). If the unit or ‘third term’ is sufficiently general, then the nature of scientific explanation is greatly simplified. For instance, if one were to examine the case of motion from the perspective of change in position (which is then determined by some unit of measurement), it becomes much easier to describe and compare the motion of the planets, the motion of ships traveling at sea, or the motion of a projectile through the air. Though these are different “kinds” of things, they can be referred to the same unit of measurement and thus their motion is tractable through the same method of comparison. It seems that Leibniz’s concept of a *mensurae repetitio* recalls this basic concept of the unit expressed by Descartes.

The unit of measure, in effect, absolves the *mathesis universalis* of the defect noted by Aristotle. Insofar as any given thing can be referred to a common measure, or a unit of measure, then there is a unifying principle for understanding both geometrical and arithmetical magnitudes in the same way. While Descartes has no real conceptual solution to the problem of incommensurability (he is still unable to treat equations with either irrational—surd—coefficients or irrational roots), he does have a way to bypass this issue by determining the unit to be any length that results in a rational coefficients.

Contemporary interpretations of the concept ‘mathesis universalis’

Thus, the notion that different kinds of things can be referred to a common measure allows Leibniz to conceive of a very broad application of the *mathesis universalis*, which supplies the technique for solving problems and applying those solutions to both quantities and qualities. Indeed, this Leibnizian interpretation of the *mathesis universalis* becomes decisive for the subsequent history of interpretation. In the most general sense, Leibniz’s understanding of the *mathesis universalis* and its role within a larger combinatorial art are often related to formalism and logicism in philosophy. This movement is most poignantly characterized by Frege and Russell at the turn of the twentieth century.²⁵⁴ However, it should be noted that, while Leibniz and Descartes gesture toward an abstract notion of “common measure” or “unit of measurement,” it appears that this concept is still essentially tied to concrete magnitudes and thus does not

²⁵⁴ See Volker Pekhaus, *Logik, Mathesis universalis und allgemeine Wissenschaft* for an impressive history of Leibniz’s legacy of formal logic up to Frege and Russell.

constitute an abstract, formal concept of number. Though Descartes and Leibniz, in their interpretation and incorporation of the *mathesis universalis*, seem to anticipate mathematical formalism of the twentieth century, this is only the earliest foreshadow of that later development. Nevertheless, both Edmund Husserl and Martin Heidegger make explicit reference to the *mathesis universalis* in Leibniz as it relates to formalism in early modern philosophy. Their discussions are broad and thematic, seemingly intended to contextualize their own philosophical ideas with a historical sensibility rather than to engage in a specifically historical treatment of the concept. Yet, these discussions are especially instructive for the way in which the concept of a *mathesis universalis* has been understood in contemporary philosophical debates.

Husserl, for his part, inserts the concept of a *mathesis universalis* into a discussion of the traditional path to an idea of formal logic, understood as “formal apophantics,” i.e., a science of logical propositions based on the pure form of ordinary judgments.²⁵⁵ The domain of what Husserl calls formal apophantics is understood to outline the principles of logic: it is a kind of logic of logic. In this way, it pertains both to the formal procedures of combination and verification that are germane to logical syntax as well as to the semantics of predication. In a broad way, Husserl claims that the emergence of a formal calculus for the mathematical sciences posed the first historical possibility of a fully comprehensive science of predication, a universal logic. Some historical verification for this hypothesis can be seen in the projects of Ramus, Bruno, van Roomen, and Alsted, as seen above. Yet this project does not really become explicitly related to the ‘*mathesis*

²⁵⁵ *Formale und Transzendente Logik*, trans. by Dorion Cairns (The Hague: Nijhoff, 1969).

universalis’ until Leibniz treats formal mathematical techniques and their relation to physical qualities through the repetition of measure. Indeed, insofar as the “repetition of measure” is an axis along with the formal logic of relations can be applied to both mathematical and physical relations, this does seem to hint toward later notions of formal logic. For Husserl, the idea of formal mathematics is of a piece with the idea of formal logic.²⁵⁶

However, especially as Husserl’s later writings focus on the historical dimensions of phenomenological concepts, the crucial philosophical question for him becomes one of rooting the formal statements of logic and mathematics to well-defined ontological domains of experience. While the early modern question is certainly tainted with uneasiness about how abstract ideas relate to concrete realities, Husserl makes this issue thematic. His hope in the *Formal and Transcendental Logic* is to generate an analysis of the semantic structure of predication that yields a general science of formal logical relations without losing the specificity inherent in ordinary language, i.e., when we talk about the world of our experience. This semantic analysis is achieved through the celebrated structures of “intentionality” that Husserl develops as early as the *Logical Investigations*. In order to describe the aim of his project in his later work, in a rare instance of rhetorical flare, Husserl calls the true mathesis universalis “a formal mathematics that does not float in the air but stands on its foundations and is inseparably

²⁵⁶ See his *Philosophie der Arithmetik*, trans. D. Willard, esp. 9-22 where Husserl builds a concept of number from the concepts of multiplicity and relation (or sets and relations). This strategy of building a formal logical concept on the basis of perceived states of affairs becomes essential to his *Logical Investigations* (1901).

one with them.”²⁵⁷ For Husserl, the foundations of any abstract science of logical relations can only be established with reference to the world of lived-experience, the *Lebenswelt*. Thus, Husserl’s real project is to specify the way that a science of formal relations, like the mathesis universalis, is tied to the world of everyday experience through the structure inherent in language, i.e., its “intentionality.” In order to do so, Husserl’s presentation of the mathesis universalis in the *Formal and Transcendental Logic* incorporates both analytic and synthetic elements from Leibniz’s account. That is, it moves back and forth between the abstract relations of logic and the concrete world of sense experience. However, Husserl’s reminiscence of Leibniz and the mathesis universalis also contains an implicit critique of the tradition. For Husserl, the movement toward greater generalization and formalization in the mathematical sciences has not been historically matched by an equal attention to grounding formal statements in the world of ordinary experience, to which they ultimately pertain, and from which they ultimately derive their meaning.

This trend can be seen in Heidegger, too, who presents the concept of mathesis universalis in the context of a historical retrieval and a historical critique.²⁵⁸ The larger context of Heidegger’s discussion of the mathesis universalis is his attempt to pose the question, “what is a thing?” as a means of interpreting Kant’s *Critique of Pure Reason*. Heidegger sees the mathesis universalis as a concept that indicates an important shift in the history of philosophy, toward a greater formalization of thought, much in line with Husserl’s presentation. In fact, he conceives his question, “what is a thing?” as the most

²⁵⁷ Ibid., 87; Dorian Cairns translation, 99.

²⁵⁸ *Die Frage nach dem Ding*.

proper question for addressing Kant's *Critique*, since the nature of Kant's work is such that it undertakes a general analysis of the thingliness of things (*der Dingheit des Dinges*), i.e., metaphysics, by way of a critique of pure reason. Heidegger remarks that such a task would have been an absurdity for classical philosophy: why engage in a critique of pure reason in order to understand the things themselves? For the ancients (conceived broadly, as Heidegger does) the thingliness of things in no way depends upon reason, but on a general cosmology, determined by the various kinds of elements and causes. By contrast, for Kant, it is the purity of reason that gives knowledge its universal scope while the critique of reason limits that scope to what can be known with certainty. In short, a critique of pure reason provides an exposition of all that can be known for certain, the domain of necessary truths. In Heidegger's account, he sees the underlying philosophical justification for this project as directly related to the nature of predication; in particular, he understands propositions to designate the way that things exist, insofar as they are identified by predicates, which themselves denote the various ontological categories of existence. The decisive difference between Kant's modern project and its ancient counterparts, for Heidegger, is that Kantian predication is already determined by a kind of mathematical preference, by placing a universal unknown under every empirical observation, e.g., the thing-in-itself or the transcendental "X." This bare unknown is then clothed in the garb of predication, so to speak, using the innate categories of the understanding.

The historical reasons for this shift Heidegger attributes to the *mathesis universalis*. He understands this term primarily in its linguistic sense, namely, as a kind of

doctrine and naming (*Lehre und nehmen*) of things in terms of their quantitative measurement (*Dinge als Zählen*).²⁵⁹ Modern science, for Heidegger, thus operates under a doctrine of *mathesis universalis*, such that it is (1) a science of facts, (2) an experimental science, and (3) one that understands its standard of truth in terms of a correctness of measurement. Heidegger characterizes modern philosophy, and here he refers to Descartes' *Regulae* and his *Meditationes*, by its conception of the world in terms of the conceivability or representability of objects to a subject, a "cogito," an "I," which becomes the ultimate subject in a metaphysical sense (*hypokeimenon*) for the categories of predication. Again, for Heidegger, the priority of mathematics in modernity emerges because it is the science that most easily avoids contradiction, the kind of error germane to the intellect, and because it meets the standard of clarity and distinctness, the criteria of truth determined by the human intellect. In this way, Heidegger understands the *mathesis universalis* as fundamentally related to mathematics and a mathematical way of thinking characteristic of modernity, which reaches its pinnacle in Kant's *Critique*. But he understands this relation to mathematics as underlying a basic privilege of epistemological considerations over cosmological ones for determining the nature of things in general. In essence, Heidegger's critical view of modernity is that a mathematical way of thinking, which privileges a concept of truth as correctness, neglects the original sense of truth as that which emerges from out of concealment. Without diverging into a complicated discussion of Heidegger's concept of truth, one can appreciate Heidegger's criticism of modernity as an age which assumes that the intellect

²⁵⁹ This can be inferred from the linguistic affinity, noted even by Descartes, between *matheseōs* (in Greek) and *disciplina* (in Latin).

and its ideas are utterly transparent to the knower and therefore the most proper objects of scientific investigation. To what extent one can attribute this trend to “modernity” in a broad sense is difficult to assess, but it is clear that Descartes at least advocated a concept of *scientia* in this vein. Moreover, the *mathesis universalis* appears to be sought as a description of Descartes’ method precisely because it provides a technique for arriving at *scientia* through a mathematical calculus that is appropriately fitted to our mental powers.

Though Heidegger’s interpretations of the history of philosophy are often controversial, contemporary commentators affirm the proposed connection between a *mathesis universalis*, as a model of scientific method based on mathematics, and modern critical philosophy. These commentators seem to follow Kant’s interpretation of the Baconian scientific method in the B preface to his *Critique of Pure Reason*, namely, that only a true concept of method could secure a solid foundation for natural science. Consider the introductory remark by Neal W. Gilbert, to his classic study on method: “Throughout the modern enterprise of science, then, it is *this critical aspect* which predominates and which stamps its procedures as carried on by the scientific method” (my emphasis).²⁶⁰ David Lachterman carries this analysis even further. He considers modern philosophy to be predicated on a prior divorce of reason from sensory perception. This divorce, he says, “is not because of any particular misdeeds on the latter’s part ... [it] is rather the recognition that pretheoretical, premethodical perception keeps reason in thrall to a putative source of knowledge over which it cannot, in principle, exercise

²⁶⁰ *Renaissance Concepts of Method*, xvii.

systematic command.”²⁶¹ Lachterman contends that the essential feature of modern philosophy, following Descartes, is to bracket the world of perceptions, render its persuasive power neutral, and then consider any truths of nature to be those that can be systematically and methodically constructed from primary intuitions. In this sense, he understands the central idea governing the revolution of Descartes’ *Géométrie* to be the idea of construction, “or, more broadly, the ‘idea’ of the mind as essentially the power of making.”²⁶² Lachterman’s notion of construction here is explicitly indebted to Kant’s notion of the “productive imagination” as that which generates, or schematizes, objective representations. On this reading, a representation is true just in case the manner in which it is represented—its schematism—is well-founded on an a priori justification of the categories of predication that define the representation. In a certain measure, this bears a similarity to Descartes’ requirement in the *Regulae* that, for our ideas of things to be true, they must be *composed* out of ‘simple natures’ whose essence is known intuitively, or a priori in the Kantian sense.

Preceding Lachterman chronologically, but echoing some of his central claims, Jean-Luc Marion has argued that the condition of possibility of mathematical certitude is a prior abstraction, i.e., a break from the material nature of everyday sensory experience. For Marion, the passage in Rule II, where Descartes eliminates probable syllogisms from science in favor of the certainty provided by arithmetic and geometry, is decisive. In that passage, the argument in favor of mathematics, as Marion points out repeatedly, is that “they alone are concerned with an object so pure and simple that they make no

²⁶¹ *The Ethics of Geometry*, 54.

²⁶² *Ibid.* 4.

assumptions that experience might render uncertain” (AT X, 365; CSM I, 12). Marion’s commentary follows: “In effect, the precision (and thus certainty) of mathematics finds its counterparty in the very condition of its possibility: the abstraction from matter, the elimination of the ‘variable’ by setting aside the *hyle*.”²⁶³ Thus, when Marion arrives at the interpretation of the *mathesis universalis*, the frequently parodied “*mathématicité non mathématique des mathématiques*,” he understands the *mathesis universalis* to respond precisely to the central proposition of Rule IV, namely, to determine a method such that “one will never take what is false to be true or fruitlessly expend one’s mental efforts, but will gradually and constantly increase one’s knowledge till one arrives at a true understanding of everything within one’s capacity” (Rule IV-A: AT X, 371-72; CSM I, 16). Marion’s interpretation of the essential interrelation between *mathesis universalis* and method is the following:

The method is always certain because it produces certainty. . . . The method, by virtue of its primacy confirms and achieves the unity of science. . . . The method thus defines the function of certainty and the necessary precondition for the objects of entirely certain *experientia*.²⁶⁴

As for the *mathesis universalis*:

²⁶³ Marion, *Sur l'ontologie grise*, 40. Doyle, *The Logic of Descartes' Method*, Ch. 2.2, argues against Marion’s interpretation of this passage. The dispute is tangential to the argument here. Marion insists that one aspect of the hyletic abstraction that is the condition of possibility of the mathematical sciences is that it annuls the irregularities of material things and thus the mere probability of knowledge about material things. On this basis he links Descartes’ criticism of “probable syllogisms” with his insistence on mathematics as the paradigm of certainty. Doyle counters that the issue of “probable syllogisms” has to do with the fact that Descartes dismisses opinion from the realm of knowledge and that it has to do with his polemic against dialectic rather than against knowledge of material things as such. I agree that there are, in fact, two arguments at work in Rule II. However, Doyle’s criticism does not diminish the accuracy of Marion’s remarks on the nature of mathematical knowledge and the reasons why Descartes takes a mathematical method as his standard for the scientific method.

²⁶⁴ *Sur l'ontologie grise*, 57.

. . . speaking of (*mathesis*) *universalis*, [Descartes] takes up again the idea of a science of the true principles of the mathematical sciences (which is the deciding blow [to Aristotelian metaphysics]) that is situated in the substitution, as important as it is often misunderstood, of *mathesis* for mathematics. It is not even a universal mathematics, that is, one that would provide the principles for the particular mathematical sciences, and thus limited to only quantity (no matter whether discrete or continuous), but it is a “universal science” that does not only govern quantity, about which it will be able to treat abstractly, but also all order and measure.²⁶⁵

On Marion’s reading, and I think it is a helpful one, the *mathesis universalis* is that in virtue of which a method can be proposed. The prior supposition that science will only investigate what can be known by order and measure submits any given subject matter to a restriction that ensures it is treated methodically. Descartes does not claim that the world is mathematical; instead he simply supposes that only the order and measure, proportions and relations (i.e., those conditions that enable any mathematical science to be mathematical), insofar as they are present in natural objects, will be considered. In a sense, this performs a proto-Kantian critical maneuver: I will consider the world *as if* ordered and measured. In so doing, I will discard all of the everyday perceptions of material things that do not admit of order and measure. This is the a priori condition of the possibility of a methodical natural science for Descartes.

²⁶⁵ Ibid. 63. Marion goes on to compare the *mathesis universalis*, not to the proposed common (or universal) mathematics in Aristotle, but to metaphysics as the study of being qua being. In short, Marion argues that the *mathesis universalis* considers any given being only insofar as it is conceived of as ordered and measured. Thus, it is the most universal and prior of all the sciences. I think this may be saying too much. While the *mathesis universalis* is clearly the rubric that governs the quest for a universal science in the *Regulae*, it is not a free-standing system. Moreover, in places Descartes indicates that he must go beyond “order and measure” in order to investigate the phenomena he wants to understand. Finally, the *mathesis universalis* gives no account of causality in the universe, either in terms of the existence of the ‘I’ or of material things. Thus, it seems difficult to conclude that the *mathesis universalis* is a science of being qua being.

In this section, we have discovered a number of historical sources surrounding and (likely) influencing Descartes' concept of method, particularly as it is articulated using the concept of a 'mathesis universalis'. First, we have found that a number of late medieval and Renaissance philosophers were intent on reforming the Aristotelian notion of scientific knowledge. This reformist strand of philosophy in the 13th through 17th centuries was largely motivated by a practical concern for pedagogy: simplifying the complex and varied syllogistic forms in favor of an *ars brevis* or compendium of the sciences that would outline a few simple rules to guide intellectual studies. During the same time, writers in philosophy and mathematics sought to recover a true method of discovery, an *ars inveniendi*, that had once been part of the purpose of Aristotle's *Topics* and *Sophistical Refutations* and had been mentioned in Proclus and Plato as the art of 'analysis', namely, a technique for discovering of first principles. However, by the Renaissance period, many elements of ancient dialectic had come to be associated with (mere) rhetoric or ornamentation. As a result, these authors saw little use in advancing the rhetorical practice of disputations for the purpose of discovery first principles. So Aristotle's true method of discovery, dialectic, was discarded. Finally, we noticed the importance of the mnemotechnic tradition, Neoplatonism, and mystical thought as an influence on the reform of classical dialectic and the search for a true method of discovery. Though these traditions were associated with a hermetic legacy and seem, as such, to be opposed to scientific thought, they were instrumental in advancing the notion that the true method of science and the classification of the subjects of scientific study

ought to be fitted to a certain psychology. In this way, authors conceived of linking their reformist project with a new understanding of the nature of cognition, emboldened by Augustinian and Neoplatonic theories of recollection that hinged on a concept of the universe as a mirror of the intellect.

Each of these themes can be seen in Descartes' *Regulae* as guiding the project of determining true scientific method. When Descartes works out an algebraic procedure for discovering the principles of geometrical construction, it seems a natural step to correlate this at once with the analytic art of the ancient geometers and the method of discovery sought by the humanists. Leibniz would go on to link such a universal *mathesis* with a philosophy of language in the hopes of determining a truly formal, symbolic language that would actually represent the ontological makeup of the world. Though Descartes never really linked his own project to a search for a universal language in the way Leibniz did, his references to *mathesis* can be illuminated by reference to that broader context.

Mathesis universalis, mathematics, method, and mind in Descartes

This section will advance beyond the above historical observations regarding Descartes' scientific method in the *Regulae* as it is expressed by the *mathesis universalis*. In a historical sense, the concepts of method and *mathesis* are united in the writings of late sixteenth and early seventeenth century Renaissance philosophers. Particularly Alsted, van Roomen, Piccolomini, Pererius, and Barozzi discuss the idea of a *mathesis*

universalis in such a way that it is connected with an idea of a general scientific method, a universal science, and a reclassification of the nature of things. This is not to imply that there is a univocal conception the mathesis universalis at the turn of the 17th century, nor to suggest that the traditional concepts of scientific method and mathesis were universally identified. However, the identification of these two concepts in Descartes is the product of a history that, particularly by virtue of a historical misinterpretation of Aristotle, the influence of Neoplatonic mathematics, and the introduction of modern algebra, blurred the distinctions between method, epistemology, cognition, and science. These factors diminish the distinctions that had existed in classical philosophy between properly mathematical and properly philosophical methods of investigation. In short, this is why Descartes simultaneously denounces the “dialecticians” and their “probable syllogisms” while heralding a new mathematical method of discovery as the unifying method that would lend the sciences a secure, that is, certain, foundation. Moreover, the issue of finding a universal method (*scientia penitus nova*, *clavis totium mysterium*, or *ars secretum*) was of longstanding interest for Descartes, from his fascination with the memory arts and the encyclopedist tradition to his first unfinished treatise (a period spanning the decade, 1618-1628). Thus, it is no surprise that remnants of this tradition would continue to influence key passages in the *Regulae*.

This section will advance upon those historical observations with a detailed examination of Descartes’ writings on mathematics and method. What I will show is that Descartes’ attempt to set the sciences on a certain and evident path to knowledge forces into the forefront epistemological concerns. In short, the method is designed according to

and emerges from Descartes' understanding of the nature of cognition. That Descartes prioritizes certainty over any other criterion for scientific knowledge is the most basic confirmation of a connection between Descartes' concept of method and his concept of mind. However, the *mathesis universalis* makes this connection much more profound. Not only is the criterion of truth adequate to the powers of the mind, but also Descartes will claim that all that can be known will be known if one follows this method. This means that, for Descartes, the realm of certain and evident cognition is not only necessary for scientific truth, but is also sufficient. This is quite a radical claim and I think it indicates Descartes' deep-rooted idealism.

As a consequence of this idealistic conception of scientific knowledge, Descartes will claim that the nature of physical reality—everything apart from the mind—has a certain structure, namely, that there is nothing other than extended matter and wherever there is something, it is extended matter. This radical thesis about the basic metaphysical nature of the universe—one that Descartes will maintain throughout his career, despite its limitations and its factual inaccuracy²⁶⁶—is a direct consequence, I will argue, of the *mathesis universalis*. To put it in the most concise terms: corporeal nature considered generally (*corpus in genere sumptum*) is the objective correlate of the idea of pure *mathesis* (*idea purae matheseos*). Moreover, this idea is the principle that makes a science based on mathematical figures and numbers possible.

²⁶⁶ Here I have in mind two decisive advances in natural philosophy that undermine Descartes' basic assumptions about physical reality: (1) Pascal demonstrates experimentally the existence of a void through his work with the Toricelli tubes. (2) Leibniz demonstrates mathematically the necessity of including forces in the explanation of physical phenomena.

Mind and method

The connection between Descartes' project for devising a general method to discover truth in the sciences and his understanding of the mind's powers is twofold. First, Descartes conceives the principle operation of the mind to be intuition [*intueor, intueri*]. In its most general sense, to intuit simply means to gaze at, look at, or regard. But in its conceptual sense, it is closely related to 'contemplation' or 'apprehension' and in this sense serves, in philosophy, as a translation of the Greek, *noeô, noein*. Therefore, at least as it was understood in the Platonic tradition, it must be identified as the essential operation of the mind. For Descartes, mathematics is a privileged subject matter because it alone provides clear and distinct intuitions that are simple, evident, and free from doubt. Second, Descartes' early methodological project is focused on the goal of devising a mathematically based method that would be applicable to "all of human knowledge." This means that Descartes' early conception of mathematics holds it to be both rooted in the essential activity of the mind and potentially applicable to the entire domain of human knowledge. These two components are quite clearly connected in Rule IV, which addresses the method for investigating the truth of things, in a passage that I have quoted above: "There are two points here which we should keep in mind: we should never assume to be true anything which is false; and our goal should be to attain knowledge of all things" (AT X, 372; CSM I, 16). In this sense, Descartes' early vision for developing a universal mathematical method was thought to have a very broad application. Certainly, the later concept of mind which finally provides a real metaphysical foundation for the

sciences goes far beyond what Descartes could have accomplished through mathematics alone (for one thing, there is no explanation of the cause of the mind's existence and nature in the *Regulae*), but the scope and aims of the early project illustrate the motivations behind this later conception.²⁶⁷

Intuition as the distinct perception of a clear and attentive mind

For Descartes, intuition is not “the fluctuating testimony of the senses or the deceptive judgment of the imagination as it botches things together [*vel male componentis imaginationis iudicium fallax*].” He specifies its nature in this way because he acknowledges the close etymological relationship between *intueor* and *percipere*, which was generally conceived to be mediated by the imagination. Descartes is clear that his notion of intuition is nothing other than “the conception of a clear [*pura*] and attentive mind, which is so easy and distinct that there can be no room for doubt about what we are understanding.” He elaborates, “intuition is the indubitable conception of a clear and attentive mind which proceeds solely from the light of reason” (Rule III: AT X, 368;

²⁶⁷ Descartes' introduction to the French edition of the *Principes de Philosophie* provides some idea of the continuity from the beginning to the end of his work (though the issue is stated here in terms of causes): “In order for this kind of knowledge [i.e., wisdom or philosophical knowledge] to be perfect it must be deduced from first causes; thus, in order to set about acquiring it—and it is this activity to which the term 'to philosophize' strictly refers—we must start with the search for first causes or principles. These principles must satisfy two conditions. First, they must be so clear and so evident that the human mind cannot doubt their truth when it attentively concentrates on them; and, secondly the knowledge of other things must depend on them, in the sense that the principles must be capable of being known without knowledge of these other matters, but not vice versa. Next, in deducing from these principles the knowledge of things which depend on them, we must try to ensure that everything in the entire chain of deductions which we draw is very manifest.... Next, I would have looked at the benefits of this philosophy and shown that it encompasses everything which the human mind is capable of knowing,” (AT IX-B, 2-3; CSM I, 179-80).

CSM I, 14). From this definition it is clear that Descartes conceives of intuition as a mental operation that is purely rational, indubitable, and emerges from innate mental capacities (the “light of reason”).²⁶⁸ Furthermore, from Rule II it is clear that these characteristics of intuition make it indispensable for scientific knowledge [*scientia*], which he defines as “certain and evident cognition [*cognitio certa & evidens*]” (AT X, 362; CSM I, 10). That Rule, which I have referred to repeatedly, makes it clear that knowledge is in some sense absolute, i.e., not admitting of differences, and that certain and evident reasoning [*ratio*] will convince [*convinco*] the intellect of any scientific truth. In other words, knowledge does not rest on the authority of tradition, sensation, or the syllogistic form; instead, Descartes’ notion of science consistently reinforces the foundational role of clarity and distinctness, both in its principles and in what is deduced from them. Though Descartes does not actually have a theory of clear and distinct ideas in the *Regulae* (and he actually never refers to ideas as “clear and distinct”), he nonetheless employs certainty and evidence in a way that clearly foreshadows this later concept. In the *Regulae*, the priority of certainty and evidence is part of his crusade against “ordinary philosophy [*vulgari Philosophia*],” which was based on the authority of the syllogistic forms and the ontological genera of Aristotle.

Descartes’ explicit focus in the *Regulae* on simple things first is directly related to his idea that all knowledge is ultimately derived from the intuition of “clear and attentive mind” (Rule III, AT X, 368; CSM I, 14). This is why he prefers to investigate the few

²⁶⁸ Unlike Kant, Descartes does not address the necessity of establishing how pure cognition, or intellectual intuition is possible. Rather, he seems to assume that it is possible on the basis of its role in mathematical knowledge.

things that can be known with certainty rather than the many things that are based on merely probable conjectures. Arithmetic and geometry, Descartes concludes,

... are therefore the easiest and clearest of all the sciences and have just the sort of object we are looking for. Where these sciences are concerned it scarcely seems humanly possible to err, except through inadvertence. Yet we should not be surprised if many prefer of their own accord to apply their minds to other arts, or to philosophy [*si multorum ingenia se sponte potius ad alias artes vel Philosophiam applicent*]. The reason for this is that everyone feels free to make more confident guesses about matters which are obscure than about matters which are clear. It is much easier to hazard some conjecture on this or that question than to arrive at the exact truth about one particular question, however straightforward it may be. (Rule II: AT X, 365-6; CSM I, 12)

This sentiment is strictly parallel to what Descartes says regarding the mathesis universalis:

So why is it that most people painstakingly pursue the other disciplines which depend on it [sc., the mathesis universalis], and no one bothers to learn this one? No doubt I would find that very surprising if I did not know that everyone thinks the subject too easy, and if I had not long since observed that the human intellect always bypasses subjects which it thinks it can easily master and directly hurries on to new and grander things. (Rule IV: AT X, 378; CSM I, 20)

This trope recurs in Rule IX, which tells the reader “how to become accustomed to intuit the truth distinctly and perspicaciously [*donec assuescamus veritatem distincte & perspicue intueri*]” (AT X, 400; CSM I, 33). This will be accomplished, he claims, if one becomes accustomed to attending carefully to a few simple things. He continues:

It is, however, a common failing of mortals to regard what is more difficult as more attractive. Most people consider that they know nothing, even when they see a very clear and simple cause of something; yet at the same time they get carried away with certain sublime and far-fetched arguments of the philosophers, even though these are for the most part based on foundations which no one has ever thoroughly inspected. (AT X, 401; CSM I, 33)

By contrast, the ease and simplicity of arithmetic, geometry, and the mathesis universalis in general provide a real foundation for the sciences. In the following chapter, we will see

that Descartes' early hypotheses about the psycho-physiological nature of cognition reinforce the idea that the mind is best suited to attend to a few simple things, rather than many complex ones.

It may at first be odd to hear Descartes proclaim the ease and simplicity of mathematics. After all, his notebooks give ample evidence that he struggled to resolve a number of very difficult mathematical problems. Moreover, the status of mathematics at the time, shifting between a modern algebraic and classical geometrical conception, was not at all clear and distinct. In response to this concern, I think that the terms *facilis* and *simplex* should be understood to apply to arithmetic and geometry only in principle. That is to say, the rational basis of geometry ought to be obvious and evident to anyone; and every arithmetical problem ought to be composed of many simple operations that anyone could perform. Thus, the foundations of these sciences are inherently transparent and self-evident, despite the fact that their application to particular problems can be difficult and complicated.

To return to the operation of the mind, the axiomatic transparency of the mathematical sciences mirrors the way in which Descartes speaks of the two mental operations that are the cornerstones of his method: intuition and deduction. He explains, "The method cannot go so far as to teach us how to perform the actual operations of intuition and deduction, since these are primitive and the simplest of all [*quae sunt omnium simplicissimae & primae*]" (Rule IV: AT X, 372; CSM I, 16). This operation of the mind is basic, as illustrated by its simplicity. And mathematical knowledge, insofar as it is paired with the cognitive faculty of intuition is similarly fundamental. One can

appreciate how central the notion of simplicity is to Descartes since it functions as a theme that runs throughout the *Regulae*. Rules V and VI stress the importance of reducing complex problems to their simple components. Rules VI, VIII, and XII all stress the importance of “simple natures” as the first principles of scientific knowledge. Indeed, the simplicity of figures and their abstract representation is exactly what drives the mathematical techniques for problem solving in Rules XIV-XVI, XVIII and in short the entire project of Descartes’ early algebra. Reducing problems to simple units—entails a perception of the basic foundation of the problem, which in turn enables its solution. When explaining how to make use of the two mental faculties of intuition and deduction, Descartes recalls the etymological root of intuition, comparing it to “vision itself [*ipsa oculorum*].... If one tries to look at many objects at one glance, one sees none of them distinctly. Likewise, if one is inclined to attend to many things at the same time in a single act of thought, one does so with a confused mind [*confuso ingenio*]” (Rule IX: AT X, 400-1; CSM I, 33). This is why, he says, “Everyone ought therefore to acquire the habit of encompassing in his thought at one time facts which are very simple and very few in number—so much so that he never thinks he knows something unless he intuits it just as distinctly as any of the things he knows most distinctly of all” (AT X, 401-2; CSM I, 34).

It is clear from these references that intuition of simples is the essential starting point for the Cartesian methodological project in the *Regulae*. The importance of arithmetic and geometry to this end also becomes evident: these are just the sciences that best prepare the mind for attending to simples, and these sciences themselves stand on

self-evident and transparent foundations so that their validity can be clearly seen. In his youth, Descartes tells the reader of the *Discours*, “I delighted in mathematics, because of the certainty and self-evidence of its reasonings. But I did not yet notice its real use; and since I thought it was of service only in the mechanical arts, I was surprised that nothing more exalted had been built upon such firm and solid foundations” (AT VI, 7; CSM I, 114). On my reading, it seems clear that Descartes would realize the “real use” of mathematics only through the project of developing a method according the general form of the *mathesis universalis*.

Intuition as the basis for method

The importance of intuition for Descartes’ method cannot be overstated. While, for instance, Descartes often speaks of deduction as the other essential mental operation, his definition of deduction makes it clear that this mental operation is essentially founded on intuition. When he introduces the concept, Descartes says, “There may be some doubt here about our reason for suggesting another mode of knowing in addition to intuition, *viz.*, deduction”; and he continues by defining deduction as “the inference of something as following necessarily from some other propositions which are known with certainty” (Rule III: AT X, 369; CSM I, 15). This distinction between two different modes of knowledge allows Descartes to account for a clear and distinct perception of complex things:

But this distinction had to be made, since very many facts [*res*] which are not self-evident are known with certainty, provided they are inferred from true and known principles through a continuous and uninterrupted movement of thought in which each proposition is clearly intuited. This is similar to the way in which we know

that the last link in a long chain is connected to the first: even if we cannot take in at one glance all the intermediate links on which the connection depends, we can understand this connection provided we survey the links one after the other, and keep in mind that each link from first to last is attached to its neighbor. (AT X, 369-70; CSM I, 369)

From this passage it is clear that Descartes defines the concept of deduction according to the understanding of intuition as it is discussed above. Deduction ought not to be understood in terms of conceptual analysis, such that the conclusion is necessarily contained in the premises. Rather, Descartes seems to use deduction in a loose sense, meaning something like: any inference from one term to another. Thus, deductions can be analytic, or they can be ampliative, i.e., they can introduce some new intuition. The only requirement for a deduction, on Descartes' account, is that each step in the sequence of reasoning is composed of a clear, simple, and distinct intuition. Since it is impossible to intuit a chain of reasons clearly, simply, and distinctly (precisely because a chain of reasons is necessarily complex, i.e., composed of parts), Descartes calls the knowledge [*scientia*] that one has of a chain of reasons *deduction*, while he maintains that each link in that chain is known through *intuition*.²⁶⁹ In this sense, deduction is simply an extension of intuition over a series of steps.

²⁶⁹ For more on the role of intuition as the foundation for deduction, see Marion, *Sur l'ontologie grise*, 53-54, where Marion makes an important and provocative observation. He notes that, while Rule II, and much the Aristotelian tradition, would support the belief that deduction surpasses intuition in terms of its certainty, i.e., that scientific knowledge is guaranteed through deductive demonstration, Rule III makes it clear that intuition is primary, since it grants or sustains [*permet*] the certainty of deduction. This observation occurs within the context of Marion's effort to reinvigorate a Cartesian sense of indubitable *experientia* as that which confirms and sustains *scientia*: "dès lors, la rapport s'inverse; l'intuitus non seulement certain, mais qui permet la production de certitude jusqu'à investir et récapituler l'experientia entière, devient le paradigme d'une certitude, que la déduction ne produit, et ne possède plus qu'en second."

The third mental operation constitutive of Descartes' concept of method, i.e., enumeration, provides a bridge between the centrality of intuition and the extension of the method to all of human knowledge. It has been noted that there are two kinds of enumeration in Descartes: an enumeration that provides a comprehensive review of the long chains of reason and an enumeration that provides a methodical survey of the various classes of things to be investigated.²⁷⁰ (It is possible that Descartes himself did not conceive of a distinction between these two operative definitions of enumeration since he speaks of both in the same breath (see Rule VII), but it is nonetheless useful to make such a distinction for the purposes of interpretation.) Descartes first defines enumeration in terms of deduction: "For this deduction sometimes requires such a long chain of inferences that when we arrive at such a truth it is not easy to recall the entire route which led us to it. That is why we say that a continuous movement of thought is needed to make good any weakness of memory" (Rule VII: AT X, 387; CSM I, 25). Here he acknowledges that deduction, which "in a sense gets its certainty from memory" (Rule III: AT X, 370; CSM I, 15), must be shored up with another mental operation that strengthens what would be a potential liability. When Descartes elaborates how this "continuous movement of thought" works, he clearly means it to reinforce deduction by expanding the capacity of intuition: "So I shall run through them [sc., a chain of reasons] several times in a continuous movement of the imagination, simultaneously intuiting one relation and passing on to the next, until I have learnt to pass from the first to the last so swiftly that memory is left with practically no role to play, and I seem to intuit the whole

²⁷⁰ Following Beck, *The Method of Descartes*, 114-20 and 126-33.

thing at once” (Rule VII: AT X, 388; CSM I, 25). The resonance of this passage with the Aristotelian and Ciceronian mnemonic tradition should be apparent. But with respect to the identification between enumeration as comprehensive review and intuition, Rule XI is even more to the point: “The present Rule explains the way in which these two operations [intuition and enumeration] aid and complement each other; they do this so thoroughly that they seem to coalesce into a single operation, through a movement of thought, as it were, which involves carefully intuiting one thing and passing on at once to the others” (AT X, 408; CSM I, 38). In this way, Descartes acknowledges that deduction derives its legitimacy from intuition, but that the long chains of reason can cause one to lose contact with that primary intuition. This is why enumeration is brought to the aid of deduction, by reinforcing the intuition that underlies that movement of thought. Indeed, this technique for reinforcing the less capable powers of the mind reminds one of Alsted’s theory of a methodical ordering in the sciences: that it could repair the “fallen” state of the faculties. More broadly, it suggests that the method is intended to be fitting and appropriate to the powers of the mind, such that it aids and supplements those natural powers. Again, in the following chapter, we will see that these powers of mind are founded on a conception of the physiological capacities of the brain. In short, memory and intellectual attention are fallible because they are restricted by the nature of the central processing center in the brain.

Rule VIII: the scope of human knowledge

In addition to this supporting and confirming function, enumeration also provides an inventory of all human knowledge: “We maintain furthermore that enumeration is required for the completion of our knowledge. The other Rules do indeed help us resolve most questions, but it is only with the aid of enumeration that we are able to make a true and certain judgment about whatever we apply our minds to” (AT X, 388; CSM I, 25). Descartes makes several distinctions relative to this notion of enumeration as a methodical survey of human knowledge, which he also calls in this sense “induction,” that are not relevant to the present discussion. For instance, he distinguishes “complete,” from “distinct” and “sufficient” enumerations. Setting these aside for the moment, it seems that all of these notions of enumeration depend on a preliminary understanding of the general categories or classes of things. That is, an enumeration, in the sense of a “methodical survey,” lists each of the pertinent categories under consideration. For instance, to prove that the rational soul is not corporeal, Descartes says, “it will be sufficient if I group all bodies together into several classes so as to demonstrate that the rational soul cannot be assigned to any of these.” Descartes is explicit that this concept of enumeration depends on a prior class-ordering of things: “... if every single thing relevant to the question in hand were to be separately scrutinized, one lifetime would generally be insufficient for the task.... But if we arrange all of the relevant items in the best order, so that for the most part they fall under definite classes, it will be sufficient if we look closely at one class, or at a member of each particular class, or at some classes rather than others” (Rule VII: AT X, 390-1; CSM I, 26-7). In other words, the kind of enumeration

that aids one in the completion of knowledge depends on a certain prior understanding of classes or categories under which the things investigated will fall.

The idea that he could devise a method that would apply to all kinds of human knowledge, which in turn depends on a preliminary inventory or categorization of the objects of knowledge, is at least as central to Descartes' mathematical and methodological project of the 1620s as is the notion of intuition. Aside from the frequently referred to letter to Beeckman of March 26, 1619, we can indicate the introduction to what appears to be an unfinished treatise, the *Thesaurus Mathematicus* (found in the *Cogitationes Privatae*). There, Descartes says, "This work lays down the true means of solving all the difficulties in the science of mathematics, and demonstrates that the human intellect can achieve nothing further on these questions" (AT X, 214; CSM I, 2). This claim is again echoed in Descartes' discussions with Beeckman in 1628, where he introduces his algebra in similar terms. Beeckman records, "He told me that he wished for nothing more in arithmetic and geometry: that is, in these nine years he had made as much progress as the human mind could grasp on the subject [*id est, se tantum in iis, his novem annis, profecisse, quantum humanum ingenium capere possit*]." Beeckman also reports Descartes' claim that "he had arrived at a perfect knowledge of Geometry, through which it is possible to arrive at all human understanding [*quaque ad perfectam Geometriae scientiam pervenit, imo quo ad omnem cognitionem humanam (sic) pervenire potest*]" (Beeckman's journal, October 8, 1628: AT X, 331-32).

Descartes restates this goal many times in the *Regulae*: in Rule IV, he calls the method a "more powerful instrument of knowledge than any other with which human

beings are endowed, as it is the source of all the rest,” extending the “discovery of truths in any field whatever” (AT X, 374; CSM I, 17); Rule VI suggests that on the basis of our knowledge “of the most simple and primary things we can make many discoveries, even in other disciplines” (AT X, 387; CSM I, 24); Rule IX echoes this claim by stating that all of “the sciences, however abstruse, are to be deduced only from matters which are easy and highly accessible” (AT X, 402; CSM I, 34); and Rule XII suggests that the method will allow us to “make the most of our human powers” and that “it is not possible for us ever to understand anything beyond those simple natures and a certain mixture or compounding of one with another” (AT X, 410 and 422; CSM I, 39 and 46). In all of the cases sighted, the method starts with simples, which can be known immediately through intuition, and it extends quite broadly, covering the many different sciences and even the entire domain of human knowledge. None of these many references to the broad scope and aim of the *Regulae* is clearer than Rule VIII, which itself is composed of what appear to be three separate attempts to articulate the same vision, i.e., that the aim of anyone who really cares about truth ought to be to extend knowledge to the limits of human understanding.²⁷¹

In many ways, Rule VIII is a linchpin in the interpretation of the *Regulae*. The centrality of this Rule is belied by its stated purpose, which appears to be merely a further

²⁷¹ See Roger Florka, “Problems with the Garber-Dear Theory of the Disappearance of Descartes’s Method,” for an appraisal of the importance of Rule VIII for understanding Descartes’ method, especially as it relates to a global vision of science, what Florka rather blandly calls the “scientia doctrine,” fully developed in the *Meditationes* and *Discours*. I especially appreciate Florka’s suggestion that we not import the anachronistic conception of “metaphysics” as reality and “epistemology” as the task to fit our thoughts with reality when talking about Descartes. Surely, for Descartes, these issues are deeply intertwined. But this cannot be because, as Florka suggests, Descartes had so little interest in questions of epistemology.

heuristic suggestion in methodical problem solving: “If in the series of things to be examined we come across something which our intellect is unable to intuit sufficiently well, we must stop at that point, and refrain from the superfluous task of examining the remaining items” (AT X, 392; CSM I, 28). However, as Descartes explains what he means by this bit of advice, it becomes clear that he is referring to the nature and scope of intuition as it relates to the nature and scope of *scientia*. He says, “This Rule is a necessary consequence of the reasons I gave in support of Rule II” (AT X, 393; CSM I, 28), which is the Rule that claims the superiority of arithmetic and geometry over dialectical reasoning as a model for the method of scientific discovery. These disciplines represent the gold standard of scientific knowledge since they are utterly certain and evident. The present Rule expands upon that foundation by showing “those who have perfectly mastered the preceding seven Rules how they can achieve for themselves, in any science whatever [*in qualibet scientia*], results so satisfactory that there is nothing further they will desire to achieve [*ut nihil ultra cupiant*]” (ibid.). In this way, Descartes adds the claim that no more knowledge can be achieved than what is certain and evident to the prior claim that certainty and evidence are paradigmatic for scientific knowledge. He reinforces this further claim with the statement that when one acknowledges that no knowledge can be gained beyond the intuition of simple things, this is “not because of any fault of his mind, but it is just what the nature of the problem itself or the human condition presents [*non ingenii culpa, sed quia obstat ipsius difficultatis natura, vel humana conditio*].” Descartes continues, “the recognition of this point is no less knowledge than that which the nature of the thing itself reveals; and one would seem to

be insane to try to stretch one's curiosity further [*Que cognitio non minor scientia est, quam illa quae rei ipsius naturam exhibet; et non ille videretur sanae mentis, qui ulterius curiositatem extenderet*]” (ibid.). These striking statements seem to identify the limits of knowledge with the limits of certain and evident intuition. That is, Descartes now claims that no knowledge can be hoped for *beyond* what can be evidently cognized. This is why it is necessary to stop one's investigation at the moment when one is no longer able to intuit certainly and evidently the nature of something; and it lends a much greater significance to the seemingly mundane title of Rule VIII.

Given that this is the context of Rule VIII, it is perhaps not so surprising that Descartes would undertake to introduce the project of examining “all truths, for the understanding of which human reason is sufficient [*veritates omnes, ad quarum cognitionem humana ratio sufficiat*]” (AT X, 395; CSM I, 29-30). He says that this is something which anyone who desires good sense ought to undertake “once in his life [*semel in vita*].” The clarion call and the nature of the project are restated three times in Rule VIII, with important variations.

In the first instance, Descartes calls the project of investigating the entirety of human knowledge “the finest example of all [*omnium nobilissimum exemplum*]” (AT X, 395; CSM I, 29). In order to outline how that investigation might proceed, Descartes first claims that “indeed one will discover by means of these proposed Rules that nothing can be understood prior to the intellect, since the understanding of everything else depends on the intellect, and not vice versa” (ibid.; CSM I, 30). This claim can be supported by what has already been shown to be the importance of intellectual intuition for knowledge. In

effect, Descartes claims that the investigation of the entirety of human knowledge proceeds first and foremost by the pure cognition of the intellect [*intellectus puri cognitionem*]. Once the knowledge attained through the pure cognition is exhausted, Descartes says, the investigator “will enumerate among whatever instruments of cognition we possess in addition to the intellect, which are only two, namely, imagination [*phantasia*] and sense-perception [*sensus*]” (AT X, 395-96; *ibid.*).²⁷² Though the translation is ambiguous, I believe that Descartes does not mean that pure cognition is one operation of the intellect, among others. Instead, I think he identifies cognition with intellection, reserving *pure* cognition for that activity of the intellect that operates without the use of corporeal faculties. The intellect in turn makes use of the other (corporeal) faculties as instruments [*instrumenta cognoscendi*]. (More on this distinction in the following chapter.) For the moment, we should recognize a distinction between pure intellection and instrumental intellection, a distinction that roughly corresponds to the mind-body distinction.

Descartes goes on to say “there can be no truth or falsity in the strict sense [*veritatem proprie vel falsitatem*] except in the intellect alone, although truth and falsity often originate from the other two modes” (*ibid.*). This is a critical distinction that appears to be the precursor of the distinction between “material” and “formal” falsity made in the *Meditationes* (AT VI, 43-4, 206-8 and 231; CSM I, 30, 145-6 and 162). In the later work, that concept is essential to Descartes’ claim that his idea of God is a real

²⁷² As Adam and Tannery point out (Appendix B to the *Regulae*: AT X, 485-6), it is notable that Descartes omits memory from this list of faculties. This is especially noteworthy since the third formulation of this topic in Rule VIII does include memory (AT X, 398.29).

idea. There, he will claim that truth and falsity in the strict sense derive from judgments, which result from an interaction between the pure intellect and the will. Yet even at this early stage, Descartes is already committed to an idea of truth that depends on the pure intellect. Though I believe that there is an important realist strand in Descartes' work, where he claims knowledge of *things* and not only *ideas*, he does not think that truth will be discovered through an elaborate, systematic explanation of the universe. Rather, it is by carefully restricting knowledge to what can be known for certain that one can be sure of the truth of one's ideas. His nascent concept of truth prejudices what might be called a critical style in Descartes' method: for Descartes, it is much more important to guard against error than to attempt an explanation of many uncertain things. This is why the investigator "will pay careful heed to everything that might deceive him, in order to guard against it" (ibid.). Finally, the investigator of human knowledge will enumerate the various "paths to truth [*vias ad veritatem*]" (a reference to the *via et ratio* of Cicero), determining what is most reliable, so that he may follow it. He will also distinguish which items of knowledge are truly useful, and which are mere ornaments of the learned (cf. Ramus' critique of rhetoric), understanding that "any lack of further knowledge on his part is not at all due to any lack of intelligence or method, and that whatever anyone else can know, he too is capable of knowing" (ibid.).²⁷³ Here the method of intuiting clearly and limiting the range of one's investigation to what can be intuited clearly

²⁷³ This sentence is actually incomplete in the manuscripts. I add what seems to be missing, namely the notion of "truly useful" items of knowledge, following Descartes' distinction in the following paragraph.

emerges as the cornerstone of Descartes' method, conceived as a reform of Aristotelian dialectic.

This outline seems to fit the ordinary conception of Descartes' method: that it places a priority on the pure intellect, it suggests that if one attends to the simple things first, the method will be accessible to anyone, and it implicitly frowns upon book learning in favor of, at least in principle, a more democratic view of knowledge. The present Rule surely does nothing to clarify these vague and provocative suggestions, but it does reinforce the claim that an understanding of the entirety of human knowledge begins with an examination of the nature of the intellect itself, or intuition, and its application to the various mental powers, which are the instruments of cognition. In this way, it supports the intimate connection between Descartes' concept of mind, however sketchily conceived, and his method.

The second draft of the project expands on these claims through an evocative metaphor. Descartes opens the section (AT X, 396.26-397.26) by repeating his refrain: "it is necessary once in our life that we inquire carefully into what in the world human reason is capable of understanding [*oportet semel in vita diligenter quaesivisse, quarumnam cognitionum humana ratio sit capax*]" (AT X, 396-7, CSM I, 30). All things being equally simple to understand, Descartes claims, we ought to begin by investigating those that are most useful. The primacy of utility is a remnant of the Stoic conception of method. Descartes adds to this that the utility of method can be understood on analogy with the mechanical arts, which have no need of any other method than their own, and apply the same method to the fabrication of their tools that is applied to the actual

production of products. This works like a primitive blacksmith who is first required to create tools to shape and mold the hot metal before he is able to forge his wares. One imagines that the figurative “tools” of Descartes’ science ought to be those mental operations, the *instrumenta cognoscendi*, that reinforce and extend the powers of the intellect such that it can treat any given matter. Indeed, one wonders if the method itself is an elaboration of the tools of the human mind which are meant to be applied to particular problems. If that is so, while the powers of the mind are surely inborn, the tools of methodical research develop and extend those limited powers. This is perhaps why a preliminary examination of the nature of the mental powers is so intimately related to the kind of method that will be devised.²⁷⁴

In the final segment, treating the project of defining the scope of knowledge (AT X, 398.26-400.11), Descartes again opens with the now familiar refrain: “Truly, no more useful inquiry is possible than this one: what is human understanding and what is its scope?... This is the one task which all those who have the slightest love of truth ought to

²⁷⁴ Incidentally, I was reminded of Descartes’ metaphor while visiting a museum in Paris. Below the square in front of the Centre George Pompidou, there is a permanent installation devoted to the Romanian sculptor, Constantin Brancusi, who spent most of his productive career in Paris. When he died, he bequeathed his remaining finished and unfinished sculptures to the French state on the condition that they were presented exactly as they had been left in his studio apartment where he had lived up to the end of his life. The installation affords a remarkable image of the artist in his studio, all of the works arranged as they would have stood during the process of production. Even more apropos of Descartes’ suggestion here, it is evident that many of the unfinished pieces are studies of finished pieces, so one can appreciate the stages of production. Also, it is evident that Brancusi had produced primitive tools, devices, and modifications to existing tools, in order to facilitate his sculpting. Most remarkable is a large circular platform, roughly formed out of stone, which apparently served as a platform on which Brancusi worked. Above it is a rope and pulley, with a drill attached to one end and a counter-weight to the other. Brancusi’s works are stunning formal abstractions: long sweeping lines with delicate features, usually forged out of iron. It is apparent that he had devised this weighted pulley system in order to allow him to wield that drill in the most delicate fashion.

undertake, since the true instruments of knowledge and the entire method are involved in its investigation” (AT X, 398-9; CSM I, 31). This time, Descartes greatly embellishes the nature of the problem and the reason for his optimism about success. (From the first chapter, we can see that this is probably because this section was written after the other two and, more importantly after the insights that constitute Rule XII.) As he explains, the task is first to inquire what kinds of things can be known by the human intellect. This amounts to defining “the limits of the mental powers we are conscious of possessing,” which he reasons to be much easier than “making judgments about things which are outside us and quite foreign to us.” Again, he suggests that the reader not be overwhelmed by this “immeasurable task,” since “nothing can be so many-sided or diffuse that it cannot be encompassed within definite limits or arranged under a few headings by means of the method of enumeration we have been discussing” (AT X, 398; *ibid.*). Again, Descartes returns to the key heuristics of the method: reducing complex problems to simple, well-defined, and clearly intuited elements; deducing our knowledge of things only on the basis of these simples; and preliminarily enumerating the categories under the present field of inquiry. These elements are said to make this most useful inquiry tractable.

Unlike the earlier two drafts of how to inquire into the nature and extent of human knowledge, this final treatment actually contains the enumeration. Descartes tells the reader that there are only two different categories relevant to this question: “either to we who are capable of cognition, or to the things themselves that it is possible to understand [*vel ad nos qui cognitionis sumus capaces, vel ad res ipsas, quae cognosci possunt*]” (AT

X, 398; CSM I, 32).²⁷⁵ These categories are certainly broad, but the fact that this is the primary division that Descartes makes relative to the nature and extent of human knowledge is crucial. Rule XII will repeat precisely this dichotomy (AT X, 411.3-4) and will be devoted to outlining carefully the nature of each of the two categories. This will be the subject of Chapters 3 and 4; and indeed it is an essential precursor for Descartes' mature metaphysics. It seems quite clear that this distinction foreshadows Descartes' metaphysical dualism, i.e., he conceives of a primitive dichotomy between the nature of cognition and the objects of cognition, between the intellect and the things themselves.

However, at this early stage there remains some ambiguity in this distinction. Descartes seems to include the intellect twice in his enumeration: on the one hand, the intellect and its faculties (here including imagination, sense-perception, and memory) are counted on the side of "we who are capable of cognition," yet these faculties are presumably counted again under the category of purely spiritual simple natures, which are a sub-category of the things themselves.²⁷⁶ It is important to realize that at the stage of the *Regulae* substance dualism is not yet a workable concept for Descartes: in this

²⁷⁵ Systematizing the former category, "we who are capable of cognition," insofar as this will include (in Descartes' later metaphysics) an examination of the ideas that we possess, could properly be called "transcendental philosophy" after Kant: "I call all cognition transcendental that is occupied not so much with objects but rather with our a priori concepts of objects in general. A system of such concepts would be called transcendental philosophy," *Critique of Pure Reason*, A 11-12; B 25.

²⁷⁶ Though Descartes will make the distinction between cognition and its objects more clearly in his later substance dualism, ambiguity remains even in that formulation. For instance, Descartes will unproblematically shift between a discussion of cognition vis-a-vis the mind-body complex, which is subject to the passions and other physical-psychological effects, and pure cognition, understood as the pure modifications of intellectual substance. This is echoed in his response to the problem of interaction posed by Princess Elisabeth (Letter 16 May, 1643: AT III, 660-62). In response, Descartes refers to a third primitive notion of the mind-body union to explain the interaction between mind and body (Letter 21 May, 1643: AT III, 663-68). In a sense, this is an explanation that is no explanation at all.

work, his categories are less tidy and he does not yet have a concept of “substance” with which to propose a dualism of substances.²⁷⁷ However, this preliminary division remains essential to understand the developmental stages of thought from which Descartes’ dualism emerges. In that sense, Rule VIII provides a prime specimen of the elements of Descartes’ method that will eventually play a central role in his metaphysics.

Rule VIII goes on to outline the distinction between simple natures, dividing these among the spiritual, corporeal, and common simple natures, as opposed to complex natures, summarizing what will be the core of Rule XII: “As for composite natures, there are some which the intellect experiences as a composite before it decides to determine anything about them: but there are others which are put together by the intellect” (AT X, 399; CSM I, 32). This comment demonstrates the productive character of the mind in science. Those composites that are, in effect, recomposed out of simples by the intellect according to deductive reasoning will comprise *scientia*. The method is to reduce complex things, which the intellect experiences *ipso facto*, to their simple elements, which are intuited clearly and distinctly by the intellect, and then recompose those complex entities from simples through a process of step-by-step inferences. Moreover, the method of recombination is not haphazard, but is guided by the “method of comparison,” which is an extension of the algebraic method. Rule XIV refers to this “combination of familiar entities or natures [*entiam sive naturam*] which produce like

²⁷⁷ The excision of “substance” as a valid metaphysical concept in the *Regulae*, is a function of one of Descartes’ primary aims in that work, namely, to undercut the notion of the syllogism, and the Aristotelian categories on which it depends, as the sole means to scientific knowledge. See Marion, *Sur l'ontologie grise*, 30-4, 60-3 and 85-98.

effects” (AT X, 439; CSM I, 57), by which unknown natures are known on the basis of known natures.

By applying this method to the categories of all possible knowledge, which he here enumerates, Descartes finally outlines his vision of a universal method for the sciences in a concrete way. This conclusion is not stated without acknowledging that the method outlined here is incomplete and not perfectly transferable to Descartes’ later metaphysical dualism. Nonetheless, the method as it is explained here is a mature, thorough, and plausible attempt to define the organization of human knowledge and place it on a firm foundation. This concrete program outlined in Rule VIII is the first real, concrete development of Descartes’ vision of a ‘mathesis universalis’ that he initially proposed to Beeckman in 1619 and which in some sense was the guiding theme of his studies in the 1620s. It shows signs of influence from the Renaissance conceptions of method, memory art, and encyclopedism.

Mind and mathematics

While Descartes’ *Géométrie* is often regarded as the most complete application of his purely mathematical method of discovery, it is also noteworthy with respect to the question of the relationship between Descartes’ concept of method and his concept of mind. The reason for this is that Descartes explains some of the most critical concepts in the *Géométrie* with reference to the nature of the cognitive powers. We will look at his classification of geometrical, as distinguished from what he calls mechanical, curves.

This distinction is, in part, explained algebraically, but it is also explained with reference to the way they are cognized. Indeed, this difference appears to mirror the difference between intuition, i.e., pure intellection and instrumental intellection.

Briefly, the *Géométrie* is a work in which Descartes showcased the efficacy of his method for solving a classical problem in geometry, the Pappus locus problem. This problem requires one to construct a number of lines (no one prior to Descartes had solved it for four lines or more) each of which would be a predetermined distance from a given point. The opening pages of the *Géométrie* outline the relationship between geometry and arithmetic, the sense in which these sciences can be reduced to a few transparent operations, the importance of the unit “prise à discrétion,” the method of forming a comparison or equation between two different forms of the same quantity, the reduction of many unknowns to one, and the corresponding geometrical construction of solutions to geometrical problems, using only conic sections. This seems fairly straightforward. However, the *Géométrie* is also a strange specimen of the method insofar as it mainly demonstrates the constructions without demonstrating how they were achieved. In the text itself, Descartes says, “But I will prevent myself from explaining this in more detail because I would like to leave you the pleasure of learning them on your own, and the utility of cultivating your mind in its exercise, which is, I believe, the highest principle one could take from this science” (AT VI, 374). In a letter to Mersenne, Descartes confirms that he had omitted certain elements (one might say the most crucial elements) from the treatise: “But the good thing is that, bearing on this question of Pappus, I included only the construction and the demonstration in its entirety, without including all

of the analysis” (AT II, 83). Thus, in order to understand what is perhaps Descartes’ greatest immediate contribution to the history of ideas—certainly the source of his greatest influence in the seventeenth century—a bit of reconstruction is required. The most convincing reconstructions of the treatise suggest that the solution to the Pappus locus problem is the organizing principle of the work, not only in terms of its crowning achievement, but also in terms of its underlying structure.²⁷⁸ Though Descartes seems to have settled on a form of the algebraic method for problem solving around 1623, the solution to the Pappus locus problem provided a means of translating algebraic equations into geometrical constructions and classifying the kinds of construction according to a criterion of acceptability, simplicity, or more generally exactness.²⁷⁹

In Rule XIII, Descartes suggests that in order to approach geometrical problems (*quaestiones*), one must perform a preliminary enumeration: “By *quaestiones*, moreover, we mean everything in which there lies truth or falsity. We must enumerate the different kinds of problems, so that we may determine what we have the power to achieve in each kind” (AT X, 432; CSMI, 53). This categorical enumeration sorts problems into classes so that the appropriate method can be applied. In the opening sections of the second book of the *Géométrie*, Descartes invokes just such a distinction in kind, i.e., in the kind of

²⁷⁸ Lachterman, *The Ethics of Geometry*, 144-48; Bos, *Redefining Geometrical Exactness*, 283: the Pappus locus problem was “the crucial catalyst; it provided [Descartes] in 1632, with a new ordered vision of the realm of geometry and it shaped his convictions about the structure and the proper methods of geometry.”

²⁷⁹ Manders, “Algebra in Roth, Faulhaber and Descartes,” has shown that Descartes’ work with Faulhaber in 1620-1621 was probably the crucial time for developing his understanding of algebraic equations and their utility in solving geometrical problems. In fact, it is most likely that Descartes’ acquired his sense of the fundamental theorem of algebra via Roth’s *Arithmetica*. Moreover, the critical conception of the multiplicative property of equations, i.e., conceiving of equations as the product of roots, appears to originate from this work as well.

curves admissible in geometry. While the first book treats only those problems that can be constructed with the use of a compass and a ruler (i.e., using circles and straight lines), which would confine it to those solutions that were classically admissible, the second book introduces new mechanisms for drawing curves that Descartes must justify.

It is frequently noticed that Descartes has a “problematical” rather than “axiomatic” or “foundational” approach to geometry. This is certainly characteristic of his treatise on geometry, and it was typical for the time. However, there is an underlying issue that approaches what Descartes himself called the “metaphysics of geometry,” and that is the issue of the acceptability of types of curves in the solution to geometrical problems.²⁸⁰ This distinction describes the conditions necessary for any possible construction; and they were in fact required to justify Descartes’ solution to the Pappus problem of greater than four lines. As Henk Bos has demonstrated in his singular effort to determine precisely the nature of construction and the acceptability of geometrical constructions in the 17th century, the issue concerning the classification of curves has direct bearing on what counts as an acceptable geometrical demonstration.²⁸¹ For the ancients, this was evident: only the circle and straight line could be used to construct the solutions to geometrical problems. One important consequence of this, at least for the

²⁸⁰ Letter to Mersenne, 9 Janvier 1639, AT II, 490. Lachterman, *The Ethics of Geometry*, 143, identifies this with the principles of determining what curves ought to be admitted into geometry. In the passage, Descartes criticizes M. des Argues for having employed a kind of “metaphysics of geometry” in reasoning about geometry. By contrast, Descartes says, “je ne m’y fie point tant, que d’assurer aucune chose de ce que j’ay trouvé par son moyen, avant que je l’aye aussy examiné par le calcul, ou que j’en aye fait une demonstration Geometrique. Car on s’y peut tromper fort aysement et mesler quelque difference specifique avec les generiques, au moyen de quoy le tout ne vaut rien” (ibid.).

²⁸¹ Bos, “The Concept of Construction and the Representation of Curves in Seventeenth-Century Mathematics,” in *Lectures on the History of Mathematics*, 23-36. See also, Bos, *Redefining Geometrical Exactness*, Ch. 1 et passim.

modern reader, is that throughout classical geometry, it is not so much the deduction (from axioms) that is paramount for true geometrical knowledge, but the construction of a solution to the problem that counts.²⁸² Thus the parameters of acceptable constructions were absolutely central to the concept of mathematical truth. Nonetheless, the classical restrictions on construction did not prevent ancient geometers from devising all kinds of devices to construct solutions to the most notoriously difficult problems, e.g., the trisection of the angle, squaring the circle or duplicating the cube (i.e., finding two mean proportionals).²⁸³ Among these devices were the quadratrix, the cissoid, the conchoid, as well as Erotasthene's compass for finding two mean proportionals (from which it is likely Descartes derived his own compass for finding mean proportionals via its discussion in either Pappus' *Collectiones* or Simon Stevin's *Arithmetica*). However, none of these "solutions" were real solutions to the problems proposed since they did not conform to the standards of geometrical exactness, i.e., constructions using only the ruler and compass.

As Bos has pointed out, the purpose of Descartes' *Géométrie* was twofold: (1) to develop an "analysis," or universal method for finding the appropriate construction for any type of geometrical problem and (2) to determine what constructions were acceptable in geometry beyond those using the ruler and compass.²⁸⁴ As we have seen, the answer to the former aim is provided through the algebraic method and the *mathesis universalis* more generally. The answer to the second question is provided in the classification of

²⁸² See Bos, *Redefining Geometrical Exactness*, Ch. 2 and 4.

²⁸³ See Thomas Heath. *A History of Greek Mathematics*, I, Ch. 7.

²⁸⁴ Bos, *Lectures on the History of Mathematics*, 43. Cf. 25-26 for a description of these principle aims as the central methodological issues in all of 17th century mathematics.

curves. I claim that, in fact, both of these elements (i.e., not only the algebraic method of discovery) are ingredient to Descartes' response to the issue of the *mathesis universalis*. That is, it seems that Descartes' notion of the *mathesis universalis* is linked to a preliminary classification of the kinds of things tractable by means of that method.

According to Bos, the acceptability of constructions can actually be divided into two different parameters: acceptability and simplicity, the former is treated in Bk. II of the *Géométrie* and the latter in Bk. III.²⁸⁵ Briefly, the acceptability of curves is determined by the nature of construction, while the criterion of simplicity states that it would be an error, or “*une grande faute*,” to use a more complex method of construction than is required by the nature of the problem.²⁸⁶ The criterion of simplicity serves to reinforce the rigor and necessity of classification for the adequacy of method to treat higher order problems.

For the present purposes, only the issue of the acceptability of curves and their classification is pertinent. The second book of the *Géométrie* makes several definitive pronouncements on the nature of acceptable curves in geometry. First of all, Descartes dismisses the ancient distinction between geometrical and mechanical curves, suggesting that the straight line (which is generated with the use of a ruler) and the circle (which is generated with the use of a compass) are no less “mechanical” in nature than other curves, since one uses tools to create them. Descartes wishes to found the distinction between curves on a different basis, in short, he says, “we are looking only for the

²⁸⁵ Ibid., 48-50.

²⁸⁶ This appears on AT VI, 444. See Bos, *Redefining Geometrical Exactness*, 357-59 for a discussion of this passage among others.

correctness in reasoning” (AT VI, 389). One may object that even though ancient geometers surely used tools to construct their lines and circles, it was the concepts themselves--the *ideal* line and circle--that made these acceptable for construction. Lines and circles were fundamental to the general ontology of classical geometry. Thus, perhaps Descartes’ appeal to the “justice of the reasoning” is closer to the original intent of those ancient authors than he would like to admit. Nevertheless, he goes on to state that the distinction between geometrical and mechanical curves is generally conceived in the following way: “It is, I think, quite clear that one can take, as one does, Geometrical as that which is precise and exact and Mechanical as that which is not” (ibid.). Furthermore, he anticipates the distinctions that will follow by claiming that “in order to trace all of the curved lines that I intend to introduce, there is no need to suppose anything if not two or more lines that could be moved, one by the other, and whose intersections trace other lines, which seems to me to provide no further difficulty” (ibid.). These passages are ambiguous. Descartes wishes to distinguish certain curves from others on the basis of several conditions: precision, exactness, movements creating them, and their conformity to reason. The overriding aim is to justify the inclusion of certain new curves, of a degree of complexity greater than the circle and straight line, in his geometrical constructions. Each of these criteria serves this purpose while also reinforcing the centrality of the cognitive apprehension of curves as the standard of their inclusion or exclusion from geometry. However, it is not entirely clear which standard we should accept and why.

Classification of geometrical curves

In an effort to clarify the technical nature of these curves, on the one hand, Descartes defines the nature of the curves according to the nature of the movement that produces them: “given that one can imagine them described by a continuous movement, or by many subsequent movements that are completely regulated by the preceding ones: for, in this way, one may always maintain an exact knowledge of their measure” (AT VI, 390). Yet on the other hand, he defines their nature according to their algebraic representation, “those that one calls "Geometrical," that is, which fall under a precise and exact measurement, necessarily have some relation to all of the points on a straight line, and which can be represented by some equation, entirely by the one, itself” (AT VI, 392). Thus, Descartes is clear that in some sense the curves that are accepted into geometry should be easy and clear to comprehend. But he defines this easy and clear comprehension in two different ways: according to the criterion of ‘continuous movement’ (with its extension to successive continuous movements, each regulated by the previous) and the criterion of ‘algebraic representability’.

These two different ways of distinguishing geometrical from mechanical curves lead to a difficulty for interpreting exactly what is intended by this distinction. It is at least clear that whatever the real nature of the distinction, Descartes intends it to coincide with a distinction between what is clear, exact and, rational (geometrical) and what is not (mechanical). Henk Bos understands this to relate directly to the two intellectual faculties of knowledge described in the *Regulae*, intuition and deduction, where the ‘continuous motion’ is a motion that is intuitively transparent, while the ‘successively combined

motions' resemble deduction. Incidentally, he sees the requirement that geometrical curves be represented by algebraic equations as a separate restriction.²⁸⁷ In an altogether analogous way, David Lachterman understands what he calls the 'kinematic criterion' to be an epistemic criterion that rest "on the motions the mind performs as it passes along a series of relations in quest of new knowledge, that continuous motion Descartes calls 'deduction'."²⁸⁸ Others have tried to understand the 'continuous movement' criterion as reducible to the algebraic criterion, insofar as the purpose is to demarcate those curves whose points are all potentially identifiable and whose intersections with other curves can be determined.²⁸⁹ Still others have denied this reduction, preferring to distinguish 'constructability' from what can be represented by algebraic equations, but have seen Descartes' geometrical curves as essentially coextensive with the first two types of curves mentioned in Descartes' letter to Beeckman of March 26, 1619.²⁹⁰ The latter historical reference is fitting for the present investigation. In that letter Descartes states:

I shall be able to demonstrate that certain problems involving continuous quantities can be solved only by means of straight lines and circles, while others can be solved only by means of curves produced by a single motion, such as the curves that can be drawn with the new compasses (in my view these are just as exact and geometrical as those drawn with ordinary compasses), and others still can be solved only by means of curves generated by distinct and independent motions which are surely only imaginary, such as the notorious quadratrix. (AT X, 157; CSMK, 2-3)

Though this passage provides little in the way of clarification, since the phrasing is nearly identical, it does serve to connect Descartes' classification of the curves c. 1637 to his

²⁸⁷ Ibid., 48-49.

²⁸⁸ Lachterman, *The Ethics of Geometry*, 182, cf. 169-74.

²⁸⁹ Rashdi Rashed, "La Géométrie de Descartes et la distinction entre courbe géométriques et courbes mécaniques," in *Descartes et le Moyen Age*, 19-22.

²⁹⁰ M. Serfati, "Les compas cartésiens."

proposed project of a *scientia penitus nova* in 1619. Indeed, it reinforces my claim that this classification ought to be understood within the broader context of issues pertaining to the *mathesis univiersalis*. This also may signal why Descartes includes two different criteria for geometrical curves, one with reference to “continuous movement,” which would be a remnant of the earlier project, and the other with reference to algebraic equations, which may have come later.

One question that is raised in virtue of Descartes’ classification of curves is whether the continuous movement criterion is in fact coextensive with the algebraic representation criterion (as suggested above, some commentators think that it is, while others claim that it is not). One way to try to adjudicate this difficulty is to appeal to our contemporary understanding of mathematics. Descartes’ mechanical/geometrical distinction is surpassed, in the history of mathematics, by Leibniz’s transcendental/algebraic distinction, still appealed to in contemporary mathematics. Indeed, things like the quadratrix, cycloid, and spiral, all of which Descartes’ identified as “mechanical”(AT VI, 390), are commonly called transcendental, while all of the curves that Descartes’ identified as geometrical are recognized to be algebraic.²⁹¹ At least in contemporary terms, a curve is algebraic just in case the set of points traced by that curve can be described by an equation of the form $F(X, Y) = 0$ where the coefficients of X and Y are rational numbers.²⁹² (Today both algebraic and transcendental curves are studied in geometry, so they are both in a sense ‘geometrical’.) Thus, in a contemporary

²⁹¹ Of note, Descartes admits the conchoid and cissoid since it is possible to find a pointwise construction for these curves and thus an equation that describes them.

²⁹² Adapted from Weisstein, Eric W. “Algebraic curve,” from MathWorld-A Wolfram Web Resource (<http://mathworld.wolfram.com/AlgebraicCurve.html/>).

understanding, Descartes' algebraic representation criterion seems to be a legitimate candidate for distinguishing the appropriate curves from all others.

What about Descartes' continuous movement criterion? Answering this question is difficult, primarily because it is difficult to understand what Descartes means by "continuous movement, or by several successive movements that are entirely determined by the preceding ones" (AT VI, 390). He tells us that this criterion omits those curves, like the quadratrix, spiral, and cycloid that are produced by "two separate movements with no ratio between them that can be measured exactly" (ibid.). But the several successive movements allows, for instance, the curve traced by Descartes' mesolabe compass, or by the Cartesian parabola, or even higher (iterated) degrees of the Cartesian parabola (AT VI, 391, 393 and 476-84). (In fact, the second degree Cartesian parabola, described in the section concerning "A general method for constructing curves" is a centerpiece of the *Géométrie*.) One thing that is certain is that Descartes' notion of "continuous movement" is not identical to the contemporary notion of "continuity" of functions, i.e., whether a function is differentiable over a finite range of values, since the latter is too broad for Descartes' purposes. This is obvious given the case of the sine wave, which is continuous and differentiable at all values, but is not "geometrical" in Descartes' sense (presumably, the quadratrix would be continuous and differentiable, though the cissoid and cycloid would not be). Secondly, there is little but historical fascination in these issues of geometrical construction today; mathematicians today use formal algebraic means to define the nature of curves. So there are few commentators with sufficient mathematical expertise who have addressed the issue. Henk Bos—one

commentator who certainly fits that bill—has offered an interpretation of what Descartes’ means by continuous movement that entails that all and only those curves constructed by means of a continuous movement can be defined algebraically. First of all, Bos understands continuous movement as rectilinear movement, reading Descartes’ rejection of the cycloid and spiral as a rejection of curvilinear motion in combination with rectilinear motion.²⁹³ Then Bos links the notion of continuous movement to algebraic representation through the concept of “generic pointwise construction.”²⁹⁴ In other words, he finds that by continuous movement, Descartes means to designate just those curves that could also be constructed by a procedure that would randomly pick out any given point along the curve by drawing the line that joins it to a point on a chosen axis. This method picks out the familiar abscissa and ordinate, or x- and y-coordinates, that describe the curve according to the way they are plotted on an ordinate plane. This procedure is possible only if the curve can be described by an algebraic equation. In fact, the algebraic equation in two variables is the ‘key’ to a generic pointwise construction: just insert a value for x and calculate the corresponding y value.²⁹⁵ While this interpretation seems eminently plausible, there is no guarantee that one could devise a method of construction,

²⁹³ The key text to defend this view is found at (AT VI, 412): “la proportion qui est entre les droites et les courbes n'estant pas connue et mesme, je croy, ne le pouvant estre par les hommes.” Cf. letter to Golius, January 1632 (AT I, 233-34).

²⁹⁴ This is the crucial concept, inferred from Descartes’ statement that the points determined by an appropriate geometrical construction are “tellement propre qu'ils ne puissent estre trouvés que par elle” (AT VI, 411), not the “point générique” or “generic point” suggested by Christian Houzd, “Descartes et les courbes transcendentes,” in *Descartes et le Moyen Age*, 28. A generic point is a specific topological property that is trivial for all Hausdorff spaces, i.e., all topological spaces that are not in some strong sense separated or disjoint. In other words, Descartes would have no use for this term. A much more general concept is required here. Bos suggests “generic pointwise construction”; I would suggest “function.”

²⁹⁵ Bos, *Redefining Geometrical Exactness*, 336-38.

according to Descartes' continuous movement criterion, for any given algebraic equation. Indeed, this seems to have been part of the difficulty behind the *Géométrie*: that generating actual methods of construction was at least as difficult as solving the analytic/algebraic side of the problem. Though the Cartesian parabola is an achievement, a contemporary reader marvels at just how complicated the construction is: a parabola of the first degree (i.e., a normal conic section) is moved along its axis in conjunction with a turning ruler in order to generate another parabola by the intersection of these two lines. Iterating this procedure one step further is even more complicated, as is attested by its description (AT VI, 480-82).

Descartes' requirement that all geometrical curves be "expressed by an equation" or that there is "some relation from the curve to all the points of a straight line" (AT VI, 392) seems to have more promise. Descartes may have a concept of "functionality" in mind (though Bos claims that the seventeenth century concept of a curve is not a functional one).²⁹⁶ If this were the case, Descartes should have in fact said that there is "a relation from *each* point on the curve to *exactly* one point on a straight line." If we take the straight line in question to be the y-axis, then this would give us a function $f(x) = y$ to describe the curve, where each point on the curve is described by $f(x)$ and each point on the y-axis is described by y . This would be a good requirement for geometrical curves and would rule out the conchoid and the spiral from the list of acceptable curves.

Additionally, the functional requirement would give an obvious explanation for why

²⁹⁶ Bos, *Redefining Geometrical Exactness*, 127. The reason for this, he claims, is that the seventeenth century mathematicians do not have the concept of independent and dependent variables; they simply conceive of equations as describing a relation between knowns and unknowns.

Descartes would identify the requirement that the “relation from the curve to all the points of a straight line” would be identical to the requirement that the curve “could be expressed by some equation.” When Descartes describes how to determine the equation of a curve according to its relation to a straight line, which he does by using the Cartesian parabola (AT VI, 393-94), he says that the “relation” of the curve to the line is determined by straight lines with definite ratios between them. This is consistent with Descartes’ requirement that all relations or proportions are (potentially) related in some definite way to a “unit” length. Such a relation would not be a rational one (Descartes even suggests that it would be impossible!) if one of the lines were curved.²⁹⁷ In any case, there does seem to be a close connection between what Descartes regarded to be the determinate ratio of lines that produce the desired curve and the algebraic representation of that curve in the form of an equation. While I do not know and have not seen a proof of the precise nature of that connection, it is at the very least an appropriately Cartesian idea. Recall that it is the ‘ratio and proportion’ or ‘order and measure’ that defines the *mathesis universalis*; and the representation of mathematical operations by line segments is ingredient to at least Descartes’ concept of mathematical truth in the *Regulae*.

One of the consequences of a detailed study of Descartes’ classification of curves in the *Géométrie* is that one begins to realize that even though Descartes is on the threshold of a purely formal (algebraic) criterion for defining geometrical exactness, he remains, in important ways, bound to the geometrical, figurative, representations of

²⁹⁷ “The proportion that exists between straight lines and curves is not known and even, I believe, is not capable of being known by men, and as a consequence one would not be able to conclude from this anything that would be sure and exact” (AT VI, 412).

curves for his concept of geometrical exactness.²⁹⁸ Though there is nothing more common than to suggest that Descartes made geometry algebraic, one should keep in mind that the algebraic equation is not the final word; the concept of geometrical construction still remains central.²⁹⁹ That is not to undermine the central importance of the equation in Descartes' *Géométrie*. Indeed, the algebraic equation, that accurately represents the problem, is, so to speak, the first principle of its demonstration. However, the construction is necessary in order for the demonstration to be complete. Lachterman has gone as far as to suggest that geometrical construction in Descartes is a paradigmatic case of Vico's principle: *verum et factum convertuntur*. According to this interpretation, Descartes recognizes the truth of a geometrical solution only insofar as he is able to reproduce that truth, i.e., to construct the solution. Moreover, insofar as the geometer-philosopher demonstrates her mastery over the subject in question, her mind, in the process of geometrical construction, is an active producer of truth. It is in this sense that Lachterman would like to link the concept of geometrical construction to the concept of the Kantian productive imagination: for Kant, "mathematical construction [comes] from the construction of a concept. But to construct a concept means to exhibit (*darstellen*) to

²⁹⁸ There is nothing shameful about this; such a bond to geometrical construction as the standard of exactness would prevail for some time after Descartes. Bos is fond of relating a story about the correspondence between Leibniz and Christiaan Huygens, where both Leibniz and Huygens seem to prefer a much more complicated algebraic expression to a simpler one; the reason for this lies in the simplicity of construction rather than the simplicity of the equation. He even finds in Newton a similar prejudice: "it is not its equation but its description [read: construction] which produces a geometrical curve." See Bos, "The Concept of Construction and the Representation of Curves" in *Lectures on the History of Mathematics*, 23-30, quoted text on 30.

²⁹⁹ Vincent Julien, *Descartes et la Géométrie*, repeatedly notes the ambiguity between algebraic expressions and geometrical representations.

oneself its corresponding intuition.”³⁰⁰ There is a great deal of truth to this proposed connection. Though Descartes consistently identifies thought with passive perception (*cogitare* = *percipere*: Meditation VI: AT VII, 79; CSM I, 55; Principles I.32: AT IX-b, 17; CSM I, 204) in marked contrast to the spontaneous activity of perception in Kant, the hallmark of truth or falsity for Descartes, i.e., judgment, depends on volition and thus the mind’s active mode. For the purposes of geometrical demonstration, this activity is made manifest in the construction; only in this sense is geometrical knowledge *proved*.³⁰¹ Furthermore, this identification between geometrical construction and the manifestation of an intuition suggests a reasonable philosophical background for the claim that there is a correspondence between the continuous movement of the geometrical construction and the continuous movement of thought that preserves the veracity of the intuition, i.e., deduction. Perhaps this is why Descartes intimates a connection between the two, though he clearly lacks an explanation for the connection.

Geometry and the intellect in the Regulae

Several texts from the *Regulae* could be cited in support of the conclusion from the *Géométrie* that truth is preserved through exact, imaginative constructions. The most

³⁰⁰ See Lachterman, *Ethics of Geometry*, 7-16 for the main lines of this argument. The Kant quotation comes from the “Doctrine on the Method” A 713; B 741.

³⁰¹ Doyle, *The Logic of Descartes’ Method*, makes a further precision of this statement with which I agree: namely, that Descartes only needs the construction (whether geometrical or physical) to demonstrate the practical efficacy of the theory, which is a necessary, but not a sufficient condition for speculative truth. The additional requirement would apparently be the causal principles of natural philosophy from which these practical truths follow. Thus, we could say that Descartes only obtains the necessary and sufficient conditions for the speculative truth of mathematical ideas when he demonstrates the existence of God and the ego as the conditions of mathematical knowledge. This is, of course, accomplished in the *Discours* and *Meditationes*, or perhaps in the doctrine of eternal truths c. 1630.

decisive passages emerge in Rule XIV, which is a rule dedicated to the representation of problems in the imagination such that they can be more clearly conceived by the intellect: “These problems should then be transformed into real corporeal extension and depicted as bare figures by the imagination. Thus they will be much more distinctly perceived by the intellect” (AT X, 438; CSM I, 56). This rule follows the method of problem solving outlined in Rule XIII whereby the real difficulty is isolated—the unknown—and all other extraneous concerns are dissolved by virtue of an abstraction (AT X, 430 and 37; CSM I, 52 and 56). This prepares for the specific (perfect) problems—those that are “determined in every respect” (AT X, 431; CSM I, 52)—addressed in Rules XV-XVIII. Descartes’ inclusion of corporeal or geometrical representations of problems in Rule XIV seems to allow him to extend the efficacy of the method beyond purely mathematical problems to physical problems as well.³⁰² He refers, for instance, to the nature of sound, the nature of extended things, weight, speed, and so on in contexts that clearly refer to perfect problems. In a certain measure, this rule can be conceived on analogy with Descartes’ application of the geometrical properties of the ellipse and hyperbola to the grinding of lenses as described in the *Géométrie* and put to use in the *Dioptrique*. In these cases, the problem can be considered to be perfect by virtue of the method of comparison used. In other words, if one can determine in every way the comparison or analogy that appropriately describes the *quaesitum*, then it is a perfect problem. By contrast, if some feature of the problem cannot be so represented, then the problem is imperfect. Descartes

³⁰² This is one reason why I do not think there is a precise analogy between perfect problems, imperfect problems and mathematical, physical problems like, e.g., Doyle, *The Logic of Descartes’ Method*, advocates.

seems to have no concern that the conclusions reached by virtue of applying the method to perfect problems will be falsifiable. They seem, at least according to the text of the *Regulae*, to be based on the same kind of *experientia* that renders geometry and arithmetic indubitable. Since Descartes' conclusions about some of these matters, especially his notions of weight and the nature of light, are not in fact accurate, one could conclude that this is an overextension of a mathesis-type method. Moreover, the unfinished nature of the *Regulae* and Descartes' use of a much more experimental method in his actual physical investigations reported, for example, in *Le Monde* and *Météors*, suggest that the difficulty of applying a strictly mathematical method to physical problems may have been one of the reasons for the discontinuation of the project c. 1628.

Nonetheless, Descartes' explanation of the method in these rules is instructive for understanding how he conceived of the mathesis universalis and its potential for application to natural philosophy in the 1620s. More than that, I maintain that these prescriptions reveal deep-seated commitments in Descartes' philosophy that will remain central throughout his career. First of all, Descartes outlines what I have referred to as the 'method of comparison' in these Rules: a method that is essentially an algebraic method of discovery in a broader natural scientific perspective. The method of comparison is outlined as a means of extending knowledge from what is already familiar to what is unknown by means of the similarity between the unknown and the known. The reason why Descartes applies this method to natural philosophy is that he acknowledges no faculty of the intellect that is able to divine the true nature of things by itself. Thus, the

best that can be hoped for is to describe the nature of unknown things according to their relation to things that are already known. To illustrate, Descartes introduces the case of the blind person who has no concept of 'color'. He suggests that one may be able to relate the nature of color to the blind person if one explains the structure of colors that we ordinarily see as a mixture of primary and secondary colors. In this way, one can perhaps explain to the blind person the nature and structure of perceived colors even though he may have no sensory intuition of them. With reference to one of his favorite examples of a difficult problem to understand, Descartes' invokes the same procedure, parts of which I have cited above, in a way that addresses ordinary human cognition:

In the same way, if the magnet contains some kind of entity the like of which our intellect has never before perceived, it is pointless to hope that we shall ever get to know it simply by reasoning; in order to do that, we should need to be endowed with some new sense, or with a divine mind. But if we perceive very distinctly that combination of familiar entities or natures which produces the same effects which appear in the magnet, then we shall credit ourselves with having achieved whatever is possible for the human mind to attain in this matter. (AT X, 439; CSM I, 57)

The nature of the magnet, Descartes claims, is unknown to the ordinary human intellect in the same way that colors are unknown to the blind man: the magnet exhibits a kind of effect whose cause we cannot perceive. However, like the case of the colors, if the nature of the magnet were explained on the basis of simple natures, which we can perceive and which operate in an analogous way to the perceived effects of the magnet, then we can completely understand the nature of the magnet on analogy with these other simple natures. The method of comparison, on the basis of which, "we perceive that the thing we are looking for participates in this way or that in the nature of the things given the statement of the problem" (AT X, 438; CSM I, 56), allows us to extend our knowledge

from the familiar to the unfamiliar without a wild intuitive leap or specious, “dialectical” reasoning.³⁰³

The method of extending our knowledge is a method of comparison, or analogy, which is basically algebraic in character. That is, one takes x to be unknown and a , b , and c to be known. If one can then establish a proportion between the known and the unknown, for example, a is to b as c is to x , then the solution becomes apparent by virtue of this stated analogy: x is related in such a way that it is proportional to b , but inversely proportional to a and c . Further, if these terms are cashed out in terms of quantitative magnitudes, then the solution of the problem is a matter of simple multiplication and division. In order to set up a problem like this, Descartes suggests translating the ratio of knowns and unknowns into an equivalent ratio between line segments. Lines segments are chosen to indicate any given magnitude because of the ease with which they are represented to the imagination. The operations of addition and subtraction (Rule XVIII) as well as multiplication and division (Rule XV) are pictured by means of line segments. Despite this reliance on geometrical figures to describe the operations of arithmetic, however, Descartes does not fall into the same difficulty as Viète with respect to the “law of homogeneity.” Instead, he takes his cue from Stevin’s *Arithmetica* and reduces figures of two dimensions to one dimension by reference to the arbitrariness of the unit segment: “we shall always understand the unit to be in every sense an extended subject and one susceptible of countless dimensions” (AT X, 453; CSM I, 66). That is, he takes a rectangle whose sides are equal to two and three units respectively and sets this equal to a

³⁰³ I say this with reference to Descartes' effort to distance himself from traditional dialectic even though I think Descartes' reasoning on this point is 'dialectical' in some broader sense.

rectangle of sides one and six. The second rectangle can then be considered as a line equal to the length of its base. Descartes even suggests representing these figures by a series of points, which can easily be set one after the other in a line in order to reduce the dimension.³⁰⁴ “So we must note above all that the root, the square, the cube, etc. are nothing but magnitudes in continued proportion which, it is always supposed, are preceded by the arbitrary unit mentioned above” (AT X, 357; CSM I, 68). In one sentence, Descartes dispatches with the confusing language of multiplication, which in the Cossist algebra referred to squares, cubes, squares squared, and so on. The metaphor of dimensionality was a great stumbling block to understanding multiplicative roots to algebraic equations. Additionally, in the same sentence, Descartes expresses the relationship between mean proportionals (the ‘geometrical mean’ as we would say today) and roots: if x is the mean proportional between y and 1, then $x^2 = y$. Thus, proportional relations, the unit, and the symbolic representation of knowns and unknowns are the “simple components” (Rule V) to which any geometrical problem can be reduced and it is on the basis of these that we ought to make a step by step assent to their solution.

The reduction of problems to symbolic relations between line segments allows one to understand the relations that exist between the known and unknown quantities. Again, symbols are useful because they help to improve the capacity of the imagination to perceive the essence of a problem in its entirety. In effect, symbolic representation of problems makes use of the method of abstraction, described in Rule XIII. Descartes describes the method as follows:

³⁰⁴ Doyle, *The Logic of Descartes’ Method*, has pointed out that this technique dates back to Euclid’s *Elements*.

We ought to write down a list of terms of the problem as they were stated in the first place; then we should note down the way in which they may be abstracted, and the symbols we might use to represent them. The purpose of this is that once we have found the solution in terms of these symbols, we shall be able to apply it easily to the particular subject we are dealing with, without having recourse to memory. For we always abstract something more general from what is less general. (CSM I, 69; AT X, 458)

Though the abstraction is meant to highlight the most general, or essential, features of the problem at hand, even this level of generality is taken to correspond to a depiction in the imagination, or even the sense perception, since these figures are supposed to be notated. Thus, Descartes clearly designs his algebraic method of comparison with attention to the strengths and weaknesses of the various faculties of the mind. Moreover, algebraic expressions notated by symbols are strict corollaries of the method of comparison of Rules XIII and XIV and the notion of an explanatory series from Rule VI. (We will have a chance to return to these issues in the next chapter.)

The method of comparison and the representation of proportional relations, using either symbols or line segments, describe the mechanics of the method. But the conditions of the method are determined by the parameters within which problems must be framed. Descartes' notion of 'quantifiability', not to be confused with quantification, carries with it an implicit bipolarity condition for all problems: "by problems [*quastiones*], moreover, we mean everything in which there lies truth or falsity" (AT X, 432). Thus, every problem must be determinable as either true or false. As is apparent in today's natural sciences, this criterion is a vital criterion for any scientific investigation. When dealing with imperfect problems, therefore, it is necessary to isolate the particular, quantifiable feature of the thing in question and to compare this to other quantifiable

features only. In that way imperfect problems can be “reduced” to perfect ones. Part of the implicit assumption behind this reduction is that any feature of a physical thing is simply a “mode” of an extended object. These perceivable features are not ‘real qualities’ or ‘substantial forms’ that have some independent ontological status. For example, when Descartes compares the tension or weight of different strings that produce some sound, he does not understand heaviness to be a real quality of the strings, but to be a quantifiable mode of the extended substance. This mode can then be treated as any number, symbol, or extended magnitude and is thus amenable to the method described above. Accordingly, Descartes’ conviction that matter is essentially extended and that all space contains some extended matter rests on the a priori conditions that make his method possible.

In the *Regulae* just as in the *Géométrie*, we see a very close relationship between Descartes’ algebraic method and the mental operations of pure cognition, imagination, and sense perception. These mental powers help to determine the way in which problems ought to be represented and solutions ought to be sought. Though Descartes is on the cusp of an independent, formal system that justifies his natural philosophy, he is still wedded to the idea that knowledge is determined by and fitted to the mind. His method is continually justified with relation to the way it is carried out by the mind. The various steps of the method correlate with the faculties of the mind. And, we will see further, objects are conceived in contradistinction to the intellect. In this sense, Descartes commits the psychologistic fallacy. He justifies purely formal truths by the psychological processes necessary to grasp them.

The idea of pure mathesis in Descartes' mature philosophy

In the *Meditationes* Descartes adds a further precision to the relationship between corporeal extension, i.e., physical nature, and purely mathematical knowledge. He opens Meditation VI by reminding himself that at least he knows that those material things [*res materiales*], which are the object of pure mathesis, are capable of existing “insofar as I perceive them clearly and distinctly” [*jam ad minimum scio illas [res materiales], quatenus sunt purae Matheseos objectum, posse existere, quandoquidem ipsas clare et distincte percipio*] (AT VII, 71; CSM I, 50—cf. AT VII, 80, ln. 10; CSM I, 55). This statement effectively dissociates knowledge of pure mathesis from knowledge acquired through the senses and imagination. As a further measure of distinguishing what is known via mathesis, versus what is known by way of the senses or imagination, Descartes distinguishes corporeal nature, understood as the object of pure mathesis from “much else that I habitually imagine, such as colors, sounds, tastes, pain and so on” (AT VII, 74; CSM I, 51). This distinction clearly reinforces the idea that whatever is tractable through the mathesis universalis is different from the perceived qualities of things. In this way, Descartes reinstates the mathesis universalis in the *Meditationes* as a matrix through which corporeal nature is understood clearly and distinctly, i.e., insofar as it is modeled on mathematics. Thus, for Descartes, nature as an object of pure mathesis is distinct from the many colors and sensations (in short the secondary qualities) that one usually has of the world. That is, only a corporeal world, understood as that which is extended in length, breadth, and depth, admits of modifications in movement and size, is indefinitely

extended, and contains no vacua, is the object of pure mathesis. Here mathematical thought, which is ideal, has a direct and determined relation to physical reality. Descartes demonstrates the truth of his clear and distinct ideas about mathematics and the mathesis universalis in Meditation V, which entails the possible existence of the object of those ideas, i.e., body in its general sense. Meditation VI goes on to demonstrate the actual existence of body, or extended matter by way of the compelling perception of its effects combined with God's benevolence.

As is well known, in Descartes' *Meditationes*, there is a real distinction between ideas, which are the property of thought, and physical objects, which are some complex of modifications in extended matter. However, for Descartes, all ideas are nonetheless directed at some object, whether that object is another idea, an incorporeal entity, or corporeal matter. Thus, Meditation V demonstrates the truth of the ideas of corporeal things, while Meditation VI proves the existence of those corporeal things. The clearest outline of the 'theory of ideas' underlying this distinction, I think, is provided by Vere Chappell.³⁰⁵ On his interpretation, which I adopt wholesale, ideas are real entities for Descartes, but they have two different aspects: they are either mental acts (material ideas) or objects represented by mental acts (objective ideas). Thus, there is only a 'distinction of reason' (*distinctio rationalis*) between these two kinds of ideas; they are different aspects of one and the same thing. It is, nonetheless, a useful distinction because through it we can distinguish objective ideas as the content of material ideas, while we understand material ideas to be coextensive with perceptions (both of thought and sensation). When

³⁰⁵ "The Theory of Ideas" in *Essays on Descartes' Meditations*, 177-98.

Descartes talks about enumerating our ideas, the relevant concept is the concept of objective ideas because material ideas are distinguished by reference to their content. Accordingly, 'objective being', which Descartes suddenly introduces in Meditation III, is the mode of being that objective ideas possess. To put it in modern terminology: the objective being of an idea refers to the ontological status of the representational content of that idea. Formal being is thus the ontological status of the cause of that idea, which includes either real things or material ideas.

In the case of ordinary perception, the objective being of a perceptual idea is the psychological counterpart to the physical thing it represents. The psychological state, in this instance perception, is causally connected to the perceived object. So, if I look at a blue ball in front of me, the proposition 'the blue ball' refers to a physical entity that is causally connected to a psychological state 'the perception of the blue ball'. The objective being of that idea refers to the ontological status of the proposition 'the blue ball', which is a proposition whose material nature is captured by 'the perception of the blue ball'. And the truth of the representational content of the idea, Descartes believes, rests on the clarity and distinctness of the psychological state. In the *Meditationes*, I take Descartes to be pointing out that our ordinary sensory perceptions are not at all clear and distinct. Only carefully deduced, mathematically modeled propositions will reliably describe the physical universe. On this reading, I take material falsity to indicate when two objective ideas are ambiguous in their representational content, i.e., they have the same external thing as their cause. The paradigmatic example from Meditation III is hot and cold: these two ideas refer to the same thing, but in different respects. Place one hand

in a container of hot water and another in a container of cold water. Then both hands and place them in the same container of water at room temperature. To the one hand it will feel cool, to the other it will feel luke-warm. Thus, hot and cold are not “real ideas,” i.e., they do not represent anything in particular.

This discussion of Descartes’ theory of ideas is important because he invokes it to explain the nature of mathematical ideas in an exchange with Pierre Gassendi. In the fifth set of objections, Gassendi suggests that he would agree with Descartes’ statement that corporeal things are the object of pure mathesis, or rather he says of some “applied mathesis,” only if it is conceded that there is no real distinction between the understanding and the imagination, insofar as these are acts of the same faculty or power of the intellect (AT VII, 328-9; CSM I, 228). He illustrates this by discussing the knowledge that pertains to intelligible geometrical figures like a triangle or chiliagon (a thousand-sided figure): “...when, not without some effort on your part, you make the [triangle] become, as it were, present before you, contemplate and examine it, and discern the three angles distinctly and in detail then you say you ‘imagine’ it” (AT VII, 329; CSM I, 229). On this point, both Descartes and Gassendi agree. However, in the case of the chiliagon, Descartes claims that there is adequate understanding of what a chiliagon is (equal to the understanding of a triangle) even while it is impossible to imagine such a figure. Gassendi, by contrast, finds that the confused state of geometrical representation in the case of the chiliagon leads Descartes to make a false distinction between the understanding and imagination: “You are in a confused state [when you try to imagine a chiliagon], just as you are when you are dealing with a myriagon or any other figure of

this sort; hence you think that in the case of the chiliagon or myriagon you have understanding, not imagination” (ibid.). This is a very important objection and is related to Gassendi’s belief that the faculty of understanding is not something essentially separate from the physical operation of the brain. We will have a chance to address some of these issues in the next chapter. For now, let us examine Descartes’ response.

Descartes claims that there is in fact a clear and distinct understanding of the chiliagon, quite apart from its being figured, or imagined, “for many properties can be very clearly and very distinctly demonstrated of it, which could certainly not happen if we perceived it only in a confused manner” (AT VII, 384-5; CSM I, 264). He continues:

And it is clear from this that the powers of understanding and imagining do not differ merely in degree but are two quite different *kinds* of mental operation. For in understanding the mind employs only itself, while in imagination it contemplates a corporeal form. And although geometrical figures are wholly corporeal, this does not entail that the ideas by means of which we understand them should be thought of as corporeal (unless they fall under the imagination). (ibid., my emphasis)

Thus, for Descartes of the *Meditationes*, the object of pure mathesis—the objective content of the idea of pure mathesis—which is characterized by its being utterly clear and distinct to the understanding, governs the *ideas* by means of which geometrical *figures* are represented; and these ideas are not identical with those figures of the imagination.

In effect, Gassendi charges Descartes with invoking a concept where none exists: geometrical ‘ideas’. For Gassendi, there are only geometrical representations and these are the ideas of geometry. However, Descartes claims that, in fact, there are independent, objective ideas of geometry: these are the properties that define geometrical objects and can be enumerated without reference to any pictorial representation. The figures that

represent geometrical objects, by contrast, are the real objective correlates of those ideas. For Descartes, extended magnitudes, which are the substance of geometrical representations, are real things (whether they are constructed or naturally occurring in the world); and those real things are the referents of the ideas of pure mathesis. This means that from the fact that a chiliagon cannot really be represented to the imagination, i.e., the brain is incapable of forming an adequate image of the chiliagon, we should not infer that no such idea exists. Nor should we require that the mind generate a clearer image of such an idea in order to say that we understand it (as Gassendi seems to want). Indeed, we are quite able to enumerate many properties of the chiliagon that must be the properties of some ideal entity without, for all that, being able to imagine it. For Descartes, the incapacity of the imagination to represent what the understanding knows to be a real thing demonstrates the distinction between these two faculties.

This is a more fine-grained distinction than what we have found in the *Regulae*, which blurs the distinction between *figura* and *idea*, but it seems to derive from Descartes' understanding of what makes geometrical figures geometrical.³⁰⁶ (The following chapter will explore the relationship between ideas, figures, and mental representation more thoroughly.) In the *Meditationes*, the mathesis universalis (the concept, not the term—which is not in fact used in that work) refers to those things that

³⁰⁶ In addition to Chappell's article, see "Descartes' Idea and its Sources" in R. Ariew, *Descartes and the Last Scholastics*. The relevant passages from the early Descartes that identify figura and idea are the following: Rule XII: AT X, 414 and Rule XIV: AT X, 441; *L'Homme*: AT XI, 174, 175, 176-77, 181, 183, 185 and 201. Descartes repudiates this identification in his later writings in the following places: Second Reply: AT VII, 160-61; Third Reply: AT VII, 181; Fifth Reply: AT VII, 363-64; and the Letter to Mersenne, July 1641: AT III, 392-93. (Citations taken from Chappell, "The Theory of Ideas," 194-95n2-4.)

can be conceived without reference to extended magnitudes or geometrical representations: its ideal content is really distinct from these figures. Furthermore, mathematics in general is distinguished from natural philosophy by the fact that the objects of mathematical thought are ideal while the objects of natural philosophy are the physical objects in the universe. The figures of geometry that are represented to the mind stand as a medium, a *tertium quid*, between the ideas of mathematics and the real objects of physics.

However, in the *Regulae*, where these two sciences are treated under one rubric, the ideas of pure mathematics are not distinguished from the figures of geometrical representation and these together are supposed to provide a means for acquiring knowledge of the physical world. The following passage from Rule XIV is particularly illustrative of this ambiguity:

Thus, if we were to say, “extension is not a body,” the term ‘extension’ here is taken in a much different way than above [where it was shown that the concept ‘extension’ contains nothing distinct from the concept ‘body’]. In this [second] meaning, there is no idea that is peculiar to these concepts that corresponds to anything in the imagination [*phantasia*]. On the contrary, what is claimed here is entirely brought about by the pure intellect, which alone has the capacity to separate abstract entities of this sort. This is the source of errors for many who, not realizing that extension taken in this sense cannot be grasped by the imagination [*non posse ab imaginatione comprehendī*], [nonetheless] represent it to themselves as if it were a true idea. (AT X, 444; CSM I, 60)

This passage contains reference to true ideas and particular ideas, the imagination (both as *phantasia* and *imaginatione*) and the pure intellect, but it takes these terms in a much different sense than what we have seen in the *Meditationes*. Here, Descartes is dismissive of those who use the pure intellect to represent merely abstract entities in a way that is then erroneously applied to actual things. By contrast, he advocates considering these

ideas in the imagination as a means of properly grasping the idea. The *Meditationes*, however, are clear that the imagination only grasps figures and that these are derivative of the ideas of the pure intellect.

I believe that the reason for this difference between the two works is that the entire aim of the *Regulae* is to determine a single (mathematical) method that would simultaneously be applied to problems in pure mathematics, arithmetic and geometry, as well as to problems in mixed mathematics, or the natural sciences (mechanics, optics, harmonics, geodesics, astronomy, etc.). This implies a reduction of the objects of mixed mathematics to the objects of pure mathematics. Such a reduction is only possible on the basis of blurring the distinction between pure ideas and imagined figures and conceiving of the latter to be really identical to extended objects. Thus, when the imagination considers the concept 'extension', it cannot help but actually form an extended figure (a thing) and thus cannot understand this concept apart from some really extended object. This is why, I believe, the imagination plays such a prominent role in the *Regulae*, whereas the *Meditationes* is much more careful to distinguish the corporeal nature of the imagination from the incorporeal intellect. The ideas of pure mathematics, in the *Regulae*, are identical to the figures and images depicted in the imagination, and for this reason Descartes supposes them to be directly and unproblematically applied to knowledge of real, physical objects. Descartes' *Meditationes* reflects the underlying doctrine that there is a "real distinction" between the incorporeal faculties of mind, intellect and will, and the corporeal faculties, imagination, memory, and sense perception. There is no doubt that

Descartes' continued reflection on the ontology of mathematics prompts him to make such a distinction. This reflection is a heritage of the *Regulae*, but it is not present there.

Thus, the distinction between ideas of pure mathesis and the figures of geometry appears to be a later development. This distinction would certainly limit the range of the mathesis universalis since that science would not, strictly speaking, be directly informative of questions in natural philosophy. While this consideration restricts the scope of the mathesis universalis in Descartes' later work, it does not diminish its importance. As we have seen, the ideas of pure mathesis are the basis for geometrical representations and the application of these to natural philosophy. Thus, the mathesis universalis determines the principles for any inquiry into geometrical or physical phenomena. Moreover, the way that Descartes conceives of the principles of natural philosophy suggests that the concept of a mathesis universalis motivates his conviction about the nature of the physical world. As we have seen in the *Meditationes*, the physical world, considered in its most general sense, is just the objective correlate of the idea of pure mathesis. In other words, the principles of any natural philosophy must conform to the requirements of the mathesis universalis: that any problem be quantifiable, that the problem express a well defined relation between known and unknown terms, that these terms be represented using symbols and line segments, and that the solution to the problem be either true or false. As a consequence of this deep-seated conviction, Descartes presumes that the physical world has a certain character, specifically, that it is composed completely and only of extended matter with shape, size, and motion as its modes.

However, this reading of the relationship between the *mathesis universalis* and Descartes' natural philosophy does not imply that Descartes' *Regulae* contains his theory of matter. The *Meditationes* shows that Descartes' mature theory of matter, the structure of the physical world, conforms to the principles of a science of pure *mathesis*. That is, the later doctrine is consistent with, but not entailed by the earlier theory. In order to arrive at his mature theory of matter, Descartes would require additional premises. These he will introduce for the first time when he describes the nature of light and the anatomy and function of natural bodies in *Le Monde*. That work will make a distinction between ideas and actual things. In the opening pages of *Le Monde*, Descartes is very careful not to identify light with a real physical action; it is a sentiment or mere perception, "that is, an idea which forms in our imagination by what the mediation of our eyes with the object that produces in us the sentiment, namely, that which in the flame or the sun we call by the name 'light'" (AT XI, 4; CSM I, 81). By the time of *Le Monde*, Descartes has made it clear that our sensations of things are only nominally and causally connected to things in the physical world. These sensations are products of our imagination, which is in causal contact with the physical world. God's providence will underwrite the causal connection between our ideas of things and the things themselves. Yet even when Descartes presents a proof, in the *Discours*, for the existence of a God that could underwrite the causal link between our sensations of things and the things themselves, he is still cautious. There, Descartes' admits that his complete causal account of the physical world depends on a number of suppositions and analogies, which is at least in part why he proposes to talk,

not about the real world, but about “a new world” that God created in some “imaginary spaces” (AT VI, 42; CSM I, 132).

It is important to be clear that at the time of the *Regulae*, Descartes had not yet clearly distinguished between discoveries in mathematics from discoveries in natural philosophy, but this would not have been unusual for a philosopher of mathematics in the sixteenth and early seventeenth centuries. During that time, it was generally believed that the ontology of mixed mathematics could essentially be reduced to pure mathematics; these were both somehow part of a larger *mathesis*. If Descartes thought, as I believe the *Regulae* shows, that the true objects of pure mathematics, i.e., those that could be represented geometrically, were somehow identical to, or accurately represented, the structure of the physical world, then he would have a philosophical justification for why problems in mixed mathematics could be reduced to, or entirely explained by, problems in pure mathematics. For Descartes, as we have seen, solutions to geometrical problems are represented through an accurate construction. His commitment to construction as the standard of geometrical truth is evident in the *Géométrie*, which presents only the constructions and not the analysis. Thus, it may have been quite natural for Descartes to believe that, somehow, the structure of the physical world could be entirely explained through geometrical constructions. In this sense, the *Regulae* implicit holds the promise of “geometricizing” or “making mathematical” all of nature; this is surely one sense in which it relies on a rather grey ontology.

If we want a complete account of the connection between God’s existence, the existence of corporeal substance, and the principles of pure mathesis, we must turn to the

Principia. The first book of the *Principia* begins with a basic skepticism about the accuracy of our perceptions, which isolates the most fundamental principles of Descartes' metaphysics from all of the qualities, forms, and substances that are ordinarily treated in metaphysics. However, the failure of ordinary perception cannot undermine the truths of mathematics. Indeed, in order to doubt the veracity of mathematical knowledge, Descartes invokes the hypothesis of the evil genius, which he admits is a weak and "metaphysical" argument. In turn, this form of hyperbolic doubt enables Descartes to make a further distinction between the pure intellect and other modes of thought. This is why the pure intellect is the essence of that thinking thing that the 'I' am. The independence of the *ego cogito* from everything else, the nature of its ideas, and the way that these ideas prove the existence of God, is the core revelation of the first book of the *Principia*. The second book goes on to treat the existence of the physical world, external to the mind. This physical world, however, exists only as the effect of corporeal substance, i.e., extension in itself. What I want to claim is that, while the actual nature of the physical world remains to be determined, either by hypothesis or by experiment, the notion of the physical world as essentially extend can only be understood on the basis of the ideas of pure mathesis. I believe that this is what the final section of that book means when it describes, in the heading, "the only principles that I accept, or require, in physics are those of geometry and pure mathesis; these principles explain all natural phenomena, and enable us to provide quite certain demonstrations regarding them" (AT VIIIa, 78; CSM I, 247). While the existence of the *res cogitans* and God who creates and sustains it are the two ultimate principles of Descartes' metaphysics, the ideas of pure mathesis are

utterly foundational for the rest of Cartesian science or natural philosophy. These principles govern all of the truths of mathematics and they outline the basic structure of the physical universe such that it is tractable through Descartes' scientific method. That the external world can be so clearly and definitively distinguished from the mind in Descartes' metaphysics, is a consequence of the fact that Descartes recognizes the principles that provide an explanation of the natural world to be *products* of the mind, they are *ideas of pure mathesis*.

Descartes' Epistemology of the *Regulae*: Ourselves the Knowing Subjects

In the preceding chapters, I have been developing an interpretation of the *Regulae* that establishes, to summarize, three principle claims: (1) the *Regulae* is a coherent work devoted to the question of what method to apply in natural philosophy; (2) the essence of the method is described by a workable technique applied to certain kinds of problems (the technique is algebraic--called the *mathesis universalis*--and the kind of problems it treats are those that admit of order and measure—which Descartes thought to encompass all problems in natural philosophy); and (3) the method, thus construed, is intimately and essentially correlated with a certain concept of mind and a certain epistemology. We have already had some hints as to what this epistemological outlook is. The primary result of the *mathesis universalis* is to put forth a research program on the working hypothesis that problems in natural philosophy will be most productively addressed if they are conceived in a way that can be treated mathematically. That is, Descartes explicitly restricts his investigations to what can be known for certain, and thus he abstracts all objects of knowledge from their place in the order of nature so that they conform to the order and measure of human intellection. Implicit in this program of research is an assumption about the nature of human knowledge, especially its limitations with respect to conceiving complex things. However, this hypothesis also had a powerful ancillary effect on Descartes, inclining him to characterize all matter in a certain way, i.e., to see the subject matter of natural philosophy or the basic constitution of the physical world as essentially corpuscular.

In this chapter, I will be more specific about the epistemological background behind the method of the *Regulae*, by focusing on Descartes' account of perceptual cognition in the first half of Rule XII. That rule treats two principle issues: "ourselves the knowing subjects" and "the things which are the objects of knowledge" (AT X, 411; CSM I, 39). The final chapter will address the objects of knowledge, or the proto-metaphysics of the *Regulae*. In this chapter, I will focus on 'ourselves the knowing subjects'. I will do so by focusing on what I am calling Descartes' theory of perceptual cognition. What I mean by that phrase is that Descartes' account in Rule XII is essentially an account of the process of cognition in its most basic form, i.e., when a subject cognizes or perceives an external physical object. This theory will exercise an important influence on Descartes' method and the justification for that method. In this way, Descartes' theory of perception is an epistemologically motivated theory. The importance and novelty of this epistemological theory will best be understood by comparing it to the historical background directly preceding the composition of the *Regulae*. Indeed, late scholastic theories of cognition have become a source of much attention in contemporary scholarship. Though there is no need to claim that Descartes was aware of all of the intricacies of the scholastic theories that I am discussing, I think it is fair to say that he had a much better grasp of those theories than today's philosopher. I indulge in this topic because I think it will help inform our reading of the *Regulae*.

Nonetheless, it seems clear to me that Descartes' discussion in at least the first part of Rule XII is indexed against Aristotle's discussion of the nature of the soul and perception in Books II and III of the *De Anima*, since the sets of issues in each of the

texts largely correlate. In those texts, Aristotle distinguishes the various powers or faculties of the soul, especially distinguishing those that are purely concerned with the conservation of life and those that are concerned with sensation and appetite from the pure intellect. When Descartes addresses these same problems, he emphasizes this latter distinction, ignoring the former. For Descartes, both sensation and the basic processes of life can be explained by appealing to physical-mechanical models. In his account of the physiology of perception, Descartes relies on his knowledge of optics and the anatomical structure of the human eye. However, when he turns to the essence of thought, the pure intellect, or power of cognition (*vis cognoscens*), he resolutely denies that it can be explained by mechanics. This bifurcation between intellectual cognition and sensory perception mirrors the deep and enduring dualism of mind and body for which Descartes is famous. In some ways, this chapter will be most directly relevant to the issues commonly considered when one examines Descartes' concept of mind.

Moreover, there are important connections between the accounts of cognition and the basic metaphysics of both the Aristotelian tradition and Descartes. These connections can be understood in light of the familiar epistemological questions: What are the causes of our knowledge? How can we justify that our knowledge of things is as we believe it to be? And what is the nature of cognition? These questions involve basic presuppositions concerning causality, the nature of explanation, and the true referents of our perceptual and cognitive beliefs. I will elaborate on what I take to be the central issues in this regard: the nature of cognition (divided into sensory perception and pure intellection), the nature of the distinction between sensation and intellection, the causes or sources of cognition,

and a justification for the veracity of ordinary cognition. It is not surprising that the later scholastics were heavily invested in debates on just these topics; in fact, scholastic positions on these topics are varied and contentious. I hope to show that Descartes is well within the bounds of scholastic debate on these issues. He does not ignore the central concerns of previous philosophers; nor is his break from the tradition without precedent. Yet, his engagement with these issues is characteristically Cartesian.

Finally, this discussion will be integral to providing a complete interpretation of the *Regulae*. Indeed, it is utterly essential to understanding Descartes' discussion of method in the *Regulae* that one understand it as a method suited to and appropriate for an immaterial mind interacting with material sense-organs in a material universe. The scientific account of sense perception in Rule XII explains the nature of the various corporeal faculties of the intellect—including also imagination and memory. These faculties play an indispensable role in the exercise of the method itself. Unfortunately, Descartes' description of these faculties, as with the entire discussion of cognition, is very brief in Rule XII. However, there are a number of passages throughout the *Regulae* that can further illuminate Descartes' thought concerning each of these faculties. In particular, I will claim (1) that Descartes' method relies on his understanding of the physiological properties of the cognitive faculties and (2) that his basic physical hypotheses (his supposed principles of explanation) are chosen precisely because he believes they can be easily comprehended by these faculties. In both ways, Descartes' physical description of cognition is correlated with his presuppositions about the way a unified immaterial mind intimately interacts with corporeal faculties of sensation and

imagination. Descartes refers to the pure intellect as a pure cognitive power (*vis cognoscens*). When this cognitive power produces new ideas, or interacts with the corporeal organs of the body in some way, Descartes says that its proper name is the *ingenium* (AT X, 416; CSM I, 42). Thus, he clearly indicates that it is the direction of this power, i.e., the application of the pure intellect to the corporeal faculties, with which the *Regulae* is concerned. I take this to refer back to the first Rule of the treatise such that training the *ingenium* cultivates human wisdom, while the spiritual cognitive power provides the “natural light” by which all the sciences are known. In short, this purely spiritual power and its consequent interaction with the corporeal faculties of cognition, though only briefly mentioned, surely underwrites the entire project of the *Regulae*.

An Aristotelian/Thomistic theory of perceptual cognition

This section will address the predominant theory of perceptual cognition in the late scholastic period. It is a general Aristotelian account, largely following the interpretation of Aristotle’s theory of cognition by St. Thomas Aquinas. While I do not pretend to address the wide variety of viewpoints on these issues, I think that restricting our account to a general Thomistic-Aristotelian account is nonetheless justified. Indeed, I think that this most closely corresponds to the kind of account Descartes is responding to in the first half of Rule XII in the *Regulae*, and one with which he would have been familiar from his schooling at La Flèche. The central issue in the theory of perceptual cognition is the nature of the rational soul’s involvement in the normal sensory activity of

the body. A theory of perceptual cognition is, uniquely, an analysis of human cognition, since perceptual cognition is the kind of cognition that is peculiar to human beings. For the scholastics, no other being has both an intellect and sensory faculties, or a rational and sensitive soul as these functions were called. Thus, the way that these faculties interact in perceptual cognition is peculiar to human existence and the nature of the human soul. Perceptual cognition highlights the role of the intellect in perception, which is our principle interest when approaching the epistemological account in Descartes' *Regulae*. In this section, I will focus on the sensory aspect of perceptual cognition. However, there is a certain sense in which these processes cannot be entirely separated from the work of the pure intellect in its more abstract cognition of things. Strictly speaking, perceptual cognition cuts across both domains, but for the purposes of exposition I treat sensation first, then intellection.

In recent years, interest in Aristotelian psychology has been revived, partly due to the success of functionalism as a research program in philosophy of mind and partly in an effort to reintegrate the mind and body in a meaningful way.³⁰⁷ The tradition of faculty psychology, on which the intuitions of the functionalist program are based, was largely derived from Aristotelian psychology. Faculties, or powers, can be conceived of in terms of their functional outputs or their operations within a mental system.³⁰⁸ However, the extent to which this philosophy of mind can be called Aristotelian has been challenged—

³⁰⁷ See M. C. Nussbaum, *De Motu Animalium: Text, Translation, and Commentary* (Princeton: Princeton University Press, 1978) and M. Nussbaum and H. Putnam, "Changing Aristotle's Mind" in *Essays on Aristotle's De Anima*, 27-56.

³⁰⁸ See Jerry Fodor, *The Modularity of Mind*.

and I think rightly so—by Myles Burnyeat.³⁰⁹ This criticism has been influential even though proponents of the view have tried to counter it. What is instructive about this debate for the present analysis is that it hinges on a distinction between the metaphysical bases of Aristotelian psychology and our contemporary metaphysical assumptions. In particular, Burnyeat highlights the sense in which Aristotle’s theory of matter, particularly the disposition of matter to receive a form, does not sit well with the contemporary theory of matter governing research in the cognitive neurosciences or in philosophy of mind. Burnyeat puts it this way: “... the failure of the functionalist interpretation of Aristotle is bound up with the fact that Aristotle has what is for us a deeply alien conception of the physical.”³¹⁰ In particular, Aristotle conceives of perceptual cognition as a kind of alteration, whereby an organ of sense receives the form of the object of cognition. I will discuss at length this idea of “receiving the form,” but for now suffice it to say that this amounts to the actualization of a capacity or disposition in the sense organ in the same way as, for instance, a person fluent in a language uses the grammar of that language.³¹¹ According to this explanation, physical facts only determine the necessary conditions for perception or cognition. While scholastic philosophers often concede that the sensory organs must be undamaged or otherwise unimpeded in their perception of the objects, these physical facts about the status of the sense organs and their relation to the objects of sense do not provide sufficient conditions for cognition.

³⁰⁹ “Is an Aristotelian Philosophy of Mind still credible? (A draft)” in *Essays on Aristotle’s De Anima*.

³¹⁰ Ibid 26.

³¹¹ This is how I interpret a classical Aristotelian example cited by Burnyeat, *ibid.* 19. He differentiates this kind of alteration from the other kind of alteration whereby the subject receives a wholly new quality, e.g., the ungrammatical human being acquires grammar.

Instead, the intrinsic capacities of perception in the soul, actualized by the presence of a perceived object, determine the nature of perception. As we will see, clarifying those capacities and their conditions of actualization requires a much more complex and ordered metaphysical picture than the contemporary philosopher is usually willing to countenance.

By contrast, Descartes' theory of matter, and consequently his account of perception, which we have seen is fundamentally determined by its adaptability to the *mathesis universalis*, is much more congenial to a contemporary understanding. According to this account, physical facts provide the necessary and sufficient conditions for every physical or material change in the process of perception. In other words, according to a Cartesian natural philosophy, one could provide a complete story about my seeing red through a physical account of reflection of light off the object and the reception of the rays of light in the retina, the transmission of that information along the optic nerve, etc. However, to be more precise, while my seeing red can be explained completely through physical mechanisms, the fact that it is 'red' that I see (what we would call a red color quale) cannot be explained physically. For Descartes, the specifically phenomenal character of perception is purely intellectual. While the physical or material story of perception is completely reductive (i.e., explained by appeal to underlying mechanical forces), the fact of perception, or what it feels like to be a perceiver, is set apart.

The explanation of perceptual qualia in terms of any kind of completely physical, or materialist, universe remains a contested issue today. This is the "hard problem of

consciousness.”³¹² Contemporary attempts to resolve to the problem of qualia perception appeal to the categorical bases of modern physics—including a description of light as spectral reflectance patterns of electromagnetic radiation, involving things like fields, forces, the transmissions of electron packets, and the corresponding acceptance of voided space—that are nothing like the bases of a Cartesian explanation of the same phenomenon.³¹³ Nonetheless, there is a much greater philosophical similarity between Cartesian science and contemporary science, particularly the commitment of each to viewing the physical world as composed of entities that can be modeled by mathematics. I think that it is principally for this reason that Descartes’ psychology appears to be so much more at odds with the views of contemporary philosophers. Indeed, the fact that Descartes has a seemingly complete physical and scientific account of the natural world leaves many utterly puzzled as to why he insists on the immateriality of the pure intellect and intellectual acts, such as perception.

Conversely, while the epistemological implications of a theory of cognition are apparent in Descartes, this is less clear for the late scholastics. Indeed, it is difficult to distinguish a discrete field in scholastic philosophy that would correspond to our contemporary questions of epistemology.³¹⁴ Our epistemological questions are typically motivated by responding to the challenge of skepticism with an adequate justification or explanation of why our beliefs are true. Thus, justified true belief answers the question:

³¹² David Chalmers, “Facing Up to the Problem of Consciousness,” *Journal of Consciousness Studies* 2 (3), 1995, pp. 200-219.

³¹³ See R. Pasnau, “The Event of Color,” or G. Hatfield, “The Reality of Qualia,” for two different, clear-sighted approaches to a contemporary theory of color perception.

³¹⁴ Robert Pasnau, *Theories of Cognition in the Later Middle Ages*, 6, makes this point.

what is knowledge? For the Latin medievals, however, knowledge is *scientia*, which was normally divided into various domains (metaphysics, physics, mathematics, ethics, rhetoric, etc.) and, for each domain, propositions that could be counted as known are those that could be demonstrated. Thus, *scientia* actually meant “demonstrative understanding,” where the syllogism was the vehicle of demonstration. One of the features of this emphasis was the development of an elaborate syllogistic logic and rules of inference designed to verify that given conclusions actually follow from given premises. As we have seen in the last chapter, one of the components that seemed to get lost in this pursuit of demonstrative understanding was the art of “finding the middle term” or analysis as it was sometimes called. Descartes saw an answer to the search for an analytic method, or a method of discovery, in the new science of algebra. Consequently, he harnessed this mathematical technique for the purposes of physical explanation and happily discarded the scholastic syllogism.

Beyond this, there is another important facet of this medieval notion of *scientia* that has been intimated above but ought to be explained. For Aristotelians, every demonstration, in order to demonstrate, must do so according to some underlying genus. For example, Aristotle rejects the idea that premises from arithmetic could be used to demonstrate conclusions in geometry.³¹⁵ Likewise, one would suppose, premises from physics should not be able to provide demonstrations for conclusions in ethics. More specifically still, Aristotelians would reject the idea that premises from mechanics or from the science of human art, could demonstrate anything about the nature of the soul,

³¹⁵ This is the problem of *metabasis eis allos genos*, Pos An ii: 7

or workings of living organisms. Here, I think, is a very clear example that illuminates why the Aristotelian framework is wholly unsuitable for a functionalist theory of mind and, similarly, why the Aristotelian concept of explanation differs radically from the Cartesian one. For the functionalist, mechanical and particularly computer models are essential to the process of defining and explaining psychological functions. Likewise, Descartes' account of perception is informed by mechanical models of the sense organs. These mechanical models play an indispensable role in the account of cognition and they provide a fundamental reason why Descartes' theory of cognition diverged so radically from prior theories.

Despite these rather significant differences, the historical excursion into scholastic theories of cognition will not be merely an exercise in erudition. Rather, it will frame the set of issues that I hope my account of Rule XII will address. In order for me to claim that Descartes provides a radically new and complete theory of cognition, I will need to show that his theory still responds to the chief issues that the older theories addressed. So, it is with this aim that I outline those theories.

Perception

I will attempt to develop this historical account in two stages: first to explain the nature of perception, and then to explain the nature of cognition proper. As I have suggested above, these two aspects of perceptual cognition can only be separated conceptually. In real terms, the whole process takes place in a unified, single act. I see a

green leaf and I immediately attribute ‘green’ to the ‘leaf’, a predicative action that requires cognition above and beyond mere color perception. Nonetheless, there are important distinctions that can be made between the process of perception, strictly speaking, and the process of cognition. In particular, the cognitive component requires a peculiar sort of cognitive activity, called abstraction. First, I will explain how the process of perception occurs on the level of the sense organs and the internal senses. Then I will turn to the more properly cognitive operation of abstraction and intellection. The distinction between perception and cognition had important consequences for how the late scholastics conceived of the separability of the mind. In the final section, I will introduce some implications for mind-body dualism by turning to these accounts.

Perception as alteration

On the standard Aristotelian view, the process of perceptual cognition is conceived to be a kind of affection or alteration. In order for a thing to be altered, according to the Aristotelian method of explanation, it must receive a form from some agent, which is the efficient cause of alteration. The efficient cause is distinguished from the underlying material that constitutes the thing, which remains the same through the process of alteration. For example, if I take a pot of cold tap water and heat it, I have introduced the form of heat to the material element water through the agency of the gas flame on my stovetop. As the water heats up, it loses the form of coldness that it originally possessed and acquires the form of heat. Moreover, in order for the alteration to occur, water must have the capacity or potential to receive the form of heat. We might

say that water is a fairly good conductor of heat (it has a high potential to receive the form of heat), unlike, for instance, clay, which is slow to receive heat and doesn't change its form dramatically under normal heating conditions.

Likewise, it is important to distinguish in what way the intellect and the sensory faculties have the potential to be altered by external objects and in what way they are actually altered. Aristotle outlines the intellect's capacity to receive the forms of things in the following way:

Within the soul the faculties of knowledge and sensation are potentially these objects, the one what is knowable, the other what is sensible. They must be either the things themselves or their forms. The former alternative is of course impossible: it is not the stone which is present in the soul but its form. It follows that the soul is analogous to the hand; for as the hand is a tool of tools, so thought is the form of forms and sense the form of sensible things.³¹⁶

Here, Aristotle recognizes that intellection and perception are unique kinds of alteration since the form of the intellect or the sensory faculties are not destroyed by the alteration. This is not to say that under certain circumstances, say, long exposure to very loud noises or very bright lights might not result in some substantial change in the sense organ. Indeed, Aristotle cites this fact to argue for a distinction between the pure intellect and the physical organs of sense.³¹⁷ The point is simply that in the course of ordinary perception, the sense organs receive the forms of things without thereby altering their capacity to receive other sensible forms. Even though the senses or the intellect grasp the nature of material things—they actually receive or become the form of the thing—the form of the thing does not alter their form. This is the sense of the analogy to the hand as

³¹⁶ *De Anima* 3: 8, 431b 24-432a 3; cf. 429a 13-17.

³¹⁷ *Ibid.*: 4, 429a 29-429b 5.

a tool of tools. The hand grasps the form of a thing without becoming that form. It is altered without losing its own form as a result of the alteration. Indeed, we will see that cognitive powers capable of grasping a greater diversity of content are higher or nobler than those that are restricted in some way. The hand's status as a tool of tools gives it a certain prominence and mastery over all other tools. Indeed, one of the main reasons for the dignity of the rational soul is its unrestricted capacity to understand anything whatsoever.³¹⁸ This is tied, in important ways, to the rational soul's immateriality and hence immortality. We will have a chance to address this connection in the following sections of the chapter.

One may still wonder how this alteration without substantial change (without a destruction of the previously existing form) is possible. It seems that the senses and the intellect must both receive and yet not receive the things cognized. This view of alteration is underwritten by the presence of forms in the soul in a purely immaterial way, i.e., as a "form without matter." That is to say that the alteration involves the acquisition of an immaterial form, one that has a different kind of existence than forms usually have when they inhere in material things. In common scholastic terminology, we would say that the form grasped by the intellect has "intentional existence" as a "species."³¹⁹ But what is a species, how is it like or unlike its object, and how is it received in the intellect?

³¹⁸ Brentano, *The Psychology of Aristotle*, 45, makes this point by contrasting the sensitive and intellective souls with the vegetative soul. The latter "has received from nature the principles of its activity in a fully actualized form," while the former are blank slates, but they have the capacity to possess all sensory and intellectual forms. In this sense, the sensitive and intellective souls are clearly better off, and higher, for their greater potential than the vegetative soul.

³¹⁹ See Alison Simmons, "Explaining Sense Perception: A Scholastic Challenge."

From the idea that species are the intelligible forms of things, we should not think of them as purely abstract or purely mental. For Aristotle, the impressions in the sensory organs are “without matter,” yet the sensory faculties perceive the actually existing external object, which is a combination of matter and form, a concrete, individual entity. So, the sensible species are without matter in the sense of having a universal, or abstract, mental content. But neither are species merely mental objects. Rather, they are the forms of objects, as cognizable. The following text from Aristotle indicates what he has in mind when he says that the sensible form is “without matter”:

Generally, about all perception, we can say that a sense is what has the power of receiving into itself the sensible forms of things without the matter, in the way in which a piece of wax takes on the impression of a signet-ring without the iron or gold; what produces the impression is a signet of bronze or gold, but not *qua* bronze or gold: in a similar way the sense is affected by what is coloured or flavoured or sounding not insofar as each is what it is, but insofar as it is of such and such a sort and according to its form.³²⁰

What is clear from this text is that sense perception involves the reception of some information about the object sensed without actually acquiring the object or undergoing any physical change (unlike the case of cold water that is heated). Here, Aristotle distinguishes the object *qua* sensible form from the object *qua* this matter. It is useful to highlight the phrase, “not insofar as each is what it is,” because this phrase picks out the peculiar individual nature of the object of perception. For Aristotle, it is the material element that individuates the thing. But the sensible species does not contain any matter. So the sensible species does not contain the thing insofar as it is what it is, but only insofar as it possesses a certain form, i.e., insofar as it is of “such and such a sort.”

³²⁰ *De Anima* 2: 12, 424a 18-23. I do not pretend that this passage is obvious or straightforward, but it is Aristotle’s clearest explanation of what he means by forms without matter.

To provide a more technical definition, we can think of the form or species (following the Latin terminology) as a configuration that encodes information that is isomorphic to an aspect of the object without that information being encoded in the same way as it is in the object. With this definition, I am imagining something like the blueprint that encodes the form of a building, or the electronic bits of data on my hard drive that encode the form of this chapter.³²¹ These systems encode information that is identical in form to the thing they represent (either the building or the document). Indeed, it is by virtue of each that we can reproduce the object in question—and, if the encoded data is specific enough, we can reproduce it *exactly* as it is. However, each encodes that information in an utterly different way: the blueprint is not made out of brick and mortar and the hard drive does not contain any words. We ought to think of the sensible (or intelligible) species or form in the same way. We will explore whether or not this interpretation allows for the intellect to be in contact with singular entities, or the essence of a specific thing, in the last chapter. For the moment, I acknowledge that Aristotle's claim that the senses perceive a thing "insofar as it is of such and such a sort" may provoke one to question whether the senses actually perceive singular things, or if instead they perceive things *as* sortal kinds. In any case, we have at least ruled out the possibility that the intellect undergoes any substantial change as a result of perception. It receives the form of the thing, but in a different way than that form exists in the thing itself.

³²¹ Much of this language is borrowed from E. Stump, "The Mechanisms of Cognition: Ockham on Mediating Species," in *The Cambridge Companion to Ockham*, 170-75.

External senses and the sensible species

Given this explanation, we may still wonder by what mechanism the senses or the intellect receive the forms of objects? The standard account that developed through the Arabic commentators, Albert the Great, and Thomas Aquinas held that the vehicles of sensory and mental content are species, but in three different senses, each of which serves a unique purpose in the entire process of perceptual cognition. The species that are received in the senses are called the sensible species. However, the sense organs are often not immediately affected by objects. Many of our senses (sight, hearing, and smell in all cases) act through some medium (air and water are the usual suspects). Thus, in order to account for the reception of a sensible species—in order for the sense organ to be moved or altered by the object—philosophers needed to posit the existence of species *in medio*, which could transmit the form of the object to the sensory faculty. Aristotle goes even further to suggest that an intermediary species is necessary for perception by claiming that if the object of sight were immediately in contact with the eye, it would not be visible; he even claims that this is true for each of the senses, but does not elaborate how.³²² I will set these issues aside for the moment and simply claim, along with Aristotle, that all sense perception occurs through some species *in medio*. Finally, the species received in the intellect is called the intelligible species, and these are truly abstract. The formation of intelligible species requires an additional, causal process called “abstraction,” which strips the sensible species of its particular content. I will briefly mention the role of the species *in medio*, and I will spend the rest of this section talking

³²² See *ibid.* 2: 7, 419a 12-21.

about the different forms the sensible species take in the process of cognition. The next section will treat the production of the intelligible species in the intellect.

The idea that there are species *in medio* tends to elicit a number of objections. For example, it is often wondered whether the air is colored by the intervening species, or why the species *in medio* do not violate the principle of non-contradiction (that two contraries cannot be attributed of the same subject at the same time), as when I see your white shirt and you see my black shirt through the same intervening air.³²³ Another problem is suggested by the fact that the intellect knows by possessing the species, but air also possesses species, so does air know as well?³²⁴ However, by far the greatest problem for the entire species theory—and the species *in medio* tend to highlight this problem—is the natural conclusion that the senses or intellect only know objects by virtue of some intermediary. It is clear that Aristotle and Aquinas thought that perceptual cognition was cognition of the object, not of some internal or intermediary likeness of the object. Yet, the species is the intermediary cause of perceptual cognition. So, it would seem that, indeed, the species is known first and the object only by means of being represented by the species. In particular, the notion that perception requires the transmission of species *in medio*, through the air to the sense organs, seems to highlight the absurdities of the theory.³²⁵

However, this need not be the conclusion we reach. Indeed, we ought not think of the species as “little images flitting through the air”—even though Descartes himself

³²³ The example comes from A. Simmons, “Explaining Sense Perception.”

³²⁴ See Pasnau, *Theories of Cognition*, 49-52.

³²⁵ See Pasnau, *Theories of Cognition*, 11-17 and Ch. 6, where he defends Aquinas against a representationalist theory of perceptual cognition.

accused the Aristotelians of just such an idea (AT VI, 121). We ought to think of the process of perception, instead, as a process that happens *through* or *by means of* the species. What the species express is simply the unique character that sensible objects have when they are perceived, the external objects *qua* phenomenal objects of experience we might say. This is the sense of their representational character and the reason, following Scotus, they were understood to present the object *sub ratione cogniscibilis seu repraesentati*, and were said to have an *esse cognitum*.³²⁶ Thus, the intentional species ought not to be understood as the objects of cognition, as if they were entities distinct from the objects themselves. Rather, the intentional species simply are the (qualities of) objects *as* cognizable. Alison Simmons puts this nicely when she says that the intentional species are corporeal, yet they are strictly speaking imperceptible. The reason why is that what one sees, when one sees intentional species, are simply the things themselves. We can understand this to be the case by virtue of the fact that the species have no independent, material existence; they depend on the object for their existence, and they do not change the quality of the medium in which they appear.³²⁷ I think this is also the sense of Robert Pasnau's claim that we perceive "through the species and to the world." The idea seems to be that the species are not the object of our judgments and beliefs about the world, but the transparent means by which we are capable of forming judgments and beliefs about the world.³²⁸

³²⁶ On Scotus, see Pasnau, *Theories of Cognition*, 289-90; Antonio Rubio characterizes them similarly, see Simmons, "Explaining Sense Perception," 265-66.

³²⁷ Simmons, "Explaining Sense Perception," 264-65.

³²⁸ Pasnau, *Theories of Cognition*, 213-19.

In this way, the intentional species *in medio* first inform our sensory faculties, which interact directly with the world by being in direct physical contact with the intervening medium between the perceiver and objects. The sensory and intellective powers are distinguished by their various capacities to receive different kinds of species. In particular, each of the sense modalities is distinguished by the limited capacities of the physical organs of sense. In short, this is what makes the intellect different from the sensory faculties: it is unhindered by its physical or material disposition, and is thus capable of grasping any object whatsoever. By contrast, each sensory faculty is individuated according to the sensible objects that it is capable of perceiving: auditory, visual, olfactory, tactile, and gustatory. These five sense modalities, called the ‘external senses’, each has its proper object of sense: sound, color, smell, texture, and taste, respectively. It is impossible for the sense of sight to hear sounds, except *per accidens*. That is, sight can see an object that is making sounds, say, a drum, but not *qua* auditory species. These proper objects of sense or proper sensibles are distinguished from the ‘common sensibles’, which can be sensed by more than one sense modality. The characteristic examples of common sensibles are movement, rest, number, figure or shape, and magnitude or size. There is an analogy between this distinction and the more common modern distinction between ‘secondary qualities’ and ‘primary qualities’ that I will pass over (more on this in the final chapter). For now, I simply want to take note of the fact that sensible qualities are distinguished by the sensory modality with which they are sensed. The reason for this is because each sensory faculty has the capacity to receive only those forms that are suited to it. This is why the external senses are the lowest form

of cognition in the process of perception; they have limited powers of perception and can receive only certain kinds of species. Nonetheless, they play an indispensable role since they provide our initial contact with external objects.

Internal senses and the phantasms

Because of these deficiencies in the external senses, there are reasons to posit higher faculties that unify sensible experience and give perceptual content a greater generality. I have already mentioned the common sensibles, which are perceived through multiple sensory modalities and suggest a sensory faculty capable of representing objects across sense modalities. In addition to this evidence, there are two principle motivations for positing the existence of some unifying internal sensory faculties. First, Aristotle notes that, aside from the senses themselves, there is an inner awareness of sensation, a sense of sensing. Though there is some truth to this idea, he thinks it will not get us anywhere. If we posit a faculty of sense for the awareness of each sensation, then there is a threat of infinite regress. Additionally, since Aristotle understands sensation as an affection of the sensory faculty (and thus that actual sensation is identical to its object), he must hold that there is no further activity of awareness beyond this. In other words, what is sensed, in the way that it is sensed, lies in the subject sensing. This leads to the second motivation. Consider the case of the sweet thing that is also white, say, sugar. It is obvious that we have an awareness of the sugar as being both white and sweet, yet we recognize that the sugar's being white is not the same as the sugar's being sweet. We might then wonder what sense is capable of discriminating the sweet from the white?

Neither taste nor sight can do the work necessary, since sight cannot perceive what is sweet (except *per accidens*) and likewise for taste in regard to what is white.³²⁹ These two examples point to a secondary faculty (or genus of faculties) of sense that enables one to discriminate among the five senses and their objects.

For these reasons, it is supposed that there are ‘internal senses’ that do the work of discriminating objects that are diversely characterized by the sensory faculties. When Aquinas introduces this notion, however, the primary argument for the nature and existence of the internal senses is neither of the two above, but a third argument, based on our capacity to perceive and represent objects of sense in their absence. It occurs to me that this argument is different from the two others an important way. To illustrate: a naive, non-representational realist (in the contemporary sense) could argue against the supposition of the internal senses in the way they are defended above. The realist would object that we recognize the sugar to be both white and sweet because that’s just what sugar *is*. Thus, the work of unifying and discriminating from among the proper objects of sense falls to the nature of things themselves which we readily and immediately perceive in ordinary perception. However, this objection seems to have less force in light of our capacity to represent objects of sense in their absence. Indeed, the idea that we normally represent things that are not present before us is closely related to the problem of perceptual illusion, i.e., our capacity to be deceived about the existence or nature of objects present to our senses under ordinary circumstances. In both cases, we represent to ourselves an object that is not there (either taking it not to be there, or mistakenly taking

³²⁹ *De Anima* iii: 2. Cf. Brentano, *The Psychology of Aristotle*, 58-65.

it to be there). This is commonly cited as a motivation behind the position of representationalism, i.e., the doctrine that some or all of our perceptions are mediated by some representational content.³³⁰ In fact, the Latin term *repraesentare* comes from the Latin translations of Avicenna, who used the term to refer to the mental content of the internal senses. Latin commentators came to conceive of the concept in terms of internal representation.³³¹

In the *Summa Theologica* Ia: 70, Thomas Aquinas addresses the nature of internal senses by acknowledging a familiar kind of Aristotelian principle of parsimony: “since nature does not lack whatever is necessary” [*cum natura non deficiat in necessariis*]. More generally, the principle is often articulated as: ‘nature does not make anything without a purpose’. Indeed, it is by virtue of the purpose or function that things are known. If there are internal senses, these will be made apparent by referring to their function in the process of cognition; if we must invoke diverse functions to explain the process, then there must be diverse faculties or powers to perform those functions. So, from the apparent necessity for animals, especially higher animals, to perform actions on

³³⁰ I do not want to make the claim that Aquinas is a representationalist; all I want to claim is that someone who holds a representationalist theory of perception may be attracted to the doctrine of the internal senses. See Pasnau, *Theories of Cognition*, 195-219, for an argument against a representationalist reading of Aquinas’ theory of perceptual cognition. My arguments here are heavily indebted to Pasnau. However, it is important to note that the target of Pasnau’s critique is a proponent of the view that the *sensible species* are the mediating content between the perceiver and the external object of sense. Here, I am not claiming that the sensible species are the carriers of representational content. Rather, I claim that the images produced by the imagination (or the internal senses more generally) are the vehicles of representational content. Thus, in cases of direct perception, these can be utterly transparent and one can come very close to a kind of direct realism. However, in the case of absent objects of representation, the account seems weighted in favor of representationalism.

³³¹ Lagerlund, *Stanford Encyclopedia of Philosophy*, “Mental Representation in Medieval Philosophy” (2004). He notes the close connection between *repraesentare* or *repraesentio* to *phantasia* and cites Quintilian as one ancient source of the concept.

the basis of objects that are not present to them, Aquinas infers the presence of some faculty to retain and preserve the images of those things.³³² In this explanation, it is particularly worth noting that Aquinas appeals to the nature of higher animals, which is “that they are moved by a succession of motions” [*quae moventur motu processivo*]. The idea here is that higher animals clearly display the capacity to carry out a sequence of activities intended to bring about a particular result. Moreover, there is a kind of complexity that is apparent in the action of animals, for instance, when the sheep flees from a wolf. In this case, the sheep needs not only to perceive the sensory qualities of the wolf, and to perceive the pleasure or displeasure that these qualities give to the senses, but also to perceive the wolf as threatening. The wolf’s threat is not easily reduced to or explained by particular sensory qualities of the wolf. “It is necessary,” Aquinas concludes, “that the animal perceives in this way by virtue of ‘intentions’, which are not perceivable by the external senses.”³³³ Here Aquinas invokes the technical term, ‘intentions’, in order to describe the kind of abstract cognition that is available to the internal senses (and thus particularly apparent in higher animals for whom these senses are well developed), as distinct from what is present to the external senses.

With this idea in mind, we can now flesh out the nature of each of the internal senses. Though Averroes held that there were five internal senses, Aquinas does not distinguish *imaginatio* from *phantasia*. In either case, the internal senses together are

³³² “... cuius contrarium apparet maxime in animalibus perfectis, quae moventur motu processivo; moventur enim ad aliquid absens apprehensum. Oportet ergo quod animal per animam sensitivam non solum recipiat species sensibilium, cum praesentialiter immutatur ab eis; sed etiam eas retineat et conservet.” *STI*. 78 4 co.

³³³ Necessarium est ergo animali quod percipiat huiusmodi intentiones, quas non percipit sensus exterior. *Ibid*.

conceived as a genus of sensory faculty that is more complex (and thus nobler) than the external senses. This genus can be divided into the four internal senses along the lines of the following square of opposition:

	[sensible species]	[complex intentions]
[perceives]	common sense	estimative power
[retains]	imagination or phantasy	memory

Along the vertical side, I differentiate between the perceiving and retaining faculties. In this respect, Aquinas calls both the imagination and memory a “*thesaurus*,” i.e., a storehouse or treasure-trove. In contrast, presumably, the other two faculties receive information from the external senses, but do not preserve this information. Thus, along the horizontal side, I distinguish between the types of information that the internal senses receive: either sensible species or complex intentions. Now, there is a sense in which all sensible or intelligible species are “intentional,” i.e., they do not have any material existence, but only have the kind of existence available to cognition. This is to conceive of intentionality in just the way that Brentano speaks of the “intentional inexistence” of mental content, i.e., something is intentional just in case it is intelligible.³³⁴ And it also serves to differentiate the level of complexity of the sensible species from the level of raw sense data. Thus, any sensible quality, whether the object of one of the external senses or the internal senses, is intelligibly constituted, and thus intentional, in this minimal sense. What differentiates the *intentiones* of the estimative power and the memory is that these intentions refer to aspects, properties, or things themselves that are

³³⁴ Franz Brentano, *Psychology from an Empirical Standpoint*. Trans. by A.C. Rancurello et al. London: 1973, p. 88.

only inferentially apparent. That a wolf appears frightening to a sheep is by virtue of some inference on the part of the sheep, some calculation based on a number of perceived qualities or perhaps prior experience and training. Toletus is quite good on this, calling the ‘intentions’ of the estimative power *intentiones non sensatas*, and he refers this faculty to a kind of cognition as opposed to a kind of sensation.³³⁵ In the *De Anima* commentary, Aquinas also refers to the capacity of the bird to apprehend its young either by its voice or by its appearance, which implies a complex intentional association between different sensory modes of presentation of the object.³³⁶ Thus, the Thomists would conclude that certain higher animals have the capacity to display inferential calculations that exceed the information given from the powers of sensation.

All of these processes are cognitive, in Aquinas’ sense, because at every level—raw sensation, external senses, and internal senses—the powers of the creature receive the forms of things. The capacity to receive forms is the sole criterion of cognition, for Aquinas.³³⁷ This is important because Aquinas offers a view of each of the powers of cognition such that there is continuity among the different kinds of cognition. This is the reason why Pasnau calls Aquinas’ view of cognition “semimaterialism”:

A semimaterialist is anyone who believes that cognition is possible in material things. The term marks what strikes me as an important distinction in theories of mind and cognition. On the one hand, one can reject materialism in the case of humans and further claim that no material thing can be cognizant. Or one can

³³⁵ *Commentarii in de Anima* III, c. 3, txt. 162, q. 6, 3: 126a.

³³⁶ *In de Anima* II: l. 13, n. 15.

³³⁷ “... cognoscentia a non cognoscentibus in hoc distinguuntur, quia non cognoscentia nihil habent nisi formam suam tantum; sed cognoscens natum est habere formam etiam rei alterius, nam species cogniti est in cognoscente.” *ST*Ia, 14. co; quoted in Pasnau, *Theories of Cognition*, 32.

reject materialism in the case of humans yet think that some material things could be (or are) cognizant.³³⁸

Indeed, St. Thomas' semimaterialism turns on conceiving the process of cognition as a continuous process, from the disparate sensory information received in the sense organs, to the sensible species of the external senses, to the composite information processed and stored at the level of the internal senses, and finally to the abstract cognition that is capable on the level of the intellect itself. Pasnau is again useful in treating this whole continuum as a hierarchy of complexity and abstraction. What it entails is that the rational intellect is highest because it can process the most complex kinds of information and is capable of receiving the most abstract forms. For Aquinas, it is not the case that the intellect perceives some radically different sort of thing than the external or internal senses. Rather, the intellect perceives this particular thing *sub specie aeterna*, or, according to its conformity with a universal. To quote from the commentary on *De Anima*:

Thus I differentiate between that which has cognition and that which has the estimative power. Cognition apprehends the individual as it exists under a common nature, which it contains in it inasmuch as it is unified by the intellect with its own subject. Accordingly, it cognizes this human being as human being, and this line as line.³³⁹

The intellect cognizes things according to a common nature, and asserts that this common nature inheres in this particular subject. The sheep does not see the wolf as wolf, but as dangerous; the bird does not recognize its chick as infant bird, but as something to

³³⁸ Pasnau, *Theories of Cognition*, 36.

³³⁹ "Differenter tamen circa hoc se habet cogitativa, et aestimativa. Nam cogitativa apprehendit individuum, ut existens sub natura communi; quod contingit ei, inquantum unitur intellectivae in eodem subiecto; unde cognoscit hunc hominem prout est hic homo, et hoc lignum prout est hoc lignum." *In de Anima* II, l. 13, n. 16.

be cared for. While the higher animals possess a kind of intentional orientation to the world, such that they make inferences about appearances that guide behavior, these animals do not yet see the world as conceptual, or in terms of general descriptions. This final capacity is identified with the power of the intellect.

Elsewhere, Aquinas outlines the various sensory powers of the soul according to a hierarchy or a *gradus de anima*. This gradation offers an important addendum to the square of opposition outlined above. According to a five-step hierarchy of cognition, where the external senses are the lowest grade and the intellect is the highest, Aquinas situates the common sense at the second level, then the imagination, and finally the estimative power. The reason for this is that the common sense functions simply as the place where the various senses come together. The imagination is a faculty for conserving those collected sensations, and thus depends on the common sense. The estimative power, then, is considered to be more like a kind of cognition than a kind of sensation, though Aquinas concedes that this is perhaps only the case in animals without thought, while the purely cognitive functions are presumably assumed by the intellect in rational animals.³⁴⁰ This is important because it indicates that the estimative power is a more genuinely cognitive power than a sensory power, as it will in fact be interpreted by Toletus. It should be obvious that this is the case since by definition the estimative power does not consider sensory objects, at least not *as* perceived by the senses. Moreover, this power indicates, in some measure, a bridge between sensation and intellection, i.e., a power that gets us on the way to abstract cognition, since it is able to calculate about

³⁴⁰ *Quaestiones in de Anima* 13co

properties that are not strictly speaking sensory qualities (e.g., the wolf's danger), and is directed toward things that are absent.

With respect to our study of Descartes, the important concept to take away from the notion of the 'internal senses' is their organizing and representing functions. For Aquinas, these internal senses mark an intermediate level of cognition between the sensible species of the external senses and the intelligible species of the possible intellect. I think that the number and names of the internal senses is less important. We have already seen Aquinas reduce Averroes' five internal senses to four; by the time we get to Toletus, he has reduced Aquinas' four to three. Toletus identifies imagination with the estimative power, maintaining Aquinas' identification between phantasy and imagination. At first this makes little sense, in view of the square of opposition sketched above. According to that schema, the imagination performs an entirely different function (retaining sensible species) than the estimative power (perceiving complex intentions). Toletus justifies his taxonomy in the following way:

I do not separate imagination or phantasy from estimation, but (as I claim) the same power is in them that elicits non-sensory species with these faculties which it perceives in the absence of the object itself and connects to the species.³⁴¹

Here Toletus makes it clear that what both imagination and the estimative power have in common is their capacity to be intentionally directed toward objects in the absence of sensible species, yet in such a way that connects this intention to those species. Whereas Aquinas would parse the distinction in a slightly more fine-grained way, conceiving of

³⁴¹ "Unde imaginationem, vel phantasiam non separo ab Aestimatione, sed eadem (ut puto) virtus est, que elicit species non sensatas cum ea, quae in absentia objectorum ipsa percipit, speciesque conectit." *Commentarii in de Anima* III, txt. 161, q. 6, 126c.

imagination's capacity in terms of retention and estimation's capacity in terms of the complexity of the intention, there is no real difference between the two accounts. This is important for our purposes because it again highlights the key function of the internal senses: to perform some intentional acts that are a result of either inference or retention, and to relate these acts to an image in the absence of the object it represents.

In another instructive example, the medical tradition identified the three organs of internal sensation with the three ventricles of the brain, the front, middle, and back. For them, the front ventricle contained the common sense and the phantasy; the former was said to receive the sensory impressions and the latter retain them. The middle ventricle contained the imaginative faculty, which was thought to be responsible for combining the images stored in the phantasy. This faculty was also apparently called the cogitative power when the intellect used it actively. Finally, memory was identified with the back ventricle of the brain. The medical tradition is interesting to take note of because it identifies the operation of these faculties of the soul with the mechanics of particular organs in the body. It is noteworthy that the intellect acts through the imaginative faculty in a process called cogitation, and the estimative power is absent from the description. Henrik Lagerlund suggests that this is the case because the estimative power was not considered to be in any part of the brain.³⁴² Again, it appears that the number and names of the internal senses are not as important as their function.

³⁴² Lagerlund, "Mental Representation in Medieval Philosophy." See also Harvey, R. *The Inward Wits: Psychological Theory in the Middle Ages and the Renaissance*. (London: The Warburg Institute, 1975).

We now have a fairly good picture of the mechanics of perceptual cognition in late scholastic Aristotelianism. We know that when the intellect is directed toward objects, when it cognizes, it apprehends the species of those objects.

Cognition

One way to think about the difference between cognition and sense perception in late scholastic epistemology is to consider the objects of intellection, the intelligible species, in contrast to the objects of sensation, the sensible species and phantasms. Receiving the intelligible species requires an additional step from the collection and representation of phantasms out of sensible species. This step is what the scholastics called “abstraction.” In a certain sense, the intelligible species is still the material thing cognized, e.g., this human being. But the intelligible species ‘human being’ is entirely abstracted from any material determination; it is truly a universal concept. In contrast, the particular human being that I am perceiving is a unique, material thing. Moreover, the sensible species that I receive when I perceive this human being are, in some sense, specified by my direct contact with the human being, via the species *in medio*. Thus, in order to get from this particular human being, or a group of human beings, intellection requires another, intellectual, agent to actualize the immaterial and intelligible form in the intellect. Perceiving many human beings does not alone give rise to the general concept ‘human being’. For instance, it may not be immediately clear what common features in a group of human beings are the essential ones, and which are accidental. Intellectual

abstraction lifts the essential features from the non-essential ones. This is why Toletus appeals to, following Aquinas and Averroës, an agent intellect:

... to cognize is an affection: thus, it is necessary that these two principles are at work, one which is like the material [cause] of intellection, the other its efficient [cause]. And this [efficient cause] is the agent intellect.³⁴³

In the above quotation, the material cause is not the material object cognized. Rather, it is the intellect itself in its material or potential aspect, what is called the possible intellect. The efficient cause is the agent intellect. To fill out the schema of Aristotelian causality: the formal cause is the intelligible species and the final cause is knowledge itself. It is important to see that, in a certain sense, the intellect is independent in its cognition of intelligible species. However, this is not entirely the case, since the intellect is intimately connected to the imagination and uses the imagination in the production of intelligible species. As one illustration of this fact, the Coimbrans refer to the phantasm as the material cause of intellection rather than the possible intellect.³⁴⁴ We will see to what extent this is the case and how.

³⁴³ “Intellegere es quid effectu: ergo oportet duo haec principia facere, unum quod sit ut materia intellectionis, alterum ut efficiens: et hoc est intellectus agens.” *Commentarii in de Anima*, Lib. III, cap. V, txt. 17, 140c-d. Cf. Aristotle, *De Anima* iii: 5: “Since in every class of things, as in nature as a whole, we find two factors involved, a matter which is potentially all the particulars included in the class, a cause which is productive in the sense that it makes them all (the latter standing to the former, as e.g. an art to its material), these distinct elements must likewise be found within the soul” (530a 10-13). Cf. also Coimbrans *Commentarii in de Anima*, “... id quod est in potentia, eget aliquo, a quo ad actum deducatur. Cum igitur intellectus possibilis sit in pura potentia, necessario erit danda aliquo facultas, a quo ad intelligendi actum deduci possit: haec autem est intellectus agens” (Cap. 5, q. 1, art. 2, 419).

³⁴⁴ *Commentarii in de Anima*, 458.

Abstraction and turning toward the phantasm

In this exposition, we are particularly concerned with an account of the activity of the intellect in the process of perceptual cognition. So, even if the intellect appears to act on its own, it must in some sense be related to and determined by the processes of perception that I outlined above. What is the point of contact between the independent operation of the intellect and the products of sense perception? The answer to that question is the ‘phantasms’. The activity can be explained in two ways: abstracting from the phantasm in order to produce intelligible species and turning toward the phantasm in order to specify the nature of the intelligible species. For Aristotle, the phantasms are related to the ‘phantasy’ as for us images are related to the imagination. We might today say that images are the vehicles of representational content, i.e., it is by way of images in the imagination that one pictures the world in a certain way. This representational capacity of imagination makes it essential to thought, which is how the late scholastics interpret Aristotle’s famous claim that there is no thought without phantasms (*De Anima* iii: 5, 430a 26).

This relationship is explained neatly in Franz Brentano’s study of these passages in *The Psychology of Aristotle*:

But how must we envisage this dependency of the intellect upon images? Aristotle answers that the intellect is related to images as sense to external sensible things. Sense receives its pictures by turning toward external objects; intellect receives its ideas by gazing, as it were, upon images.... Sensation is a kind of affection through the sensible; similarly, thinking is a kind of affection through the intelligible, and this intelligible, through which the intellect is affected is, as Aristotle says, is the sensory representations. Thus the sensitive part

which contains the images acts upon the intellect and through this the latter begins to think.³⁴⁵

Brentano exploits the analogy between intellection and sensation in the sense of a process of alteration. In both cases, the faculty of cognition is directed toward some kind of object and is determined with respect to that object, becoming the form of the object. Sensation has already made available a certain level of representational content, which is itself intelligible or immaterial, namely, the sensible species. However, this content is not yet unified and represented in a way that is readily accessible to thought, and this is the work of the imagination. Here is how Aristotle describes the relationship:

Hence no one can learn or understand anything in the absence of sense, and when the mind is actively aware of anything it is necessarily aware of it along with an image; for images are like sensuous objects, except that they contain no matter.³⁴⁶

In the discussion of the previous section, we recognized several grades of sense perception: the external senses, the common sense, imagination or phantasy, and the estimative power. The idea behind the claim that images are like the sensuous objects of the intellect simply means that in order for intellectual activity to get underway, the sensible species, received in the sense organs, have to be combined and organized by the internal senses before they are available for cognition. This is the work of the imagination or phantasy in creating the phantasms.

These images, in turn, provoke the production of intelligible species in the possible intellect. The close relationship between the imagination and the possible

³⁴⁵ *The Psychology of Aristotle*, 96.

³⁴⁶ *De Anima* 3: 8, 432a 6-9.

intellect can be observed, for example, in Toletus' comments on this very passage. In a particular passage discussing the nature of memory in the immortal soul, he writes:

Thus, that which has died does not remember, that is, we do not know by that which, embodied, we would know. And the reason for this is that embodied we would know by virtue of the passive intellect, that is, the imagination, just as all those suppose who follow Themistius. Since therefore the bodily power does not remain [after death], the soul does not know in the way as before; to [the part of the soul] that is immortal, it knows in some other way.³⁴⁷

The phrase "*per intellectum passivum, id est, imaginationem*" clearly indicates a close relationship between the passive or possible intellect and the imagination. In a sense, the passive intellect needs the imagination in order to cognize. It seems that, at least in this life, when the soul is embodied, the possible intellect is very intimately related with the corporeal faculty of imagination. Elsewhere, Toletus clarifies that "the possible intellect is not the power of imagination, rather it is another faculty that inheres immediately in the body."³⁴⁸ Indeed, he argues that since the possible intellect possesses, potentially, the immaterial forms of things, it cannot be a material thing, like the imagination.³⁴⁹ In his considered opinion, he rejects the doctrine of Themistius, who had held that the possible intellect is identical to the imagination, though he concedes that there is something right about this claim. Indeed, Toletus thinks that the intelligible species seem to have a dual

³⁴⁷ "Unde sit, quod post mortem non reminiscimur, id est, non intelligimus ea quae in corpore intelligebamus; et ratio est, quia in corpore intelligebamus per Intellectum passivum, id est, imaginationem, ut omnes ex ponunt cum Themist. Cum igitur ista non maneat, quia vis est in corpore, non intelliget anima illo modo, quo ante, a[?] quia immortalis est, alio modo intelliget." *Commentarii in de Anima* III, 5, txt. XX.

³⁴⁸ "Intellectus possibilis, non est vis imaginativa, nec aliqua facultas in corpore immediate inhaerens." Ibid. III, 4, txt. VII, q. 10, 135a.

³⁴⁹ *Commentarii in de Anima*, 135a. See section three for some problems with this kind of argument.

character, one is immaterial and inheres in the possible intellect, the other is corporeal in nature and is called the phantasm.³⁵⁰

Thus, images or phantasms are very closely related to the intelligible forms in the possible intellect. That any given form is actualized in the possible intellect depends on the presentation of some phantasm together with the activity of abstraction. In the *Summa Theologica* Ia 86.1, Aquinas addresses the nature of intellectual cognition and concludes that “a person understands by abstracting the intelligible species from its material aspects [*intelligit abstrahendo intelligem speciem ab huiusmodi materia*].” The Coimbrians, in turn, recognize the necessity of abstraction when they say that the phantasm is of a different order [*alterius ordinis*] than the intellect. Thus, it is necessary to abstract from the phantasm in order to make it suitable for possession by the intellect.³⁵¹ It is for this reason that the intellect only knows the universal, Aquinas tells us, which is “what is abstracted from the material of the individual [*Quod autem a materia individuali abstrahitur*].” Again, we will return to this issue in greater detail in the next chapter. For the moment, however, it is important to realize that intellectual abstraction does not preclude knowledge of singulars entirely, it only means that such knowledge is indirect.

Indirectly, and by a kind of reflection, it is possible to cognize singulars, which, as was said above, have been thus abstracted [to form] intelligible species. It is not possible, however, following that act, to know [singulars] unless by turning to the phantasm, in which one understands the intelligible species.³⁵²

³⁵⁰ Aquinas, *Questiones in de Anima*, 2co: “Sic igitur species intelligibilis habet duplex subiectum: unum in quo est secundum esse intelligibile, et hoc est intellectus possibilis; aliud in quod est secundum esse reale, et hoc subiectum sunt ipsa phantasmata.”

³⁵¹ *Commentarii in de Anima*, cap. 5, q. 1, art. 2, 419.

³⁵² *ST*Ia 86.1 co, “Indirecte autem, et quasi per quamdam reflexionem, potest cognoscere singulare, quia, sicut supra dictum est, etiam postquam species intelligibiles abstraxit, non potest secundum eas actu intelligere nisi convertendo se ad phantasmata, in quibus species intelligibiles intelligit.”

On this view, all thinking of particular things requires the intellect “to turn toward the phantasms” in order for the thought to be determined by some specific content. Duns Scotus characterizes the relationship quite succinctly:

The intellect understands nothing except by turning toward the phantasms: not that this turn belongs to the intellect alone, [looking] over phantasms; rather it belongs to the soul as a whole, so that the intellect understands nothing except while phantasia forms phantasms [*phantasantur*].³⁵³

The Coimbricans call this phantasm-producing fantasy the ‘express form’ of the thing. It is by such expression of the form or species in the fantasy that the intellect is determined toward cognizing the specific sensible content of a particular entity.³⁵⁴

These passages reinforce what was claimed above: that the specifying content of intellection is the phantasm, out of which the intelligible species are formed and by which they can be determined. It is in this sense that I understand the phantasms or images to form the inner representations of thought. Again, Aquinas’ statement that this process is indirect, and “a kind of reflection” serves to reinforce the idea that these images form the inner representational content of thought. However, we ought not sever the ties between this inner content and the external object too hastily. After all, there is an important sense in which the entire process, from the reception of species in the sense organs to intellectual abstraction, is a continuous process. Toletus is helpful in reminding us that, while the species, imprinting itself on the intellect by way of the sensible phantasm, is the

³⁵³ *Lectura* II, d. 3, pars 2, q. 1, n. 255. The text is quoted in Pasnau, “Cognition,” 289-90, and the translation is his.

³⁵⁴ *Commentarii in de Anima*, cap. 5, q. 6, art. 2, 456: “... intellectus agens in produendis speciebus intelligibilibus est causa universalis, quae ut hanc potius, quam illam speciem producat, eget causa particulari, a qua determinatur; haec autem causa est phantasma expressum rei sensibilis.”

motive cause [*motivum*] of intellection, the terminating cause [*terminativum*] is intellectual understanding, which possesses the species.³⁵⁵ In other words, the process of perceptual cognition may be understood according to the stages that I have been outlining, in which case one can make a distinction between the reception of sensible, concrete species in the sensory faculties from the abstraction of a more general nature in the intellect from those species. But it must also be understood that the process is only complete once the intellect possesses the intelligible species, and thus it can be broken into stages only by a conceptual abstraction. In reality, when human beings perceive an external object, they perceive the sensory qualities of that object as inhering in a subject whose nature is known by virtue of some intelligible species. This is why we recognized above that human beings always understand according to the universal, by predicating certain universal properties of particular subjects.

One of the governing metaphors for this process is the metaphor of illumination. It is often said that the agent intellect is like light to colored things: it makes them visible. The Coimbrians understand the agent intellect to have three closely related duties [*munia*]: to illuminate the phantasm, to bring the object of intellection into act, and to produce the intelligible species in the possible intellect. For them, the agent intellect is always exercising its illuminating power, but it does not produce any intelligible species

³⁵⁵ *Commentarii in de Anima* 3: 4, txt. 8 q. 9: “Intellectus est denudatus ab omni natura cuius primo speciem recipit, et ab omni eo, a quo primo moventur . . . duplex esse objectum intellectus. Unum motivum tantum, alterum terminativum, et aliquo modo simul motivum. Id dicitur motivum, quod speciem imprimit ipsi intellectui, quamvis nonsei ipsum, quod cognoscitur ab intellectu. Terminativum est, et aliquo modo etiam motivum, quod cognoscitur ab intellectu, et ipsius etiam species in intellectu est.”

unless it is presented with a phantasm.³⁵⁶ This language is closely related with the Neoplatonic idea that the agent intellect is really the divine intellect (which was conceived to be in continual activity). The Coimbrians would have rejected such a characterization, but it is difficult to see under what conditions the agent intellect would be provoked into act. It was almost universally agreed that the agent intellect was a self-mover, but whether it is set into motion only in the presence of the phantasm or if it is continually moving must have been subject to debate. We will see that a full response to this question requires thinking of the process of intellection as the completion of two partial processes. Closely related to the idea of intellectual illumination is the term *influxus*, which describes the way that intelligible species are generated from the agent intellect. The term refers to the transfer of agency from that which is in act to that which has the potential to be in act.³⁵⁷ In this sense, it simply describes the nature of the relationship between the possible intellect *qua* material intelligence and the agent intellect *qua* formal intelligence. However, the metaphorical content of *influxus*, together with the idea of “illumination,” seems reminiscent of a concept of divine illumination or the inflowing of divine intelligence in human cognition. Indeed, it is simply unavoidable to see such connections in the Thomistic doctrine of the agent and possible intellects. In part, this seems to have provided the force behind Pietro Pomponazzi’s (1462-1525) criticisms of Aquinas in his *De Immortalitate animi*. We will consider this a subsequent section.

³⁵⁶ *Commentarii in de Anima* q. 2: Quae sint intellectus agentis munia?, esp. 424 on the perpetual action of the agent intellect.

³⁵⁷ See Thomas-Lexicon, “influxus”: “id quod est in actu, agit in id, quod est in potentia, huiusmodi actio dicitur influxus” (Quodl. 3. 3. 7c).

Coordination between intellect and imagination

For now, let us focus more closely on the causal agents of intellection, their roles, the reasons why they were thought to be necessary, and the way they are related to one another. We have referred to the agent and possible intellects on analogy with the concepts of form and matter. This language is meant to clarify the causal power of the agent intellect and its necessity in the process of intellection. However, this language does not remove all concerns; even ancient Greek commentators like Theophrastus were perplexed by the terminology. Indeed, he comments on the question of the impassibility of the intellect more than on any other passage in his *De Anima* commentary. The reason for this seems to be that the issue raises a number of apparent puzzles. First, the intellect seems to be both moved and not moved by its object. If the intellect is immaterial, then it cannot be moved by a material object; yet, the intellect is wholly determined by its object, so it must be moved or altered by that object. Second, if the intellect is truly the cause of its own intellection, then does it ever cease thinking? Or, why is the intellect unable to think of anything whatsoever? No real resolution is to be found in Theophrastus, but he does seem to suggest that the impassibility of the intellect should be understood in a relative sense, and that its movement should be conceived of as an imperfect movement. In other words, it seems, Theophrastus envisages some interpretation by which the intellect is partially moved by its object and partially moved by itself, the two movements together composing intellection.³⁵⁸

³⁵⁸ See E. Barbotin, *La Théorie aristotélicienne de l'intellect d'après Theophraste*, 105 ff.

Pasnau is helpful in outlining the Thomistic account of the ‘imperfect’ movement of the soul with respect to the objects of knowledge. Aquinas, he tells us, distinguishes between two different kinds of agents: (A1) agent as sufficient to bring about an effect in the patient and (A2) agent as incompletely sufficient cause, i.e., one that needs another cause in order to complete it. Likewise, Aquinas distinguishes two different kinds of patients: (P1) patient as in no way cooperative with its agent and (P2) patient as in some way cooperating with the agent.³⁵⁹ Perhaps the A2-P2 variety of interaction seems obscure. To make this more palatable, consider the case of insemination. On the Aristotelian account, the man’s semen is the agent of generating an embryo, but it is an incomplete agent that requires the cooperation of the female’s womb in order to be effective. Now, with respect to perception, sensation is an A1-P1 type causal interaction. That is, in the presence of some color or sound, the faculties of seeing and hearing (if they are not impeded in any way) cannot help but be affected by the sensory objects. The internal senses function somewhat differently; they have an A1-P2 kind of interaction. Unlike the external senses, the imagination or phantasy and the estimative power play a cooperative role in the production of internal images: they are even able to form new images of things never seen, or things that are absent from perception. Once we arrive at the level of the intellect, we find an activity of the A2-P2 type. External objects, and indeed even the phantasms, are insufficient agents to bring about intelligible species. This is clear because they are material, while the intellect is immaterial. Thus, the intellect needs a completing agent, the agent intellect, to produce an immaterial species. Likewise,

³⁵⁹ These distinctions can be found in Aquinas, *Quodlibet* 8. 2. 1, but my discussion here is taken from Pasnau, *Theories of Cognition*, 126-30. See also, Pasnau, “Cognition,” 292.

the patient intellect must be a cooperating patient in the sense of providing the immaterial potential for producing immaterial species. Now, Aquinas conceives of the agent intellect as the real, or principal, cause in this process because it is the higher cause. However, I think it is also clear that without the aid of the phantasms, the agent intellect would need some other completing cause in order to produce the intelligible species.

Aquinas refers to this relationship as an “instrumental” one. The agent intellect simply makes use of the phantasy as a necessary instrument for the cognition of material particulars. This kind of instrumentalist view of the bodily powers of perception found some revival with the republication and translation of Simplicius’ *Commentaria in tres libros de Anima* (Venetis, 1564). The translation renders the agent intellect the *intellectus manens* and the possible intellect the *intellectus progressus*. Thus, it was conceived that the agent intellect operated as a kind of downward projection of thought through the body, that “uses the body as an instrument . . . The progressing soul goes out to cognitive objects external to itself, but only to discover upon return that it already contained these objects in its inner self as colours without light.”³⁶⁰ It may have been in response to such views that the Coimbrians reject the “instrumentalist” understanding of the phantasms. Instead they conceive of the two causal elements to be, from one perspective, the agent intellect and the phantasm, and from another perspective, the possible intellect and the intelligible species. These two different causal interrelations produce the same effect, namely, understanding. They are to be understood as two lights illuminating the same space. Either one of them has a *minus perfectum*, but together they complete the process

³⁶⁰ Quoted in Spruit, *Species Intelligibilis*, II: 161.

of intellection.³⁶¹ The Coimbrians seem to have a slightly more nuanced view of the process than Aquinas. They conceive of the intelligible species as the principle of intellection, whereas Aquinas clearly reserves the agent intellect as the ultimate principle of intellection.³⁶² In either case, it is clear that the intellect in some sense cooperates with the phantasy or imagination in the process of intellection.

Critics: Peter John Olivi and William of Ockham

Not surprisingly, there were serious detractors of this view of intellectual activity among the late scholastics. I will very briefly discuss the views of two, Peter John Olivi and William of Ockham. Neither of these philosophers accepted the real existence of species, and so they had already rejected one of the cornerstones of the theory. Olivi considered the putative role of the species in perception to be absurd. On the one hand, it did not seem possible that a spiritual process like intellection could depend on corporeal entities like the species. On the other hand, it seems that the ethereal existence of species *in medio* did not seem to be the kind of thing that could have a real effect on the corporeal sense organs or be produced by corporeal objects themselves. It seems that Olivi is trading on the distinctive nature that species are said to have, namely, intentional

³⁶¹ *Commentarii in de Anima*, 458: “Quod si quis opponat, cum duae causae ita concurrunt, quamlibet earum posse per se solam edere effectum eiusdem speciei, licet minus perfectum, ut cum duo luminosa lumen producant. Occurrendum, non esse id perpetuo verum, quia focus accidit in causis, quae sunt heterogeneae comparatione effectuum, quomodo se habent intellectus agens et phantasma ad species intelligibiles: itemque intellectus patiens et species intelligibiles ad intellectum.”

³⁶² *Ibid.* 419: “id est, intellectum principia, quae sunt species intelligibiles.”

existence. If this is conceived as physical, then it cannot be the cause of intellection; if it is conceived as immaterial, then it cannot be the cause of sensation.³⁶³

Ockham, likewise, would reject the existence of intentional species, conceiving instead of all those intentional aspects of things as conceptual, or in some sense mind-dependent. Trading on his celebrated principle of parsimony, Ockham argues that if species have any role in the cognitive process it is simply to designate the nature of objects as they are conceived in the mind. Thus, he liberates himself to reconstruct a theory of perceptual cognition by which the objects existing in the intellect are simply that, mind-dependent concepts. He calls these *ficta*: which are said to have a non-real existence whenever the mind considers some object intentionally. In his later works, however, even these mind-dependent objects are dismissed in favor of a direct view of cognition that trades on the distinction between abstractive and intuitive cognition.³⁶⁴ We will have a chance to review this distinction in the final chapter. For now, I simply call attention to the fact that it is controversies like these that lead Pasnau to claim:

By Ockham's time, the notion of intentional existence had become firmly linked with nonreal, mind-dependent existence. Intentionality was no longer of any help in explaining the mind; rather, the concept was itself badly in need of explanation and could do no more than muddy any waters into which it might be cast.

This is not entirely true, since there were a great many commentators who continued to use the concept of intentional existence and the species theory of perception in the 16th and 17th centuries. However, the concept was certainly open for debate and easily

³⁶³ Pasnau, *Theories of Cognition*, 68. Pasnau is not persuaded that these arguments are effective against Aquinas, and I am inclined to agree, though I highlight them in order to suggest that Descartes' complete rejection of the entire causal apparatus was not without precedent.

³⁶⁴ Ibid. 76-85. For a good summary, and critique, of Ockham's mature theory, see Stump, "The Mechanisms of Cognition," 168-203.

ridiculed by the early moderns. In an entirely analogous way, though Leen Spruit has no special love of the early modern philosophers, interpreting their readings of scholastic theories as distortions and even plain omissions of key concepts, he does acknowledge that by the early modern period the concept of intelligible species had almost entirely been supplanted by idea, notion, and image.³⁶⁵ We will see in just what way this can be said of Descartes' *Regulae*.

For the moment, I would like to continue the analysis of Ockham and Olivi because both of these philosophers also reject the notion of agent and possible intellects that we have been considering. Indeed, this seems to follow naturally from their rejection of the species theory of perception. After all, the purpose of the agent/possible distinction was to describe the process whereby sensible species can become intelligible. Ockham's mature philosophy of mind holds that the rational soul consists of two kinds of acts (intellect and will) and two kinds of attributes (qualities and habits). Qualities are the short-duration affections of the soul when it is in the process of any intellectual act; habits are the long-duration dispositions of the intellect to act in a certain way, given a certain kind of stimulus.³⁶⁶ Whenever the intellect is said to judge or apprehend something, what it apprehends is a sentence or proposition that has the property of signifying some thing or state of affairs in the world. Thus, Ockham can treat all sensible, imaginary, and abstract objects of cognition with the same schema, i.e., through an account of the philosophy of language. Moreover, simple apprehension involves only

³⁶⁵ Spruit, *Species Intelligibiles*, II: 267-73 and 352ff. It appears that one of the earliest sources of this transition is Augustino Nifo, who replaces *species intelligibilis* with *notio*, see *ibid.* 117.

³⁶⁶ E. Karger, "Ockham's Misunderstood Theory of Intuitive and Abstractive Cognition," in *The Cambridge Companion to Ockham*, 204-5.

asserting that this is so, whereas judgments involve some composition of sentences.³⁶⁷

Ockham places the entire causal efficacy for cognition on the object, which he maintains has the capacity to act at a distance on the sensory faculties and even the intellectual soul. He claims: “The external sensible object immediately moves sense and intellect to an intuitive act, so that the first thing caused in intellect by an object is an intuitive act.”³⁶⁸ Thus, Ockham has an entirely passive conception of perceptual cognition, one that has immediate and direct contact with the perceived object by a kind of action at a distance.

Olivi, by contrast, presents the opposite view of intellection, whereby the intellect is active throughout the process of cognition, reaching out to external objects, by a process of ‘virtual attention’. The idea that the mind’s activity in perception is a kind of attention clearly reminds one of Augustine’s theory of cognition, that the mind perceives by actively attending to aspects or properties of objects.³⁶⁹ On this view, the intellect is causally connected to the object through a kind of virtual presence, i.e., simply because it is in the intellect’s capacity to perceive the object. This entails that the external object need only be in the vicinity of the perceiver in order to be virtually encapsulated by the intellect. Here, the object is the final or terminative cause of intellection and the agency lies entirely with the intellect’s capacity for attention. This need not imply some theory of extromission, or positing some corporeal-visual ray, that is directed toward the object. Instead, it need only imply that the intellect has the capacity to perceive objects in its vicinity (thus these objects are “virtually” possessed by the intellect). In order for

³⁶⁷ Ibid. and Pasnau, *Theories of Cognition*, 277-89.

³⁶⁸ From *Questiones in libros sententiarum (Reportatio)* III. 2; *Oth* VI, 64-65. Quoted in Pasnau, *Theories of Cognition*, 165 (translation is his).

³⁶⁹ See *ibid.* 131-32.

cognition of the object, the intellect activates that *virtus* in the direction of the object (through attention).³⁷⁰

With Olivi and Ockham, we have a sample of two polar extremes in the theory of perceptual cognition that reject the species account. The motivation for these accounts seems clear: the species theory and the agent/patient intellect distinction is mysterious and complex. Surely there is a simpler and more direct way of accounting for the causes and the phenomenology of perception. Need we multiply external and internal senses, different kinds of species, and even different aspects of the intellect? To be sure, the full Thomistic account has an answer to most of these worries, but the presence of such criticism undermined the force of the theory such that it is not hard to see why it seemed in need of complete demolition by the early 17th century.

Impact on mind-body distinction and mind-body union

In this final section, we will consider some implications for the species account of perception on the issue of the rational soul's immateriality and immortality. These issues have a direct bearing on Descartes' discussion in the *Regulae*: indeed, one of the basic themes of his account is that sense perception is a process that is distinct from the operations of the pure intellect. In effect, this distinction will parallel Descartes' later mind-body distinction and the ensuing "mind-body problem"; essentially, it typifies the hard problem of consciousness. As we have seen, Thomists agree that the rational soul is

³⁷⁰ Ibid. 168-174. For a condensed account, see Pasnau's entry "Peter John Olivi" in the *Stanford Encyclopedia of Philosophy*.

composed of possible intellect and agent intellect. This conception of the soul operates on analogy with the hylomorphism of substances, explaining the causal powers of the primary components of a simple substance.³⁷¹ However, conceiving of the intellect as a separate substance from the body the relationship between rational understanding and bodily perception more mysterious. Moreover, given that the rational soul is a complex of active and possible powers in its own right, in what way does it serve as the primary activating power of the human being as a whole?

The unavoidable conclusion, it seems, is that if the intellect is immaterial and separable from the body, then its union with the body must, in some sense, be contingent. This conclusion is mitigated by a complex conception of the relationship between the separable, rational soul and the material body. It is maintained that the soul informs the body and is its activating power, providing not only the powers of cognition, but also those that pertain to bodily life. At the same time, however, the soul's participation in a higher domain, the "spiritual," lends it its peculiar powers of abstraction and its essential immateriality, and consequently immortality. The rational soul is, then, a *medium quid*, a kind of intermediate being suspended between two realms. I will explore this notion in what follows. But I will also attend to serious detractors, both scholastic and contemporary.

³⁷¹ Toletus, *Commentarii in de Anima* 3, c. 3, txt. 8, q. 10, illustrates this nicely: "Si igitur [the intellectual soul] est compositio per se, necessario oportet fateri, quod una pars sit actu, et altera potentia: et tunc erit compositio ex materia, et forma, cum sint partes distinctae." (134c)

Separability and impassibility of the soul

The account of the separability and immateriality of the rational soul is closely connected to its role in cognition. Recall that in thinking of any given thing, the intellect actually becomes that thing, i.e., it comes to possess the form of the thing cognized through a process of alteration. This is the sense of the often-repeated definition that “actual knowledge is identical with its object.”³⁷² Yet, there seems to be no limit to the things the intellect can know, whether this includes other objects or the contents of the intellect itself. At the very least, this is what we would want an account of the intellect to provide, i.e., an account such that the intellect is capable of knowing anything whatsoever. Thus, the intellect must in some sense possess or be capable of receiving all potential objects of intellection. Apart from the real objects of sense, which we have been examining in the previous two sections, it is easy to see how abstract cognition and self-reflective thought can be conceived of in exactly the same way. Aristotle writes: “Thought is itself thinkable in exactly the same way as its objects are. For in the case of objects which involve no matter, what thinks and what is thought are identical; for speculative knowledge and its object are identical.”³⁷³ From this, Aristotle concludes that thought is capable of receiving the form of anything. This is why he can affirm the seemingly bizarre claim attributed to Anaxagoras that the intellect is all things.³⁷⁴

One may then ask what kind of nature thought has such that it is capable of receiving the form of everything. Answering this question provides proof that the

³⁷² E.g., *De Anima* 3: 7, 431a 1.

³⁷³ Ibid. 3: 5 430a 3-6

³⁷⁴ Ibid. 430a 14-15

intellect is impassible and unmixed with any body. “The co-presence of what is alien to [thought’s] nature is a hinderance and a block; it follows that it can have no nature of its own other than that of having a certain capacity.”³⁷⁵ Perhaps the minor premise is not evident by itself, but it surely follows from Aristotelian physics. For Aristotle, all bodies are determined, in a prior way, by their material constitution (and that constitution is a kind of organization of matter to receive a certain kind of form). Thus, any material determination is a hinderance or block to the reception of certain kinds of form. If thought is said to receive all forms, then it cannot have any material determination. Consider the case of the external senses, each of which is determined by the nature of the sensory organs. These external senses are only capable of receiving a narrow slice of reality, the aspects or qualities of things as differentiated by the various sensory qualities or proper sensibles. Thus, any blending with a determinant matter (body) specifies the nature of a thing and limits its capacity to receive certain kinds of forms. This is why Aristotle concludes that the part of the soul that is called thought is, before it thinks, “not actually any real thing,” by which he means it is not “blended with the body.”³⁷⁶ The later scholastics would say the intellect is *denudatus*; and both the Coimbrans and Toletus reject the idea that the possible intellect could be a *vis organica*, or a power of the body. It seems that this characterization is motivated both by the desire for the intellect to be capable of receiving all things and because of the empiricist tendencies of the Aristotelians, i.e., to think of the mind as a blank slate.

³⁷⁵ Ibid. 3: 4, 429a 20-22

³⁷⁶ Ibid. 429a 22-25

But if the rational soul is impassible, unmixed with any body, and separable from the body, then what is the nature of its union with the body? Aquinas frequently repeats the definition, paraphrasing Aristotle, that the soul is “the first act of a physical, organic body possessing the capacity for life [*anima est actus primus physici corporis organici potentia vitam habentis*].”³⁷⁷ Thus, the soul is in some sense distinguished from a physical body by being the form or act of that body in the sense of actualizing the nature of that material substance or making it what it is. This is also why Aristotle calls the soul the “account” (*logos*) of a natural body: it the necessary and sufficient condition of its existence.³⁷⁸ Moreover, the body is here taken to be an organic natural body, which is not only meant to reinforce the idea that it possesses the capacity for life, but also to indicate that the body is organized in a certain way, with proper parts whose various functions serve to maintain the life of the whole. Nevertheless, it was common to distinguish three kinds of souls, or three kinds of *actus*: the vegetative, the sensitive, and the intellective. This list proceeds from the lowest (or least noble) to highest.³⁷⁹ The first was considered to be the principle of generation and growth, the second the principle of sensation, appetite, and local motion, while the third was the seat of rationality. Following this schema, it is clear that any entity possessing a sensitive soul, must also possess a vegetative soul, for sensation, appetite, and local motion, seem to be (at least for biological organisms) dependent upon generation and growth. Likewise, for a rational, biological being like a human being, it seems necessary that it not only possess a rational

³⁷⁷ For Aristotle: *De Anima* ii: 1 (412a 27-28); for Aquinas: *Summa Contra Gentiles* II, 61; *Summa Theologica* I, 76: 4 ad 1.

³⁷⁸ *De Anima* ii: 1 (412 b 11)

³⁷⁹ See Aquinas *De Veritate* 10, 1 c.

soul, but also a sensitive and vegetative soul. But are these souls or activities distinct, or are they unified in the human being?

Toletus opens his discussion of this question saying, “[Of those] who posit multiple souls, many also posit them in one substantial form; but not all, [for there are those] who posit many forms, and consequently posit many souls.”³⁸⁰ The sticking point here seems to be the distinction and unification of the rational soul, or intellective power, with the sensitive and appetitive souls in the human person. Toletus cites Philoponus and the Manicheans who both claim that appetite and rationality cannot be unified by the same form, since they are often at odds. Moreover, he adds, the rational soul seems to be of a wholly different kind than the sensitive and vegetative souls insofar as the latter are corruptible, while the former is not.³⁸¹ In what follows, I will focus on the separability and independence of the rational soul (the intellect), as well as its potential union with the sensitive and vegetative souls. The difficulty seems to be that most late scholastic philosophers thought that the rational soul was in some sense immaterial, while they maintained that it was essentially united with the human body. The chief source of this difficulty stems from Aristotle’s characterization of thought as “separable, impassible, and unmixed.”³⁸² In the passage in question, it appears that Aristotle is referring specifically to the agent intellect, or to the pure intellect in its active nature. However, we

³⁸⁰ “Qui ponunt plures animas, plures etiam ponunt in uno substantiales formas: sed non omnes, qui ponunt plures formas, consequenter ponunt plures animas.” *Commentaria una cum Quaestionibus in tres libros Aristoteleis de Anima*, in *Opera Omnia* III, 61b, L. 3, C. 3, Q. 7. He cites Duns Scotus as an advocate of a unified soul.

³⁸¹ Ibid. Here Toletus cites Aristotle’s *Metaphysics* 10: 10, 1058b 26, where he states the principle that corruptible things are of a different kind than the incorruptible.

³⁸² *De Anima* 3: 5, 430a 17, see above.

have seen that the same characterization seems to apply to the possible intellect as well.³⁸³

The Arabic commentators on Aristotle, who were instrumental in reviving interest in Aristotle's texts in the 11th and 12th centuries, held views on the rational soul that were the source of dispute. Avicenna held the position that the agent intellect (or simply intellect) is common to all and is the source of the intelligible species. Averroes held the position that both the agent and possible intellects are separable and common to all, where the possible intellect is the storehouse of intelligible species and the agent intellect is what makes them known. Both of these conceptions threatened a strong Thomistic reading of the rational soul as the substantial form of the body. If the intellect is in some sense common to all, then it cannot be the individuating element of particular human beings. Moreover, it threatened the Christian doctrine that each human being was a divinely created individual. Aquinas argues against the Averroist idea that the possible intellect is one in all human beings with an illuminating thought experiment. He supposes that two human beings are cognizing the same object in the same way. Thus, they each possess the form of that object in the possible intellect. But if each person does not have her own possible intellect, then her thought (the intelligible species as actualized in the possible intellect) would be identical (numerically the same) as the other person's, which is absurd.³⁸⁴ Instead, Aquinas supposes that the possible intellect is the individuating

³⁸³ In Toletus' *Commentarii in de Anima* 3, c. 3, txt. 8, q. 10, he confronts the question of whether the possible intellect is separable, and if this implies that it cannot be an informing form of the body.

³⁸⁴ *Quaestiones in de Anima* 3co: sed duorum hominum simul idem intelligentium, necesse est quod sit unum et idem numero ipsum intelligere, quod manifeste est impossibile. Impossibile

element of the rational soul that makes the rational soul distinct for each individual. This follows from the conception of the possible intellect as the material principle of the intellect. One can see such an argument in Toletus, where he claims that the material element, in this case the possible intellect, makes a thing, in this case the rational soul, a *quodquid*, or this particular thing.³⁸⁵ Something like this argument is what lies behind Aquinas' thought experiment: the two rational souls contemplating the same object are distinct *quid*; indeed, the intelligible species possessed by each intellect is a distinct *quid*, and thus not *idem*, i.e., there is at least a numerical distinction between them. This argument is silent on Thomas' position on the agent intellect.

Resolution of the problem and its detractors

On the standard Thomistic account of the rational soul as the substantial form of the human being, the intellect is the first act of the body and thereby accounts for all bodily activity, whether it is proper to the processes of the vegetative soul (e.g., digestion and growth) or the sensitive soul (e.g., perception and local motion). The agent intellect, being the act of intellection is thus the act of the entire body since the greatest quality (or highest form) of the body is said to individuate and identify the body.³⁸⁶ Moreover, like any substantial form, it is not corruptible *per se*. As pure form or act of the body, it cannot be a source of corruption, but only the source of activity, generation, and

est igitur quod intellectus possibilis, quo intelligimus formaliter, sit unus in omnibus.

³⁸⁵ *Commentarii in de Anima*, 134d.

³⁸⁶ Aquinas, *Quaestiones in de Anima*, 1co: "Dicendum quod hoc aliquid proprie dicitur individuum in genere substantiae. Dicit enim philosophus in praedicamentis, quod primae substantiae indubitanter hoc aliquid significant; secundae vero substantiae, etsi videantur hoc aliquid significare, magis tamen significant quale quid."

unification. However, for all other substantial forms, when the material basis of a substantial form succumbs to material corruption, the form leaves the body. This is the case of corruption and death, where the entity ceases to be what it is by virtue of losing its substantial form. Consider the case of a horse, say, Bucephalus. When the body of the Bucephalus fails, the substantial form is destroyed *secundum esse*, or accidentally, and the Bucephalus' body assumes the form of a corpse. On this account, the corpse of Bucephalus' body is an entirely different entity, and the substantial form, Bucephalus, no longer exists since it has no body to inform. Clearly, this cannot be the account of the human soul.

Indeed, in response to this very question, Aquinas has a characteristically nuanced and clever response. His response is that the rational soul is essentially separate from the body because its operations depend in no way on the body. Thus, the intellect is essentially (*secundum se*) immortal. Yet, it is relatively (*secundum quid*) mortal, since in respect of the life of the body, the intellect inheres in and informs the body.³⁸⁷ On this account, the rational soul is a substantial form that has its own *per se* existence separate from the body. In a sense, the rational soul is contingently embodied and essentially disembodied. Or, as Aquinas would say, the intellect is naturally, but not essentially, embodied.³⁸⁸

Pietro Pomponazzi charges Aquinas with infidelity to Aristotle on this count and observes what he calls the undue influence of Neoplatonism on Aquinas' account of the

³⁸⁷ *Questiones Disputatae de Veritate*, 13.4; *ST*1a 75.6; see Eberl, Jason T. "Pomponazzi and Aquinas on the Intellective Soul," *Modern Schoolman* 83:1 (2005), 65-66.

³⁸⁸ *ST*1a 89.1

nature of the rational soul. For Pomponazzi, the intellectual soul is closer to a substantial form of a material body than a substantial form that has its subsistence in itself. He argues that the capacities of the intellectual soul tend more towards the mortal than the immortal, it is more sensuous than intellectual and more concerned with the operations of the living organism than the contemplation of universals. He also adds the important criticism that if the intellectual soul exists after the death of the body without its sensitive and vegetative capacities, then it would be deprived of some of its essential capacities for eternity, which is absurd.³⁸⁹ Aquinas could counter that this, in fact, proves the necessity of the soul's reincarnation in the resurrected body. He thus accepts the premise that the intellectual soul is essentially united with its sensitive and vegetative powers, and the conclusion that it is separated from those powers *per accidens* and for a time, but denies that this state is eternal or that it is in vain.³⁹⁰ Moreover, Aquinas allows that, disembodied, the rational soul could be informed directly by the power of God.³⁹¹

This seems to be the source of the greatest controversy surrounding the nature of the intellect and its relation to the human body. To illustrate, it is useful to turn to the writings of John Buridan (ca. 1295-1361), whose commentary on Aristotle's *De Anima* addresses these issues in detail. One of the useful features of Buridan's discussion for the purposes of our exposition is that he makes a clear distinction between his investigations, which proceed according to natural principles, and a theological investigation of the nature of the soul, which would use as its principles the articles of faith. He makes such a

³⁸⁹ Eberl, "Pomponazzi and Aquinas," 67-68. Pomponazzi's work, *Tractatus de Immortalitate Anima* was burned in Venice and he only narrowly avoided charges of heresy.

³⁹⁰ *SCG* 4. 79; Eberl, "Pomponazzi and Aquinas," 69

³⁹¹ *ST*Ia. 89.1co

distinction because, as a teacher of letters, he refrained from strictly theological controversies.³⁹² Descartes, too, would avoid the strictly theological discussions concerning metaphysics and the nature of the soul. However, in neither case does this relieve the philosopher from maintaining a position that is consistent with faith.

On the nature of the soul, according to “the conclusions someone might reach if he were to use natural arguments alone, without the Catholic faith,” Buridan demonstrates how two different characterizations of the intellect each entailing that other properties also pertain to it.³⁹³ In particular, Buridan has in mind the positions of Alexander of Aphrodisias and Averroes. The former holds the position that “the intellect is generable and corruptible, extended, derived, inherent, and multiplied”³⁹⁴; the latter holds that the intellect is immaterial. What is important about these two claims is that each entails a series of consequent properties of the intellect: if you hold that the intellect is material, then it follows that it is not everlasting, is generated and corruptible, inheres in matter, is extended, and is multiplied (in the sense that it is possible that many distinct souls exist); if you hold that the intellect is immaterial, then it follows that it is everlasting, is not generated or corruptible, does not inhere in matter, is not extended, and is not multiplied (or, that there is only one immaterial soul). The entailment relation seems to follow from the nature of material forms. That is, if a form inheres in some matter as its material form (i.e., in a way that is naturally inseparable from it), then the

³⁹² My exposition here follows closely Jack Zupko’s “John Buridan on the Immateriality of the Intellect” in *Forming the Mind*, ed. H. Lagerlund, 129-47.

³⁹³ *Questiones in libros Aristotelis De Anima* III, q. 6, 48-49; quoted in Zupko “Buridan on the Immateriality of the Intellect,” 135 (translations are Zupko’s).

³⁹⁴ *Questiones in De Anima*, III, q. 6, 51; “Buridan on the Immateriality of the Intellect,” 138.

natural corruption of that matter (since all matter is corruptible) entails the corruption of that form. (The same can be said for the natural extension. Since the principle of individuation of any given thing is its matter, whether or not there are multiple souls seems to follow from the material nature of the intellect.) By naturally inseparable, I mean the sense in which the jagged and sharp form of granite cannot be separated from the granite except by the power of God. This would be different from the form of a granite sculpture, whose origin lies in the mind of the artist, and is thus separable from the granite. The question, then, seems to turn on whether or not the form of the human being, the rational soul or intellect, is a material form or an immaterial form, whether it is naturally separable or naturally inseparable. However, neither of these two positions is entirely acceptable, for on the one hand we are left with a corruptible and individuated intellect, while on the other hand we are left with an eternal, monadic soul, common to all human beings.

The more moderate position, which is the position affirmed by faith, holds that the human intellect “is not everlasting heretofore, although it is everlasting hereafter,” “is not strictly speaking generated by natural generation, although it is created; nor is it strictly speaking corruptible by natural corruption, although it is annihilable,” “is neither derived from a material potentiality, nor extended,” “is multiplied in keeping with the number of human beings,” and “is inherent in the human body or matter as long as the man is alive, and is separable from the body and will return to it again.”³⁹⁵ In an attempt

³⁹⁵ Ibid. III, q. 6, 51; 138-39. In 1513, the Lateran Council would weigh in on the issue and demand that ten propositions concerning the nature of the soul be upheld by all philosophers. Toletus quotes this verdict in the opening of his commentary on the *De Anima*. I cite all ten

to expand on these articles of faith, Buridan offers some useful clarifications, but he ultimately concludes that “even though the arguments adduced for it are readily believable (*probabiles*), nevertheless, it is not apparent to me that they are demonstrative.”³⁹⁶ In short, Buridan seems to think that true knowledge about the nature of the rational soul is outside the realm of *scientia* and in the realm of *fides*. This is a somewhat disappointing conclusion for the philosopher. But in the process of arriving at this cul-de-sac, Buridan has highlighted for us a critical aspect of Aristotelian metaphysics on which the antinomy of Alexander and Averroes hinges: the nature of the human soul depends on the way that the form of the human being (the rational soul) inheres in the body of the human being.

To return to the sixteenth century Jesuit scholars, the Coimbrians append a treatise on the separate soul (*Tractatus de Anima Separata*) to their *Commentarii in tres libros de Anima Aristotelis* in order to address just these issues. In the *Proemium* of this treatise, they announce that the rational soul is without a doubt separable from the body (“*nimirum anima rationalis, secundum separabilitatem a corpore spectata*”³⁹⁷). The

propositions here because they clarify the position of faith and because they would have been well known to Descartes: (1) The soul is one. Its “parts”—the vegetative, sensitive, and rational souls—are distinct only by reason. (2) The soul is not one in all humans, but equal in number to the number of individual human beings. (3) The soul is spiritual; it is neither a body, nor composed of bodies. (4) The soul is not divine substance or of divine substance. (5) It is created immediately by God. (6) The soul is the substantial form of the body, and makes with it an *ens per se*. (7) The soul is created at the same time as the body comes to exist. (8) The soul is not corrupted when the body is corrupted, but exists eternally. (9) Souls after death do not enter other bodies. (10) All reasons offered by philosophers against the immortality of the soul and the other truths of faith are sophistical, vain, and refutable. Toletus *Commentarii in De Anima* 7b-8d; I follow Des Chene’s presentation, *Life’s Form*, Ch. 2.

³⁹⁶ Ibid. III, q. 3, 25; 141

³⁹⁷ *Commentarii De Anima*, 562. The entire treatise is contained in pp. 562-670, making it a fairly substantial appendix.

treatise then proceeds by way of six disputations that aim to show that the rational soul is indeed separable from the body because it is immaterial and incorruptible. The first disputation, concerning the nature of the rational soul and its immortality, concludes that the power of cognition is wholly spiritual and thus cannot be corrupted. In fact, the authors argue at length that the spirituality and incorruptibility of the rational soul is analytically true, i.e., that it simply follows from what we mean by 'rational soul'.³⁹⁸ The second disputation goes on to discuss the way of being that the separate soul has with respect to the body. They conclude that the rational soul is naturally separable from the body, of which it is the form. This implies that the Coimbrians hold the position that the rational soul is the immaterial form of the body, i.e., that it is somehow contingently related to the matter in which it inheres. In the final four disputations, they consider the mode of cognition and the objects of cognition proper to the rational or separable soul. Here, the Coimbrians argue for an internalist conception of knowledge, i.e., that the separate intellect first understands itself immanently, and then is transcendently directed toward objects. They claim that the cognition of the separable soul is the first cause of any human operation. Moreover, the principle of motion relative to the rational soul is the concept of the good. On its own, however, (i.e., without the aid of phantasms) the proper objects of the rational soul are spiritual ideas, e.g., those pertaining to angels or the Holy Trinity. On this view, one can see the close connection between the immortality of the soul and its cognitive capacities, or the kinds of mental content that it potentially possesses.

³⁹⁸ Ibid. Disp. I, Art. III, 568-76.

Indeed, one of the charges that Aquinas repeatedly contended with, concerning the essential separability of the intellect, was how the intellect continues to function, once it is removed from the corporeal organs capable of producing phantasms. On the other side of this coin is a standard scholastic argument for the immateriality and immortality of the intellect, namely, that the intellect knows immaterial things and thus it is immaterial. We have seen that the intellect's power or capacity to receive certain kinds of species, specifically those that are intelligible rather than sensible, sets it apart from the organic powers of the soul, the internal and external senses. The basis for this claim is the central idea that the soul's powers are discriminated by its acts, and its acts are discriminated by its objects.

For one level follows those things that are in the soul without their proper material, but still according to their singularity and their individual conditions. These are consequently material; and this is the level of sense, which is receptive of the individual species without matter, but still in an organ of the body. However, the higher and most perfect level of immateriality is the intellect, which receives species entirely abstracted from matter and material conditions, and thus from any organ of the body.³⁹⁹

There is, however, a rather significant problem with this argument that seems entirely to elude Aquinas and his followers. The problem can be referred to as "the content fallacy." To quote from Robert Pasnau, who coins the term: "The 'content fallacy' is my name for the mistake in reasoning that comes from conflating two kinds of facts: facts about the content of our thoughts, and facts about what shape or form our thoughts take in our

³⁹⁹ Aquinas, *Quaestiones in de Anima*, 13co: Unus enim gradus est secundum quod in anima sunt res sine propriis materiis, sed tamen secundum singularitatem et condiciones individuales, quae consequuntur materiam. Et iste est gradus sensus, qui est susceptivus specierum individualium sine materia, sed tamen in organo corporali. Altior autem et perfectissimus immaterialitatis gradus est intellectus, qui recipit species omnino a materia et conditionibus materiae abstractas, et absque organo corporali...

mind.”⁴⁰⁰ In short, Aquinas frequently makes an argument from the representational content of species, i.e., what they are *about*, to the nature of the faculty that apprehends them. In the above passage, we see Aquinas arguing from the fact that the senses perceive sensible things according to their particular features to the fact that these senses must be powers of corporeal organs. Similarly, the fact that the intellect perceives purely intelligible species, abstracted from material specificity, the intellect is immaterial. This inference is apparently false, but it is an entirely standard argument used frequently to argue for the intellect’s immateriality.⁴⁰¹ To put a finer point on it, why couldn’t we assume that an immaterial mind is aware of the particular sensible features of objects? Why must my experience of seeing red be the experience of a corporeal power, while my experience of a triangle’s having three interior angles equal to 180° is not? If I were placed in a functional magnetic resonancing machine (fMRI) so that one could see the brain activity taking place in me while I was having each of these thoughts, wouldn’t there be some characteristic and corresponding activity in my brain in each case? In other words, the content of thought does not seem to be related necessarily to the nature of thought.

I think that such questions are useful because they highlight the very different metaphysical bases that underlie Aquinas’ arguments for the nature of the rational soul.

⁴⁰⁰ Pasnau, “Aquinas and the Content Fallacy,” 293. This article contains a thorough discussion of the content fallacy in Aquinas’ work: his argument that the intellect only knows universals, that the intellect is immaterial, and that the agent intellect is necessary. Thus, it amounts to a rather serious charge. See J. Novak, “Aquinas and the Incorruptibility of the Soul,” for a discussion of this fallacy with respect to the argument for the immateriality and incorruptibility of the soul.

⁴⁰¹ For example, Toletus uses the same argument to argue against Alexander’s notion that the possible intellect should be identified with the imagination, *Commentarii in de Anima*, 135a.

Throughout my discussion, I have been referring implicitly to the grades or levels of intellection, from the external senses, to the internal senses, to the intellect. Implicit all the while has been an assumption that it is necessary to posit a corresponding hierarchy in cognition to the hierarchy of objects cognized. This link between the metaphysical thesis that reality admits of degrees of perfection and the epistemological thesis that our cognition corresponds to these degrees is inseparable from the theory of cognition sketched here.

In order to illustrate, I will present a (rather elegant) argument found in Toletus to support the claim that the intellect is a non-organic informing power of the soul.⁴⁰² Toletus argues that the rational soul is the most perfect natural form (*forma naturaliu perfectissima*). Thus, it contains the lower powers eminently and participates in higher powers. On this basis, he claims that the intellect stands in between bodies and spiritual things. Though it is *unum et simplex*, in its role as an informing form, it must play this role of a *medium quid* between the spiritual and the corporeal. Here he distinguishes between two perspectives, the order of reason (*gradum rationalem*), according to which the rational soul is an informing form of an organic body, and the order of the highest intellect (*ultimum intellectum*), according to which the rational soul is like the Angels, and is a separable form. Under one perspective, the rational soul enables the body to function. This is the domain of all sense perception and the source of all of our knowledge about objects in the world. However, from the perspective in which the rational soul participates in the highest intellect, it is separable.

⁴⁰² *Commentarii in de Anima*, 3, c. 3, txt. 8, q. 10, the entire argument is contained in conclusion 3.

Toletus backs away from committing himself to either perspective by saying that “It is better for us to say that [the intellect] is alone a single and most simple intermediate between Angels and the sensible forms, which eminently contains what is inferior, and under what is more eminent attains the lowest level of what is superior, i.e., of the Angels.”⁴⁰³ In this way, the intellect is capable of informing and governing the powers of sensation even though it, strictly speaking, participates in an entirely different, spiritual order. The idea that somehow the intellect participates, simultaneously, in two different ontological domains (the spiritual and the material) depends on a rather rich ontology. We find Toletus claiming that the soul is a single, simple form, yet denying that it is either an immaterial form or a material form. The intellect somehow participates in both materiality and immateriality, conceived variously from the order of reason (the order of scientific explanation) and the order of pure intellect (the theological). Thus, by making fine distinctions between different ways of knowing, as this relates to the complex and interconnected hierarchy of being, Toletus is able to walk the knife-edge of this contentious issue.

We have seen that the scholastic account of perceptual cognition is intimately linked to a metaphysical hierarchy of forms, species, and the acts of the soul. In fact, this understanding of the nature of the soul in terms of its place in a grander system tokens a

⁴⁰³ Ibid. 135c: ... melius dicimus: esse unum solum simplicissimum gradu medium inter Angelos, et formas sensitivas, qui eminenter continent inferiores, et sub eminenter attingit infimum superioris, scilicet Angelorum.”

more general scholastic method of explanation.⁴⁰⁴ We see that the human soul plays a number of roles that might be today called epistemological, psychological, etiological, or theological. For this reason, our modern “philosophy of mind” fails to capture the much more broad class of investigations that Dennis Des Chene has recently called “the science of soul.”⁴⁰⁵ In our brief exposition of the issue here, we can see that questions of cognition are closely related to the physiological questions of operation and theological questions of immortality. I have tried to sample the diversity of opinions later scholasticism on this issue in order (1) to dispel the myth of a unified “scholastic” theory of mind and (2) to demonstrate some of the fissures in the predominant Aristotelian/Thomistic theory of mind and cognition that would later be exploited by Descartes.

Descartes’ Theory of Cognition in the Regulae

We have seen in the preceding section that the process of perceptual cognition was an important and much discussed issue in late scholasticism. Though it is impossible to say for certain that Descartes was acquainted with any of the theories that I have been outlining, there is very good evidence that he was well aware of the general thrust of a Thomistic species theory of perception and that he saw his account of perception as a substitute for that theory. This fact is most evident in the *Dioptrique*, where Descartes

⁴⁰⁴ I will have occasion to discuss this type of explanation in the final chapter. See also, Gilson, *Etudes*, 158-59, where *natura* is identified with *forma* and the task of the natural philosopher is seen to be the classification of *forma* according to their place in the order of being.

⁴⁰⁵ Des Chene, *Life’s Form*.

makes his critique of the species theory most explicit. That treatise begins with an outline of his theory of the refraction of light as a movement of corpuscles along rectilinear paths. It is followed by a short discussion of the anatomy of the eye, and the discussion of sensation where the species theory is explicitly attacked. There are a number of important historical sources of Descartes' account in that work, principally: the discovery of the sine-law of refraction, related in the *Regulae*, anatomical observations using cows' eyes and sheep brains c. 1630, and the translation of these discoveries into a coherent story about the role of light in perception and human action in *La Traité de l'homme* (c. 1632).⁴⁰⁶

Consider the following passage from Descartes's general theory of sensation, followed by a specific account of vision:

Beyond this [a discussion of the operation of the nerves], it is necessary to beware not to suppose that in order to sense the soul needs to contemplate certain images that were sent by the objects up to the brain, as is commonly held by our Philosophers; or, at least, it is necessary to conceive the nature of these images entirely differently than they are [ordinarily conceived]. Because, as long as they consider them to have some resemblance with the objects they represent, it is impossible for them to show us how they can be formed by objects, and received by the organs of external sense, and transmitted by the nerves up to the brain (*cerveau*). (AT VI, 112; CSM I, 165)⁴⁰⁷

⁴⁰⁶ *La Dioptrique* would likely have been composed at or before the time of *L'Homme* (though it certainly could have been revised before publication). Descartes' refers to the treatise on optics frequently in his treatise on man.

⁴⁰⁷ Il faut, outre cela, prendre garde a ne pas supposer que, por sentir, l'ame ait besoin de contempler quelques images qui soyent envoyées par les objects jusques au cerveau, ansi que sont communement nos Philosophes; ou, du moins, il faut concevoir la nature de ces images tout autrement qu'ils ne sont. Car, d'autant qu'ils ne considerent en elles autre chose, sinon qu'elles doivent avoir de la ressemblance avec les objects qu'elles doivent presentent, il leur est impossible de nous monstrent comment elles peuvent estre formées par ces objects, & receves par les organes des sens exterieurs, & transmises par les nergs jusques au cerveau.

It is clear from the quoted passage that Descartes thinks this psycho-physiological account of perception is sufficient to displace the species account, which would hold that “certain images” (sensible species) are conveyed from the object, through the air, to the sensory organs, and then contemplated by the soul. We have seen that the account is not so mysterious as Descartes makes it sound, but there remains an important objection to this account that is indispensable.

In the passage, Descartes claims that, at the very least, what we mean by “species” needs to be understood in an “entirely different way.” In particular, we cannot maintain the claim that there is any “resemblance” between what is transmitted to the sense organs, along the nerves, and up to the brain, and the external objects of sense. The issue of “formal resemblance,” which is integral to the species theory, must be discarded in light of Descartes’ anatomical observations together with his account of the nature of light, and more generally, his underlying theory of matter. For Descartes, an account of perceptual cognition cannot rely on there being any resemblance between our sensory perceptions and the external objects they represent. Instead, there will be only a causal connection. The account will explain sense perception as the product of a series of mechanical interactions. The putative veracity of perception will have to be recovered through an arbitrary representational schema that will ultimately be certified by the power of God, who created human beings with the capacity to decipher its code.

From the Regulae to the Dioptrique

The account of the *Dioptrique* is clearly the *terminus ad quem* of Descartes' theory of perceptual cognition, and it is in virtue of this end that it responds to the scholastic theory. Thus, understanding this text will help contextualize the account in the *Regulae*. However, there are important historical distinctions that need to be drawn between the account in the *Regulae* and the account of *L'Homme* and the *Dioptrique* in order to avoid anachronism. First, it is clear that many of the details contained in the later accounts derive from careful anatomic observations and a theory of physiology, including the circulation of blood and animal spirits, that is largely informed by Descartes' reading of Harvey.⁴⁰⁸ The *Regulae* contains almost no trace of reference to these concerns, since it is concerned with mathematics, general physical theory, and method. Even when Descartes addresses the need for experiments and observation in the *Regulae*, he refers to problems in magnetism, optics, harmonics, astronomy, and gravitation; he does not refer to anatomical observations. It is reasonable to conclude that Descartes turns to these issues after the *Regulae*, when he arrives in Holland, and that they play an important role in his shift of focus. For this reason I will speak cautiously about the details of Descartes' theory of perception, focusing my account of the principles underlying this theory.

Second, the accounts of *L'Homme* and the *Dioptrique* are underwritten by a particular metaphysical thesis about the relationship between mental content and physiological events. The phrase, present everywhere, that such a relation is "instituted

⁴⁰⁸ The best source on these connections is still E. Gilson, *Etudes*, 51-100.

by nature,” suggests an account (or at least a sketch of an account) for why the non-resembling sensations we have could be caused by the motions of matter in the nerves and brain. On Descartes’ mature account, it is God’s omnipotence and perfect creation that has instituted this relation, which is a constitutive element of the mind-body composite (and the source of “occasionalist” interpretations of Descartes, though this is only one possible interpretation of that theory). Such a hypothesis is nowhere to be found in the *Regulae*.

Finally, the account in the *Regulae* serves a different purpose than that of *L’Homme* or the *Dioptrique*. In *La Traité de l’homme*, for instance, Descartes is presenting an account of the physiology of the human being that is consistent with a general cosmology, intended to have been published as *Le Monde*. Thus, the details of perception are intended to fit seamlessly within a larger framework that he had hoped would explain all natural phenomena. The *Dioptrique*, by contrast, has a more limited scope. It is intended to show the merits of the method by demonstrating the effectiveness of Descartes’ theory of light and his law of refraction for producing lenses to enhance vision. Here, the story of visual perception has a clearly instrumental end, i.e., to fit with the subsequent account of the shape of magnifying lenses. In the *Regulae*, by contrast, the theory of perceptual cognition has a more basic purpose, namely, to provide an epistemological justification for the range of applicability of the *mathesis universalis*. In other words, the account of the *Regulae* answers the question: how do our perceptual faculties guarantee that what we discover by virtue of our mathematical method conforms to the way the world actually is? In virtue of this desideratum, the account of the *Regulae*

furnishes a more explicit representational theory that conforms to the mathematical, or geometrical, representation of problems and their solutions. If the account of cognition is correct, then Descartes has shown that we are capable of exercising the method in the way that it has been presented and that we are capable of verifying its results. For this reason I will focus my account on whether and to what extent Descartes' theory of perceptual cognition meets these demands, largely ignoring the metaphysical, physiological, and cosmological questions raised by the account.

In the first section, I will present the basic structure of the account. I will rely on *L'Homme* and the *Dioptrique* in order to flesh out the brief passages from the *Regulae*. All the while, I will try to keep our distinctions between these works at the forefront so that my analysis does not exceed the bounds of what can be inferred on the basis of the text. What we find in the first section is that Descartes presents a coherent causal story of the nature of perception that does not rely on any formal resemblance between sensations and the objects of sensation. Moreover, the suppositions or hypotheses on which this causal story is based are informed by a commitment to a certain concept of mind. The second section will then focus on the imagination, or the internal senses more generally, and describe the nature of representation at that level. It seems that the imagination is really the bridge between the intellect and the sensory faculties. Thus, it plays an utterly critical role in the account. In this section, we can be more specific about Descartes' theory of sensation without resemblance. Finally, I will turn to the operation of the incorporeal power of the intellect, which is said to be wholly distinct from the corporeal powers of sensation. It seems that the chief role of this power, in the *Regulae*, is to

interact with the corporeal powers in a methodical way in order to reliably discover the nature of things. We will examine how Descartes conceives of this interaction between the pure intellect and the body, and we will try to get a fix on the parameters of the pure intellect: What is its nature? How far do its powers extend?

Principles of the psycho-physiological account of perception

In this section, I focus on the ‘principles’ of a psycho-physiological account of perception, since this is what is important for the *Regulae*. In contrast, later accounts will fill out the details, but the later accounts stand to the *Regulae* as the results of scientific investigation stand to a program of scientific research. I will refer to these results in order to confirm or clarify the research program, but I am primarily interested in the program, and thus the principles that underlie it. In a certain respect, Descartes is quite explicit about what his aims are in the beginning of his exposition:

... it would be best if I could explain here what the human mind is, what the body is, and how it is informed by the mind, what faculties within the composite whole promote knowledge of things, and how each acts on its own. But, it seems to me, I lack the space to include all the things I wish, which [I believe] must be set out before the truth about these matters can be made clear to everyone. For I always desire to write in such a way that, before I assert anything that might provide material for controversy, I offer first my reasons, by which I have come to my view, and by which I believe others may be persuaded. But since I cannot do that here, it will be sufficient if I explain as briefly as possible what, for my purposes, is the most useful way of conceiving everything within us that contributes to our knowledge of things. You may not believe, if you do not wish, that things are this way. But what will prevent you any less from following these hypotheses [*suppositiones*], if nothing appears to diminish their truth, and moreover that they make things so much clearer? This is only to follow what one does in Geometry when one supposes certain things about quantity, which in no way weaken the

character of the demonstration, even though in physics one often takes another view of the nature of such quantity. (AT X, 411-12; CSM I, 39-40)

This long passage lays out the state of Descartes' thought and his intentions for the discussion very clearly. First, it is clear that Descartes has in mind, however vaguely, some concept of mind that is distinct from the body and is the informing form of the body. Though this claim is repeated on several occasions in Descartes' work, it is rarely expanded. Some have questioned whether or not Descartes can hold the position that the mind is an informing form of the body, given his mechanistic account of the body.⁴⁰⁹ Yet, this passage makes clear that such an account is a desideratum of Descartes' earliest concept of mind. Indeed, if we glance at the opening sentences of *La Traité de l'homme*, we find a nearly identical sentiment:

These [hypothetical] human beings will be composed, just as we are, of a soul and a body. And it is necessary that I describe to you, first, the body on its own, and a bit later, also the soul on its own; and finally, that I show you how these two natures ought to be joined and united in order to compose human beings that resemble us. (AT IX, 120; CSM I, 99)

Here Descartes takes the rhetorical guise of fabulation that is characteristic of the entire treatise, *Le Monde*. This rhetorical guise has important parallels to the *suppositiones* of the passage from the *Regulae*, which I will discuss below. What I want to emphasize for the moment is that Descartes seems to grant, as a matter of principle that the human being is necessarily composed of a body and a soul, that these each have their own independent character that can be treated separately, and that together they, by a kind of joining or union, make up the entire human being.⁴¹⁰ I do not think that this principle should be

⁴⁰⁹ See, for example, Pasnau, "Form, Substance, and Mechanism."

⁴¹⁰ This is, in fact, what Rodis-Lewis means by the "anthropologie cartésienne," *L'Anthropologie*

taken lightly, despite the fact that it difficult to see where Descartes provides a satisfactory account of it.

Second, it is clear from the *Regulae* passage that Descartes' interest is focused on the "faculties in the composite whole that lead to knowledge of things." This may surprise those who still conceive of Descartes as holding that all knowledge is deduced from innate principles known to the immaterial mind alone. It is quite clear here that he is much more interested in the way the mind interacts with the body to acquire knowledge than in its operation apart from the body (the internal reflection of so-called "Cartesian souls"). Indeed, it is with respect to explaining how the mind receives information from the body and directs the body's actions that Descartes' brief explanation will be "most useful" for his purposes. Though we will leave some of these issues for the third section, a picture of how the mind can accurately receive information about the external world is important for justifying the kind of beliefs that the mind has about the world.

Hypotheses and the account of perception

However, on both of these counts, Descartes is quite cautious. Instead of entering into the murky water of mind-body interaction and separability, he suggests that the reader accept certain *suppositiones* in order to follow the matter to its conclusion. He links this procedure to the *suppositiones* of Geometers who, in searching for some unknown quantity, assume what is sought as given. This, of course, ought to be familiar

cartésienne, 41.

to us as the ‘method of analysis’.⁴¹¹ In the *Regulae*, as if to explain the suppositions involved in the explanation, Descartes goes on to say:

Therefore, it is necessary to conceive, first, that insofar as all of the external senses are parts of the body, sensation is strictly speaking passive, even though we apply those senses to objects by action, i.e., local motion. (AT X, 412; CSM I, 40)

It is not immediately clear how this explains Descartes’ suppositions. However, I think that certain suppositions must be inferred in order for the account to be plausible. First, it is clear that Descartes conceives of sensation to be a physical process like any other, namely, to be explicable through mechanical models of contact between physical bodies. This is why sensation must be strictly speaking passive, i.e., it is a movement effected by the motion of external bodies. Thus, the principle hypotheses about the nature of sensation that will govern Descartes’ explanation of sensory perception are the familiar principles of his corpuscular mechanics. This sort of supposition is much clearer in *L’Homme* where Descartes famously claims that his imagined human beings have a body that “is nothing other than a statue or a machine,” comparing these machines to “clocks, artificial fountains, windmills,” etc. (AT XI, 120; CSM I, 99). Again, the reason for this is quite explicit: there is no satisfactory explanation of bodily motion other than a certain “disposition” (or arrangement) of the constituent proper parts of the mechanism. This is clearly a much more powerful claim than Descartes is entitled to in the *Regulae*, but it is entirely consistent with that account and even seems to be a natural consequence of it.

⁴¹¹ Doyle, *Logic of Descartes’ Method*, 378-85 is particularly effective at linking the *suppositiones* to the method of analysis with respect to Descartes’ *Optics*. More on this below.

More implicitly, in the *Regulae* passage, Descartes seems committed to the existence of an incorporeal power that directs our action, or local motion, toward external bodies. He suggests that there is some active power of the intellect that is necessary for perception, though this active power seems to act only by moving the parts of the body toward external objects. One could say that such a claim is evident from experience of one's free control over one's own actions, but there are familiar objections to that conception.⁴¹² Though almost none of Descartes' predecessors would have been inclined toward a materialist conception of the mental, clearly such ideas were in the air as both Hobbes and Gassendi present a more thoroughgoing materialist conception of cognition. Second, Descartes assumes that this incorporeal power is unified, or that its powers are nothing but the power of one single cause. One can understand this either in the way that it is presented in Rule I, namely, that there is a unified "intellectual light" that makes all knowledge possible, or it can be understood in terms of the 'ego' of the *Discours* or *Meditationes*. Clearly the former conception is a weaker claim that is closer to the purposes of our present investigation, but it is closely related to the later metaphysical picture of independently existing substantial entities whose principal attribute is to be the bearer of thoughts. And finally, Descartes seems to assume (as we will see) that in order for the single, incorporeal power to interact with the body, it needs a central locus of action, or a unified corporeal body that in some way receives and directs the actions of

⁴¹² These usually come under the heading of "problems of mental causation," where it is fairly easy to perform a kind of *reductio* argument against the idea that immaterial minds have causal efficacy in a material world. In contemporary philosophy, it is generally assumed that the burden of proof is on the side of those who would propose that mental causation exists, not the other way around.

the incorporeal power to the rest of the body and communicates bodily sensations to that power.

This final assumption is also consistently maintained throughout Descartes works; it is the source of his hypothesis that the “pineal gland” is the seat of the soul (cf. *Principia* IV, §189). However, it is a curious claim that leads to the charge of the soul’s status as a “pilot in a ship” or an inner homunculus despite Descartes’ explicit (and repeated) protestations to the contrary. One wonders: if Descartes really conceives of the mind as an incorporeal entity that informs the body, is intimately connected to every part or it, and is the cause of the body’s actions, then why doesn’t he allow for some broader notion of causal interaction between mind and body? In other words, why not just think of the mind as having causal effects in several places at once? There should be no threat to the unity and identity of the mind on this account. St. Thomas and those who followed him, for instance, insisted that the rational soul was the true cause, or the principle, of all bodily actions, governing the vegetative and sensitive souls through its eminent power. There doesn’t seem to be anything preventing Descartes from making such a claim, though we will see that he had a very incomplete picture of how the brain worked, and that the imperfections of his physical account of the body may have lead him to suggest that the soul interacted with the body at a single point. Fortunately for us, these problems are largely background issues that we can be aware of but need not focus on in order to understand the account in the *Regulae*.

However, there is a much more directly relevant issue raised by the passage we have been considering and to which we must respond. Given that I have already

suggested that the account of cognition in the *Regulae* is intended to provide an epistemological justification for the larger scientific project, one might wonder if the implicit and explicit suppositions we have been outlining undermine such an attempt at justification. In other words, how can Descartes rely on his account of perception as a justification for his method if the account itself depends on certain substantial assumptions that he cannot defend? Interestingly, the two sections of Rule XII that occupy these last two chapters of the thesis both begin with a series of suppositions or hypotheses. The second half of Rule XII compares these hypotheses to those that astronomers make when constructing “those imagined circles” (or epicycles) to explain celestial phenomena: “here, much in the same way as above, certain things are assumed which surely not all are inclined to agree with” (AT X, 417; CSM I, 43). The allusion to astronomical hypotheses is useful because it refers us to Descartes’ discussion in the *Principia* III, §15. In that paragraph, Descartes compares the position of the astronomer to the position of a sailor at high seas who cannot tell, just by looking, whether the movement of other ships around him is the result of their own proper motion, or of his motion relative to them.

In the same way, the paths of the planets, when seen from the earth, are of a kind which makes it impossible for us to know, simply on the basis of the observed motions, what proper motions should be attributed to any given body. And since their paths are very uneven and are very complicated, it is not easy to explain them except by selecting one pattern, among all those which can make their movements intelligible, and supposing the movements to occur in accordance with this. (AT VIIIa, 85; CSM I, 250)

Descartes goes on to discuss the hypotheses of Ptolemy, Copernicus, and Tycho Brahe, who begin with different assumptions (geocentrism or heliocentrism) and then attempt

to explain the observed motions of the planets on that basis. Indeed, this example is strictly analogous to Descartes' recommendations in geometry. When describing his method for solving the Pappus problem, Descartes suggests that we simply choose two lines, arbitrarily, and treat these as the coordinate lines for reference.

First, I assume that the problem is already solved and, in order to untangle the confusion created by all these lines, I consider one of those given and one of those sought, for example, AB & CB, as the principle lines according to which I undertake to refer all the others. (AT VI, 382-83)

This, of course, is the ingenious Cartesian coordinate system. What is so remarkable about it is that the arbitrariness of the initial choice of axes (principle lines) has no effect on the solution, provided that all relations are kept constant. The same is true for the astronomical observations.

In the particular case of perceptual cognition, there is no strict analogy (no one is assuming that the objects cognized are actually the cognizers, for instance). The case of perception is more closely related to the general case of empirical observations, which Descartes also addresses in part III of the *Principia*.

The principles which we have so far discovered are so vast and so fertile, that their consequences are far more numerous than the entire observed contents of the visible world; indeed, they are so numerous that we could never <in a lifetime> make a complete survey of them even in our thought.... Our purpose is not to use these phenomena as the basis for proving anything, for we aim to deduce an account of effects from their causes, not to deduce an account of causes from their effects. (AT VIIIA, 81-2; CSM I, 249)

Does Descartes mean to say that empirical study is strictly deductive or *a priori* as opposed to inductive or *a posteriori*? How would this justify assuming controversial premises for the purposes of deduction? These sorts of questions are a red herring prompted by the somewhat loose sense of “deduce” in the passage. What Descartes

means to say is simply that the account he is about to provide is based on certain principles that not everyone will agree with. What he hopes is that the account explains the phenomena, the effects, on the basis of these principles, i.e., as deduced from them, in such a way that it renders those principles plausible.

Some may be inclined to doubt the sincerity of this talk about hypotheses since Descartes goes on to admit that his suppositions are almost certainly false, and in contrast affirms the belief that the earth, in fact, does not move (since motion is relative to surrounding bodies, III, §28) and that God, in fact, created the earth in perfect order (even though he will try to provide an account of the universe as a process of generation out of equally distributed matter in motion, III, §§45-47). Surely, Descartes cannot be serious about these thinly veiled attempts to comply with orthodoxy. And I doubt that he was as committed to the falsity of his suppositions as he would like us to believe.

Nevertheless, there are a number of very important lessons to draw from these discussions that Descartes is utterly serious about. First, Descartes' definition of motion as "the transfer of one body from the vicinity of the other bodies which are in immediate contact with it" (AT VIIIa, 90; CSM I, 252) is central to Descartes' physical explanation. Second, the principle that "if we want to understand the nature of plants or men, it is much better to consider how they can gradually grow from seeds than to consider how they were created by God at the very beginning of the world" (AT VIIIa 100; CSM I, 256) is again a fundamental belief driving Descartes' scientific project.⁴¹³

⁴¹³ For more on the importance of these concepts, see D. Garber, *Descartes' Metaphysical Physics*.

Closer to our purposes, Descartes also goes on to claim that we cannot hope to understand the nature of the world through deductive reasoning alone, since there are any number of possible ways that God could have created the world in accordance with the way we perceive it. In order to distinguish which way God actually created the world, Descartes says, “experience alone must teach us which configurations he actually selected in preference to the rest” (AT VIIIa, 101; CSM I, 256).⁴¹⁴ He continues, “We are thus free to make any assumption on these matters with the sole proviso that all the consequences of our assumptions must agree with our experience” (ibid.; CSM I, 256-57). In this case, as in so many others, Descartes takes matters of faith seriously because doing so is instructive. Indeed, by addressing each of these issues, Descartes is able to demonstrate the underlying elements of his philosophical physics that are the truly radical. That motion is considered as relative local motion, that generation is explanatory of physical natures, and that our assumptions must accord with experimental evidence, these underlying principles are utterly foundational for the Cartesian project.

Moreover, we should not be concerned with charges of circularity here. It is not the case that Descartes is assuming causes in order to deduce effects that are, in turn, meant to prove the veracity of those causes. Fr. Morin levies just this charge against Descartes in response to his claims at the end of the *Discours*. At the end of that work, Descartes had attempted to preempt any concerns his readers may have about the principles underlying his *Dioptrique* and *Météors*. He assures them that they will be satisfied by his account if they read through it in its entirety.

⁴¹⁴ In this respect, Descartes was much more of an empiricist than Leibniz.

For it seems to me that the reasons follow one another in such a way that, as the last are demonstrated from the first as causes, the first are reciprocally proven from the last as effects. And one need not imagine that I commit the error that logicians call a circle; for experience renders most of the effects very certain, such that the causes not so much serve to prove them as to explain them; on the contrary, it is they [the causes] that are proven by them [the effects]. (AT VI, 76)

To this, Morin had objected, “if it is true that to prove some effects by a supposed cause, and then to prove this same cause by these same effects, were not to reason in a circle, then Aristotle misunderstood it, and [in fact] one might say that no one could ever commit such a fallacy” (AT I, 538). In response, Descartes insists that “there is a great difference between ‘to prove’ and ‘to explain’” in the passage of the *Discours*. He claims that “one may use the word ‘to demonstrate’ to mean the one or the other” (AT II, 198). Thus, Descartes is proposing that only the effects can *prove* the truth of his assumed causes, while these causes are meant to *explain* those effects. As a matter of fact, the effects need no proof at all since they are the evident data of experience! The causes, on the other hand, are potentially disputed (such as was the case in the heliocentric model of the universe); their truth can only be assessed on the basis of their capacity to explain the apparent effects. This seems like just the sort of thing we expect from scientific theories. The explanatory power of the account itself is meant to justify the assumptions. If the account satisfies the objectives it sets out, then the assumptions ought to be accepted until they can be supplanted by other assumptions and another account.

Given the principle assumptions mentioned above—that the only causal powers are either bodily, which are mechanical, or mental, which direct local motion, and that perception is a result of the interaction between these two powers (through a central processing organ)—what is Descartes’ account of sensation?

... [S]trictly speaking to sense is simply to undergo change [*per passionem*], which has the same character as when wax receives the figure [*figura*] of a seal. We ought to state this not by analogy, but conceiving of it in exactly the same way, the external form [*figura*] of the sentient body is really changed by the object, just as that, which is on the surface of the wax, is changed by the seal. This is the case, it must be acknowledged, not only when we touch some body as having a shape [*figura*], or hardness, or roughness, etc., but also when our touch perceives heat, or cold, and similar qualities. It is the same with the other senses: thus, when the first opaque membrane [*primum opacum*] of the eye assumes the shape [*figura*] impressed upon it by the illumination of various colors; and in the ears, the nose, and the tongue, by virtue an object up against its impervious membrane [*objecto imperviam*], it is changed to some new shape [*figura*] from the sound, odor, or flavor. All of this is a most helpful way of conceiving of these matters, since nothing more easily falls under the senses than shape [*figura*]. (AT X, 412-13; CSM I, 40)

First of all, we are told to conceive of sensation as an actual alteration of the external form or shape of the sensory faculties: sight, hearing, smelling, touch, and taste. This alteration is to be conceived not on analogy with the way that wax receives the form of a seal but in exactly the same way. Let us set aside the clearly essential role that this new concept of *figura* is playing in the passage above. It is clear that this notion is meant to revise and supplant the notion of *species* that had governed the scholastic account. For the moment, however, I want to focus on the change by way of contact that characterizes the interaction between the sense organs and the objects of sensation.

It is obvious that this notion of some kind of direct contact between the organs of sense and the external world, by which sensation occurs, follows the general mechanical principles of Descartes' method of explanation. However, it is not clear exactly what Descartes has in mind to explain this contact. He is careful to extend the description from the case of touch, where such contact seems obvious, to our distal sense perceptions, such as sight and hearing. With respect to vision, he claims, "the opaque membrane of the eye

assumes the shape impressed upon it by the illumination of various colors.” This account is also extended to include the other faculties: “and in the ears, the nose, and the tongue, by virtue an object up against its impervious membrane, it is changed to some new shape from the sound, odor, or flavor.” In order for such an account to make any sense, Descartes must believe that he is in possession or close to possession of a corpuscular account of sensation.

The mechanics of vision and hearing

If we focus on vision, we discover an account of the corpuscular mechanism underlying visual perception in *La Traité de la lumière*. There, Descartes proposes to understand the nature of light by first turning to the nature of fire, since the flame is one of the primary sources of illumination. He makes an important methodological provision and then he poses an enlightening thought experiment:

... as for myself, since I fear deceiving myself if I suppose anything more than what necessarily must be the case, I am content to conceive in this [the action that burns the fire] a movement of its parts. For, place yourself in front of a fire, place it where [you feel] some warmth, and then allow it to burn, as much as you like. If you do not suppose in that case that there are some small parts that move against you, or that these parts detach from their neighbors, then I do not know how to imagine that you receive any alteration or change. (AT IX, 7; CSM I, 83)

Beginning with the principle that no change can be accounted for without contact, Descartes is left with no other way to explain the heat of a fire than to suggest that there are certain very small particles released from the fire that come in contact with the skin. He supposes that, not these, but similar small particles can account for the nature of light

that comes from the fire as well as its heat.⁴¹⁵ In the *Dioptrique*, this mechanism is explained through the examples of the blind man's canes, the wine vat, and the tennis balls. Again, Descartes does not pretend that these analogies describe things exactly as they are, but they are like suppositions or hypotheses about the nature of things that make the account easier to comprehend.⁴¹⁶ With respect to the case of the blind man who senses objects with his canes, Descartes describes the nature of light in perfectly mechanistic terms.

And to take from this a comparison, I would like you to think of light as nothing other than some thing in those bodies that we call luminescent, which has a certain movement, or a very prompt and lively action, which passes toward our eyes, by the intervening air and other transparent bodies, in the same way that the movement or resistance of bodies, which the blind man encounters, pass toward his hand, by the intervening cane. (AT VI, 84; CSM I, 153)

So the light passes to the surface of our eyes, from the light source, or from illuminated objects, in the same way as the movement of one end of the blind man's cane passes to his hand. In short, all sensation is a kind of touch, a direct contact with physical bodies by which the sensory faculties are moved by those bodies.

Descartes is not very clear in the *Regulae* passage we have been considering how the mind is capable of receiving the impressions of the tiny corpuscles of light, nor how the light received in on the "opaque membrane" of the eye is transmitted to the brain and interpreted as color sensations. By the time of *L'Homme*, he is in possession of a more

⁴¹⁵ I am being cautious here, because when Descartes introduces the account of vision in *L'Homme*, he describes the contact with the membrane of the eye by virtue of those particles of the 'second element', which are the imperceptible round particles of air, as opposed to the infinitesimally small and active 'first element' that is identified with fire. Cf. AT IX, 24ff.

⁴¹⁶ It is noteworthy that Descartes again refers to the "astronomers" in defense of his use of analogies in the *Dioptrique* (AT VI, 83).

complete account of the nature of sensation by virtue of a theory about the nerves, the circulation of animal spirits, and the anatomy of the eye and brain. Descartes' debt to anatomical observations of others is evident throughout *L'Homme*: he frequently refers to *les Anatomistes* and follows the given names of the anatomical parts of the body that he discusses. He did not leave it to the authority of anatomists, however, engaging in dissections and anatomical experiments of his own (see *Anatomica*: AT XI, 549 ff.).

These empirical observations allow Descartes to fill in the gaps in his initial theory, but the entire account is regulated by the same principles: sensation is a kind of alteration, and all alteration is explained by the direct contact of solid bodies. What Descartes adds to the account is a description of the nerves, or more precisely, the *petits filets* that are contained within the nerves, along with an enveloping tissue and the animal spirits. These little nets or filaments (they were called 'fibrils' in England) are distributed throughout the body and connected, ultimately, to a central processing center in the brain: the pineal gland and the surrounding cavity. The brain itself is to be conceived simply as a very peculiar sort of soft tissue, containing pores through which the animal spirits (those very small and lively particles circulating throughout the body) can pass freely (AT IX, 170ff.). When tugged by external objects acting on the surface of the body, the filaments of the nerves open pores in the gland that releases animal spirits into the inner cavity of the brain. Descartes contends that these movements are fine-grained enough to communicate all different sorts of sensations. In the section treating the nature of touch, he notes, one movement of the nerves causes "a certain bodily fullness that is called titillation [*chatoûillement*], and which, as you can see, being so close to pain in its cause,

is completely contrary in its effect” (AT XI, 144; CSM I, 103). Thus, a slight difference in movement, or texture, of the corpuscles affecting the external sensory membranes could cause radically different sensations, by virtue of a difference in the characteristics of the animal spirits released.

Descartes’ description is particularly effective when he discusses the case of music. Here, he draws on his work in harmonics to show that certain sounds are more pleasing than others by virtue of the movement of air, or the concussive impulses, that occur in the cavity of the ear. He shows that a certain combinations of pitches, particularly a major third, fifth, or octave are most pleasing to the ear by virtue of the ratio between those pulses of sound. And he observes that the same pitches, when combined differently, can give rise to very different sensations. Thus, “it is not the things that are in an absolute sense the most sweet, which are the most agreeable to the senses, but those which titillate the senses in a more temperate way” (AT IX, 151). The same account is repeated in the case of colors, where agreeable or disagreeable natures are differentiated by the proportional relations between the colors that create either a temperate effect (agreeable) or a dissonant effect (disagreeable) (AT IX, 158). Moreover, internal dispositions of the body can react with the external object to create different sensations at different times. Descartes describes how a piece of meat can give one a sense of pleasure at one time, but taste bland or even unpleasant on another occasion, by virtue of a change in the saliva, which he thought to come from the stomach. “And this is so generally true,” he says, “that often, just as the temperament of the stomach changes, so the effect of taste changes also” (AT IX, 147). Of course, such an analogy could be

extended to the disposition of the animal spirits or the brain, such that a particular sensation occasions a different emotional or intellectual response at different times. On this understanding of sensation, it is easy to see why all sensory qualities ought to be conceived of as relative to the perceiver. This does not necessitate that all sensory qualities are “solely mental” as opposed to “real”; it could entail a sort of response-dependent, indexical, or dispositional interpretation of sensory qualities. There is nothing in these texts to decide between those interpretations. However, it is clear that, for Descartes, sensory qualities are not “real” in the sense that they play any causal role in the process of cognition. In this sense, he opposes a basic plank of the Aristotelian/Thomistic theory of cognition outlined above.

If we return to the case of vision, which Descartes admittedly spends more time on and discusses in more detail than the other senses, we get a clear explanation of the causal interaction from motions in external objects to the nerves and brain. Here, he can make use of the retinal image to clarify the shape (*figura*) of internal sensation. He claims that this image has a neurological correlate in the pineal gland, through the transmission of animal spirits. The figure, traced on the back of the eye, is immediately transferred, through the optical nerve to the interior of the brain. Descartes imagines that the optical nerve opens specific pores in the central cavity of the brain (just as in the case of touch), such that these pores release animal spirits which, in turn, move the pineal gland in a specific way corresponding to the figure seen (AT XI, 174-75; CSM I, 105).⁴¹⁷

⁴¹⁷ This relation can be quite wide-ranging, though Descartes probably conceived of it in mathematical terms. See Betsy Newell Decyk “Cartesian Imagination and Perspectival Painting,” in *Descartes’ Natural Philosophy*, eds. S. Gaukroger et al, 447-86.

Descartes understands this action of the animal spirits using two different models or analogies: a church organ and the wind against the sails of a ship. The analogy of the church organ helps to explain the way that the pores of the nerve endings, directing animal spirits through different paths, could produce diverse sensations. Descartes compares the external objects to the fingers of the organist, the animal spirits to the air from the organ's bellows, and the pores to the pipes of the organ, which, simply by virtue of the quantity of air in certain pipes produces either harmony or discord (AT XI, 165-66; CSM I, 103-04).⁴¹⁸ In similar fashion, he claims, only four factors are necessary to account for "all the diverse humors or natural inclinations that are in us": the quantity of animal spirits, their size, their movement, and the relation to those of some other time (AT XI, 166; CSM I, 104). The analogy to the wind in the ship's sails allows Descartes to explain more precisely the material nature of the brain and the way that it is moved by the animal spirits. The organ analogy highlights the diversity of effects that can be produced through changes in only a few different characteristics. However, the human brain, as Descartes was well aware, was not composed of rigid pipes or mechanical keys, like the organ. Instead, Descartes knew the brain tissue to be quite malleable, such that slight changes in the animal spirits could move the tissue of the brain and alter the nerves attached to it, just as the sails of a ship tug on the ropes attached to them. "...[B]ut," he says, "the source that produces these spirits is ordinarily so abundant, that to the extent that they enter in the cavity, they have the force to push all around the material that surrounds them, and to inflate it, and by such means to tug on those little nerve fibers that

⁴¹⁸ See G. Hatfield, "Descartes' Physiology and Its Relation to His Psychology," in *The Cambridge Companion to Descartes*, 335-70, esp. 346.

come from them: just as the wind, being moderately strong, can inflate the sails of a ship, and tug all the cords to which it is attached” (AT XI, 173). We thus have an image of a very flexible and malleable substance that can be modified by tiny, invisible particles in order to produce a wide variety of effects. The whole process is directed by way of the pineal gland, from which the animal spirits issue and by which they can be directed into the various tissues of the brain (AT XI, 170-71).⁴¹⁹

Figures or images impressed in the brain

In order not to get bogged down in the details of Descartes’ physiological account of the brain and nervous system in the *L’Homme*, we ought to return to the *Regulae* to see what is really at issue in all of this. When Descartes describes the relationship between corporeal-physical motions in the brain with motions in the senses excited by external objects, he invokes terminology borrowed from Aristotelian faculty psychology. I will postpone a discussion of these internal faculties of sense to the following section. Here, I am more interested in the appeal to mechanical analogies:

Secondly, when an external sense organ is stimulated by an object, the figure which it receives is conveyed at one and the same moment to another part of the body known as the ‘common’ sense, without any entity really passing from the one to the other. In exactly the same way I understand that while I am writing, at

⁴¹⁹ It is possible to be somewhat more critical of Descartes’ account than I am being here. Celia Wolfe-Devine claims that Descartes resorts to the animal spirits in order to hedge against the obvious inadequacies of his theory of the pineal gland. In particular, she claims that Descartes wants his account to provide a means of transmitting an image from the retina to the brain. It is unclear how the animal spirits could convey this kind of information. She suggests, “The most likely explanation for these theories being propounded by Descartes is that they are a carryover from the Aristotelian tradition, in which the cardiovascular system carries out many of the sensitive functions later assigned to the nervous system. Descartes does very little to integrate these earlier views with his own and seems to include them by force of habit without thinking out the mechanisms of the process very thoroughly,” *Descartes on Seeing*, 61.

the very moment when individual letters are traced on the paper, not only does the point of the pen move, but the slightest motion of this part cannot but be transmitted simultaneously to the whole pen. All these various motions are traced out in the air by the tip of the quill, even though I do not conceive of anything real passing from one end to the other.... Thirdly, the ‘common’ sense functions like a seal, fashioning in the phantasy or imagination, as if in wax, the same figures or ideas which come, pure and without body, from the external senses. The phantasy is a genuine part of the body, and is large enough to allow different parts of it to take on many different figures and, generally, to retain them for some time; in which case it is to be identified with what we call ‘memory’. (AT X, 413-14; CSM I, 41-42)

The analogy with the wax and seal is simply a reference to the prototypical analogy passed down from antiquity. Descartes uses it in several places and never seems to distinguish the “pictorial” character of the analogy, which implicitly endorses a kind of representation through resemblance, from his non-resembling representations.

I will pass over this analogy for the moment and focus on the pen. That analogy recalls his account of the movement of light (I am here thinking of the analogy of light with the blind man’s cane). According to that model, Descartes imagines light to transmit information instantaneously, by virtue of the contact that light corpuscles have with each other. In the passage above, the nerves (or the body more generally) are compared to the way a pen traces letters on paper at the same time as its upper portion traces figures in the air. These figures in the air are not the same as those letters on the paper; that upper movement is “quite different and opposite” to the movement of the letters. Nevertheless, the information is transmitted instantaneously from one end to the other in the same way that the external transmit information to the internal senses. The whole process is explained in material terms, by means of the contact between bodies. He describes an isomorphism between the external senses and the internal senses in terms of *figurae*:

presumably the shape, motion, and quantity of particles. He provides no details about how the “figures” in the brain are correlated with figures in external bodies, but he presumes that this can be explained using simple analogies, such as the pen. We can return to our images of the church organ and the boat’s sails to help make the picture more vivid, but the essential point to take from the description is that Descartes believes he is in possession of a mechanistic explanation of perception that accounts for how our brain may receive precise information about the external world through the mechanical contact of bodies.

The movement in the brain, whether in the common sense, imagination or phantasy, is both the locus of all of our mental information about the world and the source of local motion. In the *Regulae*, Descartes calls this point of interaction the phantasy, which, he says, “is a genuine part of the body” and the source of mental images, either produced on its own, occasioned by perception, or remembered. He is clear that whatever information the phantasy receives from the external world, it does not receive this information by virtue of the passage of some particular body. These figures arrive in the brain, Descartes claims, “pure and without body, from the external sense.” I believe this means that the information is encoded in the shape and movement of particles, and does not require the transmission of the external body. This should not imply in any way that this information is immaterial, or spiritual. Rather, it indicates the kind of material information that is passed along the nerves, namely, one that identifies the modes of material bodies, their shape, size, quantity, and movement.⁴²⁰ Along the

⁴²⁰ Jean-Marie Beyssade is quite helpful in this regard. Beyssade tells us, through an analysis of

lines of the analogy with the church organ or the ship's sails, it is easy to imagine how the alterations of shape, size, quantity, and movement of the small particles and malleable passages in the brain could convey a wide variety of information about the shape, size, and movement of external bodies. Descartes stresses that there is no need for the internal "figures" of the brain to resemble the apparent figures of external things. Just as there is no resemblance between the organ's keyboard and the air passing through its pipes (or the notes for that matter), there need be no resemblance between the activity of my brain when I see red and the redness of that red patch I am seeing.

Thus, the brief description in the *Regulae* makes it clear that Descartes believed he could offer an adequate mechanistic interpretation of perception that had no need for the species theory prevalent in the Aristotelian tradition. Moreover, the fact that Descartes could provide a mechanistic explanation of perception that could plausibly account for the accuracy of our ordinary perceptual faculties lent an epistemological justification for his broader mechanistic project. In other words, he would be able to provide a complete story about the nature of the material world—our sensory faculties included—that tells us why we can rely on those sensory faculties even though our ordinary sense perceptions in no way resemble the world described. He gives us a mechanistic explanation for how our sensory faculties accurately convey information

the analogy with the pen, that "La figure vient du sens externe au sens commun pure de tout corps. Elle arrive comme elle était partie: purement corporelle, mais sans aucun corps ou partie de corps qui fasse avec elle le voyage" (84). This interpretation is ultimately based on the Cartesian distinction between a thing, or substance, and its *modes* rather than a distinction of substances (86). Thus, the common sense represents what a generic change in the mode of extended substance and thus, through some coded connection with thought, the image. The image present in the common sense is not itself a thing, but is characterized by modes that can be correlated with the modes of the actual, extended thing.

about the external world even though nothing in his explanation relies on the way we ordinarily perceive the world. In contemporary language, we could say that the physiological account of perception does not rely in any way on the phenomenology of perception (in marked contrast to late scholastic accounts). Yet, even though our sensations do not resemble the way the world is, our sensory faculties are reliable because, Descartes' theorizes, they are in direct causal contact with the physical world. In effect, Descartes pushes the problem back: we no longer need to find a naturalistic explanation of species; we now need an account of how to explain the connection between our mental life and the complex mechanistic system that gives rise to sensations. This is the origin of the mind-body problem.⁴²¹

The internal senses, ideas or images, and representation

We now have a fairly clear picture of Descartes' naturalistic explanation of perception, by way of a contact between bodies in motion. In order to fill out this picture, Descartes relies on several models or analogies to illustrate the operation of the sensory faculties. In his mature account, which was formed by the early 1630s with the

⁴²¹ In stating this conclusion, I simply confirm what Gilson had indicated three quarters of a century ago, *Etudes*, 141-190. Consider also P. King, "Why Isn't the Mind-Body Problem Medieval?" in *Forming the Mind*. King identifies the mind-body problem with the "hard problem of consciousness," i.e., to explain the relation between the nature of our sensations and the bodily processes that cause them. He carefully and precisely demonstrates that this problem could not be medieval because, from the time *sensatio* entered the Latin philosophical lexicon, it identified, precisely, those physical processes that produced sensations. This implied the impossibility of disembodied souls having anything like sense-perceptions. In short, Latin medievals would not have accepted the possible existence of "zombies" and so the current language used to discuss the mind-body problem would have found no traction.

composition of *Le Monde* and *La Dioptrique*, Descartes relies heavily on the postulation of small and lively particles (light corpuscles and the animal spirits) to convey information about the external world to a central processing center in the brain, specifically, the cavity surrounding the pineal gland. The lack of a real physiological basis for postulating such a role for the pineal gland was beginning to be apparent to Descartes and the Cartesians of the 17th century. Louis de la Forge, in his *Rémarques* on the *Traité de l'homme*, is forced to justify the clear misrepresentation of the size and function of the pineal gland in his sketches.⁴²² Mersenne, too, seems to have questioned Descartes' hypothesis about the function of the pineal gland, prompting a very telling response. In a letter dated April 1, 1640, Descartes insists on the necessity to posit some central locus of interaction between the soul and the brain in order to account for the capacity to easily imagine a variety of things that one has not even seen: "... isn't it this gland alone to which the soul must be thus joined; for there is no other, in the entire head, that is not duplicated" (AT III, 47-48). However, in the same letter, Descartes is forced to admit that he had never actually been able to find the pineal gland in a human brain, and that it must have been so small that it was very hard to see.

Three years ago, wanting to see an autopsy of a woman at Leiden, I looked for [the pineal gland] with great curiosity, and knowing quite well where it ought to be, having been accustomed to find it in freshly killed animals without difficulty, it was entirely impossible for me to recognize it. An elderly Professor of anatomy, named Valcher, confessed to me that he too had never been able to see it in any human body... (AT III, 49)

⁴²² See AT XI, 170 note b for reference to La Forge: "... comme l'Auteur dira quantité de choses de la glande, laquelle j'ai représentée notablement plus grosse que le naturel, et que n'ont accoutumé de faire les Anatomistes dans leurs figures...."

To explain this, Descartes postulates that the gland would diminish in size if the person were ill or if the body had been deceased for a period of time. Descartes postulates that since the brain was not the first organ typically investigated, the pineal gland must have already shrunk before it was even investigated. However, it seems clear that this is a vain attempt to explain away what was an obvious difficulty for Descartes' account of cognition.

Given the obvious lack of any physiological reason for postulating the pineal gland as the "seat of the soul," we must suppose that Descartes was motivated to such a conclusion for philosophical reasons. Indeed, as I have cited above, the principle reason for maintaining such a theory of brain functions was that Descartes believed there must be a single point of interaction between the mind and body. This bodily organ had to account for all variety of mental acts through a mechanical interaction with the rest of the body. For this reason, the organ could not be duplicated in another part of the brain, and it had to have the potential for a great range of motion. It seems that not only did Descartes blithely ignore empirical difficulties with his theory, but he also seemed to be looking for the wrong thing. The fact that he was looking for one, single part of the brain or organ in the body could be responsible for *every* mental operation dooms his investigation from the start. The relationship between mind and brain is no doubt a great deal more complicated than Descartes realized. But he cannot be faulted for having failed to find a seat of the soul in the brain! Such a locus of unification and interaction for consciousness seems far from our reach even today. At least in terms of a theory of mind-body interaction, Descartes' problems are our own. Nonetheless, I find it unfortunate that

Descartes insisted on a single organ to account for interaction. The scholastic notion of form seems much more flexible than this hypothesis.

The internal senses

For this reason, it will be quite informative to examine the way that Descartes accounts for the various faculties of higher thought, the so called ‘internal senses’, and their function in mental representation. Recall that it was Averroës who first codified the various internal senses and described their function in cognition. He believed that there were five internal senses: the common sense, imagination, phantasy, memory, and estimative power. However, by the end of the sixteenth century, few thought there was a distinction between imagination and phantasy, and many sought to collapse these with the common sense. By that time, the estimative power had also lost its grip as a unique faculty of the mind, as can be seen in Toletus as well as in the medical tradition. Thus, when Descartes refers to these faculties of internal sense, he does so in a justifiably loose way. We will note differences in his terminology, but the purpose of our investigation into these internal faculties of sense will be ultimately to understand their role in Descartes’ explanation of mental representation. For almost all late scholastic authors, as for Descartes, the internal senses are the means by which human beings and higher animals are capable of representing the world in a certain way.

In the previous section, we saw Descartes refer to the transmission of information from the external senses to a “common sense”: “when an external sense organ is stimulated by an object, the figure which it receives is conveyed at one and the same

moment to another part of the body known as the ‘common’ sense, without any entity really passing from the one to the other.” I had commented that this transmission of information involves conveying the modes of the corporeal bodies of the external world with which the human body is in contact (whether immediately or by virtue of some intervening medium). It is clear from *L’homme* that Descartes understands the animal spirits to play the role of transmitting this information immediately to the brain. However, it is unclear where or what the common sense ought to be. From the fact that Descartes devotes a separate paragraph to the description of the common sense in the *Regulae*, it appears that, at that time, he conceived of it to be a distinct faculty from imagination or phantasy. In the beginning of the paragraph treating imagination, he claims “the ‘common’ sense functions like a seal, fashioning in the phantasy or imagination, as if in wax, the same figures or ideas which come, pure and without body, from the external senses.” A natural reading of this sentence would seem to entail that the common sense is distinct from the imagination, but that the imagination is possibly identified with the phantasy; it is what fashions figures or ideas *in* the imagination or phantasy.

According to the *Regulae*, the *fantasie* “is a genuine part of the body” that is called imagination when it produces or receives images, but can also be called “memory” when those images are retained. The imagination, or “corporeal imagination,” is also identified with a part of the brain which is the origin of the body’s “motive power” or force of movement. Here, the corporeal imagination must be identical to, at least physically it would seem, the phantasy. Consequently, we can reasonably suppose that, at

the time of the *Regulae*, Descartes conceives of the pineal gland as the locus of phantasy, imagination, and memory, while the common sense appears to be some collection of information from the external senses prior to the reception of images or figures in the gland.

While it is consistent with the prevailing Thomistic psychology to differentiate between the bare collection of sensory information in the common sense from the formation and reception of images in the imagination, this is not the same way Descartes conceives of these internal faculties in his more mature physiological studies. In *L'Homme*, when Descartes refers to the common sense, he does so invariably in conjunction with imagination. The section where he treats the nature of these faculties most carefully (AT XI, 174-79) confirms that there is no substantive distinction between the imagination and common sense, only a distinction in function.

The entire section is concerned primarily with specifying the nature of our ideas of objects, which, Descartes says, is the “most remarkable” function of the brain (AT XI, 174). Ideas, in this sense, are simply all those “impressions that the [animal] spirits may receive when emitted from the [pineal] gland.” Some of these are attributed to the common sense “as long as they depend on the presence of some object,” while others may come from “many other causes . . . and thus they ought to be attributed to the imagination” (AT XI, 177). In this more mature rendering of the internal faculties of sense, Descartes is careful to differentiate those faculties according to their function, much the same way as the theories in late scholastic psychology that we have seen. The common sense has to do with the formation of ideas (or sensible species) in the presence

of some external object, while the production of images in the absence of an object (whether in the form of some desire or fantasy, etc.) is attributed to the imagination. Again, it is noteworthy that the estimative power is entirely absent from this description, but that would not have been uncommon for a thinker at the beginning of the 17th century. (To my mind, this is a great shame, since the estimative power is quite a powerful functional concept that can be easily differentiated from imagination or common sense. Descartes may endorse something like this internal calculative power in his concept of “natural geometry.”⁴²³) Moreover, Descartes’ functional differentiation of the internal faculties does not rely on any specific bodily organ to be identified with the faculty. Rather, the presence of certain kinds of corporeal ideas (by which I mean certain configurations of animal spirits in the brain) is “attributed” either to the imagination or to the common sense. This is a much more useful way of conceiving of the faculties, one that does not rely on a reduction of faculties to parts of the body, but conceives of faculties as reducible to bodily *operations*, and thus second order properties of body parts.

The utility of such a conception can be readily observed in Descartes’ discussion of memory. In *L’Homme*, Descartes describes the formation of ideas in terms of the passage of animal spirits along the “tubes [*tuyaux*]” in the brain. Imagine again the church organ, where air passes along the pipes of the organ to produce various sounds; or think of the sails of the ship that are much more malleable, but through a similar effect,

⁴²³ See N. Maull, “Cartesian Optics and the Geometrization of Nature,” in *Descartes: Philosophy, Mathematics, and Physics*, 23-40, for a full account of the role of Descartes’ concept of “natural geometry” in his theory of perception.

i.e., the passage of wind, allow various impressions that tug on the ropes connecting the sail to the mast. Initially, Descartes says, these spirits do not pass into the tubes of the brain “so easily or so perfectly.” But if the action of those spirits is “stronger,” “remains for a longer time,” or “is reiterated many times,” then the brain becomes more susceptible to the passage of those particular spirits, and thus to the reproduction of that particular image. “And this,” says Descartes, “is what *Memory* consists in” (AT XI, 177-78). He compares this passage of animal spirits to the perforation of a tissue with a pad of needles. In this way, “[the spirits] have the force of forming certain passages which remain open, even after the action of the [external] object ceases; or, at least, if they close again, there remains a certain disposition in the nerve fibers of which this part of the brain is composed, by which they can much more easily be opened afterward” (AT XI, 178). Clearly this description does not appear to accommodate neuroplasticity (a demonstrable feature of the brain in contemporary neuroscience), but it is more flexible than the common caricature would lead one to believe.

This functional description of memory allows for a broader interpretation, even though *L’Homme* continues to identify memory with a particular part of the pineal gland (at least in the images that accompany the text). By the time of his letter to Mersenne of April 1 1640, Descartes seems to move toward an even more functional position, claiming that the pineal gland does not serve as the seat of memory, but “all the rest of the brain . . . principally its internal parts, and even all the nerves and muscles can serve as a kind of memory; in this way, for example, a lute player has a kind of memory in his hands, for the facility with which he plucks the strings and places his fingers in diverse

ways, which he acquires through habit, helps him to remember certain passages for the execution of which he must thus place his hands” (AT III, 48). In this passage, it is clear that the body as a whole possesses the contents of memory insofar as these consist in the reproduction of certain actions (either mental or physical) that result in certain effects for which one has trained or habituated oneself. On this reading, the pineal gland is but a conduit of animal spirits, which subsequently alter the brain, nerves, and muscles in such a way as to produce actions, images, or ideas. Thus, by 1640, Descartes accounts for psychological functions by the entire *interaction* between the pineal gland and the rest of the body, not any one organ.

Ideas, images, and figures

Though the explanation of the physiological details involved in the function of internal faculties of sense changes after the *Regulae*, there is one aspect of Descartes’ account that remains constant. In the *Regulae*, Descartes describes the “figures or ideas” fashioned in the internal senses exactly in the same way that wax receives the form of a seal. We can see from the foregoing description that this is exactly how Descartes imagines the production or reproduction of figures or images in the brain, even in his more mature physiological work. It recalls for us the sense in which this level of cognition, i.e., the level of internal sensation, remains entirely materialistic. There is nothing “spiritual” or “immaterial” about the reception of the form of a seal in wax, just as there is nothing spiritual or immaterial about the formation of images, figures, and corporeal ideas in the brain, Descartes clearly believes.

That claim may sound a bit odd, especially if one is used to considering, as Descartes does in his mature metaphysics, that ideas are the modifications or attributes of an immaterial mind. What, then, are these “figures or ideas” of the earlier work, and how do they relate to the modes of the immaterial mind in the mature metaphysics?

I have already mentioned that the word ‘*figura*’ appears to play a central role in the account of perception offered in the *Regulae*. There is a linguistic and conceptual similarity between *figura* and *species*, since both Latin terms refer to the visible shape or form of a thing, at least in the most concrete senses of the words. Moreover, the way that Descartes uses this concept, i.e., to describe the causal exchange from the external object, to the external senses, and on to the internal senses, reinforces that analogy. This is why I have referred to the figure as transmitting “information” that maintains an “isomorphism” between idea and object. This is very similar to the way that I defined species in my outline of scholastic psychology. But these words are vague; they hold the place of a more precise definition. In order to be more precise, we should recall that, for Descartes, figure is different than species in that a figure need not resemble what it represents. So, whatever form the figure of an external object takes in sensation, it will not be a replica of that external object. The idea of formal resemblance is essential to the scholastic account; it is the basis for attributing sensible qualities to external objects, the so-called real qualities or accidental and substantial forms. Even though Descartes employs the traditional analogy of a seal impressing its form into wax, and does not comment on the obvious resemblance between the seal and the impression in wax, he is clearly opposed to such a reading on philosophical grounds.

Moreover, Descartes uses the term *figura* in a number of contexts in the *Regulae* that may suggest a broader connotation of the term than the seal and wax example. For instance, in Rule IV, there is a clear connection between Geometry and figures: Geometry is the science of figures, Descartes says, just as Arithmetic is the science of numbers (AT X, 373.15-18; CSM I, 17). Again, in Rules XIV-XVII, figures play a central role in the method of determining proportional relations and discovering the solution to problems in Arithmetic, Geometry, and the applied mathematical sciences. In these rules, figures are closely connected with the imagination and external senses, since these faculties use figures to depict the nature of problems considered. For instance, the title of Rule XV—"It is generally helpful if we draw these figures and display them before our external senses. In this way it will be easier for us to keep our mind alert" (AT X, 453; CSM I, 65)—illustrates the way that figures can help the mind represent a problem clearly and concisely. In Rule XIV, figuration is connected to the imagination and is the means for verifying the truth of geometrical abstractions. In that rule, Descartes seems wary of purely intellectual abstraction, using the imagination to confirm the calculations of the intellect. This is necessary if Geometry is to be applied to real extension, since the imagination makes use of a kind of subject (which is analogous to real bodies), namely, figures, which like bodies have shape, extension, and surface.⁴²⁴ I will return to the application of these mathematical figures to the method in the final section of this chapter. For the moment, I want to emphasize the connection between figures and extended bodies. Whereas figures can be either represented abstractly in the

⁴²⁴ Dennis Sepper's *Descartes's Imagination*, Part II, 83-208, is probably the most complete source on this issue.

imagination or perceived by the external senses, both bodies and figures have some real extension (even if the extension in figures is ideal and, perhaps, two-dimensional). Thus, by using the notion of figures, Descartes can refer to a relatively abstract concept (one that can be treated through pure geometrical analysis), which at the same time has a direct analogue to bodies in the physical world.

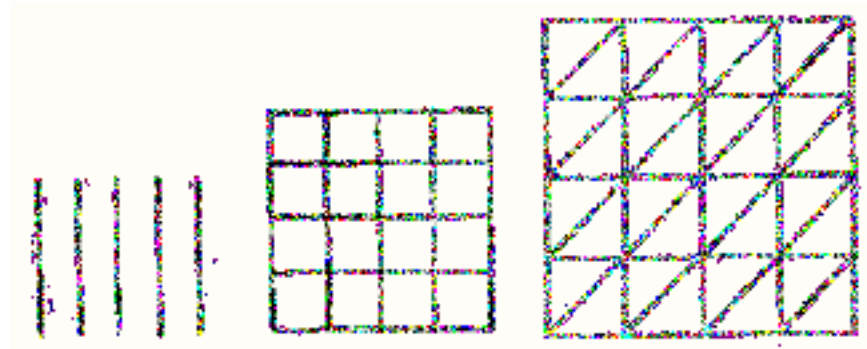
On this reading, figures can represent many different kinds of relations that need not involve a pictorial likeness to the thing represented. For instance, in Rule XV, Descartes uses simple figures to represent numbers (such as triangular numbers, i.e., those that can be represented by a triangular arrangement of points, like 3, 6, 10, 15, etc.) or familial relations. In Rule XVI, he uses a variety of different figures to represent multiplicative relations, suggesting that the concept of multiplication can be rendered in different ways, and thus that the figure itself is not a copy of the operation. When we look at the role figure plays in the definition of our ideas, we see a concept that is paradigmatic for the many different ways that corporeal extension can exist. In Rule XII, Descartes says that those simple natures “that cannot be understood without being in some corporeal body: such as figure, extension, motion, etc.” are the material simples (AT X, 419; CSM I, 44-45). Here, figure is listed first, along with extension and motion, as if it is the primary characteristic of material bodies. We can see why this might be the case: all figures contain some shape, extension in at least length and breadth, and some external form. While abstract figures can be two dimensional, figures of real bodies must have some depth. Even motion, as Descartes’ work in hydrostatics and freefall of bodies demonstrates, can be represented by a figure by virtue of the tendency to motion or the

motion vector. Thus, figures are able to represent, in an abstract and two- or three-dimensional way, all of the attributes of physical bodies. Indeed, as we saw in the physiological account of perception, this abstract representation is precisely what accounts for the transmission of information from external bodies to the senses. That is, the attributes or modes of the external body—their shape, motion, size, form, etc.—are transmitted to the senses by virtue of the external medium (in the case of the external senses) and the nervous system (in the case of the internal senses).

Representation

If we return to the text of Rule XII that has provided the background for our discussion, we see that this representational role is just what Descartes' proposes to describe the transmission of information about the material world. The example he uses is one of color, which is the essential object of visual perception, the characteristic effect of light on bodies, and thus a central quality for Descartes to account for. At first he begins with the kind of methodological caveat that we have seen before and then he goes on to describe how colors can be represented by figures.

So what troublesome consequences could there be if—while avoiding the useless assumption and pointless invention of some new entity, and without denying what others have preferred to think on the subject—we simply make an abstraction, setting aside every feature of color apart from its possessing the character of shape [*figura*], and conceive of the difference between white, blue, red, etc. as being like the difference between the following figures or similar ones?



The same can be said about everything perceivable by the senses, since it is certain that the infinite multiplicity of figures [*figurae*] is sufficient for the expression of all the differences in perceptible things. (AT X, 413; CSM I, 41)

In this passage, Descartes proposes a kind of hypothesis about the nature of color. He suggests that instead of focusing on the many different aspects of the sensible quality, color, we only focus on the fact that it possesses some shape or figure. Consequently, we can abstract from real colors that inhere in objects and simply conceive of color as an arrangement or pattern of shapes in some figure. Thus, he proposes these various sized squares and the patterns on them as representing the colors white, blue, and red.

Though the passage in the *Regulae* is meant to provide a simple illustration of the way that a pattern or configuration of figures can represent the sensible qualities of color, it is also clear from our discussion of Descartes' physiological work that such information could be conveyed by the shape, size, movement, and quantity of animal spirits transmitted to the brain. These animal spirits could conceivably be so arranged that they could represent a great variety of shapes, textures, and patterns perceived in the external world. In this way, our ideas of material things (the qualities that we perceive to be in some external subject) can be conceived as simply an arrangement or disposition of material bodies that are in causal contact with our brain. This effectively eliminates the

need to posit substantial forms or real qualities in things because such sensible qualities play no explanatory role in the account of perception. Instead, the entire process can be explained mechanically, or so Descartes would like to claim.

However, as I intimated at the end of the last section, this solution only displaces the problem. Whereas Descartes no longer maintains any explanatory role for sensible qualities like color, he is now faced with the difficulty of explaining why a certain pattern of animal spirits in the brain gives rise to the kind of sensations that are phenomenologically evident. We have seen Descartes maintain that the immaterial soul or mind of the human being is attached to the central gland and is immediately aware of the activity of that gland. How, then, are we to understand the conversion or translation of these purely corporeal figures into mental ideas? The *Regulae* gives us very little idea of how to resolve this problem. Descartes seems not to distinguish ideas from figures in that work. He is clear that the pure intellect or spiritual power of the person “receives figures from the common sense” (AT X, 415; CSM I, 42) or is “stimulated by the imagination” (AT X, 416; CSM I, 43). Additionally, he claims that the intellect can act on the imagination, producing images through that faculty. From these examples, Descartes seems inclined to think of an interaction between the spiritual or incorporeal intellect and the material brain. However, he also seems happy to blur the lines between these two domains rather than to explain their interaction clearly.

The standard interpretation of Descartes holds that the animal spirits or the impressions in the brain are the immediate objects of intellection. These figures then mediate, or represent, external bodies by virtue of the causal connection that can be made

(either presently, or through some retention) between the traces in the brain and the objects in the world.⁴²⁵ In short, the standard interpretation holds Descartes' theory of perception to rely on a thoroughgoing representationalism: all perceptions are mediated by some representation. These representations are the coded figures, or dispositions, of animal spirits in the brain. The fact that Descartes presents a naturalistic theory of perception up to and including a description of brain states that representing states of affairs in the external world effectively reduces these cognitive states to physical states. I have suggested that—at least in its mature formulation—this is not what we would call a type identity reduction, but a token identity reduction. That is, perceptual states are explained by token physical states—some characteristic interaction between the pineal gland, surrounding cavity, animal spirits, and brain tissue—rather than particular physical organs or standing physical properties. Hence, Descartes is closer to a functionalist account of sense perception, imagination, and memory than a classically physicalist one. Nonetheless, the prevailing view is that Descartes' explanation of perception is reductive. However, it is also clear that Descartes conceives of some mental acts as essentially non-reductive: the pure power of cognition (*vis cognoscens*) whose action is wholly spiritual and only analogically similar to the impression of a seal in wax. Thus, whatever this spiritual power of the intellect is, Descartes maintains that there is some essential explanatory gap between its operations and those of the brain. It is but a small step from

⁴²⁵ John Sutton summarizes the standard view quite succinctly in his preface to the symposium on Descartes on perceptual cognition in Gaukroger, Schuster, and Sutton (eds.), *Descartes' Natural Philosophy*, 524-27. The symposium itself is a response to John Yolton's work on Descartes, principally his book, *Perceptual Acquaintance*. Oxford: Oxford University Press, 1984.

such an explanatory gap to a “veil of ideas” theory of perception, similar to one standard reading of the *Meditationes*, where the ego is set apart from its own body and the external world, mediated by its imperfect ideas about the world. Such a position is then forced to confront the dual challenges of skepticism and idealism.

One way to bridge this apparent gap in Descartes’ explanation of cognition is to suppose that if Descartes had possessed a more thorough understanding of the mechanics of the brain, he may have been less inclined to suppose that certain mental acts were in principle spiritual, i.e., that they could not be explained by physical processes. John Cottingham advocates such a reading, principally on the basis of Descartes’ reliance on an argument from conceivability for the distinction between body and mind in the *Meditationes*.⁴²⁶ I do not want to linger on the adequacy or inadequacy of the modal arguments from the *Meditationes*. I simply want to cite Cottingham’s claim in order to understand its consequences for an interpretation of Descartes’ psycho-physiology of cognition in the *Regulae* and *L’Homme*. Focusing on the argument in the *Meditationes* and Descartes’ responses to Gassendi, Cottingham says:

Descartes cannot avoid admitting that, for all the meditator in the Second Meditation knows, the ‘thinking thing’ he is aware of might well be a corporeal being of some kind; his ability to doubt the existence of corporeal objects is quite compatible with the possibility that what is *doing* the doubting is after all, something essentially embodied.⁴²⁷

To transpose this argument into the language of the *Regulae*, we could say that Descartes has no basis for supposing that the actions of the soul, when it moves the body

⁴²⁶ “Cartesian Dualism: Theology, Metaphysics, and Science” in *The Cambridge Companion to Descartes*, 236-57.

⁴²⁷ Ibid. 243.

spontaneously, or imagines things that are not present to its senses, or contemplates ideas that have no corporeal representation, are essentially spiritual. Why couldn't these actions be the actions of a more complex mechanism than the one that Descartes had imagined? Isn't Descartes' argument from conceivability based on a limited conception of the physical world? Cottingham's case is strictly parallel to that of contemporary eliminativists like Daniel Dennett and Paul and Patricia Churchland.⁴²⁸ These philosophers hold that the explanatory gap between mind and body is not, in principle, unbridgeable. Given a sufficiently developed future science of the brain, we ought to be able to explain the nature of all cognitive operations reductively. What Descartes calls the purely spiritual power of cognition is just a place-holder for some set of physical actions to be explained by some future scientific theory. As Cottingham puts it: "Once Descartes had taken the vital step of assigning so many of the traditional functions of the 'soul' to the minute physical mechanisms of the nervous system, it was only a matter of time before Western science would go all the way, and make even the residual *âme raisonnable* redundant."⁴²⁹

Even without turning to the *Meditationes*, the *Regulae* already gives us sufficient reason to doubt that such an interpretation is consistent with Descartes' philosophy. Let us be clear about what is at issue: Cottingham claims that if Descartes simply had more empirical knowledge about the brain, then he would have been willing to give up the

⁴²⁸ See, *Consciousness Explained* and *Neurophilosophy*, respectively.

⁴²⁹ "Cartesian Dualism," 252. This objection was anticipated by the 17th century Cartesian, Rouhault, who writes in the *Entretiens sur la philosophie* (1671), II, 191: "Si vous tenez présentement pour certain que les bêtes ne sont que de simples automates, n'avez-vous point peur de croire un jour que les hommes ne sont aussi que de simple machines?" Quoted in Rodis-Lewis, *Anthropologie cartésienne*, 39.

notion that certain cognitive acts or mental states are irreducible to physical states. But what could more empirical knowledge possibly give Descartes, or any philosopher? It could supply him with more evidence, more empirical facts. These facts would still have to be considered the effects of some supposed causes that would explain them. This is the understanding of empirical facts that became apparent when we examined Descartes' reference to suppositions or hypotheses. In other words, greater empirical knowledge about the mechanisms of the brain would supply Descartes with more evidence that would, in turn, require a revision of his initial hypotheses about matter. On this reading, if Descartes had possessed CAT-scans, electro-encephelograms (EEG), functional magnetic resonancing machines (fMRI) and the like, he would have modified his initial hypotheses to fit with the idea that all mental acts are really physical.

There are two reasons, apparent in the *Regulae*, to suppose that Descartes would not accept any hypotheses in physics that could completely explain the nature of the intellect. For now, I can only state these claims with the promise of defending them later. First, he characterizes the intellect by its capacity to act on its own, to move the body in various ways, to imagine things that it has never encountered, and to contemplate things that have no material representation. I will discuss these features of the intellect and their importance for the *Regulae* in the final section of this chapter. But even a preliminary consideration of these acts leads one to believe that they are, in principle, of a different nature than mental acts that are in causal contact with putatively physical things. This difference, in fact, is central to Descartes' discussion of method and the application of the mind to problems in natural philosophy. In short, the kinds of mental representations

listed above exceed the scope of what Descartes' mechanistic natural philosophy can explain. Descartes seems committed to an idea of mind as a causally undetermined force that is also capable of contemplating ideas that have no material representation. This is not something that could be explained by Cartesian science. Secondly, Descartes supposes that the explanatory principles of material things are of a different kind than the explanatory principles of intellectual things. The prospect of some future science bridging the gap between the mental and the physical is impossible in principle, because such a science would be founded on a category mistake. In the next chapter, we will see that the simple natures signal such a distinction in kind, and thus rule out the possibility of an entirely naturalistic epistemology in Descartes. My argument is not that Cottingham's solution is incorrect, but simply that it is not Cartesian, even from the earliest of Descartes' writings.

Cottingham's proposed solution is not the only one. Others have attempted to overcome the explanatory gap between purely mental acts and mental acts that admit of some psycho-physiological explanation. There is some connection between the following proposals, but I will not attempt to draw that out here. Instead, I present these as possible avenues for further research. Ferdinand Alquié first put forth the hypothesis that one could reverse the representational relation between ideas and the mechanisms of the brain. In other words, we ought not conceive of ideas as brain states that in turn represent external objects. This is the way Descartes' representationalism is usually construed: mental states qua physical mechanisms in the brain represent a certain physical state of affairs and the incorporeal *cogito* somehow inspects these internal brain states in order to

learn about the external world. Instead, we should think of brain states as signifying not things but ideas: that we feel such and such sensation is the result of a signifying operation or representation on the part of small physical bodies in our brain. John Yolton has called this the “reverse-sign relation.” He explains how this reversal of the usual way of conceiving this relation helps resolve the problem of an explanatory gap between the mental and the physical.

If the processes or events in the brain were just physical, the problem of how those events could cause or relate to cognition would be a puzzle; it certainly was a puzzle for many seventeenth- and eighteenth-century writers. If those same brain events are also signs, if they play a sign (or significatory) role in relation to the mind, then we have a partial solution to the question of the relation between mind and physical objects: the same events that bring about physical (neural) events in the brain, also bring about cognitive events in the mind. They do the latter because, as well as being physical events, they are also signs. They carry information about the objects in the world, the very objects that have affected our sense organs and brain. So we have two interactive relations, a physical causal interaction and a significatory or semantic interaction.⁴³⁰

On this interpretation, brain states should be thought to play two simultaneous roles with very different natures: the first is a purely physical role (to interact with physical stuff in the external world by way of the sense organs and the nervous system); the second is a semantic role (to be a sign, symbol, or code for some concurrent mental event). Thus, the complex mechanical story that Descartes tells about perception is one way of representing the causal interaction that occurs in the event of perception. However, there is another story to be told, namely, the significatory or semantic story that explains what we might call the phenomenology of the perceptual event, i.e., how it appears to a conscious mind. The very same brain states that are causally connected to the external

⁴³⁰ “Response to My Fellow Symposists,” *Descartes’ Natural Philosophy*, 577.

world are the signs of mental life, they signify thought. Since these are different ways of explaining the same event, they surely have a causal connection, but we should not for that reason expect to reduce one to the other.

This is an attractive solution to the problem of the relationship between mental ideas and physical brain states. It suggests that perhaps most of what we think is non-reductively mental may be, in some sense, semantic. In other words, perhaps the phenomenology of mental events is, in some sense, peculiarly linguistic. Descartes makes a number of provocative statements about the philosophy of language in his corpus; it would be interesting to see what connection, if any, there is between his concept of language and his concept of mind. However, the primary passages used in defense of such a position (e.g., *Le Monde*: AT XI, 4) refer to the perception of states of affairs that are ordinarily conceived of as “signs.” For instance, Descartes calls the concussive pulses of air occasioned by speech, signs of words; he calls the expressions displayed by a person’s face as signs of emotions. These physical events are naturally conceived as “significatory,” and this may be all that Descartes’ intends to refer to when he claims that physical events “signify” mental concepts. There are serious questions about whether and to what extent these passages really support a more general theory about the significatory role of brain states in perception. In other words, it is a great idea that may not be anywhere near what Descartes was thinking.

Jean-Luc Marion offers a second hypothesis: he claims that the “idea or figure” of the *Regulae* is a “code” that mediates between the intellect and the physical world. This code institutes a certain schematism that permeates Descartes’ view of physical reality.

Moreover, it is a code that is generated by the intellect for an explicit purpose, namely, to make knowledge of the physical world clear and distinct. On Marion's interpretation, this codified understanding of the physical world operates in direct contrast to the traditional Aristotelian understanding, according to which the nature of things is essentially determined by the way they appear, their form or essence (*eidos*).

Ideas no longer represent things directly as they are perceived by our senses, nor as they present themselves to us. Rather, ideas hold the place of things by virtue of an intermediary codification that uses figures: things consist only in figures of extension in motion, which only appear to the senses by virtue of concealing their original character as figures (primary qualities) by an appearance that conforms to the senses (secondary qualities). As opposed to the sensible qualities which are ignored, figures play a fundamental role in the function of the idea. Science should thus be reconstituted: for each sensation received in the mind, at bottom, some intelligible and insensible figures cause that sensation as a sensible and intelligible effect.... Therefore, even though figure is mathematical and abstract, and thus has no resemblance with sensation, it effectively constitutes the thing itself. Figure schematizes the thing according to its true nature, considered as disfigured sensation; it thus holds the place of the thing itself that it represents in its original invisibility.⁴³¹

This is a dense passage that I try to treat in stages. First, allow me to indicate some broader themes that are indicated in the passage above. Here, Marion is presenting the concept of *idea* from the *Regulae* in order to pose a possible connection between Descartes' early notion of idea and his later notion of idea, in the *Meditationes*. At the same time, Marion wants to claim that there is, in fact, good reason to suggest that Descartes' is the founder of modern "idealism," a claim that is both banal and problematic. This is the reason for the clearly Kantian language in the passage: the reference to a hidden "thing in itself," known only by virtue of some active schematization of the thing that is at once a product of the intellect and abstracted from

⁴³¹ *Questions Cartésiennes*, 77.

the thing as such. However, there is another reason for such language that refers back to Marion's earlier study on Descartes' *Regulae*. In *Sur l'ontologie grise*, Marion states that "figure permits not only an abstraction, but a transcription, where each particular, sensible quality . . . can be *coded*; figure comes to encode the message of sensation."⁴³² This abstract encoding of sensible qualities is completely arbitrary, but figure is chosen for a reason. Indeed, the mathematical model of the *mathesis universalis*, Marion tells us, determines the way that figures "encode" sensible phenomena. In *Sur l'ontologie grise*, this interpretation lends further support to Marion's central thesis that the *Regulae* announces a new ontology, based on the mathematical ideal, that ignores and abstracts from the nature of things as such, their essence or substance (*ousia*).

Descartes' account of sensation, by virtue of a mechanical figuration of ideas in the brain, could not be more opposed to the Aristotelian picture. We are in a position to affirm this thesis by appealing to the distinction between *species*, which both transmit and resemble the real forms of things, and *figurae*, which are only causally, but not apparently, linked to external objects. Marion seems to conclude from this that the intellect sets up an arbitrary and hypothetical schematic representation of objects as figures, in direct causal connection with the sensible faculties. Thus, according to Descartes' method of representing physical events, invisible figures (primary qualities) would be the true cause of apparent sensible qualities (secondary qualities). In this way, figures (understood as the underlying, causally efficacious qualities of material things) mediate between our sensations and their objective correlates. Marion's interpretation of

⁴³² *Sur l'ontologie grise*, 118.

figures as a “code” recalls the “semiotic” or symbolic role that figures play in Yolton’s account. However, Marion seems to maintain that consciousness, or perhaps the institution of nature (God), deciphers the code in order to give rise to our ordinary phenomenal experience. The “decoding” of our brain states, then, is just what God endows embodied minds with when he creates them. In contrast to Yolton’s hypothesis, where figures actually play a dual role (one causal, the other symbolic), Marion’s account seems susceptible to the “inner homunculus” criticism of Descartes’ theory of perception. If the figures, or brain states, are codes to be deciphered, then there must be some agent that does the work of deciphering the code. On this model, the intellect would be that internal agent that decodes the information from the senses, and the immediate objects of intellection would not be objects, but coded figures.

To be fair, I think that Marion’s point is that Descartes proposes to understand all physical phenomena according to the “code” of mathematical figures. Thus, the central point is that the physiological process of perception admits of such a coded representation. This leaves the question of the intellect’s activity (as decoding agent) open. But the suggestion that the intellect is the grand “decoder” of some divinely instituted natural code badly contradicts the phenomenology of perception. To be blunt, one perceives objects, not coded figures. Marion says that, for Descartes, the apparent sensible qualities that constitute these objects conceal their original character. On this reading, objects are just figures in motion (a complex of primary qualities) even though we perceive color, sound, temperature, and all the features of sensible experience (a complex of secondary qualities). However, this sort of interpretation may commit

Descartes to a “veil of ideas” theory of perception too hastily. It seems to suggest that our sensory ideas are merely a veil, hiding the real, underlying, mechanical structure of the world. If not this, then Marion’s interpretation seems to entail that our ideas are in some sense systematically false; it leads to a kind of error theory of perception. Again, this seems to give up too much ground on the phenomenology of perception. I don’t think Descartes is committed to this kind of theory and I would hope that he is not.

There is, I think, a more straightforward reading of these passages. It makes the most sense simply to conceive of brain states as signifying mental states, rather than thinking of them as signifying physical objects. If brain states signify to the immaterial mind some state of affairs in the external world, then we face the threat of an inner-homunculus model of perception: we have external events that cause brain states, and then we have some internal mind that has to interpret those brain states. One might ask what faculties this inner spirit has in order to interpret those brain states, and we would be on the way to an infinite regress.⁴³³ Instead, we ought to suppose that the brain states simply signify mental activity which itself is directed at the external world. Then we can suppose, just as is plainly obvious in ordinary experience, that we are directly aware of the external world through perception. We can observe this scientifically by looking at the causal relation that obtains between brain states and external objects. This causal relation shows, or signifies, that the mind is actually attending to external objects. This interpretation makes the pineal gland no more mysterious an intermediary between mind

⁴³³ This is what is commonly called the “Cartesian theater” of inner sensation. It may be a plausible picture of the ego given a certain reading of the *Meditationes*, but I think the *Regulae* need not commit itself to such metaphysical absurdities.

and body than the retina of the eye is an intermediary between vision and light: we see light because of, or through, the refraction of light onto the retina. But it is obvious that we do not see the retinal image; we see the light. In the same way, figures are the physiological code of thought, but not as a code to be deciphered by the intellect; rather, figures offer a model to describe the physiology of perception that in turn explains why one perceives the external objects directly.

The incorporeal intellect and its role in the method

I have tried to play down the representational relation between figures and the intellect in order to preserve a more straightforward interpretation of Descartes' theory of perception. I have argued that the mechanical model of perception simply describes the physiological operations that are going on when perception occurs. These operations account for a causal connection between mind and objects, while entirely undermining the idea (on which the Aristotelian account of perception is based) that our sensible qualities are real, causally efficacious, properties of things. This does not threaten a representationalist interpretation of Descartes any more than the species theory threatens representationalist interpretation of Aquinas, since these intermediary causal operations simply explain the nature of direct perceptual awareness. We do not perceive animal spirits, or brain states, on Descartes' account any more than we perceive species on Aquinas'. In this section, it will become clear that Descartes' perceptual model is not an inert, theoretical model of perception; rather, it has direct consequences on the operation

of the intellect, particularly in its investigation of the world and its use of the faculties that represent the world. The interpretation that I am advancing suggests that the intellect uses the mechanical model of perception, the physiological faculties of the brain, as instruments to investigate the world. But these instruments need not be conceived as something detached from the intellect itself. Rather, when the intellect acts voluntarily, it does so by means of the faculties of the brain. We will see that there is a practical element to this activity: it is goal-directed and normative. It should not be a surprise, then, that the role of the intellect in the method is analogous to its role in moral action.

Intellect, ingenium, and method

In the last chapter, we discussed in some detail the importance of Rule VIII—*If in the series of things to be examined we come across something which our intellect is unable to intuit sufficiently well, we must stop at that point, and refrain from the superfluous task of examining the remaining items*—for defining the method in terms of the capacities and, especially, limitations of the mind. In this section, we will be able to flesh out the details of such an interrelation, now armed with an account of the mechanics of cognition. Before we get into the details, some preliminary observations are necessary. First, when Descartes introduces the concept of a purely spiritual power of cognition that “is no less distinct from the whole body than blood is distinct from bone,” he identifies it as “one single power” (AT X, 415; CSM I, 42). He reiterates its singularity, by stating that throughout its diverse operations, which receive different names in virtue of their functions (common sense, imagination, memory, etc.), it is “one and the same power”

(ibid.). The unity of the spiritual power of cognition is, I believe, the reason why Descartes earlier identified, in Rule I, “human wisdom” as the goal of all scientific investigation. There, Descartes attempts to differentiate the unity of human wisdom from the disunity of the sciences, as advocated by the Aristotelian tradition. “For the sciences as a whole,” he responds, “are nothing other than human wisdom, which always remains one and the same, however different the subjects to which it is applied, it being no more altered by them than sunlight by the variety of the things it shines upon” (AT X, 360; CSM I, 9). The analogy between a kind of intellectual power and sunlight was commonplace in late scholasticism. It was the guiding metaphor for the agent intellect, which illuminates the intelligible species in the possible intellect, when in the presence of a phantasm. There is an analogy to be made between Descartes’ notion of the intellectual light and the late scholastic idea of the agent intellect that I will explore later. For now, the important connection to be drawn between Descartes’ conception of the unified intellectual power and the intellectual light of human wisdom, is that cultivating and refining this power is the purpose of the method:

If, therefore, someone seriously wishes to investigate the truth of things, he ought not to select one science in particular, for they are all interconnected and interdependent. He should, rather, consider simply how to increase the natural light of his reason, not with a view to solving this or that scholastic problem, but in order that his intellect should show his will what decision it ought to make in each of life’s contingencies. (AT X, 361; CSM I, 10)

This highlights the practical nature of the method. It involves cultivating a kind of practical skill that allows one to judge correctly any given contingency. We should take note of the sense in which this goal of Descartes’ scientific method radically diverges from the Aristotelian one. Descartes is not at all interested in the classification of powers

and objects according to a metaphysical hierarchy. Instead, he is interested in cultivating a skill or practice that will ensure the right results.

The second preliminary observation will be brief, and it will simply confirm the conclusions of the first. It is noteworthy that Descartes identifies the application of the purely spiritual cognitive power to the cognitive faculties with the '*ingenium*'. He uses the term frequently throughout his work, but typically in an informal way that is intended to refer to the intellect itself, particularly when it concerns some intellectual training or application of method. The word emerges from Hellenistic philosophy and gained common usage in the Renaissance. It is closely related to the search for a method of discovery or invention, where the *ingenium* is conceived to be the power of understanding that is flexible and adaptable enough to invent new modes of explanation. It is a specifically human capacity that is not common to all human beings—in contrast to *ratio*—and one can increase its power through training.⁴³⁴ In its most general Latin usage, it indicates a kind of innate temperament or disposition, a bent or leaning. This temperament can have an intellectual connotation, meaning a capacity or ability; it is the etymological ancestor of our terms genius and ingenuity.⁴³⁵ In philosophical usage, *ingenium* can be applied to the common intellectual faculties associated with learning, especially memory and judgment. According to Goclenius, the most proper philosophical meaning of the term is “a rational faculty by which the soul is constituted to know, discover, or learn something. Likewise, the *ingenium* is a natural aptitude or faculty, by

⁴³⁴ See Sepper, *Descartes's Imagination*, 87-91.

⁴³⁵ 'Ingenio', *Lewis and Short*.

which we learn, according to which we know or discover something.”⁴³⁶ This is the general sense in which Descartes uses the term throughout his corpus. In the passage we are considering, however, he appears to give the term a technical definition. He says, “when [the cognitive power] forms new ideas in the corporeal imagination, or concentrates on those already formed, the proper term for it is *ingenium*” (AT X, 416; CSM I, 42). Thus, when this spiritual cognitive power is applied to the mechanism of the brain, in order to form new ideas or concentrate on those already formed, it is called the *ingenium*. As a consequence, the treatise on method—as its title indicates—is meant to direct the application of the spiritual power to the brain in forming ideas (or figures), and concentrating on those already formed. This is as clear an indication as any that the method consists in exercising the purely spiritual power of cognition in such a way that it cooperates with and utilizes the psycho-physiological powers of cognition we have been discussing. It is the practical application of the spiritual power to the cognitive faculties of the brain with which we are concerned. Sometimes Descartes invokes the *ingenium* to describe this application, sometimes he reverts to the language of faculty psychology, both for the same reasons and with the same results.

Brain physiology and the importance of the imagination

With this in mind, we ought to be clear about the key characteristics of the brain that will influence its operation. First, we must note that there is a central processing

⁴³⁶ *Lexicon Philosophicum*, 241-42: “Ingenium maxime proprie dictum, est facultatis rationalis animi constitutio, ad intelligendum aliquid, sive inveniundo, sive discendo. Seu ingenium est naturalis aptitudo seu facultas, qua nos discimus, per nos ipsos cogitamus, seu invenimus aliquid.”

location, a single point in the brain, where Descartes thinks the soul interacts with the body. This is the pineal gland and its surrounding cavity. Any activity of the purely spiritual power on the brain must be considered with reference to the mechanics of the pineal gland. Second, we know that the pineal gland has the capacity to direct the animal spirits, either toward the body through the nerves, or toward the brain tissue and nerves. The former helps to move the body; the latter helps to recall certain figures or images that are stored in the brain by virtue of a certain disposition to receive some animal spirits rather than others. Third, the pineal gland is the locus of the common sense and imagination; it is the place where all of the information from the external senses is gathered and can be formed into complex images. Finally, the pineal gland is a very small gland in the center of the brain. Though it has the capacity to receive all of the information concerning the external world, produce images, and direct the body to action, it is not large enough to store a great deal of information. These points will be important as we consider the limitations and capacities of the *ingenium*, the power of mind as it interacts with the pineal gland.

In this section, I will only be concerned with the application of the intellect to acquire knowledge of corporeal things. This is the principle focus of the *Regulae* since it has a direct application to scientific research. However, Descartes recognizes a distinction between “ideas that can be referred to the body” and “matters in which there is nothing corporeal or similar to the corporeal” (AT X, 416; CSM I, 43). The former include all ideas of the external world, our bodies, any physical or potentially physical thing, and even mathematical representations. It is not so clear what the latter might

include, though I would suppose that the idea of our own power of cognition, the idea of God, angels, and the Holy Trinity, would be included among them. It is also quite probable that, had Descartes possessed the doctrine of eternal truths at the time writing this text, he would have included these among the number of ideas in which there is nothing corporeal. Once Descartes discovers this doctrine, however, he will have no need to refer back to that earlier distinction. The doctrine of eternal truths will put the ego on a firm footing, making it entirely independent from any material thing. As long as God endows the incorporeal mind with certain innate ideas on the basis of which it can extrapolate logical truths, the knowledge of its own existence, and knowledge of God's existence, then there is no danger that these ideas may be thought to come from experience or from some unknown material source. Moreover, eternal truths are the basis for determining the causal structure that underlies all material phenomena; they are the source of all purely intellectual ideas. Interestingly, the ideas that are referred to the body will be identified with the imagination. Indeed, this is the reason for distinguishing the imagination from "the essence of my mind" in Meditation Six (AT VII, 73; CSM II, 51). At any rate, it is not our task to speculate on these later metaphysical doctrines; we are concerned with the method, and the application of the power of cognition to understanding material things.

When applying the incorporeal power of the mind to the faculties of the brain in order to discover the solution to particular problems, Descartes pays close attention to the nature of the mind-body complex. As I have indicated before, the *Regulae* is much more concerned with how the mind ought to interact with the body in order to discover the

nature of physical things rather than defining the distinction between mind and body. This feature of the treatise allows us to appreciate the basic empirical tendencies of Descartes' scientific method: he is trying to make our understanding of the world concrete and verifiable. The mechanics of the brain help define its role in creating and transmitting images or figures that represent the world. Indeed, in Rule XII, Descartes explains that producing figures in the imagination or presenting images before the external senses is necessary in order to accurately represent actual things in the world:

If, however, the intellect proposes to examine something which can be referred to the body, the idea of that thing must be formed as distinctly as possible in the imagination. In order to do this properly, the thing itself which this idea is to represent should be displayed to the external senses. A plurality of things cannot be of assistance to the intellect in distinctly intuiting individual things. Rather, in order to deduce a single thing from a collection of things—a frequent task—we must discard from the ideas of the things whatever does not demand our present attention, so that the remaining features can be retained more readily in the memory. In the same way, it is not the things themselves which should be displayed to the external senses, but rather abbreviated representations of them; and the more compact these are, the handier they are, provided they act as adequate safeguards against lapses in memory. (AT X, 416-17; CSM I, 43)

The passage appears to be ambivalent. At first, Descartes seems to endorse a kind of imaginative figuration: “the idea of that thing must be formed as distinctly as possible in the imagination.” This would not imply that any real figure be drawn or mechanically represented, only that it be imagined “as distinctly as possible.” However, he goes on to claim that “in order to do this properly, the thing itself which this idea is to represent should be displayed to the external senses.” This seems to indicate that whenever one imagines something distinctly, one must actually be in the presence of the object being imagined. It would thus seem to deny pictorial or symbolic representations of things displayed to the external senses. Such an interpretation appears to be ruled out later in the

passage when Descartes claims that “it is not the things themselves which should be displayed to the external sense, but rather abbreviated representations of them” etc. Thus, on the one hand, Descartes endorses a very distinct formation of ideas in the imagination as a means of verifying the nature of corporeal bodies. On the other hand, he claims that what is imagined most distinctly must actually be displayed to the external senses, and that this display ought to be of the things themselves [*res ipsas*]. However, he goes on to qualify that suggestion, claiming that in order for external things to be simple and singular, they ought to be represented by abbreviated symbols or representations.

There is thus some ambivalence (or trivalence) between the thing itself, its symbolic representation displayed externally, and the internal representation in the imagination. How can Descartes so blithely ignore the distinctions between these three levels of representation? The short answer is that he does not. But the reason why he seems to confuse these three different ways of representing actual things (*res ipsas*) will be instructive. First of all, we must recognize that the primary target of Descartes’ new scientific method is Aristotelian science. For scholastic Aristotelians, the things themselves are substances, whose essence is to be the bearer of many attributes. These attributes are, in turn, governed by a substantial form that organizes some underlying matter. Thus, whenever one asks about the nature of any actually existing thing, the answer will involve an explanation of its matter (what elements constitute it) and its form (the organizing principle that explains its functions, appearance, actions, etc.). Clearly, for scholastic Aristotelians, any thing itself is necessarily a complex of matter and form, usually a complex of several material elements and range of accidental forms governed

by a substantial form. Descartes signals that he is interested in the thing itself (not some mere abstraction), but the fundamental idea that all things are essentially complex just will not ensure a clear representation of them. Descartes realizes that the brain is only capable of attending to a few things at a time and that it is much more effective when it represents things as simply as possible. Consequently, the idea that all things are necessarily complex cannot be a guiding principle of Descartes' method.

However, Descartes does not simply reject the Aristotelian method of explanation without offering another method that will conform to his understanding of the way the cognitive faculties work. On Descartes' view, the mind is best suited to represent things in the imagination as clearly as possible and as they actually are. Rule XIV advances this aim: "The problem should be re-expressed in terms of the real extension of bodies and should be pictured in our imagination entirely by means of bare figures. Thus it will be perceived much more distinctly by our intellect" (AT X 438; CSM I, 56). Descartes recognizes only one attribute that is in fact common to all material things: real extension. Extension, he says, is "whatever has length, breadth, and depth" (AT X, 442; CSM I, 59), or whatever "admits of difference of degree ... [i.e.] magnitudes in general" (AT X, 440; CSM I, 58). Thus, whenever we represent an object in the external world, we should do so solely in terms of its nature as an extended body, modified by length, breadth, and depth. We should not be surprised to see this maneuver. In short, Descartes claims that the only universal criterion for any really existing object is that it conforms to the *mathesis universalis*: that it can be quantified in some sense. Thus, the only restriction that Descartes places on our conception of external things is that they conform to some

representation that has extension, magnitude, or shape. This is exactly what the imagination provides the intellect: “If we are truly going to imagine something, not only making use of our pure intellect, but aiding [our intellect] with the images [*speciebus*] depicted in the imagination [*phantasia*], then nothing can be ascribed to magnitudes in general which cannot also be referred in some way to a specific image [*specie*]” (AT X, 440-41; CSM I, 58).⁴³⁷ In other words, we can only be sure that we are talking about real things if we can represent what we are talking about with some specific image. This is because all images share the property of magnitude, shape, or extension, with all corporeal bodies.

Later in the same rule, Descartes clarifies this notion by highlighting the type of mistake that can be made when one only treats pure intellectual abstractions. This is a passage that we examined in the last chapter with reference to the connection between the *mathesis universalis* and Descartes’ theory of matter. Here, we see the same set of issues pertaining more directly to the powers of the mind.

Finally if it is said: ‘extension is not [identical to] a body’, then the word extension is taken in a quite different way than it is above. Moreover, in this sense there corresponds no idea in the imagination peculiar to it. Instead, this expression is entirely the work of the pure intellect, which alone is capable of separating abstract entities in this way. This is a source of error for many who, not realizing that extension taken in this sense cannot be grasped by the imagination, nonetheless represent it to themselves as if it were a real idea. Now, since such an idea necessarily involves the concept of body, if they say that such extension is not a body, they are unwittingly ensnared into saying ‘the same thing is at once a body and not a body’. (AT X, 444; CSM I, 60)

⁴³⁷ I think that Cottingham botches this translation, rendering the final *species* as “species of magnitude.” I am unhappy with the redundant “specific image,” but I think it conveys the right sense.

This example makes it clear that it is possible to conceive of certain statements about real things, e.g., to claim that there is extension where there is no body (or that there is such a thing as a void), while exceeding the limits of what can be accurately depicted in the imagination. In the *Regulae* at least, Descartes attempts to reign in the excesses of intellectual abstraction by carefully depicting his claims about material things in the imagination. (In the *Meditationes*, interestingly enough, the situation is quite reversed. There, the possible excesses of the imagination must be reigned in by the will in order to restrict it to what can be known by the pure intellect (cf. AT VII, 29-30).)

Implicit in all of this discussion about the relationship between the things themselves and their appropriate imaginative representation is the beginnings of Descartes' theory of matter, which he have seen already at work in the *Regulae*. The reason why ideas about external bodies must be depicted in the imagination is because both images and bodies necessarily share the property of being extended. Whereas we can intellectually abstract the concept of body from its being extended in length and breadth, Descartes claims that there is no such thing in the world and, moreover, that if we had attempted to verify such an abstraction by representing it to ourselves in our imagination, we would have readily seen our error. Thus, by representing ideas in our imagination we are able to check the excessive abstractions of the intellect. Armed with our understanding of Descartes' physiological account of cognition, it is quite apparent why he thinks this is the case. Every image depicted in the imagination corresponds to some real alteration of the body, some disposition of animal spirits, nerves, and brain tissue. These bodily alterations are linked causally to bodies in the external world, either

through experience or through a symbol. For instance, when I close my eyes and imagine a bright orange sunset, I am reproducing (according to Descartes) a physiological event in my brain that mimics the way my brain has been affected by past experiences of bright orange sunsets. The imagination thus grounds the intellect in the material world of causal relations between real bodies. A similar thing can be accomplished if I imagine a white skull and crossbones on a black background, which immediately recalls to me danger, or poison. In this case, the image represents a state of affairs by virtue of a culturally (or arbitrarily) determined symbol. In both cases, I am able to abstractly represent to myself a state of affairs without breaking its causal link to the real world. This explanation makes it clear that Descartes was not simply passing over the distinction between external object, symbolic external representation, and internal image. Rather, he was indicating a link between the object and its various representations (either symbolic or imaginative) that had been established by his account of cognition.

Mental exercises

Indeed, Descartes will exploit each element of this link between objects and their representations when he expands the heuristics of method. To illustrate, I will focus on the concepts abstraction, attention, and enumeration. Descartes borrows these terms from scholastic Latin, but alters their meaning. We have seen examples, particularly in John Olivi and Augustine, of the connection between the active power of the intellect and the operations of abstraction and attention. Enumeration, by contrast, comes largely from Renaissance theories of method, where *enumeratio sive inductio* was considered to be a

means of outlining the various categories of things to be investigated. If the enumeration is complete, we can be reasonable sure that our discoveries will be true. We have seen in the last chapter that Descartes also has in mind a different kind of enumeration, a kind of intellectual review that serves to strengthen the powers of intuition. These three concepts show Descartes' concern for focusing the mental powers on simple things, while discarding the rest. When viewed through the lens of Descartes' account of cognition, we see that his preference for simplicity over complexity can be established on independent grounds, namely, by virtue of the physiological limitations of the brain and cognitive faculties. Moreover, they show that the intellect plays an active role in arriving at the intuitions that form the basis of scientific certainty.

We have seen in the last chapter that mathematics plays such a formative role in the conception of Descartes' method for two principle reasons: he thought that training in arithmetic and geometry would better prepare students for scientific study than any other subject and he conceived of the basic power of the intellect, intuition, to be uniquely fitted to perceive the truths of mathematics. In Rule III, he describes intuition as "the conception of a clear and attentive mind, which is so easy and distinct that there can be no room for doubt about what we are understanding" (AT X, 368; CSM I, 14). We have seen that the truths of mathematics are, in principle, easily verified by a clear and attentive mind. This is why they are paradigmatic of scientific knowledge. Attention, then, is simply the act of turning the mind to perceive a certain state of affairs. Those states affairs that can be easily perceived by the mind attending to them are the basis of scientific knowledge. In this way, mathematics is characterized by its *simplicity*. Simple

things are naturally and easily perceived by the mind. But Descartes thinks they have been unjustly neglected by prior philosophers. With our summary of Descartes' account of brain functions, we can see why Descartes would have thought the mind to be best capable of attending to simple things. The mind is connected to the pineal gland, which he realized was so small that it was hardly visible in autopsies. Since this point of contact is so physically small, one must suppose that its capacity to clearly perceive complex things would be limited.

Nowhere is the limitation of the brain more apparent than in Descartes' discussion of enumeration. In Rule VII, he describes "why we say that a continuous movement of thought is needed to make good any weakness of memory." He appeals to his familiar problem of proportional relations which quickly becomes difficult to conceive clearly. In order to remedy this lack of clarity he describes a kind of mnemonic exercise: "I shall run through [these relations] several times in a continuous movement of the imagination, simultaneously intuiting one relation and passing on to the next, until I have learnt to pass from the first to the last so swiftly that memory is left with practically no role to play, and I seem to intuit the whole thing at once" (AT X 387-88; CSM I, 25). Viewed from the perspective of Descartes' psycho-physiology, it seems as if he is advocating an exercise that will predispose the brain to make a certain connection, to intuit a certain relation. Thus, the imagination repeatedly runs through the series of relations, reinforcing the neural paths associated with that series, until the brain moves (almost) immediately from the first to the last. Thus, the series is preserved, as it were, in the very tissue of the brain by this imaginative exercise. Rule XI takes up this topic again, and concludes that "one

cannot fail to see that in this way the sluggishness of the mind is redressed and its capacity enlarged” (AT X, 409; CSM I, 38). In this sense, the mental exercise of enumeration, that reinforces the neural pathways of the brain so that the mind can recognize complex connections immediately, strengthens and enhances the powers of intuition.

Bearing in mind that the brain is most capable of perceiving simple things, Descartes also advocates a peculiar kind of abstraction that is precisely fitted to his method of comparison. We have already seen the use of abstraction in the explanation of color sensations. There, Descartes abstracts from the specific characteristics of colors in objects to consider them as if they were merely patterns or shapes. This form of abstraction enables him to treat colors (secondary qualities) as if they were simply modes of extension, patterns, or shapes (primary qualities). We have also seen that problems in arithmetic and geometry are, strictly speaking, abstract. That is, they do not contain any obscurities from the variability of matter. Descartes likens these pure mathematical problems to the “perfect problems,” that are determinate in every respect (AT X, 429-30; CSM I, 51). For more complex problems, what is required is to make an abstraction so that they can be treated in the same way that problems in pure mathematics can be treated:

Once we have sufficiently understood the problem, we should try to see exactly where the difficulty lies, so that by abstracting from everything else, the problem may be the more easily resolved. In order to find out where the difficulty lies, it is not always sufficient simply to understand the problem; we must also give thought to the particular factors which are essential to it. If any considerations should occur to us which are easy to discover, we shall put these aside; and once these have been eliminated, what we are left with will be just the point we are looking for. (AT X, 437; CSM I, 56)

The particular example Descartes is considering in this passage concerns the construction of a certain fountain with a sculpture of Tantalus. Descartes is apparently thinking of a fountain where a figure of Tantalus is placed in the middle of the collecting pool. When the water reaches Tantalus' lips, the bowl is suddenly drained. In discovering the underlying principles that make the fountain work, the irrelevant factors are the sculpture of Tantalus and the shape of the bowl. The key difficulty is how to construct a container such that it lets out the water as soon as, but not before, it reaches a certain height. In many other cases, it seems that the main difficulty is obscured by a number of extraneous factors. For instance, the movement of the planets and stars is obscured by conjectures about their material constitution, e.g., are they composed of earthly material, are they gods, are they composed of some other, celestial elements? What is needed, is to abstract from these various concerns and consider the planets as points, tracing lines in the sky, in the way that Tycho Brahe did when he made his careful observations. This is the real utility of mathematical representation through lines, symbols, or figures. These representations bear no resemblance to the things themselves, and thus are unencumbered by questions about elements, essences, real qualities, substances, and the like. Instead, mathematical representations clearly express the quantitative relations that exist between things. They are based on a prior *abstraction* from these other concerns; this is why they are easily depicted before the mind; consequently, this process enables one to clearly represent the main difficulty involved in the problem.

Descartes' use of the terms abstraction and attention bear little resemblance to the traditional scholastic uses of these terms, save one important link. For Descartes, as for

the scholastics attention and abstraction are *activities* of an immaterial mind. Descartes uses these terms to describe the way that the mind interacts with the physiological powers of cognition, the brain, in order to arrive at solutions to mathematical and natural philosophical problems. Thus, the mind actively engages and directs the brain and the sensory faculties in order to solve problems. Indeed, the mind directs these faculties best, Descartes thinks, when it follows the heuristics of method that he outlines in the *Regulae*: reduce complex problems to their simple elements, follow an order among terms, and recompose simples in such a way that they necessarily explain the problem. Moreover, he seems to imagine, if the mind practices and continually engages in this kind of exercise, it will actually alter the nature of the brain, the neural pathways that contribute to reasoning. In this way, the method can engender an improved capacity to judge well and to apply the mind to various kinds of problems.

I believe this is the sense in which we must understand the example of the blacksmith who constructs his tools using the very same methods as he will use those tools to construct products in Rule VIII. On this reading, the soft tissue of the brain is the primary tool of the philosopher or scientist in understanding the nature of the world. This analogy highlights the unique role of the incorporeal power of the intellect in conducting rational investigations, and it seems to suggest a dualistic concept of mind in this early work. Unlike all physical events, which Descartes thinks are entirely determined by the disposition of corporeal bodies and their movement, the mind has the capacity to reform and reshape its most intimate instrument, the brain. Given this capacity, it seems, the mind is of an entirely different character than ordinary physical objects; it has the ability

to alter its own capacities, to enhance its own powers through training and practice.

The Explanatory Bases of Descartes' Natural Philosophy: The Objects of Knowledge

While the *Regulae* is ostensibly and for the most part a treatise on scientific method, we have seen that Descartes' methodological statements have broader implications. In this chapter, we will explore the more specifically metaphysical implications of Descartes' method. In the seventeenth century, metaphysics generally addressed questions concerning the existence of God and the immortality of the soul. Descartes treats neither of these questions in the *Regulae*. So when I refer to Descartes' "metaphysics" here, I mean it in the much more basic sense in which we think of metaphysics as being about what kinds of things there are in the universe, and what kinds of principles of explanation are acceptable for the most rigorous knowledge of things. It is noteworthy that the constituents of Descartes' universe are not the ontological genera or the categories of Aristotle, rather they are the kinds of things that can be simply apprehended by the intellect. This is characteristic of Descartes' primary concern for epistemology as the manner of access to ontology.

In the *Regulae*, Descartes imagines a world composed of "simple natures"; they are what I would call the categorical bases his science. He claims that anything that can be known about objects must be known through some composition of simple natures. But we will see that he does not mean 'physically composed', but 'rationally composed', i.e., by means of their explanatory power. Given that the simple natures are the principles of scientific explanation, it is no surprise that their nature and use are directly informed by

Descartes' methodological concerns. In this chapter, it will become apparent that Descartes' categorical division of simple natures, principally into intellectual, material, and common natures, implies a division in kind between scientific explanations of matter and those of mind. Thus, Descartes' conception of simples will be central to the aim of this thesis. However, before any of this can be addressed, it will be necessary to look at the historical antecedents to Descartes' use of the term 'simple natures'.

The concept of simple natures has a discernable and important history in the Aristotelian tradition, one that clearly informs usage of the term in both Descartes' *Regulae* and Francis Bacon's *Novum Organum*. We will see that the notions of 'simplicity' and 'nature', which together are integral to the historical use of the term 'simple natures' in the 16th century have an important precedent in scholastic metaphysics. In particular, these notions are closely associated with the concepts essence, universal, substance, and form. I will try to show how the idea of 'simple natures' emerged in scholastic philosophy, and why it was an important, though controversial, notion. However, with the earliest modern philosophers, principally Bacon and Descartes in the *Regulae*, the metaphysical context in which simple natures are understood changes dramatically.

Like Descartes of the *Regulae*, Bacon employs the term 'simple natures' in a way that makes them central to his metaphysics. It is possible either that Descartes and Bacon independently employed vocabulary that would have been well known, or that Descartes employs this vocabulary following his exposure to Baconian philosophy, to which he was most likely introduced by Mersenne, c. 1625. In either case, there are some philosophical

comparisons and contrasts between the two usages that are instructive. In short, Descartes' material simple natures, like Bacon's simples, are qualitative properties of material things that serve as the basis for a mechanistic explanation of natural phenomena. In order to explain the essential role of material qualities in natural bodies, both Bacon and Descartes advocate the use of controlled experiments and the importance of the productive capacity of human understanding. Thus, the explanation of Bacon's use of simple natures will be instructive for understanding Descartes' use of the term.

However, I will also show that there are fundamental differences between these two thinkers. First, Descartes' simple natures are determined by the intellect: they are *conceptually* simple. By contrast, Bacon's simples are not conceptually simple at all, but are selected for their putative connection to the natural laws that govern the things themselves. Bacon never enumerates these laws of material interaction, but his metaphysics is based on the belief that material things obey their own internal laws. Second, Descartes proposes that there are not only simple material natures, but simple intellectual natures as well. This suggests that the intellect may be a domain of scientific investigation in its own right, quite distinct from the investigation into the nature of material things. Although Descartes never develops an investigation of the intellectual simples in the *Regulae*, this will surely be the basis of the philosophical argument one finds in the *Meditations* I-V and *Principles* I-II, for instance. Bacon, by contrast, understands the mind to be essentially a mirror of the world, one that is more or less clouded, but whose purpose is essentially to reveal the natural world as it was created.⁴³⁸

⁴³⁸ For instance, Bacon refers to the mind as an "enchanted glass" in the *Advancement of*

There would, thus, be little cause for a Baconian investigation of intellectual simples like the one that Descartes undertakes. In fact, it seems that, for Bacon, the division in faculties of the mind is most important for maintaining proper division in the sciences (see Bacon's *De Augmentis*, Bk. V).

In sum, the investigation into the simple natures will confirm that the *Regulae* defines foundational elements of Descartes' philosophical project, especially insofar as they announce a distinction in kind between the explanatory principles of the physical world and those of the mental, a distinction that divides the universe into basic categories of thought and matter. The 'simple natures' is an important philosophical concept and one that is embedded in the principles of scientific truth, the explanation of natural things, and thus the core of Descartes' project in the *Regulae*. At the same time, however, we will glimpse the shortcomings of the *Regulae*, specifically with respect to advancing a philosophical investigation of sensory qualities and their importance for a complete understanding of the mind and its ideas.

Simple natures in late scholastic philosophy

According to Gilson's index, the term '*naturae simplices*' appears in both Toletus' *De Anima* and in the Coimbrian commentaries on Aristotle's *Physics*. In the case

Learning (Sp. III, 394-95), which is in need of "helps" in order to make any progress (*New Organon* Sp. I, 151-52; Sp. IV, 13-14). In large measure, this is the objective of debunking the "idols of nature" in the first part of the *New Organon*. As a consequence of this belief, Bacon always dismisses a skeptical stance, suggesting that the only way to grasp the essence of nature is to shore up the mind's deficient faculties with attention to method, while employing the mind's natural faculties of investigation.

of both texts, Descartes' letter to Mersenne of October 28, 1640 testifies to his knowledge of these sources from his days at La Flèche, though he claims not to remember much of the specifics, and not to have looked at these philosophers for "some twenty years" (AT III, 185). Some commentators see little influence in Descartes writings from these works before the *Meditationes*, the Replies to Objectors, and the *Principia*, suggesting that Descartes had already developed his philosophical position and later modified his terminology to appeal to his audience, particularly the faculty of theology at the Sorbonne.⁴³⁹ It is very difficult to be precise about Descartes' relation to late scholastic sources, since he intentionally avoids any real engagement with their arguments. I do not intend to dispute the claim that when Descartes' begins the *Meditationes*, he does so with careful attention to scholastic controversies and the explicit purpose of engaging in those controversies. Nevertheless, I do not think that this claim should imply that these exercises were merely window dressing for Descartes' *real* concerns, e.g., his natural philosophical project. Rather, I think that the *Regulae* demonstrates a deep and enduring engagement with traditional metaphysical questions in an effort to break free from tradition and establish scientific knowledge on independent grounds. From this perspective, it will be most useful to understand the following historical discussion as forming an intellectual backdrop against which Descartes' own philosophy can stand in relief. In this context, the commentaries of Toletus and the Coimbrians are most helpful, since these constituted the textbook treatments of philosophical issues in the 16th and 17th

⁴³⁹ Roger Ariew, *Descartes and the Last Scholastics*, 28-33.

centuries (likely a centerpiece of education at La Flèche), being reprinted many times each and widely available.

Simplicity and nature in Aristotle

The broader context for understanding the notion of simple natures emerges from Aristotle's *De Anima* and the possible connections between simple cognition and the essence of real things. In this sense, it is useful to consider the concepts of 'simplicity' and 'nature' as they influence the possible existence of 'simple natures'. Simplicity can be taken in two senses: as it refers to cognition, or epistemic simplicity, and as it refers to entities, distinguishing simple substances from composites. In *De Anima*, III, 6, Aristotle refers to the "thinking of indivisibles," a cognition of which is entirely simple, and for that reason free from error: "The thinking of indivisibles is found in those cases where falsehood is impossible: where the alternative of true of false applies, there we always find a sort of combining of objects of thought in a quasi-unity."⁴⁴⁰ Here the epistemic character of simplicity is clear. The basic reason why Aristotle makes such a claim is that what is indivisible, or what has no composition, cannot be a matter of judgment, since judgment is necessarily synthetic. In *De Interpretatione* 1, Aristotle states, "Just as some thoughts in the soul are neither true nor false while some are necessarily one or the other, so also with spoken sounds. For falsity and truth have to do with combination or

⁴⁴⁰ *De Anima* 430a 27-29

separation.”⁴⁴¹ In this passage, Aristotle extends the conditions for epistemic or cognitive simplicity to logical or propositional simplicity. In both cases, what is apprehended simply requires no judgment because judgment involves the affirmation or denial of some combination of terms, such as predicate and subject. Thus, whatever is apprehended simply, or without any division, cannot be the source of error.

In the *De Anima* passage, Aristotle extends the indivisibility of thoughts from cognition of those things that are incapable of being divided to cognition of all things that are not actually divided in the moment that they are perceived. For instance, he claims that thinking of a line segment or a period of time can both be considered indivisible, since they are taken in their actually undivided state (whereas these things naturally admit of infinite divisibility). The key to understanding this kind of indivisibility is to understand it again as an epistemic notion. All lines are necessarily divisible when considered in themselves. However, if I am conceiving of a particular line segment, then I can conceive of it as a whole without actually dividing it. The line segment is not absolutely indivisible, but only relative to a certain conception of it at a certain time.

This is how Toletus introduces the notion of simple natures: he says, for example, “Some things are themselves simply apprehended and understood, such that there is in them no question of truth nor falsity. On the other hand, some things are apprehended in composition and I judge, that is, affirm or deny, and thus am said to either compose or divide them: in such things there is a question of truth or falsity [*Altera est simplex apprehensio et simplex cognitio ipsius, in qua nihil veri vel falsi inest. Altera est*

⁴⁴¹ *De Interpretatione* 1, 16a 10-13.

composita apprehensio et iudicium, et assensus vel dissensus, qui etiam compositio et divisio dicitur: in quibus jam verum vel falsum inest].”⁴⁴² Toletus is clearly following the passages of *De Anima* III, 6 and *De Interpretatione* 1 that we have considered. This connection becomes more clear when Toletus provides examples, saying that whatever we apprehend with our mind can be divided into three categories: “Since some things are simple natures or things: such as man, animal, or white. And since other things are composite, such as rational animal or just man; so also some things are composed by way of words in the form of a proposition: such as man is an animal or God is just [*Quaedam sunt simplices naturae vel res: ut homo, animal, album. Quaedam sunt compositae, ut animal rationale, homo iustus; quaedam sic composita ut habeant verbum sintque proposito, ut homo est animal, Deus est iustus...*].”⁴⁴³ Thus, a simple nature, for Toletus, is whatever can be apprehended simply without being predicated of anything else. He seems to include both substances (like man and animal) and qualities (like white) in his enumeration of possible simples. In each case, simplicity seems to follow from the act of cognition that apprehends the object: when we simply consider the concept ‘man’ or ‘white’ without predicating it of anything, we can consider it to be simple. I will note, for the moment, that Toletus calls ‘man’ a simple nature while the definition of ‘man’ as ‘rational animal’ is composite. This introduces a difficulty that we must address.

In a sense, the case of purely epistemic simplicity becomes complicated when we consider the cognition of putatively simple *natures*. The word ‘natura’ tends to refer to

⁴⁴² Gilson, *Index*, 200: Toletus, *Comentarii de Anima*, Bk. III, Ch. 7, Txt. 27, Q. 20, p.162, col. c-d.

⁴⁴³ Gilson, *Index*, p. 200: Toletus, *Comentarii de Anima*, Bk. III, Ch. 7, Txt. 27, Q. 20, p.162, col. c-d.

the essence of a natural body, some intrinsic property or set of intrinsic properties that give a natural body its internal principle of change or motion. Thus, for an epistemically indivisible concept to be a simple nature, it must not only be apprehended simply, but it also must pick out the essence or nature of some particular thing.⁴⁴⁴ We can see the difficulty when we note that while Toletus accepts ‘man’ as a simple nature, he rejects ‘rational animal’. At first, it seems unclear how he means to differentiate these two concepts; man just *is* a rational animal. Perhaps Toletus thinks the latter concept can be analyzed linguistically, something along the lines of a form and formula distinction.⁴⁴⁵ Forms indicate the essence of an individual, but the formula, i.e., a proposition that defines the individual, expresses the nature of the individual as a member of a species. Thus ‘man’ indicates the individual man, while ‘rational animal’ indicates the species form of ‘man’: it indicates that ‘man’ refers to just those members of ‘animal’ that are ‘rational’. Clearly, this species formula is analyzable. We will see how this distinction between form and formula or species will influence the Coimbrians to the degree that

⁴⁴⁴ On the connection between ‘natura’, ‘essentia’, ‘forma’, and quiddity or definition (which we will come to later), see Aquinas, *On Being and Essence*, Ch 1: “Because the definition telling what a thing is signifies that by which a thing is located in its genus or species, philosophers have substituted the term ‘quiddity’ for the term ‘essence’. The Philosopher frequently calls this ‘what something was to be’; that is to say, that which makes a thing to be what it is. It is also called ‘form’, because form signifies the determination of each thing, as Avicenna says. Another term used for this is ‘nature’, using ‘nature’ in the first of the four senses enumerated by Boethius. In this sense anything is called a nature which the intellect can grasp in any way; for a thing is intelligible only through its definition and essence. That is why the Philosopher, too, says that every substance is a nature. The term ‘nature’ in this sense seems to mean the essence of a thing as directed to its specific operation, for no reality lacks its specific operation. The term ‘quiddity’ is derived from what is signified by the definition, while ‘essence’ is used because through it, and in it, that which is has being.”

⁴⁴⁵ I am thinking of Aristotle’s distinction in 7: 4-6 between *eidos* and *logos*. Although Aristotle is ambiguous about what this distinction amounts to, especially since the *logos* is not merely linguistic but is the very rational structure of the thing, the later scholastics were probably much more sensitive to the distinction.

they conceive of ‘substance’ as analyzable into the parts of its formula, ‘being’ and ‘self-subsisting’. In fact, the only terms that are not expressed by such a species formula are the categories and the differentia: the categories because they are the highest genera and the differentia because they are not themselves species.

This question is further vexed by the claim that Aristotle makes regarding what kinds of object are indivisibles. He says the treatment of indivisibles follows for “objects which are without matter (*anue hyle*).”⁴⁴⁶ Enrico Berti takes Aristotle to mean by indivisibles in this sense ‘universals’, which are ‘without matter’ in the sense of being abstract.

The fact that in the last line of the chapter Aristotle designates all these things, of which there is intellection, as things ‘without matter’ (*anue hyle*), does not mean that they are immaterial substances, since all essences, whether of substances or of accidents, are immaterial, but being universals, they can never be separated substances, that is they cannot exist independently of material realities.⁴⁴⁷

Berti goes on to claim that this is precisely the same concept as is expressed in *Metaphysics* Theta, 10, albeit from a the opposite point of view: “there seems to be no doubt that the ‘incomposite’ realities of *Metaph.* Theta, 10 coincide perfectly with the ‘indivisibles’ of *De An.* III, 6. Whereas the term used in the *De Anima* points out their unity, i.e., their universality, the term used in the *Metaphysics* tends, rather, to indicate their separateness, that is the condition of isolation in which they are considered by the cognitive act of the intellect.”⁴⁴⁸ In both cases, simples are considered as universals when apprehended by the intellect, i.e., the essences of physical or mathematical things. This

⁴⁴⁶ *ibid.* 430b 33.

⁴⁴⁷ Berti, “Intellection of Indivisibles,” 147.

⁴⁴⁸ *Ibid.*, 148.

intellectual apprehension of simples requires that they be abstracted from any particular matter. When they are apprehended as such, the knowledge of them cannot be in error. Here, simples or indivisibles are conceived as equivalent to ‘universals’ or ‘essences’, which seems to make the possible existence of ‘simple natures’ much more likely. However, species terms and formulae are also universals, so being a universal essence does not guarantee simplicity. Moreover, there remains some question about which are the real natures: the universal terms or the individual entities.

The idea of simples as essences or universals does seem to capture Aristotle’s understanding of their epistemic grasp. Aristotle says, “About the things, then, which are essences and exist in actuality, it is not possible to be in error, but only to think them or not to think them. Inquiry about their ‘what’ takes the form of asking whether they are of such and such a nature or not.”⁴⁴⁹ In other words, one can inquire about ‘what it is’ to be an essence by clarifying whether it is of such and such a nature or not. However, if one apprehends the essence, that is, understands it, then one cannot be in error except in attributing that essence to a particular thing or in combining that essence with another. Presumably, this is what Aristotle means when he says that with respect to incomposites, “contact (*aisthêsis*) and assertion are truth ... and ignorance is non-contact.”⁴⁵⁰ Now, just as a universal, or essence, is what it is by virtue of having been the essence of many individuals, the unified, simple apprehension of that universal can be, and perhaps even must be, referred to the many distinct apprehensions of those individuals. In this way, the universal is indivisible only in the sense in which a line segment is indivisible, that is to

⁴⁴⁹ Metaphysics IX, 10 1051b 31-33.

⁴⁵⁰ Ibid. 1051b 23-24.

say, actually undivided. Here again, one can inquire into the nature of an indivisible universal essence with reference to many particulars or with respect to the formula that defines it.⁴⁵¹

However, this way of understanding epistemic simplicity does not get us out of the woods. In fact, it places us in the thicket of the “problem of universals.” We will try to tread carefully along this path, because addressing the problem of universals, an enormously controversial topic in medieval philosophy, exceeds the scope of our present investigation. Nonetheless, it is helpful to consider some aspects of this problem in order to clarify the present issue, namely, the possible existence of simples and their apprehension by the mind. Consider the universal ‘*homo*’, or human being, from Toletus’ commentary above. This is a universal concept that describes all particular human beings. However, it is plain that, in fact, there *are* no human beings as such existing anywhere in the world. Instead, we have many individual human beings. The concept of ‘human being’ is not gendered, yet it is impossible for any given human being to exist without being gendered.⁴⁵² Thus, the universal concept ‘human being’ can only be conceived in abstraction from the actual existence of any given human being. I believe this is the sense of Aristotle’s distinction between indivisibles that are simply apprehended by the intellect and composites, which require judgment. When I think of the concept ‘human being’, the only way that I can conceive this concept is by *not* thinking that any such human being exists. That is, I make no judgment about the existence or non-existence of ‘human

⁴⁵¹ See Berti, “The Intellection of ‘Indivisibles’ According to Aristotle,” pp. 141-164.

⁴⁵² I borrow this example from Gyula Klima’s article, “The Medieval Problem of Universals,” in the *Stanford Encyclopedia of Philosophy*, when she introduces Boethius’ response to the problem.

beings'. Once I claim that *a* human being exists, I am no longer talking about 'human beings', but *this* human being, which correspondingly must be either a male or female and thus not a human being as such. So all universals are understood as abstract; they cannot be conceived as having any *matter*. As we saw in the last chapter, abstraction is the activity of the agent intellect, and it results in the formation of intelligible species. Thus, universals, or epistemic simples, like intelligible species, are products of the mind and mental abstraction. This reading does not imply that qualities or essences exist on their own, apart from actual instances. Rather, qualities or essences exist by virtue of their being abstracted from the actual bodies in which they normally exist. I understand this as a kind of shift in focus or attention of the mind.

In reading Aristotle's discussion in this way, I do not want to take sides in the debate concerning whether or not universals, essences, or categories are purely mental, linguistic, or real. To my mind, Aristotle leaves this question open, probably because he frequently identifies linguistic or mental distinctions with real ones. The important thing to realize is that various medieval commentators on Aristotle took all three positions. William of Ockham is most well known for advocating the idea that all universals are linguistic, existing in name only, while the Neoplatonic tradition would have given some traction to the notion that universals are mental (though the thought that universals truly exist *ante rem* in the mind of God does not make them *merely* mental), and Aquinas (whose view is nuanced on this issue) would hold something like the realist position about universals. To remain somewhat neutral in this debate, I will try to speak of the different ways that universals or essences can be conceived and in a broadly Thomistic

way. Given these caveats, I will attempt to restate our problem and then explore two different aspects of the problem.

Simplicity in sensation and thought

The task of science is to explain the nature of individuals, which, following the Aristotelian tradition, we can conceive as substantial entities that exist on their own. In a rough and general way, we can understand individuals according to their participation in a species and their possession of properties (those that are essential are necessarily shared by all members of the species, those that are accidental are not necessarily shared). These properties are united in the individual under a substantial form. Thus, the individual is the composite of a substantial form and some designated matter (i.e., determined in three dimensions). In order for us to grasp the essence of the individual, then, we must determine which properties of the individual are essential (i.e., belong to all members of the species), what are the implications of an entity that possesses those properties, and which properties are accidental. For this reason, it is clear that whenever we apprehend the essence of some individual, we apprehend it in abstraction from any determinate matter (as when we think the concept ‘human being’ without thinking of a specific gender). Now, a species just is a genus with a specific differentiation. Thus, the essence of the genus can be understood by abstracting from any specific differentiation. In this way, species are members of a genus in the same way as individuals are members of the species (i.e., by abstracting those differentiating elements). This process of abstraction

continues all the way up to the highest genera (*summa genera*), which are the categories (usually ten: substance, quantity, quality, relation, place, time, position, state, action, and affection). These categories cannot be further analyzed because they are the most general predicates of being, which is not a genus itself. Thus, the categories simply are the highest level of abstraction; they are not members of a higher genus.

Given this very general presentation of late scholastic metaphysics, there arise two related problems in the area of science, or how to explain the nature of individuals according to their participation in species, genus, and the categories. First, there is an epistemological issue: how do we come to understand the essence of any given individual? Second, there is the problem of explanation: how do we account for the nature of any given individual as a member of a species, genus, and instantiating any of the ten categories? From the epistemic side, it becomes clear that the doctrine of simple apprehension is actually quite complex.

Recall from the last chapter that each of the five sense modalities perceives only what is proper to it, the ‘proper sensibles’: “I call by the name of special object of this or that sense that which cannot be perceived by any other sense than that one and in respect of which no error is possible; in this sense colour is the special object of sight, sound of hearing, flavour of taste.”⁴⁵³ Now, on Aristotle’s account, one cannot be in error about one’s perception of a special object of sense, whether a color, sound, flavor, texture, or smell. Thus, with respect to one’s contact with the external world, one cannot be in error. But this basic correctness of perception pertains to a very narrow slice of reality. For

⁴⁵³ *De Anima* II, 6 418a, 11-14.

instance, we have to distinguish the bare or crude perception of some special object of sense from even the assertion that this thing here *is* just that perceived quality: “for while the perception that there is white before us cannot be false, the perception that what is white is this or that may be false.”⁴⁵⁴ In Aquinas’ commentary on *De Anima*, he explains the matter in an even more direct way: “For when what is seen is white, the senses do not lie. But if what is white is taken as this or that, in short, snow, flour or anything of this sort, in this case it is grasped in such a way to deceive the senses as with large or distant things.”⁴⁵⁵ The reason for this becomes clear from what we have already said: once I attribute any sensible quality to a determinate piece of matter, I am claiming that the quality inheres in a substance as either an essential or accidental attribute. Whether or not my eyes see white cannot be a source of error, but whether that white I see is the son of Diares, a patch of snow, or something else, is obviously open to error. Proper sensibles, then, are apprehended simply and without the possibility for error, insofar as they are perceived as bare qualities, and not the qualities of some thing.

However, these proper sensibles carry very little representational content, i.e., they tell us very little about the world. We can see this by differentiating the proper sensibles from the common sensibles. The common sensibles, Aristotle says, are “movement, rest, number, figure, magnitude; these are not special to any one sense, but are common to all. There are at any rate certain kinds of movement which are perceptible

⁴⁵⁴ *De Anima*, 428b 18-19, 21-22, respectively, Barnes, p. 681

⁴⁵⁵ *Quod enim album sit quod videtur, non mentitur sensus; sed si album sit hoc aut illud, puta vel nix, vel farina vel aliquid huiusmodi, hic iam contingit mentiri sensum, et maxime a remotis.* Aquinas, *In Aristotelis Librum de Anima Commentarium*.

both by touch and sight.”⁴⁵⁶ Unlike the proper sensibles, which are perceived by a particular sense organ, there is no sense organ for the common sensibles, but a “common sensibility [*koina aisthêta*]” as Aristotle calls it.⁴⁵⁷ He suggests that this “common sense” operates in a similar manner to the way that we conjoin proper sensibles in one object, e.g., when we call the coffee black, bitter, and hot or the bile bitter and yellow (a much less appetizing example!). As Aquinas makes clear in his commentary, the *sensus communis* does not perceive the common sensibles as if it were a sense organ and they were the proper objects of it. Rather, the *sensus communis* perceives by way of a kind of combination of the information received from the sense organs.⁴⁵⁸ In this way, the common sense is not a sense organ, but a power of organization that governs the proper sense organs.⁴⁵⁹ For Aristotle, one must conclude that while it is not possible to err in perceiving a proper sensible, one may err in perceiving common sensibles. Indeed, Aristotle claims, “[I]t is in respect of these [common sensibles] that the greatest amount of sense-illusion is possible.”⁴⁶⁰

⁴⁵⁶ *De Anima* II, 6, 418a 17-19.

⁴⁵⁷ *De Anima* III, 1, 425a 27.

⁴⁵⁸ *In Aristotelis Librum de Anima Commentarium*, lib. 2, lect. 13: “Sensus enim communis est quaedam potentia, ad quam terminantur immutationes omnium sensuum, ut infra patebit. Unde impossibile est quod sensus communis habeat aliquod proprium obiectum, quod non sit obiectum sensus proprii.”

⁴⁵⁹ On the synthesizing role of *phantasia*, see D. Frede, “The Cognitive Role of *Phantasia* in Aristotle,” in *Essays on Aristotle’s De Anima*, 282-87. She describes a kind of supervenience relation between *phantasia* and the special senses, i.e., that it is neither a separate faculty, nor reducible to the special senses. In the further discussion of these issues in *Sense and Sensibilia*, Aristotle concedes that if any one sense could perceive the common sensibles, then it would be sight (4, 442b 13-14). However, this statement occurs in the context of a denunciation of prior philosophers who thought that the common sensibles were perceived by a certain sense organ, so it is unlikely to contradict what we have noted above.

⁴⁶⁰ *De Anima* III, 3, 428b 26.

This conclusion about the apparent illusory nature of common sensibles seems to be a consequence of the principles of Aristotle's epistemology, where the common sensibles require the imagination or *phantasia*, which is an untrustworthy faculty. As we have seen from the last chapter, scholastic Aristotelian psychology characterizes the common sense, along with imagination/phantasy and memory, as an 'internal sense', which is opposed to the 'external senses' of sight, hearing, smell, taste, and touch. While the external senses perceive objects in a discontinuous and piecemeal way, the common sense unites that sensory information into 'phantasms' or representations. The act of synthesizing, or reintegrating, the information from the internal senses, for Aristotle, is prone to inaccuracy. Indeed, it is as if the dissolute sensible species are accurately resolved in the imagination when these pieces are naturally fitted together. In the case of accurate representation by some phantasm, the sensory qualities are unified by the substantial form of the object. As a consequence, it would be entirely natural for the common sense to piece them back together. The sugar is white, granular, and sweet; these are properties of its very nature; so when the imagination represents this granular, white, and sweet substance as sugar, it does so accurately. Ultimately, the form of the thing is reconstituted by the intellect in the perception of an 'intelligible species', which as we have seen is the proper object of the intellect, and also free from error. Aristotle thus begins with error-free perception of discontinuous sensible qualities and ends with error-free understanding of universals. The whole process is underwritten by the formal unity of the individual that can be perceived (though not without difficulty) by the mind.

As an aside, I must say that this preference for the epistemic certainty of proper sensibles over common sensibles seems quite contrary to ordinary experience. Even though there are some cases where perception of common sensibles is inaccurate, as when the square tower appears round from a distance, there are a great many more examples of illusion in perception of proper sensibles. Colors are notoriously difficult to pin down, since they alter in lighting conditions; sounds are frequently difficult to determine (“What was *that*?”); and it is easy to trick the sense of taste, as when you follow something sour by something sweet. I think the more intuitively plausible position is Descartes’ position, which as we will see inverts the epistemic priority of proper sensibles and common sensibles: proper sensibles (secondary qualities) will be considered merely apparent and thus in some sense systematically illusory, while common sensibles (primary qualities) will be taken as the indubitable constituents of material nature. Indeed, Descartes’ material simple natures are, in fact, identical to the ‘common sensibles’.⁴⁶¹ For the moment, let us return to the Aristotelian account and discuss, in more detail, the end of the process of cognition, the apprehension of essences.

Apprehension of essences

Aristotelian psychology would hold that the senses cannot be in error with respect to proper sensibles, since it is just the nature of those faculties to perceive those sensory

⁴⁶¹ In this respect at least, Descartes could be reckoned to hold a position like that of Democritus who, Aristotle claims, reduces the special sensibles to the common sensibles (*Sense and Sensibilia*, 4, 442b 10-17).

qualities. In the *Summa Theologicae*, Aquinas exploits this functional relation between faculty and object in order to explain the pure intellection of simple essences. In Bk. I, Q. 85 a. 6, on whether the intellect can be false, he claims, “the Philosopher compares the intellect with sense on this point. For sense is not deceived in its proper object, as sight in regard to color.” In the cognition of essences or universals, pure intellection can be understood on analogy with sense perception: when each is directed toward its proper object, i.e., the object toward which it is *per se* disposed, it cannot err.

Now the proper object of the intellect is the “quiddity” of a material thing; and hence, properly speaking, the intellect is not at fault concerning this quiddity; whereas it may go astray as regards the surroundings of the thing in its essence or quiddity, in referring one thing to another, as regards composition or division, or also in the process of reasoning. Therefore, also in regard to those propositions, which are understood, the intellect cannot err, as in the case of first principles from which arises infallible truth in the certitude of scientific conclusions.⁴⁶²

The quiddity, essence, ‘what it is’, or universal is the special object of the faculty of pure intellection. Ordinarily quiddity is distinguished from essence as a logical concept, distinguished from a metaphysical one. In this way, quiddity is identified with the definition, formula, or proposition that necessarily refers to all members of a certain class. One interesting feature of this is that quiddity cannot be simple in the sense required by the Toletus commentary. Thus, just as the senses cannot be in error with respect to their special object of sense, so the intellect cannot be in error with respect to the quiddity of a thing. So, once we have an adequate definition of some particular thing, once we have clearly stated its essence, this cannot be a source of error. For Aquinas, error arises chiefly in the perception of accidents and in the attribution of accidents to a

⁴⁶² *Summa Theologica* I: 85a6.

thing. These accidental properties are the “surroundings of the thing in its essence” as described in the passage above. One could be more precise by using the language of form: accidental forms are the qualities of things that are unified and organized by the substantial form that makes a thing what it is essentially. If we relate this passage back to the preceding discussion of internal and external senses, it becomes clear that error arises in the recombination, or synthesis, of the imagination or common sense with respect to the piecemeal apprehension of accidents and their attribution to a particular subject. As we have also seen in the previous chapter, this understanding of the situation explains why the intellect is said to be entirely separable from physical sensation. The intellect apprehends the form of the thing, its essence, immaterially. But this is made possible by virtue of the synthesizing work of the phantasy or common sense. The imagination furnishes a kind of “standardized” material, i.e., an imagistic representation of the thing that is at once accessible to the intellect for the purposes of rational contemplation, but also serviceable for the senses with respect to the particular instances of such a thing.⁴⁶³

In this picture of cognition, we have confidence in our capacity to perceive the world as it really is through the sensory faculties. However, these sensory faculties perceive, strictly speaking, a very narrow slice of reality, i.e., pure sensory qualities. In order to represent the world in a way that gives us an accurate picture about objects and the way they participate in any of the ten categories (e.g., is this white thing here or there, of such and such a quality, quantity, etc.), we require some combination and representation in the imagination. The standardized mental representation, or *phantasm*,

⁴⁶³ Frede, “The Cognitive Role of *Phantasia*,” 288-92.

can be related to what was frequently called a ‘common nature’, or the set of properties shared by some group of individuals. The common nature is a somewhat broader concept than species or genus and thus has a wider ranging use, but it generally serves the same purpose, i.e., to pick out certain traits that are shared by members of a given class. Here, at the level of the imagination and the formation of a concept of common nature, as it pertains to perceived objects, we begin to acquire the kind of information about the world that can be put in propositional terms. However, precisely at this point, we become liable to error. If we attain the level of essences, where the pure intellect apprehends the true nature of some thing, then we can also be assured that we have a fix on the truth of things. But how do we get from the non-representational, dissolute sensory qualities to the level of essences? How do we pass through, and make use of, the representational capacities of the imagination without it leading us astray?

Abstractive and intuitive cognition

As we have seen in Aquinas, as soon as the intellect is involved in the process of cognition, the object cognized is no longer a particular entity, i.e., something with determinate matter under determinate dimensions. Even at the level of the imagination, it is not clear that what is imagined has a particular character. Rather it seems to have a common character, presenting general natures or qualities that are present in the individual, but in more generic way. The process of “turning to the phantasm” allows for the intellect to be determined by the imagination, but it seems to me that this is still a

level higher than direct sensory contact with determinate bodies. Toletus argues against this reading, however. He claims that the intellect does indeed know sensible singulars. The reasons he supplies are somewhat piecemeal: the senses do not know singulars as such because, for instance, the senses cannot discriminate the white from the sweet (this requires the common sense); the intellect corrects the sense, so the intellect must have knowledge of singulars in order to correct sensory information; the intellect reasons about propositions that include singular terms; the higher power possesses eminently whatever the lower powers know; and prudence, which is practical intellection, is about singulars. These conclusions, when taken together, are supposed to show that there are a number of instances, and maybe even the principle ones, where the intellect is normally said to have knowledge of singulars. Toletus denies that the process of “turning toward the phantasm” entails that the intellect is mediated in its contact with sensible particulars. Instead, he takes it that the intellect actually knows those particulars, and that by virtue of this it can discriminate between individuals of the same species. Toletus considers the intellect to know the singular as united with a universal form, but to know the singular all the same.⁴⁶⁴ I do not wish to dispute Toletus’ interpretation of Aquinas, but I would like to point out that the issues I have outlined here lead some thinkers to reject Aquinas’ interpretation in favor of a more straightforward understanding of the cognition of particulars. I will devote some attention to the theory of abstractive and intuitive cognition, as it was developed in John Duns Scotus and William of Ockham.

⁴⁶⁴ *Comentarii in de Anima*, Lib. III, c. 4, txt. 15, q. 12, 139-140.

Duns Scotus is famous for his claim that being is the first object of the intellect. His claim is based on the “twofold primacy” of being: being is contained either essentially or virtually in any thing that can be known, i.e., being is common to every intelligible thing either by virtue of its own existence or the existence of what participates in it; and, in both of the cases mentioned, being is the primary concept.⁴⁶⁵ Scotus argues that being is univocal, though he concedes that being is predicated differently for those concepts that are irreducibly simple (since it cannot be analyzed out of those concepts). For all concepts that are not irreducibly simple (such as species, genus, and individual), they hold being in common as a designation of their real nature, or *in quid*. For those that are irreducibly simple (such as being itself, substance, and God), these concepts cannot be predicated *in quid* because nothing in the concept can be analyzed out of it (we cannot understand God in abstraction from God’s existing). Nonetheless, being can be said to be contained in these concepts virtually, or as a quidditative predicate of its effects. In either case, Scotus argues that being is the first, most primary and common, object of the intellect.

When the intellect apprehends something, it apprehends it as existing either quidditative or virtually. Moreover, this apprehension is immediate, intuitive, and evident, by virtue of the simple apprehension of the thing itself. Such a view paves the way for conceiving of the other transcendentals (unity, goodness, and truth) as pertaining to all intelligible things. Yet, for Scotus, being is unique in that it is not only the most general designation, applying to all conceivable things, but a thing’s existence makes it

⁴⁶⁵ *Ordinatio* I, d. 3, nos. 137-39; following William A. Frank and Allan B. Wolter, *Duns Scotus, Metaphysician*.

what it is in a singular, particular way. Thus, Scotus grounds his metaphysics in a concept that is the basis of the particular existence of any individual and a universally applicable concept. The simple apprehension of being allows the intellect to have general knowledge, but also be in direct contact with real entities external to the mind.

Ockham makes the notion of intuitive cognition, or the direct apprehension of a concrete particular more thematic. The idea seems to be that the mind has the capacity for direct contact with extra-mental entities in a way that is immediately evident. This kind of contact pertains primarily to contingent and temporally dependent truths about individuals.⁴⁶⁶ He contrasts intuitive cognition with abstractive cognition which is not about temporally dependent or contingent truths about individuals, but concerns more general truths about individuals. In Ockham's theory of cognition, intuitive cognition is about propositions or sentences and not about species, objects, or some other causal mechanism. That is, concepts about individuals (either general or contingent) are referred to a mental language that is acquired by virtue of the impressions of various objects on the mind.⁴⁶⁷ The initial impression generates an intuitive cognition which can then become the basis for abstractive cognitions. For Ockham, the linguistic, propositional, or logical form of mental language allows for an extension of the concrete, intuitive cognition of particulars to a more general metaphysics. In a sense, this view of cognition (though sharing some of the same terminology) is quite different than Scotus'. Whereas Scotus would hold that being is the first object of the intellect by virtue of its universality,

⁴⁶⁶ See E. Karger, "Ockham's Misunderstood Theory of Intuitive and Abstractive Cognition," in the *Cambridge Companion to Ockham*, 210-11.

⁴⁶⁷ See Calvin. G. Normore, "The Invention of Singular Thought," in *Forming the Mind*, 117.

Ockham holds that the first objects of intellection are entirely unique, discrete individuals. Unlike Scotus, for whom being is logically primary in the order of intellection, Ockham holds the individual as the primary object of the intellect because it is causally primary. That is, discrete individuals cause an intuitive cognition, which is in turn the logical basis for abstractive cognitions. In either case, however, there is a close connection between the putative existence of intelligible essences (insofar as something exists as a *this*, i.e., quidditatively) and the causal primacy of singular entities. Both allow for an explanatory metaphysics that short circuits the gap between intelligible essence and singular entity that we found in Aquinas.

Simple natures in Aristotelian scientific explanation

This very brief outline of some of the debates surrounding the apprehension of essences and singular entities allows us to move to the difficulties involved in scientific explanation. The chief difficulty in scientific investigation, for the late scholastic authors we are considering, is to distinguish the accidental from the essential properties of a thing, the manner in which they are combined and attributed to a particular subject, understanding that only those essential properties constitute the quiddity of the thing. Whether or not our intellect is capable of grasping the quidditative nature of individuals will have a direct consequence for the nature of scientific explanation. The Coimbrian commentaries introduce the concept of ‘simple natures’ in just this context, in the

commentary on *Physics* I, 1 (Q. 2, Art. 3).⁴⁶⁸ It is interesting that the Coimbrians do not address the simple natures in their commentaries on *De Anima* Bk. III, 7, as Toletus had. Their commentary on that passage is sparse. Perhaps this reflects a shift in focus, perhaps it reflects the way that the concept ‘simple nature’ was historically thematized, or perhaps it simply reflects the Coimbran’s deference to Toletus’ *De Anima* commentary.

The first book of the *Physics*, by contrast, enjoys a prolonged discussion in the commentary. The passage where they introduce the simple natures occurs in a chapter that treats the basic goal of any scientific inquiry, i.e., knowledge of principles, causes, or elements, and the method of reaching that goal, i.e., “to start from the things which are more knowable and clear to us and proceed towards those which are clearer and more knowable by nature” (184a 16-17). In a certain way, this passage indicates the close relation between epistemological questions and scientific explanations. It is, in a way, natural to consider whether there are any simple natures, or simply apprehended qualities of things, that could also serve as the starting points of scientific investigation. Of course, *Physics* I, 1 is notoriously difficult to interpret, especially when Aristotle explains what he means by this movement from what is known by us to what is known by nature. In that famous passage, he says, “Now what is to us plain and clear at first is rather confused masses, the elements and principles of which become known to us by analysis. Thus we must advance from universals to particulars; for it is a whole that is more knowable to sense-perception; and a universal is a kind of whole, comprehending many things within it, like parts” (184a 21-25). As the Coimbrians note, this passage created a great deal of

⁴⁶⁸ I refer to the *Commentarii Collegii Conimbricensis Societatis Jesu, in octos libros Physicorum Aristotelis*.

controversy and a number of different interpretations (I, 1, Exp., 48). For example, it is not clear in what sense “wholes,” which are compared to universals, are perceivable by the senses. Furthermore, it would seem that Aristotle has it backwards in this passage, claiming that we begin with universals and move to particulars, when universals, i.e., principles, causes, or elements, are what is *sought* in scientific investigation. Thus, the commentary spends nearly 30 pages expanding on the brief text of *Physics* I, 1.

In the opening explanation of the passage, the Coimbrians confirm our suspicion about the passage. The way they put it is that scientific knowledge moves from the *minus communis* to the *magis communis*, or, from particulars to universals (Exp., 50). This movement is accomplished by way of the method of analysis, i.e., by seeking the middle term that explains what is less general by what is more general. Next, they make four assertions concerning this general rule that are meant to determine the nature of scientific knowledge. First, they claim that all philosophers agree that what we know in the first place are accidents, not essences. Second, in order to understand the essence of a thing, one must know the *causa interna*, not the *causa externa*. So, it would seem, our initial understanding of the thing *per accidens* must advance to an understanding *per essendi* by way of an inquiring into the internal cause of the thing’s nature, its intrinsic features. Third, the perfect demonstration must refer to an underlying genus, i.e., the categorical basis of the thing’s nature. Finally, it is not sufficient to know the cause, one must also understand its effects and all those attributes that are essentially connected to it (Exp., 50-51). Thus, understanding of essences moves from particular to universal by reference to the causes that make a thing what it is. However, those causes are not completely

understood until one knows all of the effects of that cause, or all of the particulars contained under the universal. The Coimbrians thus take the Thomistic line that we have seen above, guaranteeing scientific knowledge through reference to the analysis of terms and the ways in which they can be said to belong to the ten categories.

In Aristotle's *Posterior Analytics*, first principles, which are also said to be necessarily true and immediately perceived, are the starting points of scientific demonstration: "it is necessary for demonstrative understanding in particular to depend on things which are true, primitive, and immediate as well as more familiar than, prior to, and explanatory of the conclusion" (*Pos. An.* 71b 20-23).⁴⁶⁹ These "true, primitive, and immediate" things are the "first principles" [*archê*] of Greek science, which are the starting-points of scientific explanation and the most universal objects of knowledge. For Aristotle, in the *Posterior Analytics*, the first principles of science are indemonstrable, "immediate" and "primitive," though it is not possible to have demonstrative understanding without possessing an understanding of those principles. In short, demonstration from first principles is the essence of scientific knowledge (*epistêmê*,

⁴⁶⁹ We should insert some caveats to a strict analogy between Aristotle's *Posterior Analytics* and Descartes' *Regulae* on this issue. First, the *Posterior Analytics* is also the source of the doctrine of a division between the sciences. In Bk. I, Ch. 7, Aristotle clearly states, "One cannot, therefore, prove anything by crossing from another genus" from which it follows, for example, that "one cannot prove by geometry that there is a single science of opposites ... nor can one prove by any other science the theorems of a different one" (*Pos. An.* 75a 38 and 75b 14-16). This is clearly a source of the division of sciences according to subject-matter, which is something that Descartes rejects. Second, Aristotle's *epistêmê* appears, at least in the *Nicomachean Ethics*, to be strictly distinguished from a science of action, *phronêsis*, and a kind of universal wisdom, *sophia* (*NE* Bk. VI, Ch. 5-7). However, in the first rule, Descartes seems suggest a strong rapport, if not an identification, between all three: "the sciences are nothing other than human wisdom" (AT X, 360) and "If, therefore, someone seriously wants to investigate the truth of things ... he should ... consider simply how to increase the natural light of his reason ... in order that his intellect should show his will what decision it ought to make in each of life's contingencies" (AT X, 361).

scientia). Aristotle defines *epistêmê* as a kind of “demonstrative understanding,” that is, an understanding of something that is both aware of the object and the explanation through which the object is what it is, such that this understanding cannot be otherwise: “whenever we think we are aware both that the explanation because of which the object is its explanation, and that it is not possible for this to be otherwise” (*Pos. An.* 71b 10-11). This is the kind of understanding sought in the *Physics* and indicated in the Coimbrian commentaries.

Now, the method of arriving at knowledge of first principles is notoriously unclear. Aristotle calls it a kind of “induction (*epagôgê*)” in the *Posterior Analytics* II, 19, which is a movement from particulars to universals by way of experience (*empeireia*). This movement is probably “dialectical” in the sense that it proceeds by way of *endoxa*, through aporiatic reasoning, in order to winnow out those universal truths from the mass of unfounded opinions. It is likely that this process of induction can be understood along the lines of generality and specificity that I have been discussing in this chapter. In other words, there are a number of different avenues available to try to discriminate the more general qualities from the less general ones as they are either contained or not contained in an individual. These techniques are sometimes linguistic, sometimes empirical, and sometimes conceptual. But in every case, it is the underlying metaphysical structure of individuals, i.e., that they are organized by a substantial form, that ensures that these various tactics all have access to knowledge of the same thing. By looking closely at the Coimbrian commentary, we will get a better sense of what is involved in this process.

Distinct and confused cognition

Elaborating on the underlying epistemology that characterizes this approach to scientific knowledge, the Coimbrians distinguish two kinds of cognition: *cognitione distincta* and *cognitione confusa* (Q. II: *Quaenam sint nobis notoria cognitione distincte*, 56-64). Distinct cognition is cognition of universals or essences, the former is understood as a ranging over particular subjects that are contained in it as parts to the whole, the latter is understood as the categorical nature of the thing, i.e., its matter, form, or its characterization by the categories of being. Distinct cognition is defined in the following way: “we know the whole of the thing and all that is contained in it by plain inspection [*Distincta est, qua totum omnibus, quae in eo continentur, enucleate inspectis, cognoscimus*]” (Q. II, A. 1, 57). By contrast, confused cognition is “when we apprehend the whole and all that is contained in it indiscriminately as if by an intermingled cognition [*Confusa est, qua totum iis, quae in eo continentur, promiscue tantum ac permixtum cognitis, apprehendimus*]” (ibid.). In confused cognition, one grasps the nature of the thing imperfectly, initially, and by way of its many aspects rather than its essence. Each of these cognitive states can be either actual or potential, and they can coexist in the apprehension of a thing. For example, it is possible to have an actually distinct cognition and a potentially confused cognition of the same thing at the same time; likewise, it is possible to have a potentially distinct, yet actually confused cognition of the same thing; but it is not possible to have an actually distinct and confused cognition, nor a potentially distinct and confused cognition, of the same thing at the same time. The

reason for this is that one may know the internal cause of a thing and thus have a distinct cognition of it, but one may not simultaneously know how that cause is differentiated from the underlying genus of the thing. One might, for instance, know that rationality defines the human being, but not be aware of the fact that rationality differentiates the human being as animal, and thus not possess the full definition of the human being. Consequently, this knowledge of human beings is potentially confused, since we are not at that moment attending to certain aspects of the thing in question. What we want is an actually distinct cognition of the whole of the thing, its internal structure, the way that it can be predicated according to each of the categories, and the relationship between its internal cause, those categories, and all of the effects related to it.

Simple natures

At this point, it becomes relevant for the commentary to introduce the concept of simple natures, since these were said to be the objects of distinct cognition *par excellence*, i.e., they are entirely simple, indivisible, essences that contain no possibility of truth or falsity. But the Coimbrians introduce this concept with a question, namely, “Is it thus possible for the simple natures to fall under an actually confused cognition [*Etiam Naturas Simples sub cognitionem confusam actualem cadere posse*]?” (Q. II, A. 3, 60). This question seems to be relevant since the standard for actually distinct cognition is so high, and we will see that in fact this does pose a problem for the actually distinct cognition of simple natures. To begin with, however, the Coimbrians seem to identify simple natures with the categories of being; they refer to them in this way: “the *summa*

genera and other simple natures [*genera summa aliaeque simplices naturae*]” (ibid.).

Thus, the simple natures, in addition to being identified with Aristotle’s notion of “indivisibles” in *De Anima*, also appear to have some relation to the highest genera of being, or the categories of being. It would seem that they, too, are relevant to gaining a distinct cognition of any particular thing, insofar as it can be explained by way of the simple natures. Simple natures are also connected to the differentiae of things, but not their species or genus. The reason for this is that species and genus are not, strictly speaking, simple. A species is defined by reference to its genus and differentia, and thus is inherently composed. The same holds true for all genera up to the highest, which of course, are not referred to any higher genera and thus are not themselves composed. Differentia, by contrast, could be conceived of as simple qualities that cannot be further analyzed.

These final comments highlight the central conundrum of the simple natures for the Coimbrians. That is, while the Aristotelian tradition, and particularly Toletus, seem to indicate that some things, e.g., essences or universals, are apprehended simply and without composition, when one pushes the nature of familiar sorts of essences, one finds them to be composed. Even though the Coimbrians acknowledge that many prior philosophers had conceived of simple natures as those things that are perceived by a distinct cognition (citing Scotus, Ockham, and Gabriel Biel “and no few others”), they object to this way of thinking. I cite the whole passage, which is relatively brief.

However, the contrary proposition of those saying [that simple natures are not perceived by an actually confused intellect] is likely more true, namely, that all of these things [i.e., the simple natures, the highest genera, and being itself] can be perceived by an actually confused cognition. This [confused cognition] is indeed

sufficient for acquaintance of this sort and any kind of account of a whole and its parts, an account that is discovered in the aforementioned natural kinds. For example, substance, by virtue of the word, as is posited by its own definition, which is to be a self-persisting entity, in its own way, even if it is improper to say so, is made up of parts: insofar as ‘being’⁴⁷⁰ is conceived in the way of a genus, and ‘to persist of itself’, in the way of a differentia. Therefore, he who would perceive of substance in terms of these distinctions will be said to know it distinctly, and otherwise to be truly confused. It is the same with the summa genera, and all the specific differences, both to the extent that they now exist or are capable of being produced by a divine power; and lastly all proximate significata of being are in some way essential parts of being, which they are by virtue of their own nature or their possible nature, distinctly assumed under being, as will be discussed elsewhere. If therefore one were able to conceive all of the details together (which, however, only God could do), he would have a distinct acquaintance with being; just as it would otherwise be confused. What kind of knowledge do they form when I hear that they conceive the absolute name of being as ‘that which is’, which is called by some according to the word ‘acquaintance’? By virtue of this [kind of knowledge], the person would attain no immediate significatum of being in its details.⁴⁷¹

From this passage, it appears as though the Coimbrians advocate a very radical position relative to distinct cognition of simples. The passage seems to imply that it is virtually impossible for human beings to possess a distinct cognition of anything because it is not possible for us to simultaneously grasp the general essence along with all of the details relative to its nature. In the case of being itself, only God could do this. In some measure,

⁴⁷⁰ Reading *ens* for *eus*.

⁴⁷¹ Verior tamen est contraria sententia aientium posse hec omnia cognitione confusa actuali percipi. Sat est enim ad huiusmodi notitiam qualiscumque ratio totius, et partium; quae ratio in praedictis naturis invenitur. Nam substantia, verbi causa, ut patet ex ipsius definitione, quae est ens per se subsistens, suo modo, et si improprie, constat partibus; quaetenus eus concipitur ad modum generis, per se subsistens, ad modum differentiae. Qui igitur substantiam hac adhibita distinctione perceperit, dicetur eam distincte cognoscere; qui vero aliter, confuse. Item genera summa, omnesque differentiae specierum, tam quae iam extant, quam quae divina virtute produci queunt; et deinceps omnia proxima entis significata, sunt quodammodo partes essentielles entis, cum sint ipsa ratio, seu potius rationes entis distincte sumpti, ut alibi fusius dicetur. Haec ergo si quis particulatim complecti posset, (quod tamen soli Deo competit) si distinctam haberet entis notionem; alioqui confusam tantum; qualis est ea, quam formant, qui audito entis nomine absolute concipiunt id quod est, quae a quibusdam vocabuli notio appellatur; propterea quod nullum immediatum entis significatum particulatim attingat.” *In octo libros Physicorum Aristotelis*, I, 1, Q. II, A. III, 60.

the passage seems to be motivated by a confrontation with the Scotist and Ockhamist positions on intuitive cognition described above. Thus, the passage ends with the contention that only God could truly be said to grasp the essence of being *in all of the details* (particulatim), while the person who says that being is simply ‘that which is’ (*id quod est*) has only a confused cognition of it.

While this may be the case, there are also some important concepts in play that need to be fleshed out. In particular, the Coimbrians make the case that a thing cannot be said to be conceived distinctly if the way in which it is conceived can be further analyzed. The example they give is substance, whose definition as an *ens per se subsistens* can be analyzed into *ens* and *per se subsistens*. Here they take *ens* to be the genus and *per se subsistens* to be the specific difference. In this way, the cognition of substance, unless that cognition is aware of the parts contained in its definition, is confused. In a certain measure this is a reasonable position. Insofar as we attend to the general nature of thing, we allow parts that compose that nature to lapse into obscurity. In fact, it seems impossible for human cognition to simultaneously grasp the general essence of a thing and its parts, whether those parts are conceptual, i.e., definitional or real. However, the Coimbrian position seems to fly in the face of the Aristotelian notion of indivisibles and universals outlined above. According to Aristotle in *De Anima*, a line or a segment of time can be conceived of as indivisible even though these are paradigmatic cases of things that can be indefinitely divided. In this way, it seems, Aristotle takes ‘indivisible’ to mean ‘actually undivided’. If this doctrine were upheld, then we could surely claim,

against the Coimbrians, that ‘substance’ is indivisible insofar as it is taken as a whole, though of course its definition can be analyzed.

Moreover, the Coimbrian position seems to collapse into a denial of any distinct cognition at all. Cognizing ‘substance’ is said to be confused unless we understand that by substance we mean a being that is self-subsistent. But this seems to imply that the truly distinct cognition of substance is actually a cognition of many things at once: the word ‘substance,’ its definition, the parts of that definition, and the identity between them. If this is what is meant by an actually distinct cognition of simples, then such a cognition is not simple at all! It is impossible—short of tautology—to provide a definition of a thing that is not itself composed of several concepts. Moreover, any general essence must range over and refer to many particulars. So, it is difficult to see how the Coimbrian position elaborated in this passage does not lead either to outright skepticism with respect to distinct cognition or to a view of distinct cognition that is so complex it could hardly be called ‘intuitive’.

In an apparent effort to mitigate the seeming intrasigence of this position, the Coimbrians make use of the doctrine of forms and the nature of sensation that we have discussed above. Even in the quoted passage, they suggest that the movement from particulars to universals depends on unlocking the internal hierarchical relation of essence, the ladder of being. This is possible because the essence of an individual includes its species, genus, and differentia. Therefore, by considering many individuals, and specifying their definitions, one can reconstruct the relationship that exists between them. Further in the commentary, they caution that such a move is not mathematical,

such that it follows some sequential order. Rather, the order of being is a rank ordering, based on the relative nobility of each individual (*Commentarium Physicorum* I, Art. IV, Resp. I). So, they conclude, the chain of being ought not be conceived as a linear ascension from lower to higher, neither should God's omnipotence diminish the nobility of any individual, but the complex relations among species define the nobility of any individual. So, for instance, human knowledge should not attempt to reach divine knowledge, even though this is the highest form of knowledge. Rather, the order of knowing ought to reflect the knower's place in the order of nature (63-64). In this respect, the human being is not in an utterly destitute position relative to scientific knowledge. Indeed, since perception, as we have seen above, is always of some particular substance, and necessarily implies the production of a phantasm, there are a variety of ways that human perception lends itself to general conclusions (Q. III, Art. IV). For instance, this perception of white admits of at least two types of classification and investigation: with respect to the genera 'color', and with respect to the 'this', e.g., Socrates, i.e., man, i.e., rational animal (69-70). The perception of any quality thus admits of investigation into its nature and the nature of the substance in which it is perceived to inhere (because it is impossible for a human being to perceive a quality without its inhering in a substance). To put this all together, one perceives an instance of some quality, or many instances of that quality, and from these particulars, one forms a *minus universalia*, a least general abstraction. The perception of this *minus universalia* is actually distinct, but potentially confused, since it is apprehended as such, but its nature is not fully known. It is this

perception that precedes and leads to the actually distinct cognition of the *magis universalia*, which encompasses the *minus universalia* as its part (Q. III, Art. V, 72).

This strange talk of *universalia* may be confusing. However, it can be understood in a much more general, epistemological way. Our cognition of things is always by means of a form or species, i.e., the sensible and intelligible species, which by their very nature contain a measure of generality, a *naturae communes*. The Coimbrians claim: “The universal is the object of the intellect, while the singular is the object of the senses [*Universale est objectum intellectus, singulare objectum sensus*]” (73). Thus, the first universal that we come to know is the *singulare*. As long as the Coimbrians maintain that the object of sensation is a singular entity whose nature participates in the order of being, and thus shares in a more general, common nature, then it is possible for them to claim that we can move from the perception of particulars to knowledge of universals. It is by virtue of one’s possessing the form of the singular entity, through perception, that one can gain a foothold in the order of being, since every entity’s form is defined by relation to its genera and specific difference. I think this is what they mean when they invoke the cryptic dictum: “The least of the highest is grasped by the highest of the least [*infimum summi conjungitur summo infimi*]” (Q. V, A. I). That is, particular substances are grasped by the intellect of human beings. Substances are the highest things to be known, while human beings are the lowest of intelligible beings. Thus, even though sensation only receives the accidents of things, it is the particular substance itself that is perceived, and it is by virtue of this unifying character of individual substances that the intellect has access to essences in general. Though this picture may resolve some of the difficulties posed in

the previous pages, it commits any epistemological account of scientific investigation to a very complex metaphysics.

In this section, we have seen a number of examples of the way that epistemology, science, and metaphysics were linked in late scholastic writings. Of particular interest to us is the apparent difficulty for traditional Aristotelian commentators (Aquinas, Toletus, and the Coimbrians) to account for any direct, intuitive knowledge of particulars. As a result, the Aristotelian theory of science relied heavily on a metaphysical picture of the world, which understood individuals to participate in a hierarchical structure of species, genus, and the categories. The essence of individuals could be discovered by carefully discriminating perceived qualities and the way that each participated, either accidentally or essentially, in the existence of the thing (on the one hand) and in that overarching metaphysical totality. According to this picture of the relationship between metaphysics and science, there does not appear to be any place for the direct, intuitive grasp of ‘simple natures’. Though Aristotle’s *De Anima* and Toletus’ commentary seem to suggest that such a direct apprehension of natures is possible, that position is severely mitigated by the possibility of those simples, grasped intuitively by the intellect, being *natures* in the relevant sense. Indeed, all natures are composites, necessarily, of some substantial form and determinate matter. Moreover, all existing forms admit of analysis into species, genus, and specific difference. So it seems unlikely that anything like ‘simple natures’ is really basic to the Aristotelian theory of science. Nonetheless, we note the existence of theories of intuitive cognition in Scotus and Ockham, where there does seem to be some

immediate and direct contact between the mind and extra-mental entities. This may be a source of the concept of ‘simple natures’, but there is no sustained discussion of simple natures in their writings. The belief in truly simple starting points for science seems to be a modern invention.

Bacon’s use of simple natures

The attention given to the concept of simple natures in the Coimbrarian commentary suggests that the term ‘simple nature’ had gained some usage in the 16th century. It may have been connected with the idea of “intuitive cognition” or Aristotle’s notion of “indivisibles” in *De Anima*. In either case, the Spanish Jesuits address the issue in the context of natural philosophical explanations and come to the conclusion that such natures, if they exist, are initially conceived in a confused way. However, Francis Bacon suggests a role for the simple natures in his metaphysics. I believe that this is the most probable source for Descartes’ use of the term in the *Regulae*. I imagine that Descartes confronted Bacon’s philosophy most earnestly in 1625 when he returned to Paris and began working on the *Regulae*. Bacon’s *Novum Organum* and his attempt to replace the Aristotelian syllogism with a mechanistic method of scientific discovery was well known to Mersenne’s Circle after the publication of *La Vérité des sciences* in 1624. Surely there were those in Paris who wondered if the simple natures that Bacon spoke so promisingly of could provide a real foundation for mechanistic natural philosophy. Though I cannot

prove that this scenario is accurate, it fits the historical information we do have about a connection between Bacon and Descartes on the issue of the simple natures.

Historical connections between Bacon and Descartes

Though there are many historical connections between Descartes and Bacon, I believe Mersenne to have provided the real impetus behind the “Baconian” elements in the *Regulae*. Isaac Beeckman and Constantijn Huygens also knew of the *Novum Organum* in the early 1620s.⁴⁷² Huygens expresses the highest praise for Bacon’s *Novum Organum* as early as 1621, but Descartes would not meet him until 1632. Conversely, when Beeckman writes a resume of Bacon’s *Novum Organum* in his journal dated 1623, Descartes had already returned to France and would not contact Beeckman again until 1628. Thus, it is most likely that Descartes heard of Bacon through Mersenne, who would publish an extended critique of Bacon’s *Novum Organum* in 1624 in his *La Vérité des sciences*.⁴⁷³ It is possible that the *Novum Organum* was making waves among intellectual circles in Holland in the early 1620s and that Descartes had been alerted to the work prior to his meeting Mersenne. However, like so many issues central to the early career of Descartes, it is in discussions with Mersenne that Descartes would consistently show an interest in Baconian philosophy. In their correspondence during the early 1630s, we find

⁴⁷² See Paul Dibon’s “Sur le reception de l’oeuvre de F. Bacon en Holland dans la première moitié du XVIIe siècle,” in *Terminologia e Fortuna nel XVII secolo*, pp. 91-115.

⁴⁷³ Mersenne, *La Vérité des sciences contre les sceptiques ou Pyrrhoniens*.

several references to Bacon, suggesting a history of discussion between the two men on that topic.⁴⁷⁴

The letter of January 1630 is most suggestive of a terminological inheritance of the simple natures from Bacon. In that letter, Descartes thanks Mersenne for giving him a list of Aristotle's categories. But, he says, "I have already made another, larger list: in part taken from Bacon, and in part from my own thought. This will be one of the first things which I will undertake to explain [in my treatise on physics], and it will not be as difficult as one might think, because, having posited the foundations, they follow directly from them."⁴⁷⁵ This letter in particular seems to indicate that the simple natures, which clearly describe the "qualities of things" and are so close to the foundations of Descartes' science that they would follow immediately from them, were developed, at least in part, with Bacon in mind.

A careful student of both Bacon and Descartes, Baruch Spinoza (1632-1677), offers further suggestion to this supposed connection in his own letters. Spinoza reinforces Descartes' testimony about the similarity between his principles of scientific explanation, his categories of material things, and Bacon's. In a letter to Henry Oldenburg, April 1662, he criticizes Boyle for attempting to restate what Descartes and Bacon have already proven in a clearer fashion:

⁴⁷⁴ The letters to Mersenne of January 1630 (AT I, 109), December 23 1630 (AT I, 195), and May 10 1632 (AT I, 251), make direct reference to "Virulamus," while the letter to Golius of May 19 1635 makes oblique reference to Bacon's *De Augmentis Scientiarum* with the phrase "to put the sea to the test." These references were first noted by Gaston Milhaud, *Descartes savant*, see ch. 10.

⁴⁷⁵ "Je vous remercie des qualities que vous avez tirées d'Aristote: j'en avais déjà fait une autre plus grande liste, partie tirée de Verulamio, partie de ma tête, et c'est une des premières choses que je tâcherai d'expliquer, et cela ne sera si difficile qu'on pourrait croire, car les fondements étant pose, elles fuient d'elles-mêmes" (AT I, 109).

... the very illustrious Mr. Boyle is trying to show that all tactile qualities depend only on motion, shape, and the remaining mechanical states. But, since these proofs are not put forward by the very illustrious Mr. Boyle as mathematical [i.e., in the form of a geometrical proof], there is no need to see whether they are completely convincing. But in the meanwhile I do not know why the very illustrious Mr. Boyle is so anxious to conclude this from this experiment of his; for this has already been proved sufficiently and more than sufficiently by Verulam and afterwards by Descartes.⁴⁷⁶

The idea here seems to be that Bacon and Descartes have both provided sufficient arguments for understanding the qualities of material things only insofar as these conform to mechanical principles. For Spinoza, Boyle's experiments on nitre (potassium nitrate) add nothing to these arguments. So, there is some confirmation from a careful (and relatively contemporary) student of Descartes' and Bacon's that they had both established a list of qualities of material things according to the principles of mechanics; indeed, that Descartes had done so after Bacon [*jam a Verulamio, et postea a Cartesio*] (the Latin suggesting not only a temporal sequence, but possibly a conceptual one as well).

Now, it is not clear that Bacon's list of simple natures (if he would have ever produced one) would resemble Descartes'. In the lists of simple natures that Bacon provides, he includes qualities such as color, volatility, maleability, weight, fluidity, dissolution, and a variety of textures. Descartes prefers to consider only the underlying properties of extension itself that could give rise to these qualities as material simple natures. However, the important thing is to realize that both Descartes and Bacon attempt to provide a mechanistic framework for understanding the qualities of material things. And perhaps it is this unifying feature that Spinoza and Descartes refer to.

⁴⁷⁶ *The Correspondence of Spinoza*, 91.

Though Bacon and Descartes have very different philosophical projects and different systems of natural philosophy, I believe that Descartes considered Bacon to be a kind of colleague in the new science of mechanism. His letters always refer to Bacon positively and he seems happy to embrace many elements of Bacon's natural philosophical program. Even in part six of the *Discours on the Method* (AT VI, 63-65), Descartes makes positive reference to Bacon's idea of "natural histories," calling on others in the scientific community to add to the number of observations and experiments on matters relevant to natural philosophy. In light of this Baconian connection, I think we can appreciate that Descartes was not necessarily (though perhaps for many practical purposes) opposed to the kind of collaborative scientific research program we associate with Francis Bacon.

Alphabet of simple letters

Bacon had used the term "simple natures" as early as his 1603 *Valerius Terminus*, written in English and published after his death. In that work, he describes metaphysics in the following way:

Metaphysics is . . . the knowledge of the forms of natures simple and not of abstract natures, which are firm and permanent. That these natures are as *the alphabet or simple letters*, whereof the variety of things consisteth . . . [I]n the schools by natural philosophy were meant the knowledge of the efficientes of things concrete; and by metaphysics the knowledge of the forms of *natures simple*; which is a good and fit division of knowledge: but upon examination there is no such matter by them intended. That the little inquiry into the production of *simple natures* sheweth well that works were not sought... (Spedding III, 243).⁴⁷⁷

⁴⁷⁷ The reference is given according to the *The Works of Francis Bacon*, ed. and trans. Spedding,

In this relatively early philosophical work by Bacon, the “natures simple” are taken to be elements of the forms sought after in metaphysics. These are said to be “the alphabet or simple letters, whereof the variety of things consisteth.” Here Bacon understands simple natures to be closely related to forms, though he distinguishes them from mere abstract natures.

He also calls them an “alphabet of simple letters,” a concept that was discussed briefly in Chapter 2 with reference to Bacon’s proposed but never completed project of outlining an alphabet of “real characters [*characteristica realis*].” The concept itself is most clearly described in *The Advancement of Learning* (1605), a text that was rewritten and expanded in Latin as *De Augmentis Scientiarum* (1623). The discussion of real characters takes place in the outline of the “Transmission of Science,” and there are few emendations of this section in the later version of the work. Here Bacon is concerned with the best way to illustrate scientific principles through discourse. Indeed, he refers to many of the Renaissance concepts of method that we have seen: in particular, he claims that the transmission of science (or learning) concerns “the *disposition* and *collocation* of that knowledge which we preserve in writing, it consisteth in a good digest of commonplaces” (Spedding III, 398). This language refers to the concept of an *ars brevis* or a compendium of *topoi*. Indeed, *dispositio* and *collocatio* are technical terms from the rhetorical tradition pertaining to the organization of knowledge in such a way that it would be transparent and easy for recollection and judgment. This is the context in which

Ellis, and Heath. A table of citations of Bacon’s use of “simple natures” can be found in M. Fattori, *Linguaggio e Filosofia ne Seicento Europa*.

we discussed classical memory art, whose techniques Bacon acknowledges as necessary to shore up the deficiencies of memory. However, he is critical of the tradition of mnemotechnics when he says, “An art there is extant of it; but it seemeth to me that there are better precepts than that art, and better practices of that art than those received” (ibid.).

Now, real characters, as Bacon conceives of them here, would serve as those “better precepts.” They are to be understood on analogy with hieroglyphics and Chinese characters which, Bacon thinks, have the common property of representing things or concepts directly, rather than through the arbitrary signification of, for example, Latinate words. Real characters are not necessarily images or pictorial hieroglyphs, they may be established by convention, but the key notion is that they represent the things themselves directly, not nominally.

Moreover, it is well known that in China and the provinces of the farthest East there are in use at this day certain *real characters*, not nominal; characters, I mean, which represent neither letters nor words, but things and notions; insomuch that a number of nations whose languages are altogether different, but who agree in the use of such characters (which are more widely received among them), communicate with each other in writing; to such an extent indeed that any book written in characters of this kind can be read off by each nation in their own language. (Spedding IV, 439; cf. Spedding III, 399-400).

A useful technique, indeed! If scientific learning could be transposed into a language of real characters, i.e., characters “which represent neither letters nor words, but things and notions,” then we would be in possession of a kind of universal language of concepts that could be “read off by each nation in their own language.” Of course, Bacon never develops the specifics of such a language, but he seems to hold out hope that such a thing could exist. Consider, for instance, the capacities of the inhabitants of the *New Atlantis*

(1624) who, as they tell Bacon, had been given a great gift “conform to that of the Apostles in the original Gift of Tongues,” which enabled them to translate any worldly language into another (Spedding III, 138-39). It seems that this secret book of translation is ingredient to the diffusion and record of knowledge in that venerable House of Solomon related in Bacon’s fable. Some of Bacon’s followers attempted to carry out this project of describing the real, notional characters, for example, consider John Wilkin’s *Essay Toward a Real Character and a Philosophical Language* (1668). And this idea would resonate with Leibniz as we have seen. Though he was unable to fulfill his vision for a true language of real characters, Bacon’s objective tokens a more basic belief: namely, that the ultimate arbiter (and only remedy for confusion) in matters of language is the things themselves, which words are supposed to represent.⁴⁷⁸ Thus, for Bacon, words, thoughts, or concepts are only valued insofar as they accurately represent extra-mental reality. Moreover, he has a fairly uncomplicated view of how thoughts and concepts might relate to reality: true concepts, which would be picked out by real characters, denote the elements of natural things.

In the *Valerius Terminus*, Bacon describes the simple natures as an alphabet or simple letters, which are “few and permanent” and “whereof the variety of things consisteth; or as the colours mingled in the painter’s shell, wherewith he is able to make infinite variety of faces or shapes” (quoted above). Thus, he considers there to be some underlying natures or elements of things that are permanent and unchanging and through which all things can be recreated or represented, just as any given object can be

⁴⁷⁸ Rossi, *Francis Bacon*, 166-69.

represented by the painter using a limited palate of colors. His hope is that one could discover these simple natures and list them, as if in an alphabet, such that anyone would be in possession of a true philosophical language of essences. The underlying philosophical claim that supports this hope is to be found in Bacon's theory of forms, since it is knowledge of the "forms of simple natures" in which metaphysics consists.

Forms and simple natures

There would certainly be a lot of philosophical work involved in translating the forms of things into a systematic philosophical language, but the basic metaphysical idea is fairly simple. Bacon believes that there are such eternal essences of things, that these are few, and that they can be known by the human intellect. For Bacon, forms are to be distinguished from the efficient causes of concrete things, since they are abstract and metaphysical. However, there is a relationship already expressed between the forms of simple natures and the efficient causes of material effects: he tells us, forms are those "laws of motions and alterations by means whereof all works and effects are produced" (Spedding III, 244). In Bacon's estimation, the greatest error of traditional philosophy is not to have adequately distinguished the forms, on the one hand, from works and effects, on the other. Here Bacon is probably referring to a trend of late scholastic philosophy, where the notion of substantial form had largely become identified with its role as an "internal efficient cause," by sustaining and regulating the existence of that which the

efficient cause originally produced.⁴⁷⁹ I propose that Bacon's doctrine of forms can thus be understood as an attempt to clarify this issue.

The full doctrine of the "forms of simple natures" will not be articulated until the *Novum Organum*. But without turning to that work just yet, is it possible to determine what the simple natures are for Bacon? First, Bacon indicates that metaphysics is the study of "the forms of simple natures." That metaphysics is the study of forms would have been widely acknowledged, but that these forms are the forms of *simple natures* is unique. I think this is ambiguous. Up to this point, I have been speaking of simple natures as elements that constitute forms. However, it may be possible to understand the forms as types of natures, referring to simple natures as tokens, or instances, of form-types. In support of this reading, we can turn to Bacon's definition of forms as "laws of motion and alteration." Here, the simple natures must be those qualities or elements from which one can abstract general laws of motion and alteration. The fact that mercury (quicksilver or aqua regis, as it was known) can dissolve gold is a result of the forms of mercury and gold. The form describes the law that holds that gold will dissolve mercury. The simple natures are those qualities of gold and mercury that Bacon thought would be the basis for the laws that govern its interactions. Anything else that possesses these same qualities would express the same law of relation, e.g., solubility. On the other hand, if we take the view that simple natures are constitutive elements of forms, then it makes sense how simple natures are to objects what the letters of the alphabet are to words in a written language. On this reading, simple natures would be those qualities or elements that give

⁴⁷⁹ Pasnau, "Form, Substance, and Mechanism," 33-34.

rise to the variety of objects perceived as parts compose a whole. While I will not try to decide which of these two readings is more accurate of Bacon, both readings entail that simple natures are real, i.e., actually existing material qualities or elements that have causal efficacy. Moreover, it is on the basis of these qualities or elements that one can discover the forms or laws governing motion and alteration. At this stage, I leave open whether simple natures are qualities or elements of things and what the special relationship is between simple natures and forms.

Baconian mechanism and method of induction

As Descartes' letters to Mersenne indicate, the simple natures will be deployed in direct contrast to Aristotle's categories of being as the basic principles of scientific explanation. Whereas Aristotle required that all scientific demonstrations demonstrate according to some underlying genus, the mechanistic science of the seventeenth century ushered in an era of scientific demonstration based on mechanical models to explain observed phenomena. In order to be clear about this context for comparison between Descartes and Bacon, let me define what I take to be the central tenet of mechanism in the seventeenth century.

Mechanism holds that the qualities and effects of observed physical phenomena are the result of unobserved micro-mechanical structures. These structures operate according to basic mechanical models: that is, given a mechanical system, the work put into that system is different than the work produced by the system. Consider, for

example, a lever, whose ends are A and C, and whose fulcrum is B. A given amount of work (force times acceleration) applied to A generates a product at C. This product is altered by the placement of the fulcrum at B, i.e., its absolute value is increased or decreased and its direction changed. Pulleys, hooks, cogs, and wheels perform similar functions. It is possible to imagine innumerable micro-mechanical systems that operate analogously and produce a variety of different effects simply as the result of some quantifiable relation between the components of the system. One can see that Bacon holds such a position when he writes, “for seeing that every natural action depends on things infinitely small, or at least too small to strike the sense, no one can hope to govern or change nature until he has duly comprehended these” (Spedding IV, 124). Furthermore, the mechanist only need posit the existence of these microscopic “machines” in order to explain all variety of effects. There are no mysterious “forces,” no “action at a distance,” and no “metaphysical fictions” like substantial forms, just microscopic mechanical configurations of matter.

It is commonly assumed that mechanical micro-structures must be composed of rigid or semi-rigid bodies, like our lever, pulley, hook, and wheel examples. However, such a view would not easily explain the kinds of phenomena that mechanists typically try to explain. Instead, we probably ought to allow for the conception of mechanical bodies as non-rigid, largely fluid bodies. In this way a great many more phenomena can be explain mechanically: we can conceive of hydrolic forces, “gunky” lubricating bodies, swift-moving gaseous bodies, etc. In the case of Bacon, we must add an additional caveat. Unlike, for example, Descartes whose material ontology is as parsimonious as

one could hope for, Bacon's metaphysics of nature is quite complex. Indeed, when Bacon appeals to "forms," he appeals to the inner workings of nature that account for the material efficacy of natural elements. In this sense, as has been noted by Paolo Rossi, Bacon's debt to alchemy and "magic" is not simply a remnant of a prior superstition but is really ingredient to his account of natural elements and their combinations. For instance, his concept of *spiritus*, i.e., those small, active material particles found in metals, is one part mechanist and one part alchemist.⁴⁸⁰ In other words, Bacon describes natural change and production according to mechanical microstructures, but he also maintains a belief that certain natural elements possess far-reaching, even mysterious powers. Of course, these powers are described mechanically, but the belief in the natural powers of elements suggests a slightly different picture than what may be inferred by the description of mechanism above.

How does this picture of mechanism and alchemy fit with Bacon's definitive description of the forms and simple natures in the *Novum Organum*? When Bacon sets out to publish his *Instauratio Magna*, of which the *Novum Organum* is the second part (and the only one completed), his goal is to proscribe a new interpretation of nature. In fact, the first part of the *Novum Organum* is dedicated almost entirely to rooting out the old interpretation of nature, what Bacon calls "anticipations of nature." He accomplishes his critique of the "anticipations" by identifying the "idols of the mind" that make them possible. These are the prejudices or entrenched opinions that cause us to suppose that we

⁴⁸⁰ Paolo Rossi, *Francis Bacon*, Ch. 1. It is important to keep in mind that Bacon's relationship to magic and alchemy is complex. For instance, he is resolutely critical of the hermetic traditions' practice of wrapping their esoteric teachings in obscurity (31).

have a grasp of nature's real essence. There are four kinds: "Idols of the Tribe" (*idola tribus*), which are common to the race; "Idols of the Den" (*idola specus*), which are peculiar to the individual; "Idols of the Marketplace" (*idola fori*), coming from the misuse of language; and "Idols of the Theatre" (*idola theatri*), which are related to speculation about causes (*NOI*, 39 ff.). In a more general sense, it is Bacon's task to present a new logic that is truly efficacious.

Like Descartes, Bacon's position at the end of the sixteenth century gives him the perspective of someone critical of scholastic logic, particularly the syllogism, as essentially rhetorical or disputatious and lacking any utility for a true method of discovery. By contrast with Descartes, Bacon proposes a logic of *induction* to provide the *ars inveniendi* that the humanistic critics had found lacking in Aristotle. In some sense, the term 'induction' is misleading, since it is not quite like either modern induction or classical induction. In the preface to the *Instauratio*, Bacon describes his logic as having a practical aim, rather than a disputatious one ("not of arguments but of arts" (Spedding IV, 24)), as proceeding "regularly and gradually" from the most particular observations to the most general axioms, and as accepting as true only what has been tested through experimentation (Spedding IV, 23-26).

This method of induction differs from the Aristotelian concept of induction where the intellect comes to rest on its apprehension of the universal at the end of the process. Baconian induction, on the other hand, always persists through further refinement in a back and forth manner from the awareness of general laws or forms of nature to

particular observations of natures.⁴⁸¹ Moreover, Baconian induction is not strictly an empiricist method of induction. For Bacon, it is not necessary to obtain a large sample of observations for the purposes of deriving a general rule, a few noteworthy instances may be sufficient. Furthermore, the practice of Baconian induction involves a preliminary awareness of the kinds of experiments and observations that are illuminative; one picks and chooses among the possible phenomena in order to shortcut the process and to arrive at crucial experiments.⁴⁸² Finally, Bacon's logic of induction is embedded in a rich and complex metaphysics. Indeed, we will see that Bacon's metaphysics mirrors his method, i.e., the method works only because of the putative nature of the forms it seeks to understand.⁴⁸³ Though he warns against hasty and habitual judgments about nature, his logic is based on an inherent belief that the mind is ultimately capable of revealing nature's essence. Consequently, Baconian induction is complex. It will not be possible to outline the inductive procedure in a few steps. Instead, I will try to provide an overview of how Bacon's induction operates in the discovery of the forms of simple natures.

The method of induction, as it is practiced in the *Novum Organum*, is the process of isolating and identifying discrete "natures" in things: "Therefore a separation and solution of bodies must be effected, not by fire indeed, but by reasoning and true induction, with experiments to aid; and by comparison with other bodies, and a reduction

⁴⁸¹ Antonio Perez-Ramos, *Francis Bacon's Idea of Science*, 266-67.

⁴⁸² See Lisa Jaridine, *Francis Bacon*, 124-26, for a discussion of "prerogative instances" and their function in Bacon's method of induction.

⁴⁸³ Perez-Ramos, *Francis Bacon's Idea of Science*, 7-31, does an admirable job of outlining the various critiques of Bacon in the history of secondary literature. He is especially clear that charges of incoherence and inconsistency alleged against Baconian induction are the result of prevailing contemporary interpretations about method in the physical science and not a result of any real inconsistency in Bacon's writings themselves.

to simple natures and their Forms, which meet and mix in the compound” (Spedding IV, 125; *NO* II, 7). This process cannot proceed *a priori*, for Bacon, since he often protests that nature is far too subtle for our gross concepts and words (Spedding III, 388; IV, 24; IV, 411); if we rely on the analysis of our concepts as a means to knowledge about nature, says Bacon, we risk “letting nature slip out of our hands.” Indeed, this is surely a motivation behind Bacon’s skepticism about the efficacy of the mathematical sciences: they abide in the “spacious liberty of generalities” (Spedding III, 359) without attending to the particularities of matter. Yet, neither is Baconian induction the process of exhaustively enumerating all instances and then, from these, drawing a general rule. He is consistently critical of the conception of *inductio* as *enumeratio* in classical rhetoric, calling it “childish” and “precarious” likely for the same reason that he dismisses conceptual analysis, i.e., nature is too vast and subtle to supposed that we could have an adequate enumeration of instances (Spedding I, 137, 205; and IV, 24, 97, 410). Instead, Baconian induction incessantly returns to the things themselves, searching for new experiments to perform, new ways to test nature in order to reveal its underlying structure. This becomes evident when one examines the various inductive methods employed in the *Novum Organum* and discussed in his other works.

The conceptual basis for Bacon’s method of induction is what he calls a “natural history,” i.e., a summary of previous accounts of a given nature, consisting of the tabulation of observations, theories, and principles about it. “The investigation of Forms proceeds thus: a nature being given, we must first of all have a muster or presentation before the understanding of all known instances which agree in the same nature, though

in substances most unlike” (Spedding IV, 127; *NO* II, 11). In our everyday knowledge of things, this role is played by memory, but in the investigation of specific natures, these lists are likely too vast, and thus must be written down (Spedding III, 552; IV, 127, *NO* II, 10). The result of this process is what Bacon calls “literate experience” (*experientia literata*) (Spedding IV, 96; *NO* I, 100-03), i.e., it is a species of experience in general, but one that is amenable to the kind of ordered investigation that Bacon wants to undertake, no mere “groping in the dark” (Spedding IV, 81, 413; *NO* I, 82).⁴⁸⁴ From this treasure-trove of literate experience, one produces tables of observation. There are several varieties of tables—tables of presence, absence, and degrees or comparison (Spedding IV, 129; *NO* II, 11-12)—but the purpose of these is to collate the various observations with the qualities and effects of the given nature in order to design experiments.

Then the process of induction proper begins. Experiments are designed in order to isolate the efficacious qualities in the tables of observation. The experiments are supposed to exclude accidental or epiphenomenal qualities from the truly efficacious ones. Bacon claims that the process of true induction “is not completed till it arrives at an affirmative” (Spedding IV, 149; *NO* II, 19). That is, the process of exclusion must continue until one has found an experiment that identifies a particular quality with the desired effect. At this point, Bacon inserts a number of heuristic suggestions that imply a scientific practitioner with a good deal of experience. He suggests that experiments be performed along the following lines: variation in matter, efficient cause, or quantity of

⁴⁸⁴ Jardine, *Francis Bacon*, 144, connects “learned experience” with “practical knowledge” and “sagacity” as the knowledge informed by ordered experience (cf. Spedding IV, 366, 413, 424; III, 164-65)

matter; repetition or extension of the experiment; translation of the experiment into another form; inversion of the cause; compulsion of the matter through experiment until the effect is no longer produced; application of the experiment to some use; conjunction of two causes that produce the same effect in order to enhance that effect; and finally, the implementation of some chance causes to create the desired effect (Spedding IV, 413-21). Though these suggestions appear strange to a contemporary reader, he suggests that these variations of experiment enable one to exhaust the nature of the thing. The heuristics are vague, however, and it seems to me to imply that Bacon's idea of the scientific practitioner is much more like an artisan than a research scientist. In other words, the scientist is supposed to recognize revealing qualities or experiments and exploit these in his analysis of nature.

The result of the foregoing treatment is what Bacon calls the "first vintage." Once one reaches this level, one prepares an "essay" on the matter in question, an "indulgence of the understanding" (Spedding IV, 149; *NO* II, 20), assessing the strength of experiments performed, conclusions reached, and matters left untreated. This is only the beginning of the true interpretation of the matter in question. Again, in order to further examine the first vintage, Bacon describes certain kinds of *prerogative instances* that can be identified in the tables of observation. These are instances that are supposed to shed particular light on the nature in question. Like the heuristics of experimentation, the prerogative instances are meant to pick out illuminative observations from the many. Thus, the process continues by returning to the particular instances and recomposing tables of observation; the first vintage is only the first step in the interpretation of nature.

It is clear from this brief outline of Baconian induction that the process of exclusion does the heavy lifting with respect to isolating the efficacious natures of the given phenomena. The inference underlying the exclusion of some qualities from the nature sought is essentially modus tollens: $p \rightarrow q, \sim q, \text{ so } \sim p$.⁴⁸⁵ In this way, the quality or principle p can be excluded because one knows that whenever p, q , and one observes $\sim q$. One can see that this is the case by looking at an example from Bacon's table of exclusion concerning the quality of heat.

On account of ignited iron and other metals, which communicate heat to other bodies and yet lose none of their weight or substance, reject the communication or admixture of the substance of another body. (Spedding IV 148; *NO* II, 18)

In this passage, I take "the communication or admixture of the substance of another body" as p and the "loss of weight or substance in ignited iron and other metals" as q . It is thus quite clear that Bacon's *induction* relies on an implicit *deductive inference*. Additionally, the heuristics of experimentation and prerogative instances mentioned above suggest a kind of analogical understanding of natures, extending one kind of experiment to apply to another kind of matter or effect. In this way, Baconian induction also depends on a kind of implicit *intuition* about analogies between some natures and others. Perez-Ramos has provided a complete discussion of the nature of Baconian induction in this regard, translating Bacon's inductive principles in contemporary logic.⁴⁸⁶ Yet, the variety of experiments, and the importance of "prerogative instances" and "crucial experiments" for isolating simple natures, implies a scientific practitioner

⁴⁸⁵ This is, in fact, an overly simplistic way of looking at Bacon's tables of elimination. There are a number of different kinds of inferences that can be made, but I use this particular inference as an example.

⁴⁸⁶ Perez-Ramos, *Francis Bacon's Idea of Science*, Ch. 17

that possesses a certain amount of know-how in the application of the Baconian method. One cannot eliminate the practitioner's input in the process. And the scientist is continually forced to return to the particulars and refine his conclusions.

For Bacon, the things themselves, the facts of observation and experiment, and ultimately the internal principles of nature itself, determine the nature of scientific truth. This is why Baconian induction is never completed in the discovery of first principles. Rather, Bacon's scientific principles—his forms, as we will see—are not the final say on the matter; they operate much more like hypotheses, framing the context for further scientific investigation. When this is coupled with the deductive aspect of Bacon's tables of exclusion, there is the sense in which Bacon represents a kind of hypothetico-deductive scientific method. In this schema, the lack of ultimate first principles does not impede its practical efficacy. For Bacon, it is not necessary to have arrived at first principles in order for the method to be effective; the inductive steps themselves often produce the desired results.

Notably, Baconian induction is coupled with a concept of "superinduction," whereby the same principles of material nature that lead one to discover its internal structure allow one to reproduce a given nature. This is why he says, "for you have but to follow and as it were hound nature in her wanderings, and you will be able, when you like to lead and drive her afterwards to the same place again" (Spedding IV, 296). The reason why this is possible is because induction is the discovery of forms, and "whosoever knows any Form, knows also the utmost possibility of superinducing that nature upon every variety of matter, and so is less restrained and tied in operation, either

to the basis of the matter or to the condition of the efficient” (Spedding IV, 362).⁴⁸⁷ Thus, once one is in possession of the forms (of simple natures), one is capable of reproducing any effect produced by those forms. This is the ultimate aim of Baconian science—reproducing desired effects in nature—though to accomplish this end, one must first discover forms. It is what Perez-Ramos has called the “maker’s knowledge tradition,” namely, the historical tradition (of which Bacon is a notably example) that recognizes the practical or productive origins of speculative or theoretical knowledge about nature.⁴⁸⁸ As I understand it, maker’s knowledge is another way of articulating Vico’s maxim, *verum et factum convertuntur*. In this sense, Baconian induction of forms is an induction of a maker’s knowledge-type, i.e., a knowledge that is primarily grounded in productive capacity of the understanding.

Baconian metaphysics and the forms of simple natures

What is the metaphysical structure of forms that allows Bacon to posit a transitive relation between induction and superinduction, discovery and production? First, it is necessary to understand that Bacon’s forms are not the forms of *things* or even elements, but the forms of qualities or simple natures. In this sense, Bacon entirely rejects substantial forms, saying that they are “so perplexed, as they are not to be enquired” (Spedding III, 355). Moreover, if one thought that Bacon was investigating substantial

⁴⁸⁷ cf. Perez-Ramos’ definition of forms: “law-like statements conveying the technological know-how which guarantees the (re)production of particular effects they describe and/or explicate,” *ibid.* 239.

⁴⁸⁸ *Ibid.* especially Ch. 5, 52.

forms, it would seem contradictory for him to claim, as he does above, that production by way of the form is possible “upon every variety of matter.” If the definition or essence of a thing were identified by its “form,” then this form would surely be united to some kind of matter (even if it were not of determinate dimensions) and there would be some question whether simply any matter whatsoever serve the production of that form. However, Bacon denies that matter is fitted in any way to particular forms; instead, Bacon seems to think that matter has a general, undifferentiated character, such that it can receive any form at all. Moreover, Bacon explicitly denies that “forms give existence” (Spedding IV, 120; *NO* II, 1). Thus, he explicitly contradicts two of the basic tenets of the Aristotelian theory of forms. Yet, Bacon is not a Platonist about forms; for Bacon, forms do not exist apart from matter. On the contrary, as we have seen, Bacon conceives of the forms of natures as necessarily connected to qualities or simple natures in the same way as “the form of those sounds or voices which make simple letters” (*ibid.*). This, of course, recalls the analogy between simple letters, or real characters, and the simple natures. It is ambiguous, as we have seen, but in either case it does not imply a Platonist view of forms. On one reading, the qualities or elements that are identified with simple natures are grouped together to constitute forms. Then forms would be made up of material qualities as wholes made up of parts. On the other hand, Bacon could conceive of forms as describing general relations between the qualities of things. Here, forms would be general laws governing the operation and interaction of simple natures.

On Bacon’s account of forms, however, it is not always easy to determine what the form of a particular quality is. For instance, if one determines that the cause of

whiteness in some particular material, say froth or snow, is the result of “the subtle intermixture of air and water,” one is not yet in possession of the form of whiteness. For example, this definition fails to explain the appearance of whiteness in things that are not composed of water and air. Still, Bacon claims, there is something noteworthy in our observation, because in these particular cases, we have identified the *efficient cause* of whiteness in froth and snow. In other words, it is the subtle intermixture of air and water in snow and froth that brings about the quality of whiteness in those cases. Now, Bacon says, the efficient cause of whiteness is the *vehiculum formae*, the carrier of the form (Spedding III, 356). He proposes that such efficient causes are the study of physics, while the forms governing those efficient causes are the study of metaphysics, i.e., “physical causes give light to new invention *in simili materia*,” but metaphysical causes are applicable to “any variety of matter” (Spedding III, 357).

How is one to understand this relationship between forms and efficient causes, and moreover the difference between metaphysical forms and physical causes? The short answer to this question, with reference to the example of whiteness above, is that the form of whiteness is the angle of reflection that is produced when light strikes the body. In the case of froth or snow, this angle of reflection is brought about by the intermixture of air and water. But this particular efficient cause is limited to similar materials as froth or snow and does not yet reach the level of a formal law. Thus, the particular, efficient causes of the natures in question give rise to the qualities perceived; they explain the perceived qualities, but only in a restricted sense. True induction does not stop with these

particular causes, but tries to extend to the most general laws. In this vein, I quote the third aphorism of the second book of the *Novum Organum* in its entirety:

If a man be acquainted with the cause of any nature (as whiteness or heat) in certain subjects only, his knowledge is imperfect; and if he be able to superinduce an effect on certain substances only (of those susceptible of such effect), his power is in like manner imperfect. Now if a man's knowledge be confined to the efficient and material causes (which are unstable causes, and merely vehicles (*vehicula*), or causes which convey the form in certain cases) he may arrive at new discoveries in reference to those substances in some degree similar to one another (*materia aliquaetenus simili*), and selected beforehand; but he does not touch the deeper boundaries of things. But whosoever is acquainted with Forms embraces the unity of nature in substances the most unlike; and is able therefore to detect and bring to light things never yet done, and such as neither the vicissitudes of nature, nor industry in experimenting, nor accident itself, would ever have brought into act, and which would never have occurred to the thought of man. From the discovery of Forms therefore results truth in speculation and freedom in operation. (Spedding IV, 120)

This passage brings together a number of lines of Baconian science that we have been discussing: it highlights the symmetry between knowledge of causes and the power of production, i.e., that *scientia* is *potentia*; it demonstrates the necessity for a metaphysical knowledge of forms, beyond the physical knowledge of causes; and it demonstrates the ultimate purpose of such a study. If we return to the example of the whiteness of snow and froth, then we may be able to understand why grasping the reflective properties of light is closer to “the unity of nature in substances most unlike.” Indeed, it seems that Bacon must hold that colors are dependent upon the reflective property of light, however this is achieved in a particular natural body. Somehow, Bacon suggests, on'e understanding of the reflective property of light that produces whiteness would enable one to produce whiteness in a variety of different media.

What remains to be explained is the metaphysical picture that underlies this schematic overview of Bacon's science. For Bacon, the physical world is composed of the following: simple natures, which are the perceived qualities or the gross textures of single or compound bodies; latent processes (*latentis processu*), which are the underlying mechanical features of compound bodies, motions, or operations; and latent configurations (*latentis schematismi*), which are the underlying structures or micro-textures of bodies. In the *Novum Organum*, Bacon refers to bodies as "a troop or collection of simple natures" (Spedding IV, 122). The simple natures do not account for the existence of bodies; rather these are simply the assembled qualities present in the body. Again, this is why Bacon claims, in sharp contrast with Aristotle, that "forms do not give existence. For though in nature nothing really exists besides individual bodies, performing pure individual acts according to a fixed law" (Spedding IV, 120). For Bacon, the substantial existence of bodies is of little importance; it is the laws governing their actions that lend "operative knowledge," i.e., knowledge of their means of production. Thus, simple natures identify the aggregate qualities in bodies that are of special interest. It does not matter whether these aggregate qualities may be present in a single body or a compound, their presence or absence is sufficient to warrant investigation. Latent processes, then, are the natural and gradual alterations of the simple natures that are revealed in the scrutiny of natural processes, e.g., growth, development, nutrition, or decay. These are what Bacon calls the "particular and special habits of nature" (Spedding IV, 123). In other words, these processes are specific to the particular matter under investigation and may not extend to all the transformations of simple natures that can be

found. Finally, latent configurations are what Bacon calls the “true anatomy” of bodies. That is, just like the gross structural anatomy of a body, latent configurations can be thought of as the organs and internal microstructures of all bodies; and they are discovered through simple experiments, like distillation or dissection. These are, in Bacon’s words, “the true textures and configurations of bodies; on which all the occult and, as they are called, specific properties and virtues in things depend; and from which too the rule of every powerful alteration and transformation is derived” (Spedding IV, 125). The latent configurations of bodies are composed of a certain quantity and configuration of “spirit” and “tangible essence.” It is this underlying structure that gives rise to the gross qualities, or simple natures, that can be perceived with the unaided sense.

It is not entirely clear to me why Bacon concentrates his efforts on simple natures, because it seems to me that latent processes and latent configurations are the far more powerful concepts. I would think that it would be a more promising avenue to try to discover the underlying microstructures of bodies rather than the gross qualities which may be only accidentally associated with those microstructures. Indeed, Lisa Jardine laments that it is one of the “great failures” of Bacon’s science not to have worked out the relation between latent processes and latent configurations.⁴⁸⁹ However, Bacon is clear in his preference for simple natures: “It must be said however that this mode of operation (which looks to simple natures though in a compound body) proceeds from what in nature is constant and eternal and universal, and opens broad roads to human power, such as (in the present state of things) human thought can scarcely comprehend or anticipate”

⁴⁸⁹ Jardine, *Francis Bacon*, 143.

(Spedding IV, 122). The only reason I can see for Bacon's insistence on the centrality of simple natures is his confidence in the capacity of perception to reveal the basic structure of nature. He seems to shun the skeptical attitude fiercely and to believe that the only progress that can be made in the sciences is through perceived qualities.⁴⁹⁰ Indeed, the simple natures appear to be the necessary starting points of Bacon's scientific method, not in the sense that they are the ultimate or highest principles, but in the sense that they define the nature to be investigated, determine the range of experiments to be consulted, and are immediately perceivable by the investigator.

The ultimate explanatory principle of simple natures and their underlying structures is the form. The form is the "true specific difference, or nature-engendering nature (*natura naturans*), or source of emanation" of any given nature (Spedding IV, 119). In this sense, the form is a kind of "internal agency" or an "immanent efficient causality" of the thing.⁴⁹¹ Thus, the form is the law that determines the relations of latent processes and latent configurations. This is why the discovery of forms is so essential to Bacon's science. He conceives of nature as an *opus*, a work, and thus he conceives of the forms of simple natures as the internal, regulating structure of that *opus*. Again, this confirms the operative-theoretical nature of Baconian science: what is discovered through scientific investigation is the regulatory framework of production. At first, it would appear that this notion of form is entirely out of place with reference to the classical notion of form. However, Bacon seems to be trading on a concept of form that was prevalent in the humanistic interpretations of late scholasticism. During the fifteenth and

⁴⁹⁰ See preface to *New Organon* (Spedding IV, 13-16) and Rossi, *Francis Bacon*, 148-51.

⁴⁹¹ I borrow these phrases from Perez-Ramos, *Francis Bacon's Idea of Science*, 91.

sixteenth centuries, natural philosophers came to equate form with “internal agency,” or with the material structure that enables the efficient cause of a thing, a kind of “internal efficient cause.” The reason for this seems to be, in part, an attempt to incorporate an experimental science with natural philosophy, and in part, a concession of the existence of artificial forms and artificial substances into late scholastic ontologies. Indeed, this shift in understanding can be characterized by a shift away from the abstract/metaphysical conception of form—in terms of its function, for example—to a concrete, efficacious conception. Robert Pasnau explains: “once the doctrine of form lost its proper place as an alternative to material and efficient modes of explanation, it became easy for the moderns to ignore the metaphysical aspects of the Aristotelian scheme.”⁴⁹² Thus, with respect to Bacon, Perez-Ramos elaborates: “Without abandoning the Form concept, Bacon is lead to uphold its material translation in terms of ‘configuration’, ‘structure’ or ‘texture’ of bodies, i.e., in terms of their internal disposition.”⁴⁹³ Consequently, Bacon speaks of the forms of simple natures both in the language of genera and specific differences and in the language of “internal agency.” These two concepts coalesce in Bacon’s description of form as a “law” of operation governing the nature of a thing (*NO* II, 2). This is why the form can be understood as a general law that governs the internal agency of a particular nature on the basis of the internal microstructures that define that nature.

The relationship I have been describing between forms and simple natures, latent processes, and latent configurations can be verified when we turn to the “first vintage,” or

⁴⁹² Pasnau, “Form, Substance, and Mechanism,” 44.

⁴⁹³ Perez-Ramos, *Francis Bacon’s Idea of Science*, 92.

the first theoretical appraisal of the collected tables of experience and the performed exclusionary experiments. In the example of heat, which is the only investigation developed in the *Novum Organum*, Bacon concludes that the form of heat is motion. He claims that this is particularly evident in observations of the flame, boiling liquids, in bellows and blasts, the rubbing motion that produces heat, and the extinction of fire through compression. Thus, Bacon refers to the tabulated experiments of his natural history in order to demonstrate that motion is indeed the general law that unites these various observed instances. He refines this concept further: “When I say of Motion that it is as the genus of which heat is a species, I would be understood to mean, not that heat generates motion or that motion generates heat (though both are true in certain cases), but that Heat itself, its essence and quiddity, is Motion and nothing else” (Spedding IV, 150; *NO* II, 20). From this, we can infer that when Bacon speaks of the form of a simple nature, he is no longer talking on the level of physical causes, such as can be explained by the operation of latent processes or latent configurations. Rather, Bacon hopes to identify the very essence (*quidditas*) of the simple nature. In the case of heat, it is not sufficient to say that it is a motion, but it is also necessary to enumerate the specific differences that identify heat among other kinds of motion (its genus and differentia). Bacon goes on to identify four specific differences: heat is (1) an “expansive motion,” (2) a motion that expands “towards the circumference” and at the same time “upwards,” (3) a motion that is “not uniformly of the whole body together, but in the smaller parts of it,” and (4) that this motion in the smaller parts is “rapid and not sluggish, and must proceed by particles, minute indeed, yet not the finest of all, but a degree larger” (Spedding IV,

151-54). One can see that in identifying the specific nature of the form of heat, Bacon returns to his understanding of the latent processes (expansion in varying directions and rapid movement of small particles) and the latent configurations (the non-uniform motion of large and minute particles) at work in this simple nature.⁴⁹⁴ As I understand it, the form is the law that determines each of these different qualities of the nature. It is not clear to me that Bacon has indeed arrived at a single “law” of heat, but he has attempted to clarify the kind of motion operating in any body that possesses the quality of heat.

Let us sum up the picture of Bacon’s notion of simple natures. Recall that Bacon’s method of induction begins by identifying some simple nature or quality. This is the basis for the tables of experience and the experiments of exclusion that follow. In the process of investigating simple natures, latent processes and latent configurations naturally arise as the explanatory bases of the simple natures. One attempts to explain as thoroughly as possible the various processes operating within many different substances that all display the simple nature under investigation. When one has exhausted the experimental possibilities and attempted to exclude any epiphenomenal characteristics pertaining to the simple nature, one then attempts to define the law that regulates these underlying structures. This law is the form of the simple nature. However, one must remember that a characterization of the form is achieved in the “first vintage” and thus

⁴⁹⁴ As Pasnau once pointed out in a seminar, specifying heat in this way is quite odd. While Bacon appears to rely on a purely mechanistic understanding of heat, he then specifies this character in a way that undermines a purely mechanistic metaphysics. How are the metaphors—“expansive,” “upward,” “outward,” and “rapid”—to be understood in a purely mechanical way?

only at the very beginning of the general statements that can be made on the matter. Bacon's method always returns to particular instances and experiments in order to refine that initial characterization. Thus, though Bacon hopes to identify the essence of the given nature under investigation, he may only succeed at a proximate description of its essence, leaving room for further investigation. Indeed, this is characteristic of Baconian science, which is much more a "regulative framework for research" than a "system."⁴⁹⁵ Furthermore, there may be many increments along the step-by-step movement up the ladder of generality. There may in fact be forms of forms of natures, or further refinements of the form that make it suitable to particular instances and not to others. Nonetheless, Bacon's science is motivated by the belief that, through an ordered program of research, the human mind can discover the internal laws of nature. Moreover, these internal laws exist, they are connected to perceived qualities, and they determine the underlying mechanical structure of nature itself.

Descartes' use of simple natures in the Regulae

Though I believe it is likely that Descartes is following Bacon in adopting simple natures as the principles of scientific explanation, and Bacon himself represents the first such attempt in a mechanistic theory of natural philosophy, there are important and indeed fundamental differences between Bacon's and Descartes' respective uses of simple natures. For Descartes, simple natures are above all considered simple insofar as

⁴⁹⁵ Perez-Ramos, *Francis Bacon's Idea of Science*, 16.

they are simply grasped by the mind. Whereas Bacon never attempts to enumerate the list of simple natures—indeed, he seems to reject that such a thing is possible—Descartes considers his list of simple natures to be a complete enumeration of everything that can be known. The most important difference, however, can be observed in the way these principles function in each of their natural philosophies. For Descartes, the simple natures are the principles of scientific explanation, i.e., only on the basis of simple natures can natural phenomena be explained. Simple natures then play the role of primitive notions, which Descartes thinks can be categorized in a few concepts and enumerated. For Bacon, simple natures are qualities that are attached to material elements and he never attempts to determine their number or kinds.

In order to understand the basic idea behind simples in Descartes, J. L. Beck's phrase "atoms of evidence" is instructive.⁴⁹⁶ Beck uses "evidence" here in its purely intuitive sense, not in the sense of empirical facts; and he characterizes the "atomic" nature of simples by our inability to meaningfully divide them into more simple concepts. That is, simple natures are unanalyzable, intuitively apparent concepts. Descartes understands that it is impossible for simple natures to be further reduced or analyzed without losing their clarity and distinctness. It is important to remember that these simples are conceptual entities, not real substances. They are the conceptual elements necessary for demonstrating scientific knowledge. This is quite opposed to Bacon's notion of simple natures, which relies on the putative metaphysical structure of reality, namely, that qualitative natures express macroscopic properties whose corollary are

⁴⁹⁶ I get the phrase from J. L. Beck, *Method of Descartes*, 79, but apparently translates a phrase from O. Hammelin, *Le Système de Descartes* (1921).

invisible microstructures governed by natural laws. The relevant natures in Bacon's science are natural properties that depend on the way physical things are actually structured, whereas Descartes largely ignores the metaphysical implications of his understanding of simples in the *Regulae*. Bacon's simple natures are in fact quite complex, while Descartes' simples are hardly natural.

Despite these stark differences, there is a broader context in which Bacon and Descartes share some common convictions about simple natures. For both, the simple natures identify the principle, scientifically determined characteristics of matter in a way that conforms to mechanistic explanation. In order to appreciate this similarity, we should conceive of scientific explanation in terms of the capacity to reproduce the thing known. We will see that Descartes, unlike Bacon, understands scientific explanation in a way that is characteristic of his mathematical method of discovery. That is, material simple natures describe the basic properties that matter must possess in order for the representation of physical phenomena to conform to the *mathesis universalis*. Consequently, for Descartes, any relation between simple natures and the qualities of ordinary perception is purely arbitrary, i.e., the result of a prior 'coding' as we saw in the last chapter. Descartes describes scientific explanation in the *Regulae* as a matter of conceptually reproducing the phenomenon by way of a necessary combination of simples. Unlike Bacon, Descartes' reproduction is a conceptual one, but the underlying commitment is the same: adequate scientific explanation, for both philosophers, amounts to using basic mechanical models to reconstruct or reproduce natural phenomena. As a consequence, scientific

knowledge amounts to a kind of production: we have understood a thing if we can reproduce its nature and effects (*verum et factum convertuntur*).

Moreover, for both Bacon and Descartes of the *Regulae*, we ought to understand this process of explanation through simples in a problematical or pragmatic way. Bacon and Descartes are schematic and probabilistic in their description of simple natures, leaving many of the details up for revision. Though Descartes speaks of deduction and demonstration, I believe that he does so in the service of producing desired results. In the *Regulae*, I see Descartes as primarily a scientist and mathematician, consumed with immediate problems and seeking pragmatic solutions. Indeed, the *Regulae* gives us a decidedly Baconian Descartes. This is why, I think, Descartes never refers to Bacon negatively in his correspondence and seems to embrace the basic thrust of Bacon's framework for scientific research. This, of course, contrasts the caricature of Descartes as an "armchair a priorist," opposed to empirical observation. The contrast will be most evident when we explore Descartes' outline of how to conduct scientific research in light of his theory of simple natures.

We will see that there are two historically and conceptually distinct passages on the simple natures, in Rule VI and Rule XII. It is evident that Rule XII is more mature and better developed than Rule VI. Between the two Rules we will notice a shift from talk of simples as the explanatory terms of a series to categories of simple natures: intellectual, material, and common. Finally, we will observe how the simples operate in specific geometrical and scientific examples: duplicating the cube, describing the curve that reflects all rays to a single point, and describing the nature of the magnet. There is a

gradual progression from pure mathematics to applied or mixed mathematics, and finally to natural philosophy. With these examples, Descartes is attempting to extend the mathematical method that he had discovered to explaining physical phenomena. He is only partially successful, but following Descartes along this path of thought will nonetheless be informative.

Terminological observations in the Regulae and elsewhere

First, we need to clearly indicate the specific locations in the *Regulae* where Descartes appeals to the theory of simple natures and discuss the relevance of this terminology for his mature metaphysics. The simple natures appear three times in the *Regulae*, in Rule VI (AT X, 381-84; CSM I, 21-23), Rule XII (AT X, 420-28; CSM I, 45-50), and briefly in Rule VIII (AT X, 399; CSM I, 32), though the passages in Rule VIII are best understood as corollaries to the passages in Rule VI and XII. The concept of simple natures also appears to be central to Descartes' explanation of mathematical solutions in Rule XVI. There are different conceptions of simples represented in these passages that we will have to attend to.

Though the terminology "simple nature" almost entirely disappears from Descartes' lexicon after the *Regulae*, the list of simples, as it appears in Rule XII (intellectual, material, and common), plays a significant role in both the *Meditationes*⁴⁹⁷

⁴⁹⁷ J-L Marion takes care to delineate the role of the simple natures, which Descartes' later terminology for "ideas" eventually supersede, in each of the *Meditations*, focusing especially on *Meditations* II and III, see *Questions cartésiennes*, (Paris: PUF, 1991), 91-109.

and the *Principia*.⁴⁹⁸ The sole appearance of the term ‘simple natures’ after the *Regulae*, in the *Conversations with Burman* of 1648, seems to confirm that, though the term is largely abandoned, the concept remains basic to Cartesian metaphysics.⁴⁹⁹ In response to a question concerning the nature and extent of God’s free will in creation, Descartes purportedly tells Burman, “[God’s] will is the cause not only of what is actual and to come, but also of what is possible and of the simple natures. There is nothing we can think of or ought to think of that should not be said to depend on God” (AT V, 160; CSMK, 343). This passage appears to align simple natures with possibility, as opposed to actuality, or as necessary principles are opposed to contingent principles.

In another response immediately following the one quoted above, Descartes makes a distinction between Mathesis and Physics on similar modal grounds. He maintains, “the complete and entire subject-matter of Mathesis [*totum et universum Matheseos objectum*] and all that is considered in it, is a true and real entity and has a true and real nature no less than the objects of Physics itself.” However, he says, “Physics considers its objects [not only as if] they are true and real entities but as actually and really existing.” In contrast, Mathesis only need claim that its objects are “possible and not actually existing in space but capable of so existing” (AT V, 160; CSMK, 343). The

⁴⁹⁸ In Principles I, §46, Descartes refers to “simple notions,” which are intellectual, material, or common. These are developed in §§47-49.

⁴⁹⁹ Reference to the *Conversations with Burman* are made with the usual caveats about that text in mind (see Garber, *Descartes Embodied*, 59, for the sources treating this issue). It may very well be the case that Burman simply pulls this word from the early lexicon of Descartes in order to describe a later concept. We cannot be sure that Descartes would have used the word in this context. Nonetheless, I think that we can take the *Conversations* in much the same way we would take any seventeenth century Cartesian text, i.e., as a description of Descartes’ philosophy by a follower attempting to be faithful to the letter and spirit of Descartes’ texts themselves.

objects of natural philosophy are taken to be actual and real entities, whereas the objects of mathesis are possible entities. The former are contingent and materially true, the latter are necessary and conceptually true. To put it another way, if an object can be represented geometrically, i.e., according to Mathesis, it is possible for that object to exist in the physical world. However, the nature of its physical existence is a contingent, empirical fact. Claims about physical objects require further, empirical proof.

In the *Principia Philosophia*, Descartes deploys the list of material and intellectual simple natures as “modes” of created substance (I, §65), whether material or intellectual; the two created substances are known through a “principal attribute” (I, §53), i.e., extension and thought respectively. Here Descartes reconfigures the intellectual and material simple natures under the rubric of the classical concept of substance, such that they become modifications or modes of substance whose essence it is to persist without the support of any other entity than the concurrence of God. Two things are of particular interest here: (1) the simple natures appear to be those essences of things that are the eternal and universal properties of substance and (2) these essences are conceived to be first and foremost divisible according to intellectual and material substances, i.e., according to a distinction between the mental and the material. Furthermore, what were formerly called the common simple natures are now diversely classified under “common notions” (I, §13),⁵⁰⁰ these are logical propositions necessary for scientific knowledge, the mode under which things exist, e.g., duration, and the way we conceive things to exist,

⁵⁰⁰ In Descartes much discussed letter to Elizabeth of 18 June 1643, Descartes uses similar terminology to describe three “primitive notions,” which include a notion of the body, of the mind, and of the mind-body composite in the human being (AT III, 691).

e.g., order and existence (I, §55). It seems that the common notions, along with the truths of mathematics, are intended to correspond to the eternal truths, a doctrine that Descartes arrived at in correspondence with Mersenne around 1630.⁵⁰¹ If this is the case, the common simple natures are effectively set apart as a group of primitive notions intended to describe the basic axioms of mathematics and logic. Descartes sets apart those axioms from the common ways that distinct substances exist and the common ways that we conceive of distinct substances.

In the *Regulae*, it is clear that Rule XII is a more mature and complete formulation of the theory of simple natures than Rule VI. The later rule, in effect, determines the vocabulary for simples that Descartes will adopt in his mature metaphysics. Furthermore, the discussion in Rule XII is much more detailed than the one in Rule VI. Whereas, for instance, Rule VI proposes only three points clarifying the nature of simples (the third of which is really a reprise of Rule V), Rule XII introduces eight points that are thorough and developed, the seventh of which alone has four sub-categories. In fact, each of the characterizations of simples in Rule VI is taken up by Rule XII, expanded and developed (AT X, 381.17-22, 382.2 – 383.10 = 418.2 – 419.5; 383.11 – 384.7 = 422.7 – 423.1; 384.9 – 385.4 = 427.4 – 26). I will discuss the nature of this expansion and incorporation in detail later in this section.

Rule VI shows a clear preference for problems in pure and mixed mathematics rather than natural philosophy. There, Descartes presents the example of finding the mean

⁵⁰¹ My understanding of this follows from Helen Hattab's presentation at the *Houston Circle on Early Modern Philosophy*, "Descartes' Doctrine of Eternal Truths: An Alternate Reading," January 31, 2009.

proportional as an application of the simple natures to the solution of a problem. Rule XII omits all mathematical examples, presumably setting these aside for their full development in Rules XV-XVIII, while alluding to problems in physics and astronomy. If we believe that Descartes followed his own method, at least to some degree, then we could infer that he applied the method first to the simpler problems in mathematics and then applied the method to the more complex problems of natural philosophy. In any case, we will discover that the mathematical conception of simples is embedded in the methodical application of simples to natural philosophy, as Rule XII indicates. Indeed, the example of the anaclastic line (the curve that reflects all rays to a single point) from Rule VIII will be instrumental in revealing this relation between mathematics and physical science. Finally, as we will see, Rule XII introduces themes that recur in Descartes' most central metaphysical propositions: he suggests a real distinction between body and mind (AT X, 415.13-15; 421.26; CSM I, 42 and 46), he claims that it necessarily follows from the fact that even if Socrates doubts everything, he knows something, namely, that he is doubting and that something is either true or false (AT X, 421.19-21; CSM I, 46); and finally, he cites the inference that if I exist, then God necessarily exists (AT X, 422.3-5; CSM I, 46). Notably, each of these propositions remains undeveloped in the *Regulae*, but they clearly situate the discussion of simple natures in the context of his later metaphysics.

Descartes' early use of simples in the Regulae

I have indicated that Descartes' reference to simple natures in the *Regulae* is not univocal. Indeed, there is a clear development in his use from Rule VI to Rule XII. As with much else, however, where we can discern some development, we do not see that the later theory annuls or entirely supplants the former. Indeed, as we will see in this section, Descartes' discussion of simple natures early in his composition of the *Regulae* signals why this terminology is so important for him and how he conceives it to announce a new basis for scientific knowledge, quite opposed to late scholastic Aristotelian philosophy. First, we will see that the idea that the atomic units of scientific explanation, or first principles, are *simple* implies a clear rejection of Aristotle's categories of being. Second, we will see how this notion became central to Descartes' method for solving problems in both mathematics and natural philosophy. We are afforded two noteworthy examples in connection with this early use of simple natures: the solution to the problem of finding two mean proportionals and the discovery of the anaclastic line. Simples are conceived of as the terminal points of a process of reduction or analysis. They are the epistemically indivisible starting points for a demonstration that would resolve a particular scientific or mathematical problem.

Descartes' rejection of Aristotle's genera entis

The fundamental insight of Rule VI, which is taken up again and expanded in Rule XII, is a clear rejection of Aristotle's "ontological categories [*genera entis*]" or the

way things “exist in reality [*revera existunt*],” favoring instead to conceive of the simple natures by reference to the way things can be “arranged serially... in so far as some things can be known on the basis of others” or “in the order that corresponds to our knowledge of them” (Rule VI: AT X, 381; CSM I, 21 and Rule XII: AT X, 418; CSM I, 44). Gilson first notes the importance of this aspect of the simple natures for Descartes’ critique of Aristotelianism in his commentary on the *Discours de la méthode*. He makes the following comment in reference to Descartes’ third rule of the method, “to conduct my thought in an orderly way, beginning with the objects that are most simple and easiest to know, in order to progress, step by step, as if by degrees, up to knowledge of the most composite things” (AT VI, 18; CSM I, 120):

The Cartesian definition of order substitutes for the conceptual classification of notions and things under the categories for Aristotle, which was common among scholastic philosophy (cf. *Reg.*, VI; t. X, p. 381, l. 7-16), an attitude based on the dependence of such concept in the order of deduction. Truths, ideas, or things, are located, from Descartes on, according to an ordered, linear series, where each member occupies a place that belongs to it, before it are the ideas that depend on it such that it permits one to deduce them, after it are the ideas on which it depends in such a way that they are necessarily required in order for its deduction to be possible.⁵⁰²

This confirms that the simple natures are deployed first and foremost with the method of investigation in mind, as opposed to having any concern for metaphysical order of things. The place of each thing, idea, and concept, in Descartes’ philosophy, is not determined by its place in the order of nature, but in the order of explanation. The French of the *Discours* is even clearer than the English translation, referring to an “ordre entre elles” which “ne se précèdent point naturellement les unes les autres,” again reminding one of

⁵⁰² Gilson, *Discours, Commentaire*, 207.

the serial arrangement of things such that some things “may be known on the basis of others.” This preference for an epistemological order over an ontological order would seem to be confirmed by later texts as a truly Cartesian theme. *Principia* I, §55 implies the same insight when it classifies “order and number,” “not as anything separate from the things which are ordered and numbered,” but “simply as *modes under which we consider the things in question*” (my emphasis, AT VIIIa, 26; CSM I, 211). This final statement is ultimately clearest in the sense that it characterizes order and number as modes of *thought* and not modes of *things*. Clearly, the simplicity and serial arrangement of simples according to their ordered relations is an epistemological rather than ontological simplicity. The extreme example, given in Rule XII, that form and extension are simples, even though it is logically impossible for one to exist without the other, goes a long way toward demonstrating the extent of Descartes’ rejection of the order of things (AT X, 418; CSM I, 44). The reason for this, however, will become clear only as we continue our analysis. We will see that Descartes conceives of simple natures in this way because they conform to his method; his list of simple natures deliberately divides these principles of scientific explanation along lines that make nature itself amenable to his scientific method.

When the term “pure and simple nature” first appears in Rule VI, it is identified with what Descartes calls “absolute,” that is, “whatever is viewed [*consideratur*] as being independent, a cause, simple, universal, single, equal, similar, straight, and other qualities of that sort” (AT X, 381; CSM I, 21). This is to be distinguished from what is “relative,” the list of opposing qualities, “dependent, an effect, composite, particular, many, unequal,

dissimilar, oblique, etc.” (AT X, 382; CSM I, 21). This opposition of “absolute” and “relative” appears to reproduce the Aristotelian opposition between *haplos legomena* and *pros ti legomena*.⁵⁰³ However, certain obvious differences follow from this initial similarity. In Aristotle, both substances and all predicates, taken abstractly, can be considered *haplos*, but substance has a privileged place in this respect. As far as the *pros ti* is concerned, Aristotle considers all what we would call relational properties to be *pros ti legomena*. For example, in the *Categories*, he says, “we call *relatives* all such things as are said to be just what they are, *of* or *than* other things, or in some other way *in relation* to something else.”⁵⁰⁴ What follows is a very long discussion of the ways such relations can be conceived, according to different kinds: larger than, similar to, unequal, double, or half; state, condition, perception, knowledge, and position; contraries, such as virtue and vice, knowledge and ignorance, etc.; correlatives that reciprocate, like master and slave; even properties of some subject (which relies on an analysis of the Greek language), like wing to winged (i.e., bird) and rudder to ruddered (boat). Following that discussion, Aristotle concludes, “no substance is relative.” Though Aristotle cautions that this conclusion cannot be too definitive, he does seem to restrict what is *haplos* to substances, whether primary or secondary, matter or form.⁵⁰⁵ Though this position may need to be nuanced by other accounts in Aristotle, it seems that whatever is attributed to the essence

⁵⁰³ Marion suggests that the list of absolute and relative in Descartes “ré-emploient les exemples que donne Aristote pour les seul *pros ti legomena*” in *Categories* 7 and *Metaphysics* VII (D), 15. Marion’s ultimate thesis, that “Si donc Descartes maintient en apparence le couple aristotélicien, il ne conçoit, en fait d’*absoluta*, que des termes qu’Aristote comprenait déjà à l’intérieur des *pros ti*; ce qui revient à dire que, dès leur dénomination, les *absoluta* cartésiens ne sont plus absolument absolus,” is prudent as we will see (see Marion, *Règles*, 172; see also Marion, “Ordre et relation”).

⁵⁰⁴ *Categories* 7, 6a 36.

⁵⁰⁵ *Ibid.* 8b 21, 8a 36-7, and 8a 32, respectively.

of a thing, meaning the form and matter that make it what it is, should be considered *haplos*.⁵⁰⁶ This is again perfectly intelligible according to our normal use of these terms: non-relational properties are called intrinsic while relational properties are ordinarily extrinsic.

Aristotle's list of relatives is augmented and clarified by the discussion in *Metaphysics* V (D), 15 (book *delta* being the book that serves as a glossary of technical terms in the *Metaphysics*). There, Aristotle divides the things that are called relative into: that which exceeds and that which is exceeded; the active to the passive; and the knowable to the known, or the perceivable to the perceived. The first category is the category whose essence it is to be relative, because these are essentially numerical or quantitative relations, all of which refer to the unit of measurement. The second category refers to capacities and their actualization, since receiving and conferring activity is a relation between things. The third are called relative because 'thinking', 'knowing', and 'perceiving' are transitive operations that necessarily imply an object of relation. Indeed, Descartes seems to be aware of this discussion, referring at one point to the fact that "Philosophers, of course, recognize that cause and effect are correlatives; but in the present case, if we want to know what the effect is, we must know the cause first, and not *vice versa*. Again, equals are correlative with one another, but we can know what things are unequal only by comparison with equals and not *vice versa*, etc." (AT X, 383; CSM I, 22). Thus, Descartes seems to acknowledge that cause and effect, as well as numerical

⁵⁰⁶ This seems to be confirmed by *Topics* I, 5, (Barnes, I, 170), which restricts the *pros ti* to "properties" and "accidents," but not to genera; and *Metaphysics* VII (Z), where he states, "And so form and the compound of form and matter would be thought to be substance" (1029a 29-30).

relations, are correlative. But he denies that this makes the cause itself a relative term, since the effect is what it is because of its cause, and not *vice versa*.

It is difficult to derive some general characterization of Descartes' list. Perhaps we can see "equal, similar, and straight" as the units of quantitative measurement. The notions of independence, simplicity, and single-ness (not to say singularity which is usually reserved for the particular material nature of an individual) seem to relate to the sense in which these are "simples" in the strict sense. And then there remains: cause and universal. I wonder if these final "absolute" simples are the ones that really unify the others. That is to say, I wonder if the simples in Rule VI are *archai* in the Greek sense, as both cause and principle. In effect, this interpretation would mesh quite well with the description I have given above where the "simples" are the "principles" of scientific explanation. Moreover, it is a perfectly classical notion that the special objects of the pure intellect are causes and universals. Therefore, whether these principles are the units of quantitative measurement or the simple elements of a given problem, they are the principles of scientific explanation.

This would seem to be confirmed by the fact that Descartes understands what is absolute or relative purely in reference to its explanatory power. That is, what is absolute can explain the nature of what is relative, though what is relative may not necessarily explain what is absolute. This seems to follow more closely what Aristotle says about contraries in *De Anima*: "one element in each pair of contraries will suffice to enable it to discern both that element itself and its contrary. By means of the straight line we know both itself and the curved—the carpenter's rule enables us to test both—but what is

curved does not enable us to distinguish either itself or the straight.”⁵⁰⁷ It seems that if we know the simple or absolute elements, we can explain the nature of their contraries, while relatives cannot explain the nature of absolutes. Thus, only the former can serve as starting points of demonstrations, while the latter are always dependent on some prior premise. However, for Descartes, this distinction itself ought not to be taken absolutely, since the “secret technique [*artis secretum*]” of the method, consists in being able to distinguish properly the absolute from the relative, since “some things are more absolute than others from one point of view, yet more relative from a different point of view [*aliter spectata*]” (AT X, 382; CSM I, 21).

The upshot of this, as Marion has shown, is that Descartes privileges the *pros ti*, or relational properties of things, over the *haplos*, or non-relational properties of things, to such an extent that even what is taken as absolute must sometimes be considered relative. Ultimately, Marion contends that for Descartes some terms may be more absolute than others, but all terms are understood first in relation to order and then in relation to consciousness.⁵⁰⁸ On this reading, there is nothing that exists apart from what is methodically ordered or consciously perceived. Thus, the ultimate non-relational property of all things, *ousia*, or substance, necessarily drops out of Descartes’ categories, as they are presented in Rule VI.⁵⁰⁹ Moreover, the excision of Aristotle’s categories of being, and above all of *ousia*, as the category of being par excellence, derives from what

⁵⁰⁷ *De Anima* I, 5, 411a 3-7

⁵⁰⁸ “Si donc cette universelle référence au point de vue de la science se dit selon notre manière de *spectare*, et si le relatif se dit bien *respectivus*, il faut en conclure que les natures (*ousiai*) solitaires (*choristai*) deviennent relatives, de par leur relation au savoir même.” Marion, *Sur l’ontologie grise*, p. 80.

⁵⁰⁹ J.-L. Marion *Sur l’ontologie grise de Descartes*, 4th edition (Paris: J. Vrin, 2000), pp. 78-85.

Marion has elsewhere called the Cartesian principle of nominalism, i.e., economy of explanation.⁵¹⁰ This is essentially what makes Descartes' science so attractive to contemporary philosophers: his ontology is parsimonious and pragmatic, unencumbered by the complex systems of the classical philosophers. If the easiest and simplest way to explain the nature of things is by following the order in which they are arranged according to thought, then reference to the categories of being would fall outside of what is necessary for explanation. Hence, we should apply "Ockham's razor" to eliminate such entities from our demonstrations.⁵¹¹

The reason why Descartes can take such a pragmatic, or problematical, approach to simple natures is that he does not consider them to be elements of reality in the sense of constituting substances. Rather, Descartes considers simple natures to be the bases of scientific explanation in the sense that they provide the elements for our scientific understanding of nature. Simple natures allow Descartes to organize and enumerate the conceptually basic elements to any mechanistic explanation as he conceived it. In this way, Descartes no longer explains natural phenomena by specifying the metaphysical nature of entities. Instead, he proposes some conceptually simple mechanical principles that he then uses as a model to reproduce the nature of particular phenomena. Quite rightly, such principles ought to be characterized by their epistemic character, i.e., insofar as they are *known*, not as they are *per se*. This is the fundamental insight of the "pure and simple natures" of Rule VI. However, the enumeration of simples in Rule VI seems ad hoc and incomplete. Descartes seems to be pulling bits and pieces from what he may

⁵¹⁰ Marion, "Ordre et Relation," 252.

⁵¹¹ See Eustachius St. Paul, *Sum phil* I, 86-87 as a possible source for Descartes' notion.

have studied in his school textbooks without a clear sense of outlining a new set of categories. Rule XII will much more closely approximate a complete enumeration of the bases of scientific explanation in a way that the mature Descartes will continue to support. But before we turn to that later treatment of simples, it will be useful to see how Descartes proposes to use simples in the solution of particular problems. Indeed, problem solving is the primary reason for positing such simple natures and these examples demonstrate the pragmatic rather than dogmatic features of Descartes' science that set it apart from the Aristotelian schools.

Simple natures and the problem of finding two mean proportionals

In Rule VI Descartes appears to be describing the principle *relations* that allow one to solve problems in mathematics and physics, rather than the intrinsic natures of things themselves. In Rule XII, by contrast, he has moved to a characterization of the categories of things, though these categories end up being relational properties as well. In order to understand the importance of relations in Descartes' theory of simples, it will be useful to look at the mathematical example of a geometrical series of numbers that is supposed to explicate these simple natures in Rule VI. I have treated the concept of a geometrical series and its importance for Descartes' mathematical method in the Chapter 2. Now it will be my task simply to explain how this concept provides the kind of scientific explanation that Descartes is after.

The principle of a geometrical series is the ratio or proportion that exists between any number in the series and its immediate successor. This is what is sought as the causal

explanation of this series. Thus, when Descartes is looking for the “mean proportional” between two numbers, he is looking for a ratio whose property is the following: $a/x = x/b$, where a and b are the given numbers and x is the mean number sought. This is the form of the algebraic method of comparison that I have identified with the *mathesis universalis*. Again, this method is the following: (1) every problem has some unknown which is sought, (2) this unknown must be determined in some way, thus (3) one must find the relation that pertains between the known and the unknown in the way that it is determined. As I have shown in the example of the mean proportional, the relation sought is a ratio of numbers.

The presentation in Rule VI begins by showing the proportional relations in a geometrical series of numbers. The key is to indicate “what points we may usefully concentrate on discovering first” (AT X, 384; CMS I, 23). Descartes continues:

For example, say the thought occurs to me that the number 6 is twice 3: I may then ask what twice 6 is, viz., 12; I may, if I like, go on to ask what twice 12 is, viz., 24, and what twice 24 is, viz., 48, etc. It would then be easy for me to deduce that there is the same ratio between 3 and 6 as between 6 and 12, and again the same ratio between 12 and 24, etc., and hence that the numbers 3, 6, 12, 24, 48, etc. are continued proportionals. All of this is so clear as to seem almost childish; nevertheless when I think carefully about it, I can see what sort of complications are involved in all the questions one can ask about the proportions or relations between things, and in what order the questions should be investigated. This one point encompasses the essential core of the entire science of pure mathematics [*purae mathematicae*]. (AT X, 384-85; CSM I, 23)

Here Descartes outlines the nature of a geometrical series and identifies the ratio or proportion between successive members of the series as the principle to be discovered. He goes on to claim that understanding the appropriate ratio or proportion is the “essential core of the entire science of pure mathematics.” From Chapter 2, we can

surmise that this claim follows from Descartes' early work in mathematics and proportional relations when he conceived of the mesolabe compass as an instrument for finding mean proportionals. From his work on algebra, he knew these mean proportionals to be the roots of algebraic equations. And he would see the discovery of a general technique for finding the roots of equations as the highest achievement in mathematics at that time.

As Descartes acknowledges, there is nothing particularly difficult in constructing a geometrical series if a person starts with a given number and knows the ratio that determines its successor. The problem becomes difficult when one starts with two numbers that are not successive numbers in the series and attempts to find the missing proportional numbers: "when the extreme terms 3 and 12 were given, I could not find just as easily the mean proportional, 6" (AT X, 385; CSM I, 23). Descartes describes the difficulty in cognitive terms: "we must attend at the same time to the two extreme terms and the ratio between them, in order to obtain a new ratio by dividing this one" (AT X, 385; CSM I, 23-24). In other words, we have to consider simultaneously the numbers 3 and 12 as well as the ratios between each of these numbers and the missing mean proportional. We know the two ratios to be equal, but the problem is obviously more difficult. Later in the rule, Descartes identifies the first problem as a "direct" sort of problem, while the second problem is "indirect" (AT X, 386; CSM I, 24). Indirect problems are identified with division and root extraction because they involve searching for a term that is only indirectly determined by the numbers given. In the text, Descartes goes on to describe the problem of finding two mean proportionals (e.g., two numbers in

a geometrical series between 3 and 24) and three mean proportionals (e.g., three numbers in a geometrical series between 3 and 48). The problem of finding three mean proportionals, Descartes claims, can actually be “split up and made easier” (AT X, 286; CSM I, 24). In effect, this problem amounts to three problems of the first kind: find the mean proportional between 3 and 48, i.e., 24, then find the mean proportional between 3 and 24 and the mean proportional between 24 and 48. This *reduces* the problem of finding three mean proportionals to three problems of finding one mean proportional. This is clearly a heuristic, rather than algorithmic, method and it shows that Descartes is focusing his attention on the properties of numbers with a view to discovering the underlying principles that would allow him to find solutions to classical problems in Arithmetic and Geometry. In the case of Rule VI, Descartes identifies the ratio or proportion between successive numbers in a series as the ultimate principle, or simple nature, that allows one to solve any sort of problem related to that series. In effect, knowing this ratio allows one to generate any term of the series.

One can see an analogous method in Rule XVI, which shows the utility of employing symbols in the mathematical method in order to better represent the nature of the problem under investigation. The full title suggests that this ‘algebraic’ use of symbols surpasses the reliance on memory, which was often seen as the linchpin of the method of discovery for the humanists. Descartes opens his demonstration with the following introduction; “we should note first that arithmeticians usually represent individual magnitudes by means of several units or by some number, whereas in this context we are abstracting just as much from numbers as we did from geometrical figures

a little while back—or from any matter whatsoever” (AT X 455-56; CSM I, 67). This introduction makes it clear that the following demonstration belongs in the context of the *mathesis universalis*. It also shows the kind of reduction that we recognized in Rule VI. He says: “if the problem is to find the hypotenuse of a right-angled triangle whose sides are 9 and 12, the arithmetician will say that it is $\sqrt{225}$ or 15. We on the other hand will substitute a and b for 9 and 12, and will find the hypotenuse to be $\sqrt{a^2 + b^2}$, which keeps the two parts a^2 and b^2 which the numerical expression conflates” (AT X, 456; CSM I, 67-68). What is so useful about the algebraic representation is that it shows the relation between the sides. Indeed, a contemporary reader may recognize $c = \sqrt{a^2 + b^2}$ as an expression of the Pythagorean theorem. What this means is that the algebraic form presents the theoretical rule or law underlying the solution to the problem, whether it be arithmetical or geometrical. “Accordingly,” Descartes says, “once we have investigated the problem expressed in general terms [i.e., algebraically], we should re-express it in terms of given numbers, to see whether these might provide us with a simple solution” (AT X, 457; CSM I, 68). Indeed, it may be the case that certain problems may be more easily solved by looking at the numbers rather than the algebraic form. At the end of the rule, Descartes suggests that the same problem may be expressed as a figure, with sides AB and BC, being represented by a and b , or 9 and 12, respectively.

The point is that Descartes remains neutral about which representation is best. He leaves it open whether he will represent the problem in numbers, figures, or symbols. But the principle that allows Descartes to move back and forth between the arithmetical and geometrical representations is the *mathesis universalis*, i.e., the proposition that these two

kinds of expression can be conceived reciprocally. Moreover, the algebraic expression shows the relation that each of these numbers or magnitudes bears to the others in the expression of the problem, and the algebraic expression preserves the path of discovery, or the method of analysis used to arrive at the solution, namely, by virtue of the relation expressed.

Now, Descartes clearly thinks that his simples of Rule VI extend beyond mere mathematics (that is why he includes the straight and curved, cause and effect, universal and particular among his list of simples). It seems to me that these notions enumerate the kinds of relations that pertain between knowns and unknowns in a natural science. Let me be clear, it seems that Descartes has determined a number of principal relations that are sought in any scientific inquiry: namely, relations of quantitative measurement, relations of a single thing to a multitude of things, relations of cause to effect, and relations of universal to particular. It seems plausible to me that one could work out a mechanistic science of matter on the basis of these four relations. And I think that this is why Descartes is confident that imperfect problems (those that require further inquiry into the nature of the problem) can be reduced to perfect ones (those problems where the object of sought is well-defined and the relation it bears to known quantities determined). Moreover, he seems to believe that he can extend his algebraic method of comparison and the principles of the *mathesis universalis* to problems in natural philosophy. Thus, Descartes has a relational, non-intrinsic, understanding of the principles of scientific explanation. In the final section, we will see how this is characterized in Rule XII and how this notion of simples ultimately meshes with Descartes' method.

Simple natures and the discovery of the anaclastic line

In Rule VIII, Descartes uses his discovery of the anaclastic line, i.e., a line that describes the shape of a lens that would refract parallel rays of light to a single point, in order to demonstrate the utility of his method. He tells us that solving this problem requires one to analyze or reduce it into its constituent elements. Only by determining which elements are primary, or most simple, can we discover the underlying principles governing the problem and thereby demonstrate its solution. Our examination of this passage will help link Descartes' insights on method to his discoveries in mathematics as they were applied to problems in natural philosophy.⁵¹² I quote the relevant passage at length:

Now take someone whose studies are not confined to mathematics [i.e., someone who has an understanding of natural philosophy] and who, following Rule One, eagerly seeks the truth on any question that arises: if he is faced with the same problem [i.e., the anaclastic], he will discover when he goes into it that the ratio between the angles of incidence and the angles of refraction depends upon the changes in these angles brought about by differences in the media. He will see that these changes depend on the manner in which a ray passes through the entire transparent body, and that knowledge of this process presupposes also knowledge of the nature of the action of light. Lastly, he will see that to understand the latter process he must know what a natural power in general is—this last being the most absolute term in this whole series. Once he has clearly ascertained this through mental intuition, he will, in accordance with Rule Five, retrace his course through the same steps. (AT X, 394-95; CSM I, 29)

For Descartes, it is not sufficient (nor perhaps even necessary) to know the nature of the thing in question as defined by its genus, species, and specific difference. Instead, one must understand the general mechanical principles at work in that thing. With respect to

⁵¹² See Garber's essay "Descartes and Method in 1637," *Descartes' Embodied*, 33-51, for a discussion of the importance of this problem for Descartes' method.

the anaclastic line, these principles must explain: the effect the material has on the path of light, the process whereby light is transmitted through transparent bodies, the basic nature and action of light, and ultimately what a natural power is. This ultimate term is a bit perplexing since it seems to imply some power inherent in natural bodies, which is contrary to a strictly mechanistic conception of matter.

In the *Dioptrique*, however, Descartes treats the natural power of bodies more explicitly. There, he stipulates that motion is the only acceptable natural power. We will see that motion is one of the material simple natures, so it is reasonable that this ultimate term would turn out to be a simple nature. In the *Dioptrique*, Descartes describes the power of light using analogies from everyday moving bodies, e.g., the bouncing ball, the blind man with a stick, and the moving grape skins in the wine vat (AT VI, 81-105).

Though the *Dioptrique* was written in the early 1630s, it is remarkably similar to a passage from Rule IX, which outlines this exact technique for discovering what a natural power is. Here is the passage from Rule IX:

If, for example, I wish to inquire whether a natural power can travel instantaneously to a distant place, passing through the whole intervening space, I shall not immediately turn my attention to the magnetic force, or the influence of stars, or even the speed of light, to see whether actions such as these might occur instantaneously; for I would find it more difficult to settle that sort of question than the one at issue. I shall, rather, reflect upon the local motion of bodies, since there can be nothing in this whole area that is more readily perceivable by the senses. And I shall realize that, while a stone cannot pass instantaneously from one place to another, since it is a body, a power similar to the one which moves the stone must be transmitted instantaneously if it is to pass, in its bare state, from one object to another. For instance, if I move one end of a stick, however long it may be, I can easily conceive that the power which moves that part of the stick necessarily moves every other part of it instantaneously, because it is the bare power which is transmitted at that moment, and not the power as it exists in some body, such as a stone which carries it along. (AT X, 402; CSM I, 34)

This notion of “instantaneous motion” is perhaps a remnant of the “hydrostatic papers” in the *Physico-Mathematica*, where Descartes’ unique contribution to the hydrostatic paradox is to conceive of the force applied by the water’s pressure on the base is conceived an incremental, momentary force. The principles of micromechanical motion, which originated in that work with Beeckman, are thus related to the method in this example. Moreover, it develops the characteristic Cartesian conception of the power of light, the animal spirits, and in general any power that appears to have an instantaneous effect over a distance. The basic methodological import of this example is that the nature of something even as perplexing as the instantaneous transmission of light, the attraction of a magnet, or the influence of the stars, can be resolved by considering the mechanical structure of nature and supposing that this underlying mechanism conforms to analogous movements of more mundane objects easily perceivable by the senses.⁵¹³ So, for Descartes, discovering what a “natural power” is ought not be mysterious. Instead, it should be approached in exactly the way that other problems are approached: by determining the essential terms of the problem, understanding the relationship between those terms, and producing mechanical models that explain those relations.

We can now return to the first passage from Rule VIII where Descartes applies his method to the problem of the shape of a lens that would refract all rays of light to a single point. Garber has provided an interpretation of this passage in terms of Descartes’ method

⁵¹³ A similar claim is made in Rule VIII, “we should, where the objects of inquiry are equally simple, always begin our investigation with those which are more useful” (AT X, 397). The notion of utility, here, should be taken in the sense of ‘useful to explain the phenomenon in question’. Indeed this claim is expanded with the very suggestive example of the blacksmith, who uses the same method of fabrication to construct the tools that he will ultimately use in the practice of his craft.

that is clear and concise.⁵¹⁴ I will use this reading as a starting point, though I wish to modify it somewhat in order to illustrate some of the nuances in Descartes' application of mathematics to natural philosophy. Garber conceives of the "reduction" mentioned in Rule VII as a series of questions, where the answer to each question is presupposed by the answer to a logically prior question: "Q₁ is reduced to Q₂ if and only if we must answer Q₂ before we can answer Q₁."⁵¹⁵ Thus, the former question can be "reduced" to the latter, since the latter provides the basis for a response to the former. In effect, we must trace our way back to the logical foundation of our investigation, determine the answer to this foundational question, and then retrace our steps back to the original question. At the end of the series of questions, Descartes arrives at two unnerving questions, each of which seems to block further investigation: "what is the nature of the action of light?" and "what is a natural power, in general?" The answers to these questions are the fundamental insights that will inform Descartes' answer to the question "What is the shape of the lens that reflects light rays to a single point?" They are the simple or absolute terms of the series and form the explanatory basis for resolving the whole problem. Briefly, the answer to the first is the sine-law of refraction and the answer to the second is motion, as we have seen above. But how does he arrive at these insights?

Garber claims that the reductive process "ends" at these ultimate terms and that "at this point, Descartes seems to think that we can 'clearly see through an intuition of the

⁵¹⁴ *Descartes Embodied*, 88 and 37 provide the relevant table.

⁵¹⁵ *Ibid.* 89.

mind' what a natural power is."⁵¹⁶ On what basis would Descartes claim to have an intuition of a natural power? In the *Regulae*, he seems committed to the idea that intuitions are reserved for simple and evident truths, like the axioms of arithmetic and geometry. In what sense can we understand a "natural power" in this way? As we have seen, the very idea that natural bodies have powers seems to cut against the grain of Descartes' mechanism. Garber's account is insightful because it displays the anaclastic example in terms of a reduction to and composition from simples. What it lacks is an explanation of how our knowledge of a "natural power" or the "movement of light through a body" is supposed to be a simple and evident intuition. The normal account of simple natures is that they are the special objects of the intellect, and thus intuited straight off. However, the chief issue with the anaclastic is that "the problem before [the inquirer] is composite and relative, and it is possible to have experiential knowledge which is certain [i.e., *scientia*, cf. Rule II] only of things which are entirely simple and absolute" (AT X, 394; CSM I, 29). So, the reductive series of questions is supposed to arrive at a simple, but at this stage, the problem is still complex, i.e., there is no intuitive access to the explanatory principles of this particular phenomenon.

Bret Doyle's interpretation is helpful in responding to these issues: he understands the passage in terms of its exposition, namely, in the sense of an inquirer looking into the nature of the anaclastic. He finds that "on Descartes' account, at two points in the course of this inquiry we come across things which it seems 'our intellect is unable to intuit sufficiently well...' [392]. So at each of these points we might think we have reached a

⁵¹⁶ Ibid. 88.

limit beyond which it is impossible for human cognition to proceed. However, it turns out that there is a way around both of these obstacles.”⁵¹⁷ Doyle suggests that what blocks the inquirer at each stage is that he has the wrong idea about the nature of scientific knowledge. In particular, this inquirer conceives of the knowledge of physical phenomena to be of a different kind than mathematics, and thus ignores the dictum of Rule I: “that the sciences as a whole are nothing other than human wisdom” (AT X, 360; CSM I, 9). Doyle postulates that the principles necessary for solving problems in natural philosophy are established by “suppositions” or “hypotheses” that conform to the limits of our mental powers. As I understand it, this means that the mechanical microstructures of physical phenomena are hypothetically chosen to fit the capacities of my mind, i.e., the limits of one’s mental powers. Doyle puts it this way: “the *Regulae* is solely concerned with elaborating effective procedures of discovery that ‘measure up’ (or are adequate) to our (quite narrowly limited) cognitive powers.”⁵¹⁸ If I understand this correctly, the restriction of scientific knowledge to the limits of our mental powers is precisely the role played by the *mathesis universalis*. By that I mean that the method of *mathesis* is applied to a restricted domain of entities, those that admit of order and measure. These entities conform to the idea-type of mathesis; they can be easily and completely comprehended by the human intellect. In a wholly analogous way, I will claim that the material simple

⁵¹⁷ *The Logic of Descartes’ Method*, 375.

⁵¹⁸ *The Logic of Descartes’ Method*, 379. To me, Doyle’s phrasing sounds like he understands Descartes to redefine the nature of truth in a way that recalls Husserl’s idea of noetic adequation. I prefer to read this in terms of the mechanistic project, as I have outlined it above. I’m not sure we can talk about anything like a transcendental notion of adequation at this stage in Descartes. I am convinced that Descartes is a realist about his natural philosophy; the “hypotheses” are not yet so severe.

natures describe the kind of entities that fall under the mathesis idea-type and thus are a complete enumeration of possible physical substances that can be grasped by our cognitive powers.

So Doyle has set us on the right track. Let us now return to the passage in order to fill out the picture of what is actually going on in Descartes' discovery of the solution to the anaclastic. First of all, I propose to return to the text of paragraph 3 (commentators tend to focus on the meat of the problem in paragraph 4). Descartes states:

If, say, someone whose studies are confined to mathematics [*mathematicae*] tries to find the line called the 'anaclastic' in optics—the line from which parallel rays are so refracted that they intersect at a single point—he will easily see, by following Rules V and VI, that the determination of this line depends on the ratio of the angles of refraction to the angles of incidence. But he will not be able to find out what this ratio is, since it has to do with physics rather than with *mathesis*. So he will be compelled to stop short right at the outset. (AT X, 393-94; CSM I, 28-29)

This passage contains the only other use of the word 'mathesis' in the *Regulae* apart from Rule IV-B. Moreover, it clearly links its discussion of method with Rules V and VI.

Recall that Rule V is the rule that recalls a reduction of complex things to simples and a step-by-step recomposition of those simples according to a deduction; Rule VI is the first mention of the "pure and simple natures," a rule we have discussed above with reference to the mean proportional. This passage recalls a person schooled in mathematics, whose concept of method would be restricted to *mathesis*, i.e., that learning or way of study common to the mathematical sciences.

Here, Descartes suggests that this person would be unable to find the ratio needed to describe the anaclastic line. Why? Because the sine law expresses the ratio of the angle of incidence to the angle of refraction as a function of the sine of the angle, i.e., $\sin i = n$

($\sin r$); and Descartes tells us later that “the angle of refraction depends upon the changes in these angles brought about by differences in the media” (AT X, 394; CSM I, 29). The constant ‘ n ’ in the ratio of the angle of incidence and the angle of refraction changes based on the kind of material the light passes through. This constant differs if one considers glass, water, or some other transparent medium. Thus, without experimenting with different kinds of material, the student of mathematics, the follower of *mathesis*, would not have been able to find the solution to this problem. Unlike the case of the mean proportionals, the sine law is a mathematical law of nature, i.e., an application of *mathesis* to natural philosophy. This passage reflects Descartes’ growing understanding of natural philosophy. He realizes that purely mathematical methods of analysis will not reveal the core principles necessary for resolving certain problems in natural philosophy. These problems must be aided by empirical observation. In fact, one could suggest that this passage—and not Rule IV-A—reflects Descartes’ real movement beyond the *mathesis universalis* and it is a very clear instance of a tension in his universal method.

In a way, what Garber’s schematic misses is the way *mathesis* is applied to natural philosophy. He has it right that this “workable procedure” for discovering the basic intuition about physical phenomena ensures a return along the path of discovery through a process of deduction. Since the relationship that exists between each question is one of a necessary foundation, the deduction from the final “intuition” that responds to the most absolute question in the series ensures a deduction back to the initial question. This procedure allows Descartes to preserve and expand *scientia*, Garber rightly

claims.⁵¹⁹ *Scientia* is preserved just in case cognition is certain and evident; this is only possible if the explanation of the phenomenon is based on intuition and deduction, and thus is free from doubt. However, as I have noted, it is not entirely clear how one acquires the intuitions related to the sine-law and the nature of the power of light in Garber's schema. It seems that what must be missing is the natural scientific application of mathematics.

Let us return to Descartes' questions, as outlined by Garber: Q₁) What is the shape of a line that focuses parallel rays of light to the same point? This is what we would like to know. Q₂) What is the relation between the angle of incidence and the angle of refraction? This question is informed by Rule VI, where Descartes demonstrates that the simple nature sought ought to be expressed as a ratio between knowns and unknowns. However, in Garber's scheme, he writes "(i.e., the sine law of refraction)." This is where I am not entirely satisfied with Garber's account. Remember that the reason why a person trained in *mathesis* is unsuited to discover the ratio between the angle of incidence and the angle of refraction (unlike the mean proportionals) is because this ratio requires experimental knowledge. In other words, the sine law of refraction is not a purely mathematical law; discovery of the sine law requires additional information. How is this additional information to be acquired? Through experiment and observation.⁵²⁰ Thus,

⁵¹⁹ *Descartes Embodied*, 91-93.

⁵²⁰ To be fair, Garber is very sensitive to this issue. He points out that "experiment is somehow supposed to help us find the *right* deductions, the ones that pertain to our world and to the phenomena that concern us. In this way, experiments seem not to *replace* deductions, but to *aid* us in making the *proper* deductions" *Descartes Embodied*, 93. But this insight comes when Garber is addressing the *Discours* and *Essais*, not the *Regulae* (he says that "Experiment comes up at best only implicitly in the anaclastic line example," 94).

step two in the reduction requires a supplemental step, namely, the requisite observations of light passing through various media in order to establish this relation as a *constant* that depends on specifying the medium through which the light refracts. Similarly, the next three questions all require some analogical reasoning that is, strictly speaking, beyond the bounds of strictly mathematical fields: Q₃) How is refraction caused by light passing from one medium into another? Q₄) How does a ray of light penetrate a transparent body? And Q₅) What is light? There are no “intuitions”—at least no mathematical intuitions—corresponding directly to these questions. Each answer requires a physico-mechanical model that is proposed on analogy with the problem as stated.

The analogical nature of these answers is different than the answer to Q₂. In the *Dioptrique*, Descartes will answer Q₄ by referring to “small balls rolling in the pores of earthly bodies” (AT VI, 331); he will answer Q₅ with his theory of instantaneous propagation. These answers depend on Descartes’ method in a slightly different way. They offer a mechanical explanation of the nature of light by making a comparison between the putative mechanical forces in the action of light and macroscopic phenomena (e.g., small balls, sticks, or a writing quill). Realize that none of these answers is a “simple nature” *per se*; but each of the macroscopic models falls under the categories of extension, shape, and motion. So they are supposed to be analogous to the microscopic mechanical forces at work in light. This supposition is based on the idea that there is only extension, shape, and motion *all the way down*. Thus, it is not quite right to say that the end of this reductive procedure is the discovery of simple natures. Rather, the result of each reductive step is an intuition that conforms to the theory of simple natures. Indeed,

this kind of explanation fits the two criteria that I have identified for Descartes' mechanical framework in the *Regulae*: these mechanical structures are, in some sense, hypothetical; and they are posited on analogy with observed phenomena. So, in a certain sense, the method of discovering each of the final three intuitions that answers this explanation still conforms to the general scientific method that I have been outlining. However, these physical intuitions import a basic thesis of mechanism into the process: namely, macroscopic phenomena can be explained by reference to invisible micro-mechanical systems; and they connect Descartes' understanding of his mathematical method to an experimental-mechanical approach to natural philosophy.

Again, we can understand this application of mathematics to natural philosophy in terms of the *mathesis universalis*: the *mathesis* determines the idea-type of mechanical representations, it provides the logical rules of inference necessary to make the analogies that will inform our description of the phenomenon, and it provides a method of discovery that allows Descartes to determine the mathematical natural laws that govern the phenomenon. The example of the anaclastic line shows Descartes to be working with a very complex procedure of discovery: one that employs reductive steps to simples and that utilizes the algebraic method of comparison along with a mechanistic explanatory framework and empirical observations to arrive at the insights at each level of deduction. This example has revealed an important relationship between the purely mathematical aspect of this method and the experimental aspect. Indeed, they seem to be mutually dependent and each indispensable to the discovery of the laws of natural philosophy.⁵²¹

⁵²¹ I think this is the right way to understand the relationship between mathematics and physics; in

In essence, we have determined that there is a necessary relationship between three different methods of the *Regulae*: the method of the *mathesis universalis* (Descartes' algebra), the method of reduction, and the experimental method.

Descartes' later use of simples in the Regulae

If we turn to the more mature use of simple natures in the *Regulae*, we will find a clearer explanation of the philosophical theory behind the application of simples to natural philosophy that is suggested by the discovery of the anaclastic line. Though the discussion will still leave some questions unanswered, we will try to think of the simple natures as simple notions that are arrived at through the process of analysis. I believe that they are the primitive axioms of a deductive explanation of natural philosophical phenomena. In effect, they are the first principles of Descartes' *Regulae*. Though the mature Descartes will see substance—particularly infinite substance, God—as the ultimate first principle of scientific knowledge, the simple natures remain a necessary step along the way to that idea. Indeed, when we understand Descartes' use of the simple natures in the *Regulae*, we will appreciate how they fit into Descartes' mature metaphysics. We will note that the simple natures of the *Regulae* are already divided into intellectual, material, and common natures, and they are conceived in a way that is entirely consistent with his concept of substance. In other words, Descartes is already

effect, Descartes has oversold his case when he claims that “imperfect problems can be *reduced* to perfect ones” (AT X, 431). That mathematics is indispensable for natural philosophy does not imply that the latter can be reduced to the former.

conceiving of some basic conceptual distinction between material and intellectual entities and he is conceiving of these entities in a way that is consistent with his mature distinction between body and mind.

We will discuss the intellectual and common simple natures, though Descartes does not elaborate on them in the *Regulae*. Nevertheless, he makes a number of provocative claims that suggest a kinship to key concepts in his mature philosophy. Conversely, the material simple natures are the real discovery of the *Regulae*. The later metaphysics surpasses and founds the material simple natures discovered in this text on natural philosophy. Material simples function as the categorical bases of Cartesian natural philosophy: all physical entities are understood as a combination of these causally primary types.

With the mature list of simple natures, Descartes is beginning to clarify the basic metaphysical categories that he thinks best correspond to his philosophical project. What will be most noteworthy for our investigation is why he enumerates the simples in the way he does, how this operates in his concept of scientific explanation, and what relationship this bears to his mature metaphysical dualism

Simple natures as primitive notions or ultimate determinables

I believe that it is most helpful to understand Descartes' idea of simples as the final terms of an analysis. This is why I call them primitive notions. They are primitive in

classical sense of first principles, i.e., they are the result of a dialectical process, passing from what is known to us immediately to what is known by nature in the most elementary and basic sense. In Chapter 2, we explored the influence of this kind of method on Descartes' *Regulae*. In particular, we saw that Descartes was seriously engaged in a search for a true analytic art of discovery during the formative period of 1618-1628. Although I use the phrase 'dialectical process' here to describe the method of arriving at simple natures, Descartes is quite dismissive of dialectic in the *Regulae*. We have seen, however, that this attitude is a consequence of a historical reaction to late scholastic logic. Nonetheless, there is an analogous concept to dialectic in Descartes' thought. Descartes' interest in mathematics lead him to conceive of the process of discovery in mathematics as "analysis," which was explicitly referred back to Proclus' idea of an upward movement of thought. Moreover, he conceives of his method of upward ascension and discovery as proceeding by way of a reduction to simples and a recombination of those simples in a deductive, or necessary, way. The discovery of the principles, or simple natures, is a process of analysis, while the recombination of simples provides an explanation.

The Latin terms *reduco* and *compositio* were closely allied with the Greek *analysis* and *synthêsis*. Goclenius describes the term *reducere* as "that motion by which one ascends to causes [*reducere notat motum, ait Scal. de caus.*]." ⁵²² He even cites as an example of reduction the discovery of two mean proportionals in order to solve the problem of duplicating the cube. For Goclenius, the mean proportionals, or roots of a

⁵²² Goclenius, *Lexicon Latinus*, 965.

quadratic equation, are the final terms or propositions compared by the intellect when it discovers the solution to this problem.⁵²³ We have already seen that, in Descartes, the solution to the problem of finding two mean proportionals lies in determining the ratio between successive terms in the series. This ratio is the simple nature or ultimate term that explains the nature of the series. Such a process, in classical Geometry, was called ‘analysis’. As a seeming historical confirmation of this connection, Beeckman’s Journal reproduces Descartes’ construction of two mean proportionals, using a circle and parabola with the Greek words, “*Analytikôs*” and “*Sunthetikôs*.” The *analytikôs* relates the proportional relations between the line segments and draws the figure representing those relations. The *sunthetikôs* explains the result (AT X, 342-344).

Returning to Goclenius, the encyclopedist cites as one definition of the many ways in which ‘compositio’ is understood: “that act by which the intellect conjoins accepted simple notions [*ut actio intellectus simplices notiones consentaneas conjungens*].”⁵²⁴ When he describes the process of composition, Goclenius distinguishes the knowledge attained through composition from the knowledge of axioms or primitive notions. While the former is apprehended through a simple operation of the intellect, the latter relies on the certainty of the argument that conjoins axioms or simple notions. In the former, there is no possibility of falsehood, he says, while the latter is either true or

⁵²³ “Geometrae voce Reductionis etiam utuntur pro Translatione. Reducere enim unum problem vel Theorema ad aliud est trasferre aad aliud, quo cognito & percepto comparatoque, etiam id, quod primo propositum est, sit manifestum: ut quando duplicationem cubi investigant, quaestionem suius propositionis ad aliam propositionem, quaehanc sequitur, transtulerunt, nempe Invenite duas medias rectas proportionales, & quod restabat, investigarunt: qua ratione datis duabas rectis duae mediae inveniri possint proportionales” (965).

⁵²⁴ Ibid., 421.

false.⁵²⁵ These descriptions of the cognitive apprehension of simple and conjoined natures reflect Descartes' understanding of the cognitive apprehension of simples in the *Regulae*. As we have seen, Descartes claims that simple natures are apprehended with complete intellectual clarity, while explaining problems in terms of those simples requires deduction in order for them to be necessarily true. All of this suggests a close linguistic similarity in the seventeenth century between analysis and reduction, synthesis and composition. I believe that this is the case because both conceptual analysis and methodical reduction lead to simple natures while deduction and combination produce explanatory models of physical phenomena.

This connection is nowhere clearer than at the beginning of Rule XII where Descartes claims that by the term “simple” he means “only those things which we know so clearly and distinctly that they cannot be divided by the mind into others which are more distinctly known” (AT X, 418; CSM I, 44). This seems to confirm the idea that simples are the final terms of a process of analysis or reduction: they cannot be conceptually divided into distinct parts; they are the most simple and utterly clear ideas. The conceptual nature of this division or analysis is primary. To illustrate, Descartes considers a body with extension and shape. While he admits that “with respect to the thing itself, it is one single and simple entity,” he will consider it as “a composite made up of these three natures [corporeal nature, extension, and shape], because we understood

⁵²⁵ “*De Compositione Enuntiativa seu Axiomatica*: Haec opponitu Intellectioni indivisibilium, id est, operationi intellectus simplici, qua res ipsas apprehendimus. Est igitur compositio conceptuum intellectus, cum ipsas res componimus mente faciendo propositionem. Est argumenti cum argumento ad formandam affirmationem, veluti amica quedam conjunctio ... Inter has operationes dupliex est discrimen: Alterum est, quod in prima operatione non est ulla falsitas: At in secunda est Verum, vel Falsum” (422).

each of them separately before we were in a position to judge that the three of them are encountered at the same time in one and the same subject” (AT X, 418; CSM I, 44).⁵²⁶

Here, one single entity is understood as a composite of three simple natures since it is possible to conceive or understand these three natures apart from and prior experience of the entity.

One might wonder what concepts cannot be divided in this way. Isn't any proposition composed of words or propositional components analyzable? Descartes claims that the analysis must stop at the point where further division results in a loss of clarity and distinctness. Moreover, the analysis involved is conceptual, rather than linguistic. While every concept can be understood in terms of its definition, and every definition is articulated in propositions that may be analyzed, Descartes seems to think that some concepts lose their conceptual integrity through such analysis. When we analyze the definitions of some concepts, the parts of those definitions no longer relate to the whole in a way that explains the nature of the whole in the relevant way. Just below the example of the body with extension and shape, Descartes considers whether the concept 'shape' can be further analyzed into, for example, 'limit'. Shape can be defined as the boundary, or limit, of a geometrical body. Thus, one could analyze the definition of the concept 'shape' into the concepts 'limit' and 'geometrical body'. When we consider the concept 'limit', does it explain the nature of the concept 'shape' in the relevant way? What is relevant to the concept 'shape'? For Descartes of the *Regulae*, the idea of shape

⁵²⁶ This distinction in the natures “corporeal nature” and “extension” ought to be distinguished from the inseparability of these two natures when they are adequately represented in the imagination, see Rule XIV (AT X, 444-445; CSM I, 60-61).

supposed to explain the nature of bodies. But he thinks that all bodies, insofar as they are conceived as merely extended and corporeal, can be represented geometrically. So, the only relevant concept of limit for explaining the concept of body is the limit of a geometrical body. When we consider the concept ‘limit’ apart from ‘geometrical body’ we may think of a period of time, for instance. But Descartes thinks that when limit is so conceived (as ambiguously applied to material entities, intellectual entities, and common entities), it loses its clarity and distinctness (AT X, 418-19; CSM I, 44). This suggests that Descartes already conceives of distinct categories of things, each with their highest, or most simple notions.⁵²⁷ Descartes takes shape to be one of the simplest notions that refers to material entities because any further analysis of the concept results in a concept that refers ambiguously to material and intellectual entities.

I believe that the relationship between simple natures and the kinds of things they explain can best be understood along the lines of the determinate-determinable distinction.⁵²⁸ The determinate-determinable distinction will make perfect sense of why ‘shape’ cannot be explained by ‘limit’. This distinction is ordinarily brought to bear on propositions like ‘red is a color’. It is noted that these propositions involve a different sort of claim than, for instance, ‘Paul is wealthy’ or ‘Paul is a man’. In the latter two cases, wealth and humanity are attributed to Paul as a property or predicate is attributed to a subject. But the relationship between red and color is different. Color does not predicate the red; it is not a property of red, not even an essential property. Yet it is impossible for

⁵²⁷ See Marion’s notion of “simplification” in *Sur l’ontologie grise*, 131-36 and Gaukroger, *Descartes*, 180-81.

⁵²⁸ This distinction originates in W.E. Johnson’s *Logic* and was notably advanced by John Searle.

a thing to be red without its being colored. Contemporary philosophers understand this relationship as one of a determinate (red) to a determinable (color). Red determines the color of the object. In turn, red can be understood as a determinable in relation to determinates maroon, scarlet, or crimson. If we return to our example of simple natures, we can see that the particular shaped body is determined in extension, shape, and in being corporeal. Without specifying each of these determinables, we would not be able to uniquely understand the particular body. One must imagine that the body itself has a determinate extension, certain shape, and corporeal nature. Leaving out any of these determining factors would render our concept of the object vague or ambiguous. Conversely, if we try to imagine shape as determining limit, we find our understanding confused. A triangle determines shape, but does shape determine any concept that is less determinate than it? Except perhaps in very special fields of mathematics, we do not normally conceive of limit as a concept that requires determination by either shapes or durations. There is no concept that is either shaped or temporally extended in the same way as a shape is either triangle or square. So, it seems that when we conceive of the simple natures as describing the least determined concepts, i.e., the ultimate determinable, relating to a certain category of entities (intellectual, material, or common) then we have a fairly good grasp of why Descartes speaks the way he does about those simple natures.

The determinate-determinable relationship is similar to, but much more flexible than the ontology of species and genera. Different determinates (say, red and blue) specify the determinable 'color', but they do not need to be considered species of the

genus color. Color is not a natural kind that must then be further specified into other natural kinds. The determinate-determinable relation does not have the ontological weight of genera-species distinction. Nor is color a property of the red, so we do not have to conceive of objects in terms of the subject-predicate or substance-property way that they are normally understood. One way to understand this is to see determinates and determinables as purely conceptual distinctions. Whereas the species-genus distinction requires a physical and metaphysical ground in order to explain it, the determinate-determinable relation seeks no such ground. In this way, the determinate-determinable distinction preserves the hypothetical and schematic way that Descartes approaches natural philosophical explanation. Nonetheless, when Descartes' simple natures are understood to be the highest determinables, there is an analogy to be made with Aristotle's categories, the highest genera. In both cases, the list of concepts is the result of an analysis taken to its ultimate term.

Indeed, when the simple natures are understood in this way, it is easy to see why the list of simple natures from Rule XII reoccurs in Descartes' lists of the modes of substances. Jorge Secada has recently offered a very insightful interpretation of Descartes' concept of substance along just these lines: "Descartes understood the inherence of a real property in a subject as the actual determination of a determinable nature by one of its determinates. Substance is an existing ultimate subject, a determinable essence which is not itself determinate."⁵²⁹ Thus, we only need to understand Descartes' mature concept of substance as taking an additional step back from

⁵²⁹ Secada, *Cartesian Metaphysics*, 190.

the ultimate determinables of intellectual, material and common simple natures to the determinable that each of these categories determine, i.e., substance. Substance is either intellectual or material. If we understand Descartes' mature concept of substance in this way, we can see why common simples will have to be classed in a different category: there is no common substance. Thus, these simples are diversely classified as logical primitives, common modes of existence, and modes of conception. In this respect, Descartes' later metaphysics confirms our suspicion that there is a similarity with an important difference between Descartes' notion of categories and Aristotle's (where the ultimate category is substance).

This way of conceiving of Descartes' metaphysics is quite instructive. As Secada points out, the idea that properties or attributes are determinations of substance allows Descartes to incorporate the vocabulary of substance, attribute, mode, and the various distinctions from his scholastic predecessors, but to understand these concepts in an entirely new way. In Secada's language, Descartes is an "essentialist" while the scholastic Aristotelians were "existentialists." What this somewhat obscure terminology means is simply a restatement of one of the most fundamentally Cartesian insights: knowledge of what a thing is (*quid est*) precedes knowledge of its existence (*an sit*). For Descartes, one cannot know that a thing exists unless one specifies its nature. Conversely, the scholastic Aristotelians held that one cannot know what a thing is unless one knows that it exists.⁵³⁰ These broad claims do admit of nuance (Descartes is certain of the existence of the "I" before he knows what it is and he knows that God exists without

⁵³⁰ Ibid., 7-10.

comprehending God's nature, while Aquinas will acknowledge that in order to know that a thing exists one must have "some account" of its nature). However, the difference is quite striking and really goes to the heart of the Cartesian break from the tradition.

According to this interpretation, understanding what a thing is amounts to determining it according to the categories—the ultimate determinables. In the later metaphysics, this ultimate category, the ultimate determinable is substance.⁵³¹ By contrast, the *Regulae* stops with the simple natures. Once Descartes has the idea of substance, he no longer needs the simple natures. He can treat all conceptually distinct entities as "ideas" and distinguish these according to their ontological nature. The idea of substance becomes the most "real" or fundamental idea, and hence the foundation of what are no longer understood as simple natures (cf. AT VII, 40; CSM II, 27-28).⁵³²

Correlatively, the process of determining the essence of an entity is the process of recomposition or "conjunction." In the *Regulae*, Descartes distinguishes between necessary and contingent conjunction of simples. Simples are necessarily conjoined if the concepts they express are logically contained in the concept of the entity. Descartes gives us some examples of this sort of logical containment: the concept 'extension' is contained in the concept 'shape', the concept 'duration' is contained in the concept 'motion', the concepts '4' and '3' are contained in the concept '7', 'Socrates understanding something' is contained in 'Socrates doubting', 'God exists' is contained in 'I exist', 'I have a mind distinct from my body' is contained in 'I understand'. Logical containment is a one-way

⁵³¹ A good place to start to develop this interpretation would be with Marion, *Sur la théologie blanche*, 110-139.

⁵³² Marion, *Questions cartésiennes*. 81, claims that "la doctrine cartésienne de l'idée ne met pas d'abord en jeu le terme même d'idée, mais son substitut ... la nature simple."

relation, he tells us. Even though 'God exists' is contained in 'I exist', 'I exist' is not contained in the concept 'God exists'. Indeed, my existence is merely contingent, given God's existence. Examples of contingent conjunction are the relationship between 'body' and 'animate' or 'man' and 'being dressed' (AT X, 421-422; CSM I, 45-46). I do not wish to dwell on the validity of Descartes' claims here. Rather, I only wish to point out that Descartes thinks that the necessary composition of simples is a kind of logical implication. Whenever simples are composed in a way that is logically implied by given simples he thinks that our knowledge of the entity so determined is true.

This composition of simples that determines the nature of an entity is supposed to coincide with the perception of the entity. So Descartes claims, "those natures we call 'composite' are known to us either because we learn from experience what sort they are, or because we ourselves put them together" (AT X, 422; CSM I, 46). By experience here he means sensory experience. One might expect Descartes to think that it is simply impossible to trust the experience of the senses, but this is not what he says. In fact, he claims, "the intellect can never be deceived by any experience, provided that when the object is presented to it, it intuits it in a fashion exactly corresponding to the way in which it possesses the object" (AT X, 423; CSM I, 47). So, the senses are reliable, but only in exactly that way in which they relate the information to the intellect. This seems to follow from Descartes' account of perceptual cognition. The reliability of the senses is certified by the causal connection between the sensory organs and real objects. Bearing in mind the nature of this causal connection, we ought not to presume that the senses present the object the way it exists on its own. In such cases, "we are liable to go wrong . . . as

someone who has jaundice does when, owing to the yellow tinge of his eyes, he thinks everything is coloured yellow” (AT X, 423; CSM I, 47). The “wise man,” presumably the one who has trained his *ingenium* in just the way that the rules instruct, will recognize that the image presented to the intellect by the imagination is already composed in a certain way out of the causal connection between the sensory faculties and the external world. Thus, the yellow could be a property of the object, or the yellow could be a property of the eye. We will not assume that the senses give us direct access to the object, but we will realize that the senses are mediated in their causal connection to the object.

This sort of example leads Descartes to suggest that there are three different sorts of composition: impulse, conjecture, and deduction. Composition by impulse is the immediate and, we might say, instinctive judgments we make about the world. These can be the result of our nature, thus placed in us by a “superior power,” or it could be an engrained disposition of the corporeal imagination, as in the case of an acquired reflexive reaction, or as a result of our “free will,” which seems obscure and is given no explanation, though Descartes thinks it is “rarely” a source of error (AT X, 423-424; CSM I, 47). Conjectures are those suppositions we make about things we have no direct experience of but presume to have a nature similar to the things we do have an experience of. Descartes is distrustful of this sort of combination, leaving him with deduction as the “sole means of compounding things in a way that enables us to be certain of their truth” (AT X, 424, CSM I, 48). The way to ensure that deductive composition is valid is to “intuit that the conjunction of the one [term] with the other is wholly necessary” (AT X,

425; CSM I, 48). Thus, deductive or necessary composition is certified by intuition in the same way as the “chain of deductions” is certified by the intuition that each link in the chain is securely fastened to the next one. Descartes promises to tell us more about this process of deduction, presumably to work out a variety of different kinds of valid deductions, but he abandons the task and leaves us only with the basic foundation for this concept of necessary deduction (cf. AT X, 428; CSM I, 50).⁵³³

Simple natures in Rule XII: intellectual and common

Where Rule VI begins by saying that it “contains the principle secret of my art [*praecipuum tamen continet artis secretum*],” the second half of Rule XII begins: “our aim here is to distinguish carefully the notions of simple things from those which are composed of them and to see in both cases where there exists a possibility of error, so that we may guard against it, and what it is possible to know for certain, so that we can concern ourselves solely with that” (AT X, 417; CSM I, 43). The former reflects Descartes’ belief that the scientific method would be a kind of intellectual art, while the latter develops a sophisticated analogy between our guarding against error and our concern solely with what can be known for certain. This reflects a change in focus on the nature of the scientific method: the former is reminiscent of the humanistic tradition, while the latter implies an attempt to provide foundations for knowledge. The simple natures are thus carried through to the beginnings of Descartes’ thought on the

⁵³³ The *La Logique ou L’art de penser* of A. Arnauld and P. Nicole would seem to advance some of these objectives (Paris: 1662).

foundations of knowledge. This is part of the reason why I believe they continue to be central concepts in our understanding of Descartes' philosophy.

Furthermore, the second half of Rule XII offers a rather remarkable concession to the nature of the scientific knowledge that will be discussed in the remainder of the rule, i.e., the doctrine of the simple natures. He says:

... as we have done above,⁵³⁴ we will now need to make certain assumptions which perhaps not everyone will accept. But even if they are thought to be no more real than the imaginary circles which astronomers use to describe the phenomena they study, this matters little, provided they help us to pick out the kind of apprehension of any given thing that may be true and to distinguish it from the kind of thing that may be false [*qualis de qualibet re cognitio vera esse possit aut falsa, distinguatis*]. (AT X 417; CSM I, 43-44)

This introduces the notion of hypothesis in Descartes' scientific method, which we discussed in depth in the last chapter. Unlike the "hypothetical" character of Bacon's scientific method, where the principles are hypothetical in the sense that they could be surpassed by more accurate principles, Descartes' principles are *a priori* hypothetical, i.e., they are *assumed*. Of course, this could be characteristic of Descartes' concession to the men of the church who had educated him and whom he would not want to appear to contradict. However, it is also possible that Descartes realized that his principles of scientific explanation, insofar as they involved elaborate mechanistic models for the explanation of material things, did rest on hypotheses about the material universe and the method appropriate for natural philosophy.⁵³⁵ Indeed, Descartes willingly eliminates a number of concepts essential to scholastic natural philosophy from his natural

⁵³⁴ I believe this refers to AT X 410-11.

⁵³⁵ Doyle, *The Logic of Descartes' Method*, 5.2, suggests that the aim of suppositions is to delimit the realm of genuine *scientia* by restricting the mental powers from attempting to understand things that are beyond its grasp, like the essences of natural things.

philosophical explanation. He does not have any reason to support this arbitrary elimination of things like substantial forms or final causes except that his principles are clearer and easier to apply to experiment and observation. The nature of a “supposition” or “hypothesis” seems to capture this quite neatly: in his scientific method, Descartes has explicitly and *a priori* excluded certain kinds of entities from consideration. He has deliberately represented the world in such a way that it conforms to his scientific method, in particular, to order and measure; and this could only be accomplished *ex hypothesi*.

After a resume of the essential insights about simples that we have already discussed—that they conform to the order of cognition rather than the order of being, and that they are the product of a process of conceptual analysis—Descartes’ introduces his list of simple natures: intellectual (e.g., corporeal ideas, knowledge, doubt, ignorance, volition, etc.), material (e.g., shape, extension, motion, etc.), common simples (i.e., existence, unity, and duration), and common notions (the basic rules of inference). I will treat the intellectual and common simple natures first because they can be treated quickly: Descartes does very little to elaborate on the nature of these simples. Conversely, nearly the entire Rule XII is devoted to outlining the role of the material simple natures. Thus, extended reflection on these is warranted.

In short, the intellectual simple natures are the faculties of the mind. Marion notes that Descartes’ categorization of intellectual simples is the result of a reflection, which captures the essence of Aristotle’s notion of *parergon*, i.e., an action “next to consciousness ... meaning the consciousness of consciousness and its modalities.”⁵³⁶ The

⁵³⁶ *Sur l’ontologie grise*, 137. The complete references to Aristotle are: *De Anima* II, g, 418a 17-

importance of this comment is that it reveals the intellectual simple natures to be known through an entirely different means than the material simples. Whereas the latter are the results of a conceptual analysis of the properties of material bodies, as representations of the mind, the former are available only when the mind represents to itself its own acts of cognition, i.e., through self-reflection. Thus, the access to intellectual simples differs from access to material simples. Indeed, when Descartes reexamines the issue in the *Meditationes*, this difference in access will eventually determine the intellectual simples to be more fundamental than the material simples. While the latter are subject to doubt, it is not possible to doubt that one is thinking, willing, imagining, or perceiving, insofar as one is actually thinking.⁵³⁷ The manner of access to consciousness and its modalities, an awareness of consciousness alongside consciousness, is different than the consciousness of external objects. In the *Regulae*, Descartes provides no account of the nature of the intellectual simples.⁵³⁸ It is unfortunate that he does not, because this would greatly clarify the doctrine of the simple natures, and perhaps even determine the relationship between the different kinds of simples.

There is only one element of the passage that could give someone a clue to the underlying nature of the intellectual simples. Descartes says, “Those simple natures which the intellect recognizes by means of a sort of innate light, *without the aid of any corporeal image*, are purely intellectual” (my emphasis: AT X, 419; CSM I, 44). That these simples are recognized by a sort of “innate light” and thus require no “corporeal

18; III, 1, 425a 16. See also III, 3, 428b 22; *On Sense and Sensebilis* 1, 437a 9; 4, 442b 5-7; *On Dreams* 1, 458b 4-6; *On Memory* 452b 7-14; 450a 9-10.

⁵³⁷ Marion, *Questions cartésiennes*, 86-87

⁵³⁸ *Questions cartésiennes*, 81-88.

image” seems to imply something like the claim that these simples are known in a different way than the material simples. This language also refers back to Descartes’ account of perception earlier in the rule, namely, that up to a certain point, images are considered inform the mind in *exactly the same way* as a wax receives the imprint of a seal, but at the point when the mind perceives ideas without the aid of a corporeal image, the model is purely analogical (AT X, 412; CSM I, 40). In other words, corporeal images are impressions on the flesh of the brain, in the place where the brain receives “common sensibles.”⁵³⁹ Descartes clearly thinks that the purely incorporeal power of thought (*vis cognoscens*) has no need for impressions in the brain and the ideas pertaining to this power of thought indicate this fact. These two brief passages suggest that Descartes conceived of the explanatory bases of thought in a fundamentally different way than those of matter. Indeed, as we saw in the last section, the concept of ‘shape’ cannot be further analyzed because the analysis leads to an ambiguity between something that is represented spatially (the limit of a geometrical body) and something that requires no spatial representation (the limit of a duration). That the material simple natures require a corporeal image would seem to reinforce the upper limit of analysis at the point where further conceptual distinction results in an ambiguity between spatial, corporeal representation and non-spatial, or non-corporeal representation. We will have to wait for the *Discours* and *Meditationes* in order to gain access to that special realm of thought.

⁵³⁹ See also Rule XIV where corporeal things require the “aid of the imagination” in order to be certain about their nature. In short, they determine the nature of the “code” of “representative ideas” about corporeal matter. See Marion, *Questions cartésiennes*, 75-81, for the identification between “idea” and “simple nature” in Descartes’ terminology. One must, however, distinguish between those ideas that are the product of self-reflection and those that are the product of representation, those that are innate and those that are corporeal.

However, the division between what physical and mental already suggests what Descartes' method of doubt will reveal: one level of knowledge is susceptible to ordinary doubt (the 'dream hypothesis' and the 'madness hypothesis'), while another is hyperbolic (mathematical truths), and a final level is utterly immune to doubt (the *cogito* and its ideas). The utility of doubt for revealing this stratification of knowledge appears to be part of Descartes' discoveries c. 1630.

What about the common simple natures? This last category is somewhat confused. Clearly, Descartes understands that there are some principles of scientific explanation that underlie and potentially unite the intellectual and material simples. On the one hand, it seems clear that the rules of inference, which he elsewhere calls "common notions," can serve as "the links which connect other simple natures together" (AT X, 419; CSM I, 45). On the other hand, universals like unity, existence, and duration, seem to be leftover simple notions from Rule VI, without a clear application to either material or intellectual natures, which are nonetheless basic to scientific explanation. Gaukroger has shown that these common simples actually fail Descartes' test for simplicity.⁵⁴⁰ The argument that disqualifies 'limit' as a simple nature, i.e., that it is ambiguously applied to both extension and duration, would also hold for the common simple natures. Does it mean the same thing when a concept like 'unity' is applied to a watch, an animal, the human mind, or God? On Descartes' more mature metaphysics, clearly not: the human mind is an entirely different kind of thing than a watch or an animal, while the unity of God's existence exceeds comprehension. So, the common

⁵⁴⁰ Gaukroger, *Descartes*, 181.

simples do not appear to be simple in the required sense for Rule XII. It is likely, as Gaukroger concludes, that Descartes is trying to accomplish more with these concepts than he has the resources to prove. In particular, Descartes is trying to provide a legitimacy framework for his mechanistic physics and the application of his scientific method. By the time of the *Principia*, as we have seen, he is much more clear about the common notions, or logical simples, as a distinct sort of concept from the common ways that things exist or are conceived. Descartes' project in the *Regulae* is focused much more carefully on the material simples and their connection to each other, for these are actually the explanatory principles of Descartes' science. These simples are, in a sense, perfectly self-contained and provide a framework for understanding the application of Descartes' *mathesis universalis* to natural philosophy. The set of common notions are leftover logical concepts that connect the other simple natures together; they provide the "cement" that binds together the "basic building blocks" which compose the physical world.⁵⁴¹

Material simples as categorical bases of natural philosophy

⁵⁴¹ I borrow this useful image from J. Cottingham's *A Descartes Dictionary*. However, I restrict it to the material simples, since I do not think that Cottingham's "brick and mortar" picture holds for the intellectual simples. In particular, the mind is not *composed* of the will, senses, imagination, memory, etc. These are the *acts* or *modes* of the mind. Moreover, when Descartes does analyze some of the mind's ideas—e.g., the ideas of cold and hot, or of substance—these ideas are analyzed by reference to a theory of ideas that is not based on the intellectual simple natures in the same way as Descartes' explanation of physical phenomena is based on the material simples. That is, what simple nature gives rise to the objective/formal distinction that is essential to the analysis of Descartes' ideas in the *Meditations*? Our determinate-determinable interpretation of the simples seems distinct from Cottingham's brick and mortar picture.

In what sense do the simple natures play the role of the categories, or ultimate principles, of scientific explanation? I contend that these simples are the categorical bases of scientific explanation. That is, they explain the phenomena by virtue of certain fundamental, causally efficacious properties or elements that are present universally. They are categorical in the sense of having an unrestricted application. However, they are also all relational. Consider the list of material simples: motion, shape, and extension. Surely, each of these categories admits of greater and lesser and, moreover, can only be specified by relation to a unit of measure. Again, the intellectual simples are knowledge, ignorance, imagination, and volition. But each of these “faculties” of the mind can only be understood in terms of their intentional direction toward an object, and thus they, too, are relational properties. Therefore, we can add another argument in favor of Marion’s thesis that Descartes privileges the *pros ti legomena* over the *haplos*, namely, that his categorical bases are relational properties.

In Chapter 2, I determined that the *mathesis universalis* sets up the standard for representation to which Descartes’ picture of the material world conforms. Let us put this thesis to work in favor of our interpretation of the simple natures: we will say that the mathesis determines the idea-type to which the basic categories of material entities must conform. In this respect, the material simples clearly conform to a mathesis idea-type: motion, extension, and shape each admit of order and measure, and even more profoundly, they are each commensurable with a unit of measure. Thus, the material simple natures enumerate the kinds of things that can be treated by the *mathesis universalis*. When we return to the examples of “common notions,” their relation to the

mathesis becomes immediately apparent: Descartes says that common notions include ‘Things that are the same as a third thing are the same as each other’ and ‘things that cannot be related in the same way to a third thing are different in some respect’ (AT X, 419; CSM I, 45). In one sense, these examples are not noteworthy; they are simply two different ways of articulating the principle that ‘equals plus equals are equal’. One would assume that other principles of logic would be contained in this category. In another sense, however, these two examples are illuminating: these are precisely the principles that legitimate what I have been calling the algebraic method of comparison. In other words, Descartes takes special care to note two principles of logic that have direct bearing on his scientific method of the *Regulae*. Put another way, while the material simple natures enumerate the properties of things that conform to the *mathesis* idea-type, the common notions highlight logical principles that are basic to the method of *mathesis*.⁵⁴² The way that this is cashed out in the examples given in Rule XII, will be discussed in a moment.

One question that ought to be addressed first is: why are these categorical simples preferable to the relational simples of Rule VI? One possible reason is that they are much easier to sort and apply to real phenomena. Another reason could also be that these categories surpass the explanatory power of the absolute and relative terms of Rule VI. For example, what is universal and particular? With respect to material substance, the particulars are the physical things and the universals are the simple natures.⁵⁴³ What

⁵⁴² This confirms the thesis of Marion, *Questions cartésiennes*, 83.

⁵⁴³ ‘Universal’ ought to be taken in the sense of ‘determinable’ as I have explained above. This is surely one thing that Descartes has in common with Bacon: both Bacon and Descartes of the

about cause and effect? In the mature metaphysical account, of course, the ultimate cause is God, but this will only enter into the discussion after Descartes' discovery of the idea of substance and the argument for God's existence following the method of doubt. With respect to the physical world and the laws of nature, extension, motion, and shape are the only material causes in Descartes' metaphysics. So, in essence, the categorical bases do the work. But what about the equal, similar, and straight? Well, as we determined above, these are the units of quantitative measurement. Furthermore, it seems that with these simples, Descartes is striving for an enumeration of the various principles of order and measure. But the science that treats order and measure is, of course, the *mathesis universalis*. So we can understand the simples of Rule XII as a more mature, complete, and scientifically desirable account of simples than Rule VI. In Rule XII, we have an account of simples as the basis of scientific explanation. The material simple natures are the categorical bases of Descartes' natural philosophy. However, these categorical bases are somewhat unique: they are relational, determinable properties of corporeal bodies.

Simple natures and the explanation of the magnet

In Rule XII, Descartes poses the magnet, a much more complex phenomenon, as a natural phenomenon that would provide an application of simple natures in natural philosophy. This example will reveal how Descartes' incorporates experiment into his method in the *Regulae*. In short, we will find that Descartes' analogical method of

Regulae provide a metaphysical account, i.e., a higher order explanation, of the principles of mechanistic science, just as Spinoza recognizes in his letter to Oldenburg.

mechanical explanation conforms to Bacon's method of scientific discovery. However, we will have to go well beyond the *Regulae* to see how Descartes explains the nature of the magnet.

These kinds of problems, i.e., those that require an application of *mathesis* to physical phenomena through experimentation, are what Descartes' calls "imperfect problems." Recall that Descartes thinks the algebraic method of comparison applies equally well to both perfect and imperfect problems, both purely mathematical and physical inquiries: "these conditions hold also for imperfect problems" (AT X, 430; CSM I, 52). However, physical problems require the supposition of a mechanical framework of explanation (one that conforms to the *mathesis* idea-type) and they require some experimentation in order to test our intuitions or our mechanical models used to explain the particular nature in question. The paradigmatic example of this kind of reasoning in the *Regulae* is the nature of the magnet. Descartes refers to the magnet in several different places in the *Regulae*. It seems as though this particular phenomenon posed a peculiar problem for Descartes and was something he hoped to explain by means of his method. In Rule IX, the magnet is identified as a phenomenon that is difficult to understand in a passage we have seen above:

If, for example, I wish to inquire whether a natural power [*potentia naturalis*] can travel instantaneously to a distant place, passing through the whole intervening space, I shall not immediately turn my mind to the power of a magnet, or the influence of the stars, or even to the speed of light, to see whether actions such as these might occur instantaneously... (AT X, 402; CSM I, 34)

The magnet is here identified with other occult powers, such as the influence of the stars, and it is deferred as an object of study until more basic and simpler questions can be

resolved. In Rules XIII and XIV, however, Descartes seems more bold than cautious. In these rules, he suggests that the magnet is a phenomenon that is tractable according to his method. Rule XIII suggests that Gilbert's studies on magnetism can be consulted as an example of "perfect problems," i.e., problems whose components are entirely known. Clearly, the physical problem of defining the nature and power of the magnet is "imperfect," since the relevant nature cannot be seen and is not known. However, Descartes seems to suggest that one could begin by studying Gilbert's investigations into the magnet, and that these may lead one on the path to discovering the magnet's true nature. At the end of the same paragraph, Descartes suggests that one's investigation into the nature of the magnet be restricted: "once we have decided to investigate specific observations relating solely to the magnet, we no longer have any difficulty in dismissing all other observations from our mind" (AT X, 431; CSM I, 52). This word of caution suggests that we restrict the investigation solely to observations concerning the lodestone and not allow it to extend to the imagined effects of magnetism or other similar phenomena. In Rule XIV, Descartes again limits the scope of inquiry. However, this time he gives some indication as to the kind of knowledge that is possible concerning the magnet's nature.

[I]f in the magnet there were some kind of entity [*genera entis*], the like of which our intellect had never before perceived, it is pointless to hope that we shall ever get to know it simply by reasoning; for that we would either need to be endowed with some new sense or with a divine mind. But if we perceive most distinctly a combination of those known entities or natures which produce the same effects that appear in the magnet, then we shall credit ourselves with having attained whatever it is possible for the human mind to attain in this matter. (AT X, 439; CSM I, 39)

In other words, instead of trying to posit some new kind of entity to explain the nature of the magnet, we need to return to the categorical bases of all natural phenomena and try to reconstruct the same set of effects observed in the magnet as a combination of material simple natures. Appealing to some kind of thing that we have never seen or cannot know is, he claims, like trying to teach a person who was blind from birth the nature of colors. Since the doctrine of simple natures has already enumerated the kinds of entities that are readily apparent, we should begin by reconstructing the properties of the magnet using these. Moreover, once one has performed such a reconstruction, one can be sure that one has attained all that is possible for the human mind to attain on the matter

Indeed, this is precisely the method that is suggested in Rule XII. In that rule, Descartes claims, “the whole of human *scientia* consists uniquely in our achieving a distinct perception of how all these simple natures contribute to the composition of other things” (AT X, 427; CSM I, 49). The reason why he can claim this is that any entity that does not conform to the simple natures is not an entity that can be *known* by the human mind: “for that we would either need to be endowed with some new sense or with a divine mind.” Again, Descartes recognizes that the inquiry into physical phenomena will present some obstacle, and “almost everyone gets stuck right at the outset, uncertain as to which thoughts he ought to concentrate his mind on, yet quite convinced that he ought to seek some new kind of entity previously unknown to him” (ibid.). This is where Doyle’s suggestion, noted in the Anaclastic example above, is very helpful. Instead of searching after new kinds of entities, we should restrict our investigation to what *can* be known, and to try to determine what is sought according to its relationship to what is already

known. “Thus,” Descartes continues, “if the question concerns the nature of the magnet, foreseeing that the topic will prove inaccessible and difficult, he turns his mind away from everything that is evident, and immediately directs it at all the most difficult points, in the vague expectation that by rambling through the barren field of manifold causes he will hit upon something new” (ibid.). Indeed, the magnet seems to present just the kind of nature that would lead one to posit a “soul” or motive force in the material itself that gives the stone its strange power of “action at a distance.” However, we should not simply “ramble through the barren field of manifold sensations,” or “wander blindly” (as Bacon would have said). Rather, we must remember the method of investigation that Descartes has been outlining: “. . . take someone who thinks that nothing in the magnet can be known which does not consist of certain, self-evident, simple natures: he is in no doubt about how he should proceed” (ibid.). Let us restate this in the terms that we have been using: one realizes that the categorical bases, the ultimate determinables of all physical bodies should conform to our mathesis idea-type; one appreciates that the way to access the hidden powers of things is by way of a method of comparison; and one reduces the initial question to a series of questions whose answers are logically dependent on one another; then one will be able to discover the nature of the magnet.

But Descartes inserts some interesting language at this point that reveals an underlying commitment to the experimental framework of Baconian science. He says, “First [the investigator] carefully gathers together all the available observations [*experientia*] concerning the stone in question; then he tries to deduce from this what sort of mixture of simple natures is necessary for producing all the effects which the magnet

is found to have. Once he has discovered this mixture [of simple natures], he is in a position to make the bold claim that he has grasped the true nature of the magnet, so far as it is humanly possible to discover on the basis of given observations” (ibid.). First of all, it is important to note that this passage reproduces the claims of Rules XIII and XIV noted above: namely, that the investigation into the magnet should begin by studying the “perfect” problem of what observations had already been made (by Gilbert, for instance) and that once one has reproduced the set of effects that are observed of the magnet through a mixture of simple natures, one has attained whatever is possible for the human mind to attain on the matter. What is unique about the passage in Rule XII it seems to me is that it quite clearly refers to the *Novum Organum*. Descartes refers to the collection of *experientia* and the mixture of simple natures that would be distinguished in that collection, ultimately with the aim to determine the true nature of the magnet. I suggest that this language implicitly cites Bacon and, for that reason, obscures Descartes’ point to a degree. In short, it is Bacon who speaks of material bodies as “a troop of simple natures”; but Descartes does not conceive of bodies as a collection or mixture of qualities and elements that he calls simple natures. Rather, the “mixture” of simple natures in Descartes’ method is a result of reconstructing the effects found in the entity according to a determination of the underlying determinable bases of material natures. Just as we saw in the case of the anaclastic, one does not discover particular simple natures by way of a reduction of the problem to its constituent components. What one discovers is a mechanical description of the phenomenon, or a mathematical description of the phenomenon, that determines the phenomenon in a precise way according to simple

natures. In short, the explanatory terms apply Descartes' scientific reasoning to the particular phenomenon in conformity with the simple natures, but not by virtue of the simple natures. (On Cottingham's analogy, the simple natures are not the "building blocks," but they define the kind of building blocks we are looking for.)

Unfortunately, Descartes never carries out an investigation into the nature of the magnet in the *Regulae*. We will have to wait until the *Principia* where he publishes that account. It is not our task here to explain the nature of the magnet, as it is presented in the *Principia*. Indeed, Descartes has a grand story to tell about the nature of the magnet as a species of the nature of terrestrial phenomena. I simply want to verify the hypothesis that the nature of the magnet elicits an application of Descartes' mathematical method of discovery in an experimental framework that conforms to the Baconian method of discovery. One phrase from the preceding paragraph ought to give us confidence that this hypothesis will be borne out by the facts: Descartes claims that the true nature of the magnet will be discovered "on the basis of given observations [*ex datis experimentis potuit inveniri*]." That is, there is an indispensable experimental basis for the discovery of the nature of physical phenomena, like the magnet.

In the *Principia*, the magnet is described in terms of Descartes' hypothesis that all earthly matter contains pores of different shapes and sizes. He assumes that the magnet has some such striated pores, which he likens to the threads of a screw or the shell of a snail, which can receive small particles that are fitted to such pores in one direction but not the other. Then Descartes imagines that such small particles are continually circling the earth and passing through the earth along its axis, from North to South. Thus, when a

magnet is freely suspended, it tends to point North because it is bombarded by these small particles passing in that direction and the interior striations in the magnet are one-directional, like the threads on a screw, so that the magnet aligns itself with the passing particles. Descartes takes the magnetic rock to be a special remnant of the metallic interior of the earth, a piece of earth's interior that preserves the original shape and orientation of the pores. Thus, he explains the special relationship between magnets and iron, since iron is the metal containing the largest particles of matter and thus still contains the pores that are peculiar to the magnet, though these pores are often misdirected and irregular in iron ore. What is remarkable about the passages in the *Principia*, treating the nature of the magnet, is that Descartes not only seeks to explain the nature of the lodestone itself according to mechanical principles, but he has assimilated this particular phenomenon into an entire story about the formation of the earth and various metals found in it. This reaches far beyond the cautious framework of the *Regulae*, where Descartes suggests investigating the nature of the magnet in abstraction from all other phenomena.

However, §145 of the *Principia* does list various observations about the nature of the magnet that, in effect, provides the history of experiments on the magnet that he requests in the *Regulae*. Sections 146-186 provide an interpretation of each of these experiments in turn. Adam and Tannery note that this list reproduces a list that Mersenne had sent Descartes in 1639, though they also note that such a list of experiments had been published by other authors, including Althionius Kircher in his *De Magnete* (1641). In the introduction to the section explaining the history of observations, Descartes writes, "I

now hope to show that all of the properties that the most curious experiments of admirers of the magnet have been able to discover up to now can so easily be explained in such a way that only this would be necessary to convince one of their truth, even though they would not be deduced from first principles of nature” (AT IX-b, 280).⁵⁴⁴ In other words, this list of experiments or observations on the nature of the magnet can be explained by Descartes’ mechanical reproduction of the magnet’s nature and thus they verify the accuracy of Descartes’ mechanical suppositions. This, combined with the fact that the explanation itself is deduced from first principles, *proves* that the explanation is correct. I believe that this is precisely what Descartes indicates in the *Regulae* as an application of his method to “imperfect” problems. Though the story is much more complex in the *Principia*, he considers his mechanistic picture to be deduced from first principles and verified by experiment.

Clearly the *Principia* present Descartes’ systematic natural philosophy in a way that he did not possess at the time of the *Regulae*. However, the method underlying this story, the reason why it can be considered *scientia*, is that it conforms precisely to the regulatory framework of the *Regulae*. As we have seen, Descartes’ scientific method enables an extension of certain and evident cognition to physical phenomena through a reduction of the initial investigation into constituent, more fundamental, inquiries. The answers to these queries are provided by Descartes’ method of comparison. In specifying the nature of any given physical phenomenon, Descartes requires an experimental step in

⁵⁴⁴ “. . . j’espère maintenant faire voir que toutes celles de ces propriétés que les plus curieuses expériences des admirateurs de l’ayant ont pû découvrir jusques à present, peuvent si facilement estre expliqués par leur moyen, que cela seul suffiroit pour persuader qu’elles sont vraies, encore qu’ells n’auroient point esté déduites des premiers principes de la nature.”

order to specify our intuitions about the nature of the phenomenon, according to its effects.⁵⁴⁵ Also, in the background of some of these deductive steps, we have seen Descartes' mathematical method. That is, he determines mathematical laws of nature through an application of his mathematical method of discovery to experiment. The *Principia* shows that Descartes has, in effect, reconstructed the natural world—he has supplied us with a systematic mechanical explanation of natural phenomena—according to his principles of scientific explanation, his material simple natures, and the logic of comparison that links them together. In this sense, Descartes performs a conceptual reproduction of the matter in question. This differs from Bacon's "superinduction," to be sure, but the methodical application of mechanical principles of explanation to experiment and observation is markedly similar.

Whereas Bacon conceives of the simple natures as the qualities of natural things on the basis of which laws of nature operate, Descartes clearly conceives of the material simple natures as the ideal categorical bases for any scientific explanation. Whatever Descartes' explanation of natural phenomena, it must be an explanation that determines the entity according to its extension, shape, and motion. He restricts his explanation to these kinds of explanatory principles because he thinks that any other basis for explanation would surpass the mind's capacities for clear and distinct cognition. One might even suggest that these simple natures transcend the variety of particular explanations; in Kantian language, they are the transcendental conditions of the

⁵⁴⁵ In *Sur l'ontologie grise*, 144-45, Marion correlates the recomposition of simple natures through necessary and certain deduction with the expansion of the domain of *experientia certa*, in other words, the definition of *scientia* from Rule II.

possibility of any mechanical explanation. When Descartes performs his reduction, he does not discover simple natures, rather he discovers particular mechanical substructures, which are only intelligible because they conform to the mind's powers. Descartes willingly concedes that his simple natures do not describe nature's essence; they are "hypothetical." Nonetheless, this hypothesis does not diminish the efficacy of the explanation. Indeed, Descartes believes that through careful experiment and observation, one can gain the right kind of insight into the mechanical structures that operate in nature and produce perceived effects. He borrows Bacon's method of experimentation wholesale, with its tables of comparison and its natural histories, because these conform perfectly to his objective. He seeks to amass as much information about particular phenomena as possible in order to ensure that the mechanical explanation he offers actually explains the matter in question. However, Descartes has no need for Baconian induction and superinduction, or Bacon's "forms of simple natures." These rely on metaphysical claims about nature's essence that have no place in Descartes' method. Where Bacon was open to the possibility that nature did, in fact, possess hidden powers that the trained scientific practitioner could harness, Descartes reminds us that knowledge of these powers exceeds our mental powers. Instead, he prefers to investigate nature according to what is simple and easy to understand. It is this epistemological framework of science that I take to signal Descartes' deep and abiding interest in the nature of the mind, the cognitive powers, and the mind's place as the fundamental ground of first philosophy.

Conclusion

The purpose of this dissertation has been to discover the origins of Descartes' concept of mind. On the way to this goal, we have sought to place Descartes' earliest treatise, the *Regulae ad directionem ingenii*, in its proper historical context. As a result, we have come to understand Descartes' concept of mind as a concept that develops out of his engagement with traditional, Aristotelian philosophy, in an effort to set the new science of mechanism on a firm and independent foundation. The *Regulae* is a relic of Descartes' first efforts to provide the foundations of mechanistic natural philosophy. We have seen that as early as 1618-1620, with Descartes' initial apprenticeship with Isaac Beeckman in Holland, he turned his attention to the possibility of an entirely new science, applying the principles of mathematics to problems in natural philosophy. This application of mathematics to natural philosophy required Descartes, along with Beeckman, to conceive of physical nature, or matter, as essentially quantifiable. This working hypothesis, which was so fundamental to the origins of modern science, required an equally fundamental rejection of Aristotelian metaphysics. Ultimately, this confrontation with Aristotle would determine the parameters of Descartes' concept of mind.

That Descartes conceives of providing a secure foundation for science by writing a treatise on method was a direct consequence of the project of scholastic reform in the 16th century. The Renaissance authors had thought to reform Aristotle's metaphysical system by ordering the metaphysical categories in terms of a conceptually simple system. This movement was born out of a number of different influences: the tradition of memory

art, the Neoplatonic understanding of intellect and its relation to nature, a belief that the classical syllogism could not lead to new knowledge but only rhetorical disputations, and a practical concern for pedagogy. These elements led thinkers to attempt to compose a shortened compendium of knowledge, an *ars brevis*. Descartes' signals his interest in these writings, exploring the art of Ramon Llull, and studying a German treatise of mnemotechnics by Lambert Shenkel. However, Descartes does not seem convinced that prior authors had added anything to classical Aristotelianism. Instead, he believed that by concentrating on an algebraic method of discovery in mathematics, and applying this method to the natural sciences, he could solve any problem in natural philosophy. This vision is the essential aim of the *Regulae*, and it is best captured by the phrase, *mathesis universalis*, a universal science or learning based on the principles of mathematics. There were limitations to this science; it was not an entirely universal science. But Descartes thought he could easily apply the principles of mathematics and the method of algebraic comparison to problems in natural philosophy by conceiving of natural bodies as nothing more than determinately quantifiable features. Though the *Regulae* does not yet contain Descartes' full-blown theory of matter (an achievement that would come several years later, with *Le Monde*), it nonetheless demonstrates the core insights that led to that matter theory: all objects should be understood only insofar as they are determined by their extension, shape, and motion.

This vision of natural philosophy is both a product of and holds important consequences for Descartes' theory of mind. First, the supposed essence of corporeal nature, namely, as extended matter, is chosen because this is the easiest and clearest way

to conceive of matter. When Descartes goes on to describe the nature of the brain and sensory faculties, he shows why the brain has a limited capacity to conceive complex things. In particular, he holds that the locus of all thought, or the seat of the soul, is only a very small organ in the center of the brain. Thus, in order for the mind to accurately conceive things in the imagination, it must conceive them as simply as possible. Second, Descartes consistently warns against overreaching the bounds of what the intellect can conceive clearly. He is more concerned to guard against error than to assure readers that he has discovered the nature of the most mysterious phenomena. This methodological concern is a direct consequence of the way Descartes conceives of the mind to be in contact with the external world. He understands that contact to be direct and immediate, as though all senses were a kind of touch, where the point of contact is extremely small. Thus, we need not be concerned that we do not have an accurate picture of reality; rather, we need to be concerned that we restrict our judgments about reality to what we actually have access to. This picture of Descartes' early epistemology should be a word of caution to those who see Descartes as deeply skeptical about our knowledge of the external world.

In the *Regulae*, Descartes' account of perception and cognition provides an epistemological foundation for his science. Though Descartes denies that the things we see, hear, touch, taste, and smell resemble the things themselves, he does account for a causal connection between mental ideas and extra-mental realities. This distinction between sensible qualities and the nature of external bodies foreshadows an important modern distinction that, following Locke, we call the primary/secondary quality

distinction. For Descartes, primary qualities (shape, extension, motion, etc.) are the real, mathematically representable, features of the external world. Secondary qualities (color, sound, flavor, temperature, etc.), by contrast, do not accurately represent the external world. Instead, these sensory qualities are arbitrarily linked to the external world by virtue of our embodied state. This is the way minded bodies see the world; it is entirely contingent on the unique union of mind and body that human beings possess.

We see that Descartes actually separates those primary qualities, which will serve as the categorical bases for scientific explanation, from mental acts and mental content. The latter are understood through “intellectual” simple natures, while the former understood in terms of “material” simple natures. In a sense, both are products of ideas, since we have seen that Descartes’ concept of extra-mental reality is informed by a certain idea of science and a certain goal for scientific knowledge. Yet, Descartes is clear that there is little connection between the two realms. This, I believe, is the real origin of Descartes’ claim for mind-body distinctness. It arises from a desire to set mechanistic natural philosophy on a firm foundation in contradistinction to traditional, Aristotelian metaphysics. In order to do so, Descartes must set aside all of the phenomenal features of mental experience (the colors, sounds, tastes, etc. that define our everyday experience) and establish clear boundaries for an investigation into extra-mental reality. Descartes divides the mental from the physical primarily because his predecessors had seemingly not provided a way for a mathematical science of the natural world to truly explain natural phenomena. Their science of explanation had divided all things according to forms and categories that were determined by sensory qualities, regardless of whether

these qualities could be represented mathematically. Mathematics was thought to be derivative on this, more basic, qualitative understanding of nature. In Descartes' effort to describe a mathematical method of discovery in natural philosophy, he had to separate the mathematically representable features of science from those that could not be so represented. In his later metaphysics, he will simply call the one *res extensa* and the other *res cogitans*.

If this study has helped us to understand better Descartes' claims about substance dualism, I think it must make us aware that this distinction between entities (*rei*) is not easily dismissed, nor does it emerge from a naïve conception of objects. Rather, Descartes' subject in the *Regulae* is an entity that is deeply engaged with objects; it is seeking to understand those objects. What Descartes recognizes is that the entity that seeks to understand is a unique sort of entity. Indeed, he thinks that the kinds of explanatory terms we use to talk about this entity will be entirely different than the way we speak about objects in the physical world. The distinction is apparent and it has had an enduring impact on philosophy and science, as is evident from the fact that still today we have no good answer to the question 'what is consciousness?'. We are still unable to say what it is to be conscious in a way that unifies our understanding of consciousness with the natural world that consciousness understands. In the *Regulae*, we see that Descartes is already quite aware of this problem. His solutions are schematic and piecemeal, but his general approach appears consistent with his mature philosophy.

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