PASCAL, DEVOUT SAVANT:
SCIENCE, RELIGION, AND THE LEARNED COMMUNITY
IN SEVENTEENTH-CENTURY PARIS

By

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To Sarah, Olivia, and Cecily

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Blaise Pascal (1623-1662) ranks among the best known intellectual icons in Western culture. Recognized as a child prodigy since his youth, Pascal was celebrated throughout his adult life for his contributions to science, mathematics, philosophy, religion, and literature. But unlike Mozart, whose musical genius was singular, Pascal remains a puzzle. The complexity of his thought (much like his *Pensées*) underscores deep ambiguities in his thought and identity. This study aims to draw Pascal's life and career into a more coherent whole, particularly the relationship between science and religion. The central perspective that shapes this study is the tension between two sets of human virtues: the virtues of childhood and the virtues of maturity. Each group of virtues provides insight into Pascal, his social, cultural, intellectual, and religious milieu. Given these issues, it is clear that Pascal's life and thought cannot be treated as mere abstractions; a coherent and satisfying interpretation must combine critical conceptual analysis with a nuanced reading of his personal development. Drawing on the earliest studies about Pascal's childhood, as well as his own statements, the present study tests the tension between childlikeness and maturity as a means of making sense of Pascal's "scientific" and "religious" worlds. A key objective is to trace these interconnections throughout his life and work: his

earliest development as child prodigy, his youthful acclaim in the learned circles of Paris, and the later struggles that marked his "maturity" as one of Europe's most celebrated savants.

The pattern of Pascal's life and career was not linear or oppositional. The unfolding of the child into the mature and disciplined scholar had unexpected turns. To provide detail and nuance, I aim to explore the role of mathematics within learned culture through the example of Pascal, showing that his life, like his thought, was not free from reversals and contradictions. This study also aims to understand how religious devotion and the learned community were related in the seventeenth century. Biographically, I argue that Pascal's career was launched by a group of scholars who recognized a significant talent that could accomplish, if cultivated, the "perfection" of geometry. The early association of Pascal's talent with his youth was tempered by Pascal's expressions in his scientific work that suggested his distance from childhood. This distance, however, was tested by Pascal's association with the Jansenists and the biblical tension between childlike and spiritual maturity. In the end, Pascal's last mathematical work drew from the same source of virtues, both childlike and mature qualities, but this dual identification was rejected by the learned community, given the aura of secrecy and incommunicability of Pascal's geometrical connections. Although Pascal sought to balance the devout and the mathematical life, the ambiguities between precocious child and disciplined scholar remained unresolved.

CHAPTER 1
INTRODUCTION

Knowledge has two extremes which meet; one is the pure natural ignorance of everyone at birth, the other is the extreme reached by great minds who run through the whole range of human knowledge, only to find that they know nothing and come back to the same ignorance from which they set out, but it is a wise ignorance that knows itself.
Blaise Pascal, *Pensées* (Brunschvicg 327)
Translated by A. Krailsheimer

Pascal: Contested Identities

Blaise Pascal (1623-1662) ranks among the best known intellectual icons in Western culture. Recognized as a child prodigy from his youth, Pascal was celebrated throughout his adult life for his contributions to science, mathematics, philosophy, religion, and literature. Subject to serious scholarly consideration for over three hundred years, Pascal continues to defy traditional labels, whether as mathematician, theologian, philosopher, physicist, or literary scholar. The complexity of Pascal's career (much like the fragmentary *Pensées*) underscores deep ambiguities in his thought and identity. The present study does not aim to resolve these longstanding difficulties. Instead, the central perspective that shapes this study is a tension between two sets of human virtues: the virtues of childhood and the virtues of maturity. This tension provides insight into Pascal's life, his work, and his social, cultural, intellectual, and religious milieu. A key objective of this study is to draw Pascal's life and career into a more coherent whole, particularly the relationship between science and religion. Employing the tension between childhood and adult virtues, this study aims to avoid anachronism by testing distinctions used by Pascal and his contemporaries.

Pascal's resistance to labels reflects his historical status as a child prodigy and mature polymath. For nearly four centuries scholars have attempted to categorize his achievements. As a mathematical and scientific icon, his name is attached to a numerical pattern (Pascal's triangle), a unit measure of pressure (the pascal = 1 $N \cdot m^{-2}$), and a computer programming language

(Pascal). As a French literary icon, Pascal continues to be celebrated for his classic work *Les lettres provinciales*. As a religious icon, he is touted as a mystic and critical thinker for his response to skepticism, which balances intuitive and reasoned belief. Pascal's iconic status is especially striking because of the scope of his achievements. Unlike Mozart, whose musical genius was singular, Pascal's breadth of talent and accomplishment has shaped his image as an enduring puzzle. Pascal's image as a child, easily dismissed as simple genius, was quickly outgrown, as it no longer befitted the complexity of his mature work as a mathematician, natural philosopher, and religious devout. Since the appearance of Pascal's first biography, written by his sister, the image of Pascal has grown more complex but somehow less telling.

Pascal's complexities were evident during his lifetime and spread with the publication of the first biography and his fragmentary thoughts (*Les Pensées*) immediately following his death. Like his unpolished religious reflections, scribbled in multiple directions and gathered loosely into thematic categories, Pascal's life could not be readily be reduced to a formula by his friends or foes. Having died at the age of 39, Pascal's life, like his planned apology for the Christian religion, remained brilliantly piecemeal and finally unfinished.

In the centuries following his death, ambivalence toward Pascal's life increased. Celebrated and derided by those who encountered his life and writings, one writer concluded "one loves him or one detests him."[1] Some authors have done both. For Voltaire and Nietzsche, Pascal, by turns, inspired admiration and provoked disgust.[2]

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[1] Maurice Anatole Souriau, *Pascal* (Paris, 1898), 236.

2 Voltaire wrote of him: "I respect the genius and eloquence of Pascal," Voltaire, Letters on England, trans. Leonard W. Tancock (New York, 1980), 120. He goes on to criticize him, however, since he believed it was Pascal's goal "to portray man in a hateful light," using "false and dangerous reasoning," ibid. 121, 120. For Nietzsche, Pascal was an example of an admirable human intellect corrupted by Christianity: "We must not deck out and adorn Christianity: it has waged a deadly war upon this higher type of man, it has set a ban upon all the fundamental instincts of this type, and has distilled evil and the devil himself out of these instincts: the strong man as the typical pariah, the villain. Christianity has sided with everything weak, low, and botched . . . it has corrupted even the

The present study takes cues from a long tradition that has puzzled over Pascal. It aims to bring together, rather than separate, his religious and scientific work. Specifically, it draws on Pascal's identification as child prodigy and childlike mystic to analyze his life and work as a tension between the virtues of childlike-genius and the disciplined scholar. Working against earlier interpretations, this interpretive strategy is sustained by contradictions in Pascal's life as well as contradictions in earlier biographical treatments. The present study aims to draw together Pascal's life and work into a more satisfying whole: his early development as a child prodigy, his youthful acclaim in the learned circles of Paris, and his final struggle as one of Europe's most celebrated savants.

The purpose of this Introduction is to address one of the defining issues in Pascal scholarship, the reduction of Pascal's legacy to a basic opposition between religion and science. Thereafter, the present chapter explores the contours of Pascal historiography, identifying suggestions by earlier scholars about the importance of childhood and childlikeness and the implications for understanding Pascal's identity. To supply further context, I then provide a brief overview of the notions of childhood, childlikeness, and maturity that govern this study, and in turn, I argue that these ideas are not anachronistic but deeply rooted in early modern culture. The last section of this Introduction identifies key questions and summarizes the central argument that shapes the present study.

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reason of the strongest intellects, by teaching that the highest values of intellectuality are sinful, misleading, and full of temptations. The most lamentable example of this was the corruption of Pascal, who believed in the perversion of his reason through original sin, whereas it had only been perverted by his Christianity," Friedrich Nietzsche, *The Complete Works of Friedrich Nietzsche,* vol. 16, ed. Oscar Levy (New York, 1911), 130.

Fragmented Pascal

First Source: Pascal's Life

Pascal's identity is not so much a puzzle as a series of historical and biographical puzzles. Any exploration of his fragmented identity must begin by addressing the work of earlier scholars. Through a unique set of circumstances, Pascal earned a reputation for his mathematical and "scientific" works and his religious writings.[3] Pascal was born 19 June 1623 in Clermont, France and died 19 August 1662 in Paris. As a teenager, he composed a work on conic sections that was announced to some of Europe's leading mathematicians by Marin Mersenne, the "secretary of Learned Europe." Pascal's subsequent invention of a machine for arithmetic calculations, begun at age nineteen, and a set of writings about the artificial creation of void spaces in glass tubes, earned him recognition and respect in the learned world by his late twenties.

Pascal, in the meantime, became acquainted with the spirituality of a relatively new Catholic movement, Jansenism. After his younger sister's entry into the convent of Port-Royal, the epicenter of French Jansenism, Pascal became even more involved with the group. A mystical experience in 1654 (often called his "Night of Fire") led him to seek a spiritual director at Port-Royal and, according to some, resulted in his decisive renunciation of mathematics and natural philosophy. Pascal then wrote the *Provincial Letters* (1656-1657) a defense of Jansenism and an ironic attack on the spiritual principles expressed by Jesuit writers. Though this work was written pseudonymously, Pascal's authorial identity was widely known prior to his death.

[3] The terms "science" and "scientific" are not entirely proper to the early modern period. There are fine distinctions, however, between the several disciplines of pure and mixed mathematics (geometry, arithmetic, music, and astronomy) and natural philosophy during the seventeenth century. In order to refer to Pascal's diverse work collectively and conveniently I will employ the word "scientific" in various places throughout this study.

In 1657-1658, between intermittent bouts with the illness that would eventually kill him (an undiagnosed malady that caused damage to both brain and stomach) Pascal found long-sought solutions to a set of mathematical problems related to a curve called the roulette.[4] The solution was perhaps less important than the presentation. Pascal stirred up the learned community by anonymously proposing a contest to solve these problems. He then published his own results under the name Amos Dettonville. Even more thinly veiled than the *Provincial Letters*, this work secured Pascal's reputation as a talented mathematician. Yet Pascal's generally positive reception was tempered by knowledge of his religious connections with Port-Royal.

Posthumous Biographical Accounts and the *Pensées*

Pascal was known for his mathematical, scientific, and religious work long before his death, but the connections between these aspects of his life were tenuous at best. The preface to the posthumous publication of a pair of scientific treatises (*Traitez de l'equilibre des liqueurs et de la pesanteur de la masse de l'air*, 1663) supplied a short biography of Pascal. The account proposed a link between Pascal's scientific and religious work that that placed them in opposition. The narrative highlighted Pascal's preternatural talent for mathematics and its early onset, but it went on to claim that "more serious studies" (i.e., religious projects) prompted him to leave his mathematical and physical interests.[5] The short account did not specifically mention

[4] Pascal's illness has been the subject of many hypotheses. A brief summary of the different diseases suggested by three centuries of scholars who have studied the descriptions of his autopsy is in Georges Deboucher, "La maladie de Pascal: une mise à jour," *Courrier du Centre International Blaise Pascal* 14 (1992), 8-9. Deboucher's diagnosis is that Pascal was afflicted by a combination of an intracranial aneurysm and polycystique kidney disease, ibid., 10.

[5] "Ce fut incontient apres ce temps là que des estudes plus serieuses ausquelles Monsieur Pascal se donna tout entier, le dégousterent tellement des Mathematiques & de la Physique qu'il les abandonna absolument," Blaise Pascal, *Traitez de l'equlibre des liqueurs et de la pesanteur de la masse de l'air* (Paris, 1663), all translations mine unless otherwise noted.

the *Provincial Letters*, but referred instead to fragmentary *pensées* ['thoughts'] that Pascal had penned before his death.

Pascal's *Pensées* were published for the first time in 1670 by his family. The work was ostensibly an apology for the Christian religion that Pascal had planned but was unable to complete. The *Pensées* cover a wide range of topics: human nature, skepticism, justification for belief, and the relationship between knowledge of nature and knowledge of God. Pascal's religious reflections tended to downplay the usefulness of scientific knowledge, reiterating the split between Pascal devout and Pascal savant. The lack of organization of the fragments also encouraged two basic responses from scholars. On one hand, the gaps in Pascal's organizational plan for his work meant that the puzzle of his thought could be assembled in multiple ways, creating significantly different Pascals. On the other hand, isolated fragments of the *Pensées* developed a life of their own, separate from the apparent concerns of the author. The most famous example of the second trend is the fragment entitled *Infini rien*, popularly known as "Pascal's Wager." Pascal's reasoning that it is expedient to "bet" on the existence of God has inspired philosophical debate while ignoring its significance for understanding Pascal's thought in historical context.[6]

The publication of the *Pensées* firmly established the problem of Pascal's unification. Writings about Pascal since his death have multiplied steadily. For obvious reasons, the figure of Pascal looms large in his native country, where French monographs regarding Pascal's faith, philosophy, "science," literature, and mathematics regularly appear. Academic specialization has further fragmented Pascal's identity by engendering studies that focus on a single dimension of his life or thought. The search for a holistic view of Pascal is daunting but alluring. Previous

[6] One collection of essays on the philosophical and religious issues surrounding the Wager is *Gambling on God: Essays on Pascal's Wager*, ed. Jeff Jordan (Lanham, MD, 1994).

attempts to describe Pascal and his work provide a rich set of interpretations that inform this study and Pascal's portrayal in terms of childlikeness and adult discipline.

Childlikeness and Maturity in the Historiography of Pascal

One strategy for integrating Pascal's identities has been to emphasize his role as a child, the perspective that first suggested this study's focus. Previous Pascal scholars have placed particular emphasis on his childhood or his childlikeness. Others have attempted to highlight his accomplishments and ambition. No previous study has considered in any detail how the interaction between childlikeness and maturity relate to Pascal's life and works. This study attempts to provide that analysis while sustaining the historical dimension of the categories of childhood, childlikeness, and maturity.

The focus on childhood as a central theme for Pascal's life begins with the first full biography. Written by Pascal's sister, Gilberte Périer, *La vie de M. Pascal* introduces enduring examples of Pascal's precocity and his emergence onto the French savant scene. The most telling and famous episode is his near-miraculous "discovery" of mathematics on the playroom floor. The story foreshadows and seemingly foretells Pascal's mathematical future and his destiny as a devout. For the first time, Pascal is presented as a special child with shockingly adult-like qualities.[7]

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[7] Gilberte Périer's biography of Pascal was probably composed very soon after his death, not with the view of publication, but for those close to Pascal and his family. It was first printed in Amsterdam in 1684,*La vie de Monsieur Pascal* (Amsterdam, 1684). The text of this biography in two slightly different versions is in Blaise Pascal, *Oeuvres complètes de Blaise Pascal,* 4 vols., edited by Jean Mesnard (Paris, 1964-1992), vol. 1, 571-642 (hereafter Mesnard *OC* [vol#]:[page#]). For a critical study of the composition and publication of the work, see Mesnard *OC*, 1:539-570. More information of biographical interest may be found in Gilberte's biography of Jacqueline Pascal, "La vie de Jacqueline Pascal," Mesnard *OC*, 1:657-671. It was first published as a part of a collection of spiritual biographies in 1751, Mesnard *OC*, 1:652-653. A recent edition of these two early works is Gilberte Périer, *La vie de Monsieur Pascal: suivi par la vie de Jacqueline Pascal*, trans. and ed. Alain Couprie (Paris, 1994). A much later composition, which yet holds interest for the family tradition it preserves, is written by Marguérite Périer, Gilberte's daughter, sometime around 1732, Mesnard *OC*, 1:1063. The piece is entitled "Mémoires concernant M. Pascal et sa famille," and a critical rendering of it is given in Mesnard *OC*, 1:1091-1105. This account is the source of some of the less substantiated claims about Pascal's life, including the story of the spell cast on Blaise as a boy. The first posthumous writing that provides some biographical information is in Florin

Gilberte's narrative of Pascal's early geometrical discovery offers a striking parallel to the New Testament story of the appearance of Jesus in the temple. The gospel according to Luke records the surprise of Jesus's parents when they found their twelve-year-old conversing with elders about Scripture. Pascal was just twelve when his father discovered him doodling geometrical diagrams from Euclid's thirty-second proposition of his *Elements* (Bk. 1). Like Jesus's "astonished" parents, Blaise's "surprised" father was "terrified." The comparison between Jesus and Pascal became an enduring piece of the Pascal puzzle. Although the foray into adult realms of knowledge risked parental displeasure, Étienne, like Mary and Joseph, could not punish such unusually mature behavior. From the moment his father recognized his son's striking potential, Pascal took a place among his elders, the mathematicians of Paris.

Gilberte's story links Pascal's youthful genius to his adult accomplishments. Her account of Blaise's last days of life, in turn, reverses the direction, drawing attention back to Pascal's childhood. As she provides details of Pascal's final years, Gilberte takes pains to emphasize her brother's humility and submission. Périer recounts the words that Pascal's last confessor spoke about Blaise: "This is a child, he is humble and submitted as a child."[8] Périer brackets Pascal's life by the mature discovery of Euclid's thirty-second proposition and his childlike acceptance of

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Périer's preface to one of Pascal's physical treatises. Monsieur Périer borrows some passages from his wife's biographical account to write his "Préface contenant les raisons qui ont porte à publier ces deux Traités après la mort de Monsieur Pascal, et l'histoire des diverses expériences qui y sont expliquées." The work was published as *Traité de l'équilibre des liqueurs et de la pesanteur de la masse de l'air* (Paris, 1663). The "Preface" is 23 pages, non-paginated.

[8] "C'est un enfant, il est humble et soumis comme un enfant," "La vie de Monsieur Pascal," Mesnard *OC*, 1:637. The literature on Pascal's last illness, and his religious opinions at his death, is extensive. Mesnard provides a historiographical study of "La maladie de Pascal," which traces Pascal's symptoms, treatments, and the various medical explanations that have been given, Mesnard *OC*, 4:1469-1503. This study concludes with a bibliography of both primary and secondary sources. Pascal's relationship with Port-Royal at his death has been the subject of speculation, with some claiming that he had renounced his association with the Jansenists sometime during the last two years of his life. Mesnard considers this question in his "Note sur les derniers sentiments de Pascal," Mesnard *OC*, 4:1511-1517. As on most issues, Mesnard hews closely to the traditional view of Pascal as "obstinately faithful to Port-Royal" to the last, Mesnard *OC*, 4:1514.

suffering during his last illness. Gilberte made Pascal's childhood the center of gravity for his life and work.

The theme of *wunderkind* was the central feature of Périer's biography. In addition to the story of Pascal's precocity in the playroom, Périer emphasized her brother's unusual curiosity for knowledge and his talent for philosophical explanation of natural phenomena. Famously, Périer writes that after having heard a fork and plate hit one another at random at the dinner table, young Blaise wrote a treatise on sounds. For Pascal's sister, these youthful episodes announced qualities of mind that would be demonstrated by adult discipline: "an admirable clarity of mind for discerning what is false;" "his genius for geometry;" his curiosity; and "this mind, which could not remain within . . . boundaries."[9]

Pascal's childhood display of his aptitude for geometry provided other writers with a similar key to Pascal's identity. Tallemant des Réaux (1619-1692), noted gossip, wag, and author of the *Historiettes*, wrote that through the discovery of Euclid's thirty-second proposition, Pascal "testified from his childhood the inclination that he had toward mathematics."[10] Pierre Bayle's entry in his *Dictionnaire historique et critique*, written shortly after Pascal's death and drawing heavily on the Périer biography, claimed that "from childhood [he] gave proofs of a mind very much above the common."[11] Likewise, for the romantic Chateaubriand, the episode

[9] "La vie de Pascal," Mesnard *OC*, 1:572-574.

[10] "Le president Paschal a laissé un filz, qui tesmoigna dez son enfance l'inclination qu'il avoit aux Mathematiques," Tallemant des Réaux, *Les Historiettes*, ed. Antoine Adam, vol. 2 (Paris, 1961), 57. This description of Pascal is included in des Réaux's longer description of "Le President Paschal," 56-58.

[11] Pierre Bayle, "Pascal," in *Dictionnaire historique et critique* (Amsterdam, 1734), 4:734.

of the "invention" of mathematics foretold Pascal as "this frightful genius" [*cet effrayant génie*].[12]

More recent scholars have followed suit in their interpretation of the young Pascal, among them the most influential Pascal scholars of the twentieth century. Léon Brunschvicg, editor of the seminal *Oeuvres complètes* (1914-1923), recognized in Pascal's childhood discoveries the "prodigious capacity that [he] manifests for observation and reflection."[13] Jean Mesnard, Pascal scholar *par excellence* since the 1950s, averred that the playful geometrical doodling of the twelve-year-old marked the primacy of intuition over reason, one of the themes of Pascal's later religious reflections.[14]

Pascal's earliest indication of geometrical talent has also suggested to scholars the "youthful nature of his genius."[15] Characteristics of the child Pascal are used to generalize to the tendencies of the later Pascal, providing unity to his life. William Russell exemplifies an early version of this perspective:

> In fact, every attribute of character which marked his maturity was but the continuous development of qualities which grew with him from his earliest youth, - the stupendous intellect united with the humblest, simplest faith, - the playful sparkling wit, the polished subtle sarcasm, restrained only by kindliness and generosity of mind, - the ardent devotion to truth; - in all things the child was emphatically the Father of the man.[16]

On a first reading, Russell's claim that Pascal's early years were important for his adulthood is no more than could be said for anyone. But for Russell, Pascal's boyhood was not common; more than others, only the thinnest veil separated the virtuous displays of the child Pascal from

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[12] François René de Chateaubriand, *Génie du christianisme, ou Beautés de la religion chrétienne* (Paris, 1803), 3: 90.

[13] Léon Brunschvicg, *Blaise Pascal* (Paris, 1953), 21-22.

[14] Jean Mesnard, *Pascal, his life and works*, trans. G. S. Fraser (New York, 1952), 12-13.

[15] Albert Béguin, *Pascal par lui-même* (Paris, 1952), 5.

[16] William Russell, *Extraordinary Men: Their Boyhood and Early Life* (London, 1853), 66.

the outstanding accomplishments of the adult. Pascal's life is offered as a unique blend of childlikeness and maturity.

Pascal's Character and the *Essai Pour Les Coniques*

The first documentary evidence of Pascal's early talent, his *Essai pour les coniques*, has also been used to emphasize the centrality of youth in Pascal's later career. When Pascal wrote this *Essai*, a single sheet of geometrical propositions concerning projective geometry, he was only 17. A number of biographers have used this treatise as a starting-point for themes that shaped Pascal's adult life. Some scholars have identified intellectual qualities that marked Pascal's *Essai* and have sought to show how these innate characteristics might sharpen and simplify Pascal's varied and complex career. Several Pascal studies have argued that his early work on conic sections evidenced reliance on "visuality" in approaching geometrical problems. Pierre Humbert, Thomas More Harrington, and Daniel C. Fouke have claimed that this disposition toward visual strategies extends to Pascal's work in natural philosophy and his religious reflections.[17]

Pascal's perspectivist approach is an early manifestation of his attention to the "concrete character of geometry."[18] For Humbert, Harrington, Fouke, and other scholars, Pascal's early work in projective geometry presaged his later tendency to offer parallels between sensory processes and abstract thought. Jacques Chevalier, whose opinion was echoed by Michel Le Guern, distinguished Pascal's "realistic, intuitive, and concrete mind" from René Descartes'

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[17] Pierre Humbert, *Cet effrayant génie: L'oeuvre scientifique de Blaise Pascal* (Paris, 1947), 166-167; Thomas More Harrington, *Pascal philosophe: une étude unitaire de la pensée de Pascal* (Paris, 1982), 12-20; Daniel C. Fouke, "Pascal's physics," in *The Cambridge Companion to Pascal*, ed. Nicholas Hammond (Cambridge, 2003), 99-100. Fouke provides a full analysis of Pascal's "Method of Discovery," which includes elements of perspective and the visual in Fouke, *Pascal's Method of Religious Investigation and Its Relation to His Methodology in Mathematics and Physics* (Ph.D. diss., University of Chicago, 1986).

[18] Émile Caillet and John C. Blankenagel, introduction to Blaise Pascal, *Great Shorter Works of Pascal* (Philadelphia, 1941), 20.

tendency to abstraction.[19] This characteristic of Pascal was also employed by Mesnard and others when describing Pascal's religious works.[20] Ernst Mortimer used Pascal's "realism" as the central theme of his 1959 monograph.[21] During the early modern period, the senses were considered central to childhood.[22]

Religion and Childlikeness

Gilberte's emphasis on Pascal's childlike virtues was not entirely innocent. It is important to note that her narrative stressed the maturity Pascal's childhood as a means of emphasizing his saintliness. She also recollected the account of Pascal's confessor, Jean Beurrier, regarding the childlike piety of her brother, especially his untroubled trust in God. The general tone and message of *La vie de M. Pascal* builds on the same identification: "[He] was simple as a child in what regards piety."[23] Pascal's simple genius went hand in hand with simple piety.

A variety of scholars have commented on Pascal's spiritual childlikeness.[24] Ivan Gobry expanded on one dimension of childlike spirituality in his *Pascal ou la simplicité*. Simplicity, argues Gobry, is safeguarded by submission and humility; each virtue, he claims, characterizes Pascal, who bears a "heroic . . . spirit of childhood."[25] Dawn Ludwin's more recent work

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[19] Jacques Chevalier, *Pascal* (New York, 1930), 51. Michel Le Guern highlights the importance of Pascal's and Descartes' educational backgrounds as the source of the change, Le Guern, *Pascal et Descartes* (Paris, 1971), 89-90.

[20] Pascal's style in the *Pensées*, writes Mesnard, "is coloured by a powerful imagination, which transforms every idea into a concrete vision, every demonstration into an analysis of facts, Jean Mesnard, *Pascal, Life and Works*, 178.

[21] Ernst Mortimer, *Blaise Pascal, the Life and Work of a Realist* (London, 1959).

[22] See below, p. 38.

[23] "La vie de Monsieur Pascal," Mesnard *OC*, 1:636.

[24] Some examples of childlikeness as a positive religious quality in the secondary literature, include: Alexandre Rodolphe Vinet, *Études sur Pascal* (Paris, 1848), 111-112; A. J. Krailsheimer, *Pascal* (New York, 1980), 75.

[25] Gobry, *Pascal* (Paris, 1985)., 122. In discussing these aspects of Pascal, Gobry reflects on this "spirit of childlikeness": "It is not that children are without defects: on the contrary, they abound in them. But it is the recognition of his powerlessness, his smallness, and his incorrigibility, which makes the spirit of childhood," ibid., 119. He also writes: "The spirit of childhood is not angelicalism but the acceptance of not being an angel; it is not

describes Pascal's "phenomenological approach" to religion, which Ludwin associates with a childlike, "common sense" perspective that links Pascal's theological thought to mystical traditions.[26]

Childlikeness has also been considered crucial to Pascal's *Provincial Letters*. Widely recognized, the *Provincial Letters* used naivety as a strategy to highlight Pascal's argument. Naivety was first pinpointed as a central characteristic of Pascal's writing style by Faugère nearly two centuries ago.[27] More recently, Pascal's strategy of naivety was examined by Robin Howells who characterized it as "polemical stupidity."[28]

Pascal's Childhood: Health and Psychology

Pascal's simplicity, humility, and naivety have also been are linked to psychological analyses. These writers have also expanded the repertoire by adding a new childhood episode and placing it center-stage in their psychological accounts. Marguerite Périer, Pascal's niece and the daughter of the author of *La vie de M. Pascal*, wrote a "Memoir on Pascal and His Family," where she provided a fascinating story.[29] According to legend, sometime before he reached his

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innocence, but the opinion that one has lost innocence, and the confidence in those who want to make us draw profit from this opinion," ibid., 118-119.

[26] "The phenomenological way of seeing is the way of common sense ('dans l'usage commun'). It is often formulated in the Pensées as a child's experience of the world, that is to say, a simple perception that is free from preconceived notions and school jargon," Dawn Ludwin, *Blaise Pascal's Quest for the Ineffable* (New York, 2001), 132. Ludwin's analysis compares Pascal's writing to that of apophatic, or negative, theology, with its origins in the treatises of a fifth-century theologian who wrote under the name Dionysius, ibid., 4-5.

[27] Vinet, *Études*, 116.

[28] Robin Howells, "Polemical stupidity in the *Lettres provinciales*," in *Pascal: New Trends in Port-Royal Studies*, ed. David Wetsel and Frédéric Canovas (Tübingen, 2002): 231-237.

[29] This anecdote is based on a recollection made by Gilberte on 14 August 1661, preserved in original by the Oratory of Clermont, and first published in Gilberte Périer, Jacqueline Pascal, and Jacqueline Périer, *Lettres, opuscules et mémoires de Madame Périer et de Jacqueline, soeurs de Pascal, et de Marguérite Périer, sa nièce*, ed. Armand Prosper Faugère (Paris, 1845), 471-473; Mesnard *OC*, 1: 507-508. Marguerite's more detailed version, which appeared in her "Mémoire sur Pascal et sa famille," was also kept by the Oratory of Clermont. The portions of the memoir dealing with this episode were published in ibid., 447-459 and in Blaise Pascal, *Des Pensées de Pascal: rapport à l'Académie française sur la nécessité d'une nouvelle édition de cet ouvrage*, ed. Victor Cousin (Paris, 1843), 390-394.

second birthday, Blaise fell ill and came close to death. The incident involved his violent reaction to the sight of his mother and father embracing and also, peculiarly, to the sight of water. The origin of Pascal's illness was eventually traced to an old woman who had placed a spell on the child to take revenge on Étienne Pascal for his neglect of a law case. After the source of mischief was discovered, following negotiations carried out between Étienne and the unnamed witch, a cat was conveniently substituted for the young child. By tradition, Pascal's family applied herbs to Blaise's stomach and he gradually returned to health.

This Pascal legend was first published in 1843 and quickly became the bellwether of Pascal's persistent ill-health. This new episode resonated with earlier reports found in Gilberte's biography, which spoke of her brother's sickness with sympathetic and reverent tones regarding his patience under suffering and the constant scourge of his illness.[30] Her claims were in turn buttressed by a prayer composed by Pascal in which he praised God that "it has pleased you to reduce me to the incapacity of rejoicing in the sweetness's of health and the pleasures of the world."[31]

Pascal's illness was a life-long and genuine concern that forced him, on several occasions, to retreat from concentrated work.[32] The story of the vengeful witch became a recurring interpretation of Pascal by focusing on his ever-present maladies, further buttressing Gilberte's view of Pascal's pain and suffering, now common knowledge. Enlightenment thinkers continued expand the place of Pascal's health. For his part, Voltaire criticized the *Pensées*, connecting

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[30] "[I]l nous a dit quelquefois que depuis l'âge de dix-huit ans il n'avait pas passé un jour sans douleur," "La vie de M. Pascal," Mesnard *OC*, 1: 577.

[31] Blaise Pascal, "Prière pour demander a Dieu le bon usage des maladies," in Brunschvicg *OC*, 9: 325.

[32] The various periods of Pascal's ill-health are summarized in Georges Duboucher, "La maladie de Pascal: une mise à jour," *Courrier du Centre International Blaise Pascal* 14 (1992), 6-7.

vague suggestions of Pascal's ill-health with what the *philosophe* deemed fanaticism, apparently in an attempt to discredit the legitimacy of Pascal's religious devotion by making it aberrant.[33] During the late eighteenth and nineteenth centuries, Romanticism gloried in the peculiarities and tragedies of its literary heroes rather than feeling repulsed. Pascal's strange illnesses became the feature attraction in interpreting his peculiar genius.

Louis Francisque Lélut wrote a study of Pascal's life shortly after the publication of the account of Blaise's curious encounter with witchcraft. *L'amulette de Pascal, pour servir à l'histoire des hallucinations* (1846) was sold as a case study of nervous disorders that built on family legends.[34] The tale was good evidence, Lélut claimed, that "the constitution of Pascal so feeble, so irritable, and finally so sickly, dated . . . from the first year" and that "the sad *bizarrerie* of the alterations which menaced [his health] were betrayed from the crib."[35] Lélut focused on Pascal's health to explain the "renunciation" of mathematics and science, his austere religious discipline, his rejection of familial affection, and the "nearly insane melancholy" of a man "so full of oppositions and miseries."[36] Lélut catalogued and addressed a growing list of apparent contradictions in Pascal's life, especially those that appeared unattractive to thinkers like Voltaire. Lélut argued that clear understanding of Pascal's illness, which began with the early tale of the witch, would allow readers to see Pascal's true "greatness" despite "his weaknesses and all the proofs of his dependency."[37] Lélut's claim that Pascal skirted insanity

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[33] In remarks on Pascal's *Pensées*, Voltaire writes: "Pascal, one indeed sees that you are ill", Voltaire, *Lettres philosophiques, ou Lettres anglaises, avec le texte complet des Remarques sur les Pensées de Pascal* (Paris, 1964), 286; "True discourse of illness," ibid., 289; and "Pascal speaks always *en malade*," ibid., 291.

[34] Louis Francisque Lélut, *L'amulette de Pascal, pour servir à l'histoire des hallucinations* (Paris, 1846).

[35] Ibid., 128.

[36] Ibid., 114.

[37] Lélut, *L'amulette de Pascal*, 117.

might have tainted his image for some, but it undoubtedly focused attention on Pascal's psychological state.

Lélut's conclusions reflect contemporary studies related to the nervous system, disorders of the brain, and a biographical strategy to understand past "great men" based on medical factors.[38] Lélut's physiological account was written ten years before the birth of Sigmund Freud, whose psychoanalytic theories would eventually add another layer of interpretation to Pascal's childhood.

In 1958, Erik Erikson pioneered an approach to biography known as "psychohistory" that sparked a flurry of similar studies and significant criticism.[39] The psychoanalytic approach of Erikson, building on Freud's pioneering work, had drawn attention to Luther's relationships with his parents and his childhood experiences.[40] The tradition continued. Charles Baudouin contributed a psychohistorical account of Pascal's life in 1962, just a few years after Erikson's work.[41] Drawing on the story of the witch's spell, and Pascal's early loss of his mother, Baudouin offered a new reading of Pascal's life inspired by the work of Freud and Jung. For

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[38] Some years previously, Lélut had written *Du démon de Socrate* (1836), in which he had claimed that Socrates was the victim of hallucinations. This work, and the study of Pascal, are a part of Lélut's drive to assume the position of "physician-philosopher," Florence Vatan argues. Vatan argues that Lélut is a representative of a nineteenth-century movement that aims for a holistic treatment of man, Vatan, "The 'Poet-Philosopher' and the 'Physician-Philosopher': A Reading of Baudelaire's Prose Poem 'Assommons les pauvres!'," *Nineteenth-Century French Studies* 33 (2004-2005), 89-93. Lélut, among others, would help to encourage the acceptance of Pascal's complexity.

[39] Erik H. Erikson, *Young Man Luther: A Study in Psychoanalysis and History* (New York, 1958). An introduction to the issues and retrospective responses to Erikson's work may be found in *Psychohistory and Religion: The Case of Young Man Luther*, ed. Roger A. Johnson (Philadelphia, PA, 1977).

[40] In a representative passage from Erikson's work, he writes: "[T]his observant and imaginative boy, inclined to rumination about the nature of things and God's justification in having arranged them thus, may well have suffered–call it neurotically, call it sensitively–under observations which leave (or, indeed, make) others dull. At any rate whatever happened in this boy's dreams and in his half-dreams, and was sensed and heard in sleep and half-sleep, became richly associated with the sinister dealings of demons and of the devil himself; while some of the observations made at night may have put the father's moralistic daytime armour into a strange sadistic light," Erikson, *Young Man Luther*, 63.

[41] Charles Baudouin, *Blaise Pascal: ou l'ordre du coeur* (Paris, 1962). Subsequent references are from idem, *Blaise Pascal* (Paris, 1969).

Baudouin, Pascal's early illness revealed "the extreme and precocious nervous susceptibility of Pascal."[42] In Freudian terms, Baudouin drew from Pascal's childhood experiences to argue for a "pre-oedipal" and "pre-genital" understanding of the "astonishing genius", stating that "it is not certain that the genital stage had ever been fully attained."[43]

Following Baudouin's lead, a later psychological account by John R. Cole focused on Pascal's childhood as a key to interpreting his career and religious sentiments. According to Cole, the early loss of Pascal's mother resulted in profound difficulties with attachment. Latent anxieties about losing his father also provoked attempts to please him with scientific "offerings." These responses of Pascal, Cole argued, were accentuated by the father's possessiveness of his son's affections. Extending his view further, Cole concludes that the death of Pascal's father, and the loss of his sister to a cloistered life at Port-Royal, caused crises in Pascal's life that eventually led to his religious conversion and to alternations between mania and depression.[44]

The work of Lélut, Baudouin, and Cole demonstrates how various approaches to Pascal's life converge on the formative role of Pascal's childhood. Cole's work, for instance, emphasizes the infantile qualities of the adult Pascal and his dependence on his father. Each of these three writers de-historicized Pascal's childhood as it related to the broad scope of his work and the

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[42] Baudouin, *Blaise Pascal* (1969), 10.

[43] Ibid., 17.

[44] John R. Cole, *Pascal: The Man and His Two Loves* (New York, 1995). Cole interprets the story of the witch from Pascal's early childhood as possibly having to do with weaning, ibid., 16-25; on Cole's interpretation of the arithmetic machine and the writings on the void as "offerings" to his father, see ibid., 42-49; concerning the "crises of separation and loss," see ibid., chapters 4-6, 51-82. Cole considers the connections between these early attachment issues and Pascal's involvement with Port-Royal and his religious writings in ibid., chapters 7-14, 91-230; evidence for Pascal's depression during his later years is considered in ibid., chapter 15, 231-251; finally, psychological issues and apparatus are considered in several appendices to Cole's book, ibid., 261-276. Cole's connection of Pascal with manic-depressive symptoms draws on an increase in interest during the late twentieth century in the relationship between creativity and specific mental disorders. Jablow Hershman and Julian Lieb, *The Key to Genius* (New York, 1988), describes Newton, Beethoven, Dickens, and Van Gogh as manic-depressive and examine the contributions and costs of such psychological disorders on these noted individuals. These sorts of works should be distinguished from earlier, more general attempts to link genius with "madness."

continuing course of his life. The psychoanalytic approach employed in these studies failed to draw on Pascal's contemporaries to understand the context of his childhood; instead, the aim was to develop a more general "scientific" understanding of human development. In each of these studies, to be like a child was to be psychologically immature, while to be complete was to overcome the complexes of infancy by attaining the goal of maturity. While these studies offer a general picture of Pascal's development, they offer little insight into the biographical complexities that went unresolved, nothing new about the historical particulars that shaped Pascal's life.

The present study is an attempt to understand Pascal as his contemporaries might have viewed him. Importantly, this is not psychohistory in the manner of Baudouin and Cole. Instead, the present study draws attention to historical notions of childhood and childlikeness. Rather than search for the hidden secrets of Pascal's psychology, this study focuses on how Pascal's mentors treated him, how they understood his position as an apprentice savant, how Pascal presented himself and his work, and how these perspectives reflect an early-modern tension between childlikeness and maturity.

Influences of Childhood: The Mersenne Group

Pascal's childhood was also considered influential in more historically-centered ways. Some scholars have examined the formative role of his education and the learned community where Pascal's career began. Instead of isolating character traits that appear in childhood, some twentieth-century historians of science sought to uncover other influences (in the form of books, correspondence, and personal meetings) that shaped the thought of individuals such as Pascal.

Positivist philosophy, since the turn of the twentieth century, became a driving force for understanding the social underpinnings of science. For some, Pascal's interest in method made him an icon of positivism. In his *Positivist Calendar* (a list of intellectual "saints"), Auguste

Comte included Pascal under the month devoted to modern philosophy, joined by Francis Bacon, Thomas Hobbes, and John Locke.[45] Pascal's work in physics, portrayed as perfectly distinct from his religious devotion, was also considered important. As an exemplary model of method, Pascal was virtually canonized for his cautious approach to hypothesis and his critically reasoned experimental designs.[46]

The history of science in its early decades was influenced by the assumption that science is essentially cumulative but punctuated by "great discoveries" of great men. The positivistic picture of Pascal reflected the philosophy he was made to represent. Pascal's positive contributions to physics were methodically isolated from his other, often disappointing and frightening, contributions to learning. Ernst Mach, a quintessential positivist, specifically highlighted Pascal's experiments on the equilibrium of fluids and on atmospheric pressure as a key contribution to positive knowledge.[47] Others looked to Pascal's mathematical work and saw an anticipation of the integral calculus of Leibniz and Newton. These and similar evaluations were often accompanied by the lament that because of his "abandonment of mathematics" Pascal was "perhaps the greatest might-have-been in history."[48]

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[45] Auguste Comte, *Calendrier positiviste, ou système général de commémoration publique* (Paris, 1849), 33.

[46] Pascal's conservative attitude toward hypotheses is upheld in E. J. Dijksterhuis, *The Mechanization of the World Picture*, trans. C. Dikshoom (Oxford, 1961), 450. Reijer Hooykaas labels Pascal a "positivist" for his distrust of corpuscularian and Aristotelian hypotheses, Hooykaas, *Fact, Faith, and Fiction in the Development of Science* (Boston, 1999), 347. J.-P. Fanton d'Andon denies the positivist label to Pascal, but allows him a place as "the shortest path between medieval thought and modern science," since he was able to fill in gaps in a Cartesian approach, Fanton d'Andon, *L'horreur du vide: expérience et raison dans la physique pascalienne* (Paris, 1978), vi.

[47] Ernst Mach, *The Science of Mechanics: A Critical and Historical Account of its Development*, trans.Thomas J. McCormack, 6th ed.(Lasalle, IL: Open Court, 1960), 66, 111, 116, 117, 119, 137-141. Mach's work was first published in 1893. Mach also mentions Pascal's religious beliefs, but not to criticize them. As "the foremost of scientific discoverers," Pascal, Leibniz, Newton, Euler, and others, "were able, in spite of the contracted horizon of their age, to which even their own *aperçus* were chiefly limited, to point out the path to an elevation, where our generation has attained a freer point of view," ibid., 545-546.

[48] Eric Temple Bell, *Men of Mathematics* (New York, 1937), 73.

Historians of science imbued with positivistic tendencies made efforts to create a grand narrative of progress that magnified individual genius and triumphal discovery in a relentless search for precursors. This approach also fostered investigation of the educational background of individuals, and here interest in Pascal's intellectual circles took root. These early studies were also encouraged by fresh scholarship about early-modern intellectual groups. Martha Ornstein, Harcourt Brown, Frances Yates, and René Taton pioneered early inquiries on the formation of informal academies, especially those devoted to natural philosophy.[49] These efforts prompted further scholarship on the relationship between Pascal and the "mathematical academy" organized by Mersenne. Pierre Humbert, against tradition, argued that Pascal was not essentially a loner but the product of a social network of savants.[50] The childhood dimension of Pascal's biography, showing the importance of such networks, will be the subject of chapter 2 of this study. Pascal's experience in the Mersenne group launched his career and situated him as a promising young geometer. As this study seeks to show, the group's expectations for intellectual productivity prompted young Pascal to develop his natural inclinations, which eventually transformed him into one Europe's most celebrated scholars.

Mature Virtues in Pascal Historiography

It is clear from the preceding sketch that Pascal's childhood and his characterization as childlike have been pivotal concerns among Pascal scholars. By contrast, the complimentary

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[49] Martha Ornstein, *The Rôle of Scientific Societies in the Seventeenth Century* (Chicago, 1928); Harcourt Brown, *Scientific Organizations in Seventeenth-Century France* (Baltimore, MD, 1934); Frances A. Yates, *The French Academies of the Sixteenth Century* (London, 1947; repr., 1988); René Taton, *Les origines de l'Académie des Sciences* (Alençon, 1965).

[50] Humbert, *Cet effrayant génie*. Alexandre Koyré reiterated the importance of influence for Pascal, primarily in order to temper heroic, hagiographic portrayals in Koyré, "Pascal Savant," in *Blaise Pascal: L'homme et l'oeuvre*, ed. M. A. Bera (Paris, 1956), 262. Koyré states: "Je crois . . . que nous pouvons voir dans Pascal un véritable élève de Desargues," Alexandre Koyré, An English translation of the essay is available: idem, "Pascal Savant," in *Metaphysics and Measurement: Essays in Scientific Revolution*, trans. R. E. W. Madison (Cambridge, MA, 1968): 131-156.

aspect of this study (maturity) is marginal in the scholarly literature. The "mature" Pascal has been posited as a generally vague and always undeveloped counterpoint to the childlike image of Pascal. The traditional gloss of Pascal as the perpetual child is sometimes punctuated by suggestions of opposition, with hints that Pascal's ambition and stubborn intellectual pride showed shades of maturity, though not necessarily virtuous maturity.[51]

The clearest examination of Pascal's attempts to establish a self-sustaining, mature identity is a study published by Robert Nelson (1981).[52] Nelson's work stresses the self-assertiveness of Pascal that he perceives as coexisting with Pascal's more traditional submissiveness. By doing this, Nelson creates a picture of a man "at once reflective and spontaneous, compassionate and combative, submissive and impetuous."[53] And while from a psychoanalytic perspective he recognizes Pascal's "filial dependency," Nelson hastens to add that it "leaves much room for self-assertion and self-distinction." [54]

Pascal's pedagogical efforts have also been viewed as indicators of Pascal's "maturity." As this introduction will later show, one of the early-modern hallmarks of reaching a mature stage of life was the transition from learner (student) to teacher (master). Although Pascal was never a teacher in an official capacity, he was involved in the project of Port-Royal's *petites écoles* in substantial ways. Pascal invented a method for teaching reading that the schools of Port-Royal adopted, and his ideas on argument and proof found a place in textbooks composed by the movement's leaders. Pascal also contributed to discussions on the education of princes.

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[51] Jean Mesnard describes Pascal's spiritual struggle with ambition as "an interior drama" that takes place "between pride and humility, between glory and obscurity," Mesnard, *Pascal: His Life and Works* (New York, 1952), 63. Elsewhere, Mesnard emphasizes Pascal's assertiveness by describing him as a "man of violence" and a "man of self-mastery," ibid., 185.

[52] Robert James Nelson, *Pascal, Adversary and Advocate* (Cambridge, MA, 1981).

[53] Ibid., 29.

[54] Ibid., 50.

These manifestations of pedagogical interest are underrepresented in Pascal studies, and it is only with the recent work of Nicholas Hammond that they have been considered in depth.

In an article that focuses on Pascal's *Pensées*, the Port-Royal document *Recueil de choses diverses*, and Pascal's *Entretien de M. de Sacy*, Hammond argues that Pascal's religious works should be given a "pedagogical reading" that includes the *petite écoles*.[55] He calls Pascal a "teacher figure," drawing on his reputation for contributions to education at Port-Royal.[56] Hammond expands on this theme in a subsequent book that uses "memory" as a lens for viewing the approach of the schools. An examination of Pascal's *Pensées*, he argues, demonstrates the pedagogical purpose of the unfinished work.[57]

Hammond's pedagogical Pascal provides a link to seventeenth-century notions of the virtues of a mature adult. The "ages of Man" concept that recurs in some early modern literature (and is described below) stresses the natural progression during the life-span from student to teacher. This study sheds light on how Pascal's work reflects the value of moving from childhood to maturity, from protégé of the Mersenne group to teacher figure.

Childhood and Childlikeness in the Early Modern Period

The foregoing section suggests that secondary scholarship on Pascal includes significant themes of childhood/childlikeness and, clearly but less prominently, of adult virtues and maturity. The two themes have occasionally been linked, albeit suggestively and tenuously.

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[55] Nicholas Hammond, "Pascal's *Pensées* and the Art of Persuasion," in *The Cambridge Companion to Pascal*, ed. Nicholas Hammond (Cambridge, 2003): 235-252; idem, "Pascal, Port-Royal, and the *Recueil de choses diverses*," *Romance Quarterly* 50 (2003): 131-148. The *Recueil de choses diverses* is a recollection of some of the teachers and pupils of Port-Royal's *petite écoles*. A recent critical edition of the text is Jean Lesaulnier, ed., *Port-Royal Insolite: Édition critique du Recueil de choses diverses* (Paris, 1992).

[56] Hammond, "Pascal, Port-Royal, and the *Recueil de choses diverses*," 144-145.

[57] Nicholas Hammond, *Fragmentary Voices: Memory and Education at Port-Royal* (Tübingen, 2004). Indeed, it was an attempt to expand the scope of Hammond's pedagogical interpretation of Pascal that led to this dissertation.

Nelson's work argues, for example, that submission and self-assertion coexist in Pascal, while other scholars merely acknowledged seemingly contradictory qualities. Émile Boutroux writes:

> Pascal united in himself singularly diverse qualities; a gift for the sciences depending on observation and on reason, together with the most penetrating sense of the things of the heart and the soul; the craving to know and the craving to love; a drawing towards the inward life, and an ardent desire to influence other men; childlikeness and ambition; simplicity and passion and will-power; the spontaneity of a generous nature, and inclination for work, struggle and effort.[58]

Pascal's identification as a child prodigy serves as another means to link the opposing categories. The image of a child prodigy carries the impression that the child has skill that is unusually mature for others the same age. The stories of Jesus in the temple and Pascal in the playroom feature the adult surprise of seeing children with learning that is typically reserved for adults. For the most part, in the case of Pascal, the peculiar problems of the maturation of gifted children have not been considered by scholars. This study underscore how Pascal's early exposure to Mersenne's learned circle, and his own claims to savant maturity, created a sense of expectation for Pascal's future.

The possibility of anachronism is a key danger of the analytical strategy proposed in this study. A historically sound approach necessitates investigating Pascal not from the point of view of modern categories but from a perspective Pascal's contemporaries might recognize. This study takes care to present the virtues of childlikeness and maturity in their early-modern dress. This approach represents a unique contribution to Pascal scholarship and brings new clarity to Pascal's identification as a man living between these always dynamic categories. In return, it offers a reflection on early modern views of human nature and the acquisition of spiritual and learned virtues.

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[58] Émile Boutroux, *Pascal* (Manchester, England, 1902), 195. Cf., Mesnard, *Pascal, His Life and Works*, 185.

The seventeenth-century perception of childhood, childlikeness, and maturity provides the backdrop for the present study. In the following section, associations between age and virtue are identified and evaluated. The key ideas of childlikeness and maturity will be introduced with a preliminarily sketch before developing them further later in the study.

Childlikeness and the Historicity of Childhood and Youth

The characteristic of childlikeness is a reflection and a development of the category of childhood. That said, it is clear that during the seventeenth century the concept and understanding of childhood was not unproblematic. Philippe Ariès's history of childhood during the early-modern period has been a traditional point of departure for understanding the social and intellectual status of children.[59] First published in 1960, Ariès's field-defining work attempted to locate a particular shift in attitudes toward childhood in early-modern Europe. According to Ariès, the Middle Ages had been devoid of a distinctive attitude toward childhood. Children were introduced to adult society and treated as "little adults" from the age of seven years old.[60] During the early-modern period, however, children were increasingly viewed as needing special attention because of their weaknesses. New ways of dealing with children emerged, including isolation from adults.[61] Ariès's study problematized the historical construct of childhood and prompted a number of studies arguing for an earlier and more differentiated view of childhood, including adolescence. [62]

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[59] Originally published as Philippe Ariès, *L'Enfant et la vie familiale sous l'ancien régime* (Paris, 1960); it was translated into English in idem, *Centuries of Childhood: A Social History of Family Life*, trans. Robert Baldick (New York, 1962).

[60] Ibid., 329.

[61] Ibid, 415.

[62] Shulamith Shahar, for example, made the claim that adolescence was a definable period by the time of the Late Middle Ages, Shahar, *Childhood in the Middle Ages* (New York, 1990).

The emergence of a more nuanced understanding of childhood is linked to the notion of "ages of life." In antiquity and during the Middle Ages, thinking about the life-process had evolved into a systematic way of subdividing human existence. Traditionally, there were seven ages: childhood, puerility, adolescence, youth, senility, and old age.[63] Ariès argues that, despite this original separation, there was no intelligible difference between adolescence and the rest of childhood until the eighteenth century. The original age of adolescence (which was sometimes considered to extend until 25) was combined with the previous two ages into a single long childhood.[64] Despite the successive changes in attitudes posited by Ariès, linguistic limitations (the lack of a word equivalent to the Latin *adolescens*) meant that there was much ambiguity about different stages of childhood.[65]

Scholars have taken issue with Ariès' linguistic claim that there was no coherence to an idea of adolescence before the eighteenth century. Natalie Zemon-Davis argues, for example, that "one cannot infer that a period of adolescence was not recognized" merely from a lack of a precise vocabulary.[66] What may be concluded, however, is that if there was a clear conception of adolescence during the seventeenth century, there was at the least a common practice of collectively referring to all simply as children.

One example of this generalization of ages is Juan Huarte's work on judging children's intellectual proclivities.[67] Huarte divides the human life span into five stages: childhood, youth,

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[63] Ariès, *Centuries of Childhood*, 18-19.

[64] Ibid., 25.

[65] Ibid., 25-29.

[66] Natalie Zemon-Davis, "The Reasons of Misrule: Youth Groups and Charivaris in Sixteenth-Century France," *Past and Present* 50 (1971), 61-62 n63.

[67] Huarte's views are considered at some length below, pp. 103-105.

manhood, middle-age, and old age.[68] The divisions between ages outlined in Huarte's work (originally published in 1575 and widely translated through the seventeenth century) suggest the continuing ambiguities in the definition of childhood. Huarte recognizes, for instance, different lengths for the various stages of life: childhood, he states, may end anywhere from twelve years old to eighteen. Similarly, the age of youth may extend to as late as forty years of age.[69]

Other evidence supports diverse intellectual attitudes toward the "ages." Within learned treatises, the Latin term *adolescens* had some currency as an ironic, derogatory term. Jean Chapelain lobbied Guez de Balzac on behalf of a friend to remove the term *adolescens* as a part of the description of him: "this term is in our language no longer taken up, and is said only in an ironic way of speaking."[70] The seven age divisions, in some cases at least, were replaced by a generalized contrast between young and old, between childhood and maturity.

The boundaries of childhood were fluid during the seventeenth century and this imprecision is reflected in contemporary perceptions of young Pascal. As this study will reveal, references to Pascal's early display of mathematical talent are typically confined to generalized marveling at his productions, works usually associated with older, more experienced savants. Despite the lack of a traditional, well-defined categorization of ages, an understanding of the intellectual background for such distinctions is important to this study. They are the clearest source of information about the virtues and vices that Pascal and his contemporaries would have

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[68] Juan Huarte, *Tryal of Wits, Discovering the Great Difference of Wits among Men, and what Sort of Learning Suits Best with Each Genius* (London, 1698), 45.

[69] Huarte, *Tryal of Wits*, ibid. Huarte's extended discussion of the ages of man lists the official years of childhood as through age fourteen and the years of youth from fourteen to twenty-five, ibid., 82.

[70] Jean Chapelain to Guez de Balzac, 17 February 1636, in *Lettres de Jean Chapelain, de l'Académie française*, ed. Philippe Tamizey de Larroque, vol. 1 (Paris, 1880; repr. 1968), 108.

associated with childhood and maturity. Equally clear, the connotations of childhood and adulthood ground the related concept of childlikeness in adults.

Childlikeness assumes a distinction between children and people of other ages. To be childlike is to exhibit a set of traits that "child" somehow represents. These characteristics may be deemed positive by serving as a model of emulation for adults. They may also be deemed negative, a contrast to proper adult behavior, as a term for those who exhibit traits deemed 'childish.' This study attempts to show that the two concepts of positive childlikeness and negative childishness framed the imperatives that shaped Pascal's career.

The Virtues and Vices of Childhood

Most historians of childhood recognize that attitudes toward children have consistently hesitated between suspicion and admiration. This is nowhere more clearly evident than in the period from the Middle Ages through the seventeenth century. Some scholars have argued that the view of children during this period was primarily negative, that children were seen merely as "imperfect adults."[71] Most studies also acknowledge that attitudes about childhood were profoundly ambivalent. Negatively, children were thought to lack the capacity for reasoning because they were "entirely submerged and entirely shrouded in the senses."[72] The Augustinian doctrine of the depravity of human beings also stressed that children were born with evil desires and that childhood was a time of unbridled lust.[73] Lack of reasoning and self-control made the

[71] This is the view of James A. Schultz in Schultz, *The Knowledge of Childhood in the German Middle Ages, 1100-1350* (Philadelphia, 1995), 244-256. Schultz claims that it was not until the eighteenth century that a different view of children developed that enhanced their unique positive attributes, 249.

[72] "[D]ans les premieres annees de l'enfance l'ame de l'homme est comme toute plongée & toute ensevelie dans les sens, & . . . elle n'a que des perceptions obscures & confuses des obbjets qui font impression sur son corps," Antoine Arnauld, *Nouveaux elements de géométrie* (Paris, 1667), preface, n.p. [3]

[73] Shahar, *Childhood in the Middle Ages*, 14-16.

child "no more than a Brute Beast."[74] Notions of the depravity of childhood will be further developed in Chapter 5, where moral inclinations and discipline are considered at length.

Children were not only viewed negatively. In her study of childhood in the Middle Ages, Shahar argues that Augustine's view of children also stressed the innocence of baptized children in comparison with their adult counterparts.[75] The importance of the virtue of the child was rooted in Jesus's words in the synoptic gospels: "Let the children come to me, and do not hinder them; for to such belongs the kingdom of God."[76] This sentiment was further reiterated by the requirement for childlikeness in adults:

> Truly, I say to you unless you turn and become like children, you will never enter the kingdom of heaven. Whoever humbles himself like this child, he is the greatest in the kingdom of heaven.[77]

The innocence and purity of children also appeared in the Middle Ages in the form of cults of the infant Jesus and in stories of the early lives of the saints.[78] Saint-Cyran, one of the key figures of Jansenism, the religious movement with which Pascal would be associated during the last years of his life, was particularly imbued with the virtues of childhood, including spiritual receptivity:

> God who says that he rejoiced with his eternal Wisdom in making the world, rejoices often in these little souls, and does in them what he would like to do in big ones [but cannot] because of the opposition and the continual resistance that he meets in them.[79]

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[74] Juan Huarte, *Tryal of Wits*, 59.

[75] Shahar, *Childhood in the Middle Ages*, 16-17.

[76] Matthew 19.14, Revised Standard Version; cf., Mark 10.14; Luke 18.16.

[77] Matthew 18.3-4, RSV.

[78] Shahr, *Childhood in the Middle Ages*, 18-20; Colin Heywood, *A History of Childhood: Children and Childhood in the West from Medieval to Modern Times* (Malden, MA, 2001), 32-34.

[79] Jean Duvergier de Hauranne to Princesse de Guéméne, n.d. [January 1642], in Jean Duvergier de Hauranne, *Lettres inédites de Jean Duvergier de Hauranne,l'abbé de Saint-Cyran*, ed. Annie Barnes (Paris: J. Vrin, 1962), 265.

The virtues of childhood did not always end with innocence, purity, and receptivity. Huarte extends their scope to include docility, tractability, gentleness, bashfulness and fearfulness (which he views as the basis of temperance), credulity, submissiveness, frankness, humility, and lack of deception.[80] For Huarte, the virtues of childhood outweighed its vices.

The virtues of childhood, as many as they may be, were not understood as the final product; maturation was necessary. The goal of the child was always to become an adult. The process of growth included increasing self-control and the development of good manners, each virtue encouraged by innumerable manuals of etiquette that appeared from the late Middle Ages onward.[81] The mature person was also called to follow the natural evolution from learner to teacher, which, as this study shows, is reflected in Pascal's assumption of informal "teaching" roles.[82]

The clearest source of the childlike/mature duality for learned individuals in the early modern period was the New Testament. Carrying the authority of scripture, it employs a positive view of children worthy of imitation; but it also urges growing up and abandoning childish ways. Neither mandate takes precedence over the other; they are frequently quoted in the same passage.

Scriptural evidence continued to carry great weight. Jesus's well-known articulations of children's privileged position in the kingdom of heaven have already been mentioned.[83] Jesus

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[80] "The Virtues of Infancy are very many, and the Vices but very few; Children, says *Plato*, admire from what Principles the Sciences arise. In the next Place they are Docile, Tractable, Gentle, and Easy to receive the Impression of all Kinds of Virtues. In the third Place, they are Bashful, and full of Fear, which, according to *Plato*, is the Foundation of Temperance. In the fourth place they are Credulous and Easy to be led; they are Charitable, Frank, Chast, Humble, Innocent, and Undesigning. To which Virtues Jesus Christ had regard, when he said to his Disciples, *Except you become as little Children, you shall not Enter into the Kingdom of Heaven*," Huarte, *Tryal of Wits*, 81.

[81] These manuals are a central component of the important work by Norbert Elias, *The Civilizing Process*, trans. Edmund Jephcott (New York, 1978).

[82] Daniel Bartoli, for example, argues that life should be subdivided into three parts, in which an individual learns, practices, and then teaches, Bartoli, *The Learned Man Defended and Reform'd* (London, 1660), 333.

[83] See p. 38, n. 73.

also cites an advantage that children (and by extension childlike adults) have in receiving the revelation of God: "I thank thee, Father, lord of heaven and earth, that thou hast hidden these things from the wise and understanding and revealed them to babes."[84] In addition, Peter commands his readers "like newborn babes, [to] long for the pure spiritual milk" while the Pauline writer urges the Corinthians to "be babes in evil."[85]

Peter's imperative to crave the milk of divine revelation assumes, however, that the nourishment will then enable believers to "grow up to salvation."[86] Moreover, the writer of the book of Hebrews describes the milk imbibed in Christian "childhood" not as the source of maturity, but as a less nutritive substitute for the "solid food" of more difficult doctrines.[87] And importantly, if the Christians at Corinth should maintain a childlike innocence, they should also have the disciplined mind of an adult: "do not be children in your thinking; be babes in evil, but in thinking be mature."[88]

Thus, the New Testament writers maintain the necessity of childlikeness, for it is as a child that the kingdom is inherited. But there is also the final goal of a "mature manhood" in which believers are called to "no longer be children, tossed to and fro and carried about with every

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[84] Matthew 11.25, RSV; cf. Luke 10.21.

[85] 1 Peter 2.2, RSV; 1 Corinthians 14.20, RSV.

[86] 1 Peter 2.2.

[87] "About this we have much to say which is hard to explain, since you have become dull of hearing. For though by this time you ought to be teachers, you need someone to teach you again the first principles of God's word. You need milk, not solid food; for every one who lives on milk is unskilled in the word of righteousness, for he is a child. But solid food is for the mature, for those who have their faculties trained by practice to distinguish good from evil," Hebrews 5.11-14, RSV.

[88] 1 Corinthians 14:20, RSV.

wind of doctrine."[89] Instead, they move beyond their age of minority to their full status as heirs of God's gracious promises.[90]

The biblical pairing of childlikeness and maturity, as interpreted through Augustine and other theologians, is undoubtedly the source for Jansenist doctrines. This tension between submissive receptivity and striving for perfection are evident in Pascal's religious writings.[91] The relationship expressed in the New Testament between these two types of virtues also serves as a backdrop to early-modern intellectual issues. The present study aims to show the value of exploring this duality by linking early modern religious and scientific work. Two examples suggest further possibilities from this perspective.

Francis Bacon's inductive method bears the signature of both adult control of nature and childlike openness to it. Carolyn Merchant has famously sketched the themes of the dominance, control, and interrogation of nature during the early modern period, all of which are linked to its coding as female. The role of the violent investigator undoubtedly represents the authority and purposefulness of the adult, while the natural world ultimately submits to its patriarchal inquisitors. Merchant suggests that this attitude toward nature represents a transformation of the perennial identification of nature as female, as an organic, productive, and nurturing mother. But even in the works of Bacon the natural philosopher was idealized at once as the receptive child

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[89] "And his gifts were that some should be apostles, some prophets, some evangelists, some pastors and teachers, to equip the saints for the work of ministry, for building up the body of Christ, until we all attain to the unity of the faith and of the knowledge of the Son of God, to mature manhood, to the measure of the stature of the fullness of Christ; so that we may no longer be children, tossed to and fro and carried about with every wind of doctrine, by the cunning of men, by their craftiness in deceitful wiles," Ephesians 4.11-14, RSV.

[90] "I mean that the heir, as long as he is a child, is no better than a slave, though he is the owner of all the estate; but he is under guardians and trustees until the date set by the father. So with us; when we were children, we were slaves to the elemental spirits of the universe. But when the time had fully come, God sent forth his Son, born of woman, born under the law, to redeem those who were under the law, so that we might receive adoption as sons," Galatians 4.1-5, RSV.

[91] See Chapter 3.

and as the strategic, aggressive, probing manipulator. The attitude and difference is clear in Bacon's "Of the Interpretation of Nature":

> For as in the inquiry of divine truth, the pride of man hath ever inclined to leave the oracles of God's word, and to vanish in the mixture of their own inventions; so in the selfsame manner, in inquisition of nature, they have ever left the oracles of God's works, and adored the deceiving and deformed imagery, which the unequal mirrors of their own minds have represented unto them. Nay, it is a point fit and necessary in the front, and beginning of this work, without hesitation or reservation to be professed, that it is no less true in this human kingdom of knowledge, than in God's kingdom of heaven, that no man shall enter into it, 'except he become first as a little child.'[92]

Bacon's advocacy of a childlike approach to nature is drawn explicitly from the biblical passage and demonstrates, like Pascal, that the Christian tradition provided a justification for the submissiveness of human beings to well-ordered experience, not unlike the Adamic subduing of nature. According to John Henry, Bacon's method should be understood as religiously motivated, an attempt to "return mankind to the prelapsarian state."[93] The original man, according to Bacon, was at once childlike and mature, and thus the fall was one from the "state of innocence" as well as from the "kingdom over the creatures."[94] Bacon's project sought to create a "mind totally liberated and cleansed," but it did so through the disciplined application of his "New Organon," which overcame elements of credulity and childishness in method.[95]

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[92] Francis Bacon, "Of the Interpretation of Nature," *The Works of Francis Bacon*, 3 vols. (Philadelphia, 1844), 1:84. There is a similar passage in the *Novum Organum*, which especially emphasizes the need to leave aside one's preconceptions when approaching nature: " So much for the kinds of *idols* and their trappings; all of which must be rejected and renunced and the mind totally liberated and cleansed of them, so that there will be only one entrance into the kingdom of man, which is based upon the sciences, as there is into the kingdom of heaven, 'into which, except as an infant, there is no way to enter'," Bacon, *The New Organon*, ed. Lisa Jardine and Michael Silverthorne (New York, 2000), Book 1, Aph. 68, 56.

[93] John Henry, *Knowledge is Power: Francis Bacon and the Method of Science* (Cambridge, 2002), 136.

[94] Bacon, *New Organon*, Book 2, Aph. 52, 221.

[95] Bacon equates the cleansing of the understanding to the biblical becoming like a child, ibid., Book 1, Aph. 68, 56. But he also describes unreflective "wonder at learning and the arts, which is simple enough in itself and almost like the wonder of children," ibid., Book 1, Aph. 86, 71. Bacon also believes that the prior practices of induction also partook of the negative aspect of childhood activity: "For the induction which proceeds by simple enumeration is a childish thing, its conclusions are precarious, and it is exposed to the danger of the contrary instance; it normally

If Bacon represents England and the empirical tradition, Descartes represents the continental rationalist tradition. In his 1616 law thesis, René Descartes portrayed the process of learning with images of the receptive infant, again embracing the metaphor of the nurtured child and the disciplined adult.

> [W]hen, a short time ago, with a peculiar felicity I began learning, almost from the tender conclusion of a squalling young age until now, I attached my little lips to the delicious well-springs of the liberal arts with the foster-mother's moist milky dew.[96]

This childlike metaphor is best understood in the context of Descartes' later philosophical project. In the course of his publications, Descartes would argue that many of the errors of adulthood were acquired in childhood, when the senses govern one's view of the world.[97] As a double metaphor, his meditations by the fireside were an attempt to strip away accumulated falsehoods, an adult process requiring determination, self-discipline, and self-knowledge.[98] Theoretically, this denuding of mind gave rise to a childlike innocence with respect to knowledge. But emptiness was not Descartes' goal. Through disciplined reason, he attempted to build an entirely new philosophy based on the certainty of his *cogito ergo sum*. Childlike simplicity brought clarity and distinctness through the exercise of adult discipline.

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bases its judgment on fewer instances than is appropriate, and merely on available instances," ibid., Book 1, Aph. 105, 83.

[96] René Descartes, "Descartes' 1616 Law Thesis–English Translation," trans. Holly Johnson and Kurt Smith, http://plato.stanford.edu/entries/descartes-works/tenglish.html (accessed 12 September 2007). The image of Descartes being nourished in learning parallels the depiction of nature as the many-breasted Diana of Ephesus. For a seventeenth-century example linked to natural philosophy, see Stukely's image of Diana holding a medal depicting Newton's head, Patricia Fara, *Newton: The Making of Genius* (New York, 2002), figure 2.5.

[97] One of the paragraph headings (part 1, paragraph 71) of Descartes' *Principles of Philosophy* is: "That the principal cause of errors proceeds from the prejudices of our childhood," René Descartes, *Principles of Philosophy*, trans. Valentine Rodger Miller and Reese P. Miller (Boston, 1983), 32.

[98] "I procrastinated for so long that I would henceforth be at fault, were I to waste the time that remains for carrying out the project by brooding over it. Accordingly, I have today suitably freed my mind of all cares, secured for myself a period of leisurely transquillity, and am withdrawing into solitude. At last I will apply myself earnestly and unreservedly to this general demolition of my opinions," René Descartes, "Meditations on First Philosophy," in *Discourse on Method* and *Meditations on First Philosophy*, trans. Donald A. Cress (Indianapolis, 1993), 59.

Overview & Summary

The present study is divided into six chapters. In the following chapter, Chapter 2, I examine Pascal's life emphasizing his earliest relationships in the Parisian community of mathematicians. Pascal's participation in the Mersenne Circle represents a pivotal period in his live when he served his "mathematical apprenticeship," which extended and enriched the education he received from his father. The purpose of Chapter 2 is to link Pascal's experience as the protégé of the Mersenne group to the attitudes of its central members on education and children. It uncovers the backgrounds in pedagogy shared by several key members of the "académie toute mathématique," including Mersenne, and ties these educational concerns to a vision for the future of mathematical studies. As a rising "New Archimedes," linked in this way to another key seventeenth-century mathematician Christiaan Huygens, Pascal represented a bright, young hope for Mersenne. The vision for the future of mathematics would be carried to completion by identifying and training undiscovered talent. This new but latent talent would in turn be perfected through discipline and exercise.

Chapter 3 relates Mersenne's strategy for the development of talent to Pascal's early works in mathematics and natural philosophy. It demonstrates Mersenne's insistence on the importance of developing natural inclinations through concerted effort, and it shows how Pascal uses language that parallels Mersenne's ideas about talented musicians. This chapter focuses largely on Pascal's early adulthood in Rouen, time spent outside the French capital. Using Pascal's writings about his arithmetic machine and the "Preface" of his proposed *Treatise on the Void*, Chapter 3 analyzes Pascal's attempt to enter the highest echelons of learned society. He did so, the evidence suggests, by drawing contrasts between his own work and the productions of artisans, children, and beasts. Eschewing childishness, Pascal distanced himself from his own childhood, actively seeking to assume his Archimedean position.

Chapter 4 identifies a period of struggle when competing forces of Pascal's past and present sought to control his life. In particular, this chapter addresses the tension between Pascal's growing religious interests and his earlier role as Mersenne's "Young Archimedes." Pascal's struggle manifested itself in a growing rift between mature virtues, so prominently displayed in Pascal's earlier work, and the limitations of his scholarly pursuits, expressed by both his religious and "worldly" friends. This critical period of struggle ended in 1654 with Pascal's "Night of Fire" conversion.

Pascal's new role as a "devout savant" is identified and evaluated in Chapter 5. A key concern in developing Pascal's role as "devout savant" is to draw parallels between childlike virtues and mature virtues from Pascal's early life and relating them to his efforts on behalf of an Augustinian Christianity. Employing both the *Provincial Letters* and a lesser known work, which deals with baptism and catechetical instruction, this chapter illustrates the duality of age-related virtues in Pascal's religious productions. Importantly, while both works have religious themes, they also both address issues of pedagogy. Pascal's involvement with Port-Royal's *petite écoles* offers additional evidence for his interest in issues of childlikeness and maturity.

Finally, Chapter 6 addresses the relationship between Pascal's life at Port-Royal and his scholarly life in Paris. The key concern of this chapter is to examine how Pascal applied virtues sharpened among his friends at Port-Royal to his scholarly life in Paris. Near the end of his career Pascal returned briefly to the mathematical pursuits of his youth, this time as an intellectual diversion. This final chapter shows how characteristics of the child and the adult converged in Pascal's last mathematical exercise, the contest of the roulette. The debate that unfolded illustrates the uneasy relationship between Pascal's success as a child prodigy and his failure as an adult scholar. Pascal's final mathematical offering represents unresolved conflicts.

In the end, his contribution and comportment were thought to conflict with core values of the Parisian learned community.

CHAPTER 2
PASCAL IN THE TEMPLE: A NEW ARCHIMEDES AND HIS EARLY TRAINING

Mersenne and His Circle

The *Essai pour les coniques* launched Pascal's mathematical career. Printed in the first months of 1640, it sketches on a single page Pascal's proposal for an ambitious project.[1] The planned work would build upon the three definitions and three lemmas presented in the *Essai* in order to prove theorems universally true of all types of conic sections (circles, ellipses, parabolas, and hyperbolas). Pascal's *Essai* boldly labels this future work as "des Éléments coniques complets," a description captured in the Latin title of the work, *Conicorum opus completum*.[2] Pascal never gave this "complete work" a finalized form, however, and no copies are known to exist.[3] Nevertheless, Pascal's work on conics propelled him to a prominent position in Paris's elite circle of geometers, Marin Mersenne's "académie toute mathématique."

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[1] Only two copies of this page have been found. One, consulted by Leibniz, remains in the *fonds Leibniz* at Hanover, Mathematik. XXXV; volume XV, I, *Pascaliana.* The other is at the Bibliothèque Nationale, Paris, Département des Imprimés, Réserve, V 859-860, Part 1, Number IV. Information about the location of Pascal-related manuscripts and printed works is Mesnard *OC*, esp. 1:262-397. See *Catalogue des ouvrages de Pascal conservés au Département des Imprimés*, ed. Marie Thérèse Dougnac (Paris, 1935).

[2] *Essai pour les coniques*; The title *Conicorum opus completum* is stated in Pascal's written report to a group of mathematicians meeting at Paris, "Celeberrimae matheseos academiae parisiensi." Pascal describes the treatise as "encompassing the conics of Apollonius and innumerable others [from] a nearly unique proposition, completed at the age of 16, Mesnard *OC*,2:1034. In her biographical narrative, Pascal's sister refers to the work as the *Traité des coniques*, "Vie de Monsieur Pascal," Mesnard *OC*, 1:576.

[3] The information about the structure of the larger work comes from Leibniz. He obtained copies of Pascal's manuscripts on the conics from Pascal's family by 1676. What remains of the treatise are Leibniz's notes and a letter to Étienne Périer, Pascal's nephew, from Leibniz. This collection of materials is in the *fonds Leibniz* in Hanover, Mathematik. XXXV; volume XV, I, *Pascaliana*, folio 1r^{o} ("Conica Pascaliana"); folios 4-9 ("Generatio Conisectionum"); folio 11r^{o} ("Ms. de M. Pascal. Coniques"); folio 12r^{o} ("Hexagrammum Pascalianum, mysticum ut vocat"). A copy of Périer's letter is folio 3r^{o}-v^{o}, and although quoted at length is not printed in its entirety in Mesnard's *OC*. It is printed in Brunschvicg *OC*, 2: 2, 220-224 and in Blaise Pascal, *Oeuvres Complètes*, ed. Michel Le Guern (Paris, 1998-2000), 1:129. The manuscripts Leibniz reviewed were in fragmentary form and not yet put into a full treatise. However, they were deemed by Leibniz "assez entières et finis pour paraître à la vue du public" and "en état d'être imprimé," Le Guern *OC*, 1:129, 131. Leibniz arranges those he considers to be part of the originally planned treatise as follows, mostly with titles created himself: 1) *Generatio conisectionum tangentium et secantium* (Pascal's title); 2) *De hexagrammo mystico et conico*; 3) *De quatuor tangentibus* . . . ; 4) *De proportionibus segmentorum secantium et tangentium;* 5) *De tactionibus conicis*, Le Guern *OC* 1:129-130.

For the Mersenne Circle, as it is often called, the *Essai* was a sign of the possibilities of a young and talented mind. Pascal needed encouragement, exercise, and discipline, and this educationally-minded group was in a unique position to shape Pascal's career. For Mersenne, Pascal was an example of the undiscovered talent that he sought to cultivate in order to fulfill a religious vision for the sciences. From his teenage years, Pascal was given a catechetical instruction in geometry, with the Parisian mathematicians as his godfathers. He was groomed with great expectation for the role that he would play in the perfection of knowledge through mathematics.

Pascal's early work in geometry provides a point of contact with the individuals and vision of the Mersenne group. The beginning of his mathematical career reveals the way that this informal group embodied an alternative educational model by which a talented prospect could be cultivated. Mersenne's stated goals include the "completion" or "perfection" of mathematics. One way this goal could be fulfilled was by nurturing young individuals (such as Pascal) who demonstrated mathematical promise. The educational atmosphere of Mersenne's self-styled "académie" emerged out of the interests and experiences of its members, many of whom were specifically involved with pedagogical concerns. These educational approaches informed the group's attitudes toward the development of the young Pascal, who would always recognize this "school" as the locus of his mathematical apprenticeship. This chapter makes the case that the Mersenne "académie" was a school whose singular pupil was Pascal. The educational backgrounds of the key members and their shared vision for the completion of mathematics (the unfolding of its divine, infinite potentialities on the model of ancient mathematics) are central to understanding Pascal's views of mathematics, education, and spiritual growth.[4]

[4] The idea of the completion of mathematics expressed in Mersenne's work is considered below, pp. 53-62.

The Mersenne Circle: Its Organizer, Members, and Purpose

Mersenne was a monk of the Minim order who lived most of his adult life at a convent near the Place Royale in Paris. Besides being the "secretary of Europe", one of his greatest accomplishments was "regrouping and animating the principle amateurs of science of the capital."[5] His letter to Peiresc in May 1635 makes the defining announcement of the existence of "the noblest academy in the world which was formed a short time ago in this town." It is, Mersenne specifies, "entirely mathematical."[6] In a later letter, Mersenne lists the members of the group: Étienne Pascal (Blaise's father), Claude Mydorge, Claude Hardy, Gilles Personne de Roberval, Girard Desargues, the abbé of Chambon, and "some others."[7] As the organizer and host of the group, Mersenne was in a unique position to provide structure and purpose. His pedagogical experience, then, is particularly important for investigating this academy as the "school" from which Pascal received impetus for his mathematical career.

On 25 December 1639, Descartes wrote a letter in response to a communication from Mersenne:

> I do not find it strange that there are some who demonstrate conic sections more easily than Apollonius, for he is extremely long and burdensome, and all that he has demonstrated is itself quite easy. But there are other things that could also be proposed, regarding conic sections, that a child of 16 years would have difficulty untangling.[8]

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[5] Taton, *Les origines de l'académie royale française*, 13.

[6] Mersenne to Peiresc (23 May 1635), Marin Mersenne, *Correspondance du P. Marin Mersenne*, 17 vols., ed. Cornélis De Waard (Paris, 1945-1986), 5:209.

[7] This list should not be considered as exhaustive, as we shall see. Armand Beaulieu adds Jacques Le Pailleur, Jean Beaugrand, Pierre Petit, Pierre de Carcavy, and Pierre Gassendi (to whom the information in the letter to Peiresc was to be relayed), Beaulieu, *Mersenne: le grand minime* (Brussels, 1995), 177.

[8] "Je ne trouve pas estrange qu'il y en aye qui demonstrent les coniques plus aysement qu'Apollonius, car il est extremement long et embarrassé, et tout ce qu'il a demonstré est de soy assez facile. Mais on peut bien proposer d'autres choses, touchant les coniques, qu'un enfant de 16 ans auroit de la peyne à demesler," René Descartes to Marin Mersenne, 25 December 1639, Mersenne, *Correspondance*, 8:697.

The letter's timing and its content make clear that the subject is Pascal's *Essai pour les coniques*. Descartes' comments attest indirectly but clearly to Mersenne's desire to promote the early efforts of this emerging geometrical talent. But Mersenne's efforts were not used only on behalf of Pascal; they represent one expression among many of his interest in undiscovered talent, a pedagogical concern that molded and benefited Pascal during his formative years. His evidently positive comparison of Pascal with the legendary Apollonius of Perga, author of a brilliant third-century BCE work on conic sections, suggests Mersenne's hope that Pascal and others would bring the work of the ancients to completion.[9] For Mersenne, this "perfection" of mathematics was a religious goal and its pursuit was a sacred vocation.

Mersenne's Educational Goals and the Order of the Minims

The Order of the Minims was founded in the fifteenth century. Unlike the Jesuits, the Minims were not dedicated to teaching but preaching.[10] For Mersenne, however, "preaching" took an unconventional form. In his cleverly titled intellectual biography, *Mersenne: le grand Minime*, Armand Beaulieu argues that Mersenne's superiors recognized that "his vocation consisted in the defense of the faith by pen and by conversation even more than through

[9] Apollonius's *Conics* was central in mathematics and the development of planetary astronomy. Kepler's work on planetary movement, with its use of conic sections, is deeply indebted to Apollonius. A recent English translation of the first three books of the *Conics* is Apollonius, *Apollonius of Perga: Conics, Books I-III*, ed. Dana Densmore, trans. R. Catesby Taliaferro (Santa Fe, NM, 1998). A key recent study of this work is Michael N. Fried and Sabetai Unguru, *Apollonius of Perga's* Conica*: Text, Context, Subtext* (Leiden, 2001). Only the first four books of the *Conics* were available in Europe until just prior to Pascal's death. Books V-VII had survived only in Arabic translation, and were first translated into Latin in 1661 in Florence, G. J. Toomer, "Apollonius of Perga," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie, vol. 1 (New York, 1970), 180, 191-192. Apollonius, *Apollonii Pergaei conicorum lib. V, VI, VII, paraphraste Abalphato Asphahanensi, nunc primum editi. Additus in calce Archimedis assumptorum liber. Ex codicibus arabicis mss*, trans. Abrahamus Ecchellensis, ed. Giovanni Alfonso Borelli (Florence, 1661), is available in several copies at the Bibliothèque Nationale in Paris. Book VIII of the *Conics* is not extant.

[10] The standard English-language source on the Minim order is J. P. S. Whitmore, *The Order of Minims in Seventeenth-Century France* (The Hague, 1967). For general attitudes of the order toward intellectual pursuits, including educational endeavors, see Part III, Chapter I, "Studies," 111-119.

preaching."[11] Robert Lenoble, Richard Popkin, and Peter Dear have each sought to identify Mersenne's goals.[12] All three agree that Mersenne sought to undermine arguments of the faithless or unfaithful, which threatened all forms of knowledge, including revealed truth. Significantly, Beaulieu's account of Mersenne's life and work takes seriously his religious vocation and the demands and values of the Minims. And while the Minims were not a "teaching order" in the strict sense, J. P. S. Whitmore argues that a broader definition demonstrates the importance of such pursuits to the monks of the black cowl:

> If, however, the term 'education' be taken in a wider sense than the mere giving of instruction in classes, the Order plays not an insignificant role in the education of the seventeenth century. A few of their members played an important part in the diffusion of new ideas and in the teaching of specific skills such as book illustration, turning, the construction of sun-dials and other bits of scientific apparatus.[13]

Mersenne's duties as a Minim introduced him to teaching young men. From 1615-1617, Mersenne taught philosophy at Nevers to those destined to be monks, and in 1618, he taught theology for another year.[14] It was during his sojourn at Nevers that Mersenne's future biographer, Hilarion de Coste, became his pupil. This first recorded teaching experience

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[11] Beaulieu, *Mersenne*, 22.

[12] Lenoble argues that Mersenne embraced mechanism in an attempt to save the reaction against scholasticism from the libertine, unbelieving snare of Renaissance Naturalism, Robert Lenoble, *Mersenne ou la naissance du mécanisme* (Paris, 1943), 5ff. Popkin labels Mersenne a "mitigated skeptic," accepting the basic caution of the skeptics while seeking to establish "convincing or probable truths about appearances," Richard Popkin, *The History of Scepticism: From Savonarola to Bayle* (New York, 2003), 112. Dear expressed Mersenne's goal as the desire to establish "knowledge of nature as a cumulative acquisition experimentally or observationally ratified facts made into demonstrative science through the techniques of mathematics," and this in order to prevent the success of unorthodox religions and attacks on the social order, Dear, *Mersenne and the Learning of the Schools* (Ithaca, NY, 1988), 3, 237-238.

[13] Whitmore, *Order of Minims*, 117. Furthermore, Whitmore emphasizes a general trajectory from polemic to "instruction" in the writing of the Minims of the seventeenth century. The precise meaning behind this differentiation of approach is left unclear, but the key aspect is the move toward a "reconciliation of science with the tenets of faith." The teaching of skills is closely linked to the question of the relationship between science and art/technique in Chapter 3 of this dissertation. I am unsure as to the role of the Minim monks mentioned in dispersing knowledge about turning, sun-dials, and scientific apparatus, but it seems that if taught to novices, this could be considered a particular aspect of their spiritual training and education.

[14] Mersenne, *Correspondance*, 1:xxv.

provides a backdrop to Mersenne's interest in the training and instruction of the young, which was clearly recognized by the editors of Mersenne's correspondence. Beaulieu, one of the collaborators in that project, summarizes: "There is an aspect of Mersenne's activity about which little has been said, [and] that is his interest in youth."[15]

Beaulieu's research highlights Mersenne's propensity for identifying and encouraging young provincial talent. It is, he argues, an expression of his identity and of the responsibilities of his religious vocation. In this pedagogical task, Mersenne, "un moine passionné de musique, de sciences, et d'amitié," reconciled his penchant for intellectual studies with the ambivalent view of "profane work" held by his order.[16] He believed that a completed knowledge of the sciences was a task of devotion and that undiscovered talent would help accumulate it. Central to Mersenne's vision was mathematics. A key to its accomplishment was young talent.

The Beatific Completion of Mathematics: Mersenne's Vision

Mathematics as Epistemological Foundation

Peter Dear, in his *Mersenne and the Learning of the Schools*, describes what he calls Mersenne's "mathematical agenda for natural philosophy."[17] At its core, it was "an alternative mathematical natural philosophy to replace essentialist physics."[18] A critical part of scholastic education during the early modern period was the certainty and utility of mathematics. According to Dear, Mersenne's educational experience at La Flèche, and these views of mathematics in particular, shaped the trajectory of his career. For Mersenne, mathematics

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[15] "Il est un aspect de l'activité de Mersenne dont on a assez peu parlé, c'est celui de son intérêt pour la jeunesse," Mersenne, *Correspondance*, 15:35.

[16] The quotation is from the title of an article, Armand Beaulieu, "Un moine passionné de musique, de sciences et d'amitié: Marin Mersenne," *XVIIe siècle* 41 (1989): 167-193.

[17] Peter Dear, *Mersenne and the Learning of the Schools* (Ithaca, NY, 1988), 47.

[18] Dear, *Mersenne*, 72.

(including arithmetic, geometry, music, and astronomy) was paradigmatic, the most useful for grounding other types of knowledge.

In Mersenne's *La vérité des sciences contre les sceptiques ou Pyrrhoniens* (1625), mathematics plays the central role in overcoming the arguments of the skeptics, who deny the possibility of certain knowledge. He calls mathematics "the sciences very-certain and very-true in which suspension [of judgment] does not at all find a place."[19] For most of this dialogic work, the "Christian Philosopher" (the voice of Mersenne) answers the questions and challenge of the "Skeptic" about the foundational status of mathematics.[20] Mathematics, Mersenne argues, is necessary to understand philosophy, medicine, alchemy, cabalism, politics and jurisprudence, and mechanics.[21] One may not neglect the study of this discipline, the Christian Philosopher claims, without risking exclusion from the genuine community of the learned, just as Plato refused entry to his academy to those "ignorant in geometry."[22]

The importance of geometry was not only classical but Christian. Knowledge of mathematics is the characteristic trait of the only voice in the book labeled "Christian." Mathematics, especially geometry, provides unique access to the divine: as an analogy for God and as a mirroring of God's thoughts. Mathematics is an aid to religious maturity. The mid-1630s organization by Mersenne of the so-called "académie toute mathématique" is the manifestation of a belief in both the supremacy and orthodoxy of mathematical knowledge.

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[19] Marin Mersenne, *La vérité des sciences contre les septiques* (Paris, 1625).

[20] Mersenne considers such diverse areas as the ratio of the elements in the world and the analogy between different types of ratios and different political systems.

[21] Mersenne, *La vérité des sciences*, 235-247.

[22] "Let us now see its necessity [i.e., mathematics], and its utility, which are so great that Plato would not admit anyone to his Academy [Académie] who was not a Geometer . . . ;this is why he sent away someone who would be his disciple, . . . for you do not have the handles [*anses*] (that is, the knowledge of Mathematics, which is necessary to understand Philosophy) . . . they lead the understanding to the truth, soften it, tame it, excite it, lead it, raise it, and transport it to the contemplation of abstract, intellectual, and divine things," ibid., 233.

Mathematics as Divine Science

God and mathematical objects

Although Mersenne emphasized the importance of mathematics as a foundation for human knowledge, he also directly links God and mathematics, stressing connections between God and mathematical objects. In *La vérité des sciences*, for example, Mersenne develops an analogy between God and unity. Both, he states, are able to generate an infinite number of elements from their ultimate simplicity. Mersenne's analogy is linked to a theological issue of a particularly enduring quality. A strict, orthodox monotheism must emphasize God's unity. Ontologically, he is without parts and cannot be separated. Yet God is also considered the source of the plenitude of creation. The problem of the Many arising from a simple, complete one created perennial theological difficulties, not least of which what Arthur O. Lovejoy has called "two antithetic kinds of being.": a "complete" God absolutely independent of creation and the God that has a need of the world as the emanation of his goodness.[23] Neoplatonic notions of the world as an emanation of God were translated with difficulty into an account that made sense within the Genesis account of creation *ex nihilo*. Through the mathematical analogy, Mersenne gives an example of how a simple entity is capable of engendering a creative multiplicity, an approach that mirrors Nicolas of Cusa's approach toward the One-Many problem.[24] And since mathematics is separate from material reality, it represents the intellectual productivity of God

[23] Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (New York, 1936), 315.

[24] John H. Gay, "Four Medieval Views of Creation," *The Harvard Theological Review* 56 (1963), 265-270. In his article, Gay compares the views of Augustine, Pseudo-Dionysius, Thomas Aquinas, and Nicolas of Cusa on the unity-multiplicity question.

and maintains the freedom of the Creator to actualize only the intellectual manifestations that he chooses.[25]

Mersenne claims that the correspondence between God and unity, representing as it does both parsimony and plenitude, is a fitting way to approach the perennial difficulty of the Christian doctrine of the Trinity.[26] Another similar mathematical-theological correspondence is between the circle and God. Like the circle, "God is always uniform . . . , and has neither end nor beginning, for he is eternal."[27] These most basic mathematical objects of arithmetic and geometry demonstrate the proximity Mersenne perceives between mathematical properties and the transcendent truths of Christianity and suggest that the creative work of enunciating the principles of mathematics is an act in imitation of the Creator.

God the transcendent geometer

The infinite generativity of unity and the circle are evidence that Mersenne uses to demonstrate the transcendence of mathematics. Transcendence is not limited to what mathematics and the divine create. Mathematical objects also transcend human understanding,

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[25] Cusa also uses mathematical analogy in order to escape the problem of material multiplicity. Cusa highlights the importance of the unity of the straight line, triangle, circle, and sphere when considered to the point of infinity: "The learned ignorance . . . uses the analogy of mathematics, which, already free from materiality, leads to the perfections of infinity. For instance, the straight line, triangle, circle, and sphere, when allowed to expand without limit, are one at infinity," ibid., 266.

[26] "[I]t is very right to compare unity to God, in as much as unity eminently contains all the perfections which are in numbers, as God contains all the perfections of the creatures and nonetheless unity is simple and unique, as God is very simple and very unique in his essence, notwithstanding that he is three in persons," Mersenne, *La vérité des sciences*, 669.

[27] "Dieu est tousiours vniforme . . . , & n'a ni fin ni commencement, car il est éternel," ibid., 762. Cusa describes the Trinity in terms of geometrical analogy, again leading back to ultimate simplicity. He gives a specific explanation for God's "threeness," as Gay explains: "There must be three and only three persons in the Trinity, since the triangle is the plane figure with the minimum number of sides, and is the simplest plane figure which coincides with the unity of the straight line at infinity. Moreover, the Unity in Trinity contains all things because the circle is the polygon with an infinite number of sides, and becomes a straight line when its radius becomes infinite," Gay, "Four Medieval Views of Creation," 267.

setting the stage for belief in a God who is beyond sense experience and human imagination. The figure of the circle serves as an example emphasizing the eternity of God and his simplicity.

The goal is in part apologetic, as it suggests the necessity of a divine mind superior and incomprehensible to the human mind.[28] The clearest demonstration of the transcendence of mathematics is the failure of the many attempts to find the exact proportion between the diameter and circumference of the circle and, therefore, the square that equals the area of the circle. This human inability to discover the quadrature of the circle, despite the pursuit of so many great minds, serves to point to "someone more *savant* than all men." This sort of potential mathematical knowledge, which exceeds the power of human beings, proves the existence of a "power or active understanding which could know them."[29]

Knowledge of the quadrature of a circle, Mersenne claims, is found in this powerful "active understanding" (i.e., God, the Divine Geometer). During the seventeenth century, a quotation from the *Book of Wisdom* often served to reinforce God's geometrical tendencies: "God made all things in number, weight, and measure." The language of "God's two books" (the book of revelation and the book of nature) extends this same theme. The book of nature, Galileo claimed, is written in the language of mathematics.[30] The two books of God, read side

[28] Cf., Pascal's statement in the *Pensées*, Brunschvicg, no. 267: "La dernière démarche de la raison est de reconnaître qu'il y a une infinité de choses qui la surpassent," Brunschvicg *OC*, 13:196.

[29] "[I]l faut necessairement qu'il y ayt quelqu'vn plus savant que tous les hommes, qui la cognoisse, car pourquoi ces difficultez auroient elles vne puissance passiue pour estre cognuës, s'il n[']y auoit aucune puissance, ny aucun entendement actif qui les peut cognoistre?" Mersenne, *La vérité des sciences*, 764.

[30] "Philosophy is written in this grand book–I mean the universe–which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth," Galileo Galilei, *The Assayer* (Rome, 1623), in *The Controversy on the Comets of 1618*, trans. Stillman Drake (Philadelphia, 1960), 183-184.

by side, could yield a fuller picture of God's creation.[31] Exploring this composite picture and perceiving God's role as Geometer could, as Johannes Kepler believed, reveal the deep wisdom of the Creator. For Kepler and others, the cosmos must be seen as designed according to a rational, mathematical plan. Kepler was convinced that the five regular geometrical solids were essential for understanding planetary movements. No unschooled artisan could construct such a system, for it required a mathematical design. Like the Demiurge in Plato's *Timaeus*, Kepler's God created the world according to mathematical patterns. But Plato saw the Demiurge as a divine artisan following a preexisting pattern in an ideal world of forms and limited because of the recalcitrance of that matter. For Kepler, the Creator is also the Divine Geometer, out of whose mind come geometrical principles. God's geometrical design trumps the limitations of matter. Geometry was indispensible for the imitation of God in genuinely creative endeavors.[32]

Mathematics as Imitation of God

Apprenticeship to a divine artisan

Just two years prior to his writing of *La vérité des sciences*, Mersenne wrote *L'usage de la raison*. Here he argues that human beings are capable of imitating God's essence by imitating his actions, a theme that he would develop specifically for mathematics in *La verité des sciences*. The goal of the soul is perfection, and it is attained by becoming an apprentice to the Divine Master:

> I do not want to stop myself at the essence of these faculties, let us pass to their operations, which seem to represent more from life [realistically - as in a painting] the eternal secrets

[31] Kenneth J. Howell describes Mersenne's view of the two books with respect to the Minim's *Quaestiones celeberrimae in Genesim*: "Genesis gave truth about nature, but only science can detail the structure of nature through empirical inquiry," *God's Two Books: Copernican Cosmology and Biblical Interpretation in Early Modern Science* (Notre Dame, IN, 2001), 37. Howell's work focuses on how theologians during the early modern period handled scripture when dealing with the question of planetary theories, such as those of Nicholas Copernicus and Tycho Brahe.

[32] Arthur Koestler provides a brief, documented description of Kepler's Pythagorean impulses in Arthur Koestler, *The Watershed: A Biography of Johannes Kepler* (New York, 1960), 59-65.

> of divinity; for I perceive nothing in this infinite essence, that our soul cannot imitate, and know nothing through which it can perfect itself further, than through this imitation, since its perfection consists in rendering itself similar to this immense archetype, as the perfection of an apprentice consists in imitating the canvas, the example, the edifice, or the painting of his master, until he makes his work similar to the prototype, which has been proposed to him.[33]

Mersenne depicts God as Master Artisan, whose masterpiece (the universe) is on display to human beings. The human being approximates God's perfection by reasoning and working in ways that mirror the operation of God's own faculties.

For Mersenne, as we have seen, the simplicity, complexity, fruitfulness, and incomprehensibility of mathematics help reveal God to humans. But applying oneself to the problems, solutions, and uses of mathematics also moves the mind to a self-transcendence that approximates the divine nature:

> For there is no Science, after Theology, which proposes to us, and makes us to see, so many marvels as Mathematics does, which elevates the mind above itself, and forces us to recognize a divinity; for Statics, Hydraulics, and Pneumatics produce such prodigious effects, that it seems that men can imitate the most admirable works of God.[34]

Through the imitation of the Master Geometer, individuals who exercise their capacity for mathematics come closer to the perfection of God.

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[33] "Je ne veux pas m'arrester à l'essence de ces facultez, passons à leurs operations , lesquelles semblent representer plus au vif les secrets eternels de la divinité; car je n'apperçoy rien dedans ceste infinie essence, que nostre ame ne puisse imiter, et ne sçay rien par quoy elle se puisse perfectionner davantage, que par ceste imitation, puis que sa perfection consiste à se rendre semblable à cet immense archetype, comme la perfection d'un apprentif consiste à imiter le tableau, l'exemple, l'edifice, ou la peinture de son maistre, jusques à ce qu'il face son ouvrage semblable au prototype, qui luy a esté proposé," *L'usage de la raison*, 79-80.

[34] "Car il n'y a point de sciences, apres la Theologie, qui nous proposent, & nous fassent voir tant de merueilles comme font les Mathematiques, lesquelles éleuent l'esprit par dessus soy-mesme, & le forcent de reconnoistre vne diuinité; car la Statique, l'Hydraulique, & la Pneumatique produisent des effets si prodigieux, qu'il semble que les homes puissent imiter les oeuures les plus admirables de Dieu," Mersenne, preface to *La vérité des sciences*, n.p. [6].

Actualizing the infinite potentialities of mathematics

Linguistically, "perfection" and "completion" are closely related.[35] For Mersenne, as for most early modern Europeans, perfection was the potentiality that has become actuality. The mathematician who uncovers a multiplicity of propositions and applications is actualizing the infinite potentialities of mathematics in the human realm. The accumulation of these mathematical accomplishments progressively approximates the perfection of God's own geometrical reasoning. As "mediator" and "intelligencer" within the seventeenth-century learned community, Mersenne encouraged the collective attainment of this perfect knowledge. Mersenne's great contribution to the science of his generation, according to contemporaries and historians, was his ability to pose questions and to promote research of theory, instrumentation, and application. In so doing, he also promoted the religious task of assisting the Master in the technical education of humanity. His collection and dissemination of the work of scholars, including those formerly unknown, created a cascading effect of multiplied results, moving progressively toward a perfected mathematics.

Approximating the heavenly state

For Mersenne, there is a clearly religious significance in the pursuit of the mathematical sciences. In seeking this perfection, one draws closer to the state of beatitude. This is the religious grounding for encouraging others.[36] He suggests this motivation in *La vérité des sciences*, in a discussion of a number theory problem:

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[35] Oliva Blanchette provides an analysis of *perfectum* as it relates to the work of Thomas Aquinas and his views on the perfection of the universe. At its heart, perfection is the end-point of a process of becoming: "It is not becoming alone that gives us the idea of per-fection, but a becoming that has reached a certain completion, where nothing of the process remains to be done," Blanchette, *The Perfection of the Universe According to Aquinas: A Teleological Cosmology* (University Park, PA, 1992), 42. For a detailed analysis of the term, especially as it relates to the work of Aquinas, see Blanchette's Chapter 1, "The Original Meaning of Perfection," ibid., 41-73.

[36] Robert Lenoble writes: " . . . surtout la science n'est-elle pas l'annonce et comme les prémisses de la béatitude?" *Mersenne ou la naissance du mécanisme* (Paris, 1943), 75.

> I would strongly desire that some excellent Mathematicians would study to find some method by which one could find the root of each number, only seeing the number of characters, in order that as one knows by the number of points subscribed how many characters the root ought to have . . . I believe that this understanding, and this method is not impossible, and that it is contained in the perfection of the science, just as the quadrature of the circle, and the Geometric invention of two mean proportional lines are contained in the science of Geometry: consequently, the Angels know all these difficulties perfectly, and we will likewise know them when it pleases God to take us to the ranks of the blessed.[37]

For Mersenne, even the pursuit of seemingly esoteric mathematical knowledge is important in itself. In an ever-increasing comprehensiveness, this work approximates the ultimate heavenly state of the blessed. The approximation and multiplication imitates the handiwork of the Divine Artisan.[38] Mersenne's proposal for the spiritual task of geometry was put into practice by members of his mathematical academy.[39]

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[37] "Or ie desirerois fort que quelques excellens Mathematiciens s'estudiassent à treuuer quelque methode, par laquelle on peût treuuer la racine de chaque nombre à la seule vûe du nombre des characteres, afin que comme on sçait par le nombre des points souscrits combien la racine doit auoir de caracteres . . . . Ie croy que cette cognoissancce, & cette method n'est pas impossible, & qu'elle est contenuë dans la perfectio[n] de la scie[n]ce, aussi bien que la quadrature du cercle, & l'inuentio[n] Geometrique de deux ligne moye[n]nes proportionelles est contenuë dans la science de la Geometrie; par consequent les Anges sçauent parfaictement toutes ces difficultez, lesquelles nous cognoistrons pareillement lors qu'il plaira à Dieu nous mettre au rang des bien-heureux," Mersenne, *La vérité des sciences*, 666-667. Also regarding the state of beatitude engendered by geometry, Mersenne writes: " You tell me perhaps that sciences do not treat infinite things: but I respond to you that the Geometer does not make a habit of discoursing on the imperfect infinity of these parts, or of these points of quantity, he contents himself with the magnitude that is finite, nonetheless restricting himself only by eternity itself, to which he cannot attend; this is why, if he is wise, he will in this way treat gently his operations, and all his labor, that he will connect all to this eternity, in order that after having *pourmené* his mind among the finite country of its propositions, and of its problems, and having served God in his art of making lines, he enters into this new world, which has no restrictions but eternity, in which there is more contentment in a moment, than he could have here of it in an infinity of years," ibid., 729-730.

[38] Later in his life, Mersenne would publish a series of three works that are an expression of this attempt to give an all-encompassing picture of areas of investigation in physics and geometry and to uncover God's vast canvas of natural philosophy. A series of three works gives a summary of all the fields for which Mersenne advocates further study, Marin Mersenne, *Cogitata Physico Mathematica* (Paris, 1644); idem, *Universae geometriae mixtaeque mathematicae synopsis* (Paris, 1644); idem, *Novarum Observationvm , physico-mathematicarvm, tomus III* (Paris, 1647).

[39] An example is the work of Claude Mydorge, one of the original members of Mersenne's mathematical academy. Mydorge's *Traité de géométrie* is a manual of geometrical constructions. The author demonstrates how the geometer may, with compass and straightedge, construct progressively more complex figures. Among over one thousand figures for which Mydorge gives instructions are a tetradecagon (a fourteen-sided figure) and an egg shape, which Mydorge labels "orbe difforme." The complexity of these instructions demonstrates how necessary it was that geometers be a talented manual worker with a compass, Bibliothèque Nationale, Paris, fonds français 656.

The motivation for moving towards God's perfection in mathematics is important because it brings together the technical pursuit of mathematics (the solving of individual problems and types of problems) and the broader pursuits of the Christian Philosopher, who seeks above all the establishment of the faith through knowledge and behavior. Mersenne believed deeply in the virtue of seeking comprehensiveness that approximates God's completion. Pascal's years of apprenticeship with the Mersenne Circle taught him about the unbreakable link between virtue and the proper practice of the savant.[40] For Mersenne, the mathematician who seeks the state of beatitude (that comes with the discovery of all the results of a particular proposition) is engaging in the same virtuous work as the penitent engaged in true repentance. By claiming that the exercise of mathematics led to beatitude, Mersenne could answer questions about the importance of technical mathematics to spirituality. As Pascal's life shows, however, later experiences led him to a significant parting of ways with Mersenne on this matter. Subsequent to Mersenne's death, as this study will show, Pascal reevaluated this relationship and ultimately labeled mathematics as "only a *métier*."[41]

Finding Talent in Unexpected Places

Recruiting the "Best Minds" to Perfect Mathematical Disciplines

Mersenne expresses his desire for the completion of mathematics by articulating his hope that potential talents not yet involved in the project would come forward. This is evident from an expression of Mersenne's hopes for music, one of the Pythagorean quadrivium of mathematics. In the dedication of the treatise *Des orgues* in his *Harmonie universelle,* Mersenne exhorts Étienne Pascal, Blaise's father, to use his skill in music to give it a solid learned foundation. He

[40] The relationship between virtue and scholarship during the early modern period has been pursued, among other studies, in Peter N. Miller, *Peiresc's Europe* (New Haven, CT, 2000). See note 27 in this chapter for further consideration of virtue and spirituality in connection with mathematics.

[41] See below, pp. 327-333.

urges Étienne to "put the final touches" [*mettre la dernière main*] to music as an expression of his hopes for its perfection:

> I hope that the rare experiments [Fr. *expériences*] that you meet in this book will convince you to seek the reasons for them, for they merit the study of the best minds, in addition to which you possess to such a high degree all the hidden resources of the most subtle analysis . . . This is why I dare to promise to all those who cherish the Muses that you will soon put the final touches to this part of philosophy, so that it might no longer fear to appear before the most learned [Fr. *plus savants*] in the company of the other sciences . . . It longs to be a participant in the certitude of geometry and arithmetic, if possible, so that its principles might not be able to be contested by Pyrrhonians and doubters.[42]

Mersenne believed music deserved to be "perfected" like the other branches of mathematics. Music was important because it imitated divine works in several ways. Perhaps most obviously, Mersenne saw music's unmatched potential for influencing human affections and behavior. This capability of music to have profound, even spiritual effects on human beings particularly animates Mersenne's *Harmonie universelle*. It is an expression of a Pythagorean tradition that stretches unbroken from antiquity.[43] The Pythagorean tradition stressed the powerful psychological influence of music, with legends of Pythagoras and others illustrating the ancients' mastery of musical manipulation.[44] Pythagoras's heirs, including Ficino, continued to highlight these effects, music's ability to move people toward the divine.[45]

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[42] "J'espère que les rare expériences que vous rencontrez dans ce livre vous convieront à en rechercher les raisons, car elles méritent l'étude des meilleurs esprits, joint que vous possédez à un si haut point tous les ressorts de la plus subtile analyse . . . . C'est pourquoi j'ose promettre à tous ceux qui chérissent les Muses que vous mettrez bientôt la dernière main à cette partie de la philosophie, afin qu'elle ne craigne plus désormais de paraître devant les plus savants dans la compagnie des autres sciences . . . . Elle désirerait d'être participante de la certitude de la géométrie et de l'arithmétique, s'il était possible, afin que ses principes ne lui puissent être contestés par les pyrrhoniens et les doutants . . . ," Mersenne, *Harmonie universelle*, "Traité des instruments à chordes," Dedicatory letter for the "Traité des orgues," excerpted in Mesnard, *OC,* 2:121.

[43] The tradition includes Augustine, who, Brian Brennan argues, saw music "as the pattern for a well ordered life," "Augustine's 'De musica'," *Vigilae Christianae*, 42 (1988), 270.

[44] Yates, *French Academies*, 38. One of Mersenne's correspondents, Jean-Baptiste Doni, wrote to Mersenne, arguing that the abilities of the ancients in this regard was so great that the moderns can never hope to achieve it, Jean-Baptiste Doni to Marin Mersenne, 27 February 1636, Mersenne, *Correspondance*, 6:30.

[45] Yates, *French Academies*, 40.

Mersenne had also been inspired by the sixteenth-century musical academy of Baïf. He sought what he believed to be a divine goal of using music to bind together mathematical knowledge of the world.[46] The Pythagorean tradition stressed the harmony embodied in music as guiding the design of the cosmos, thus mirroring its structure and providing a portal to divine knowledge. It was therefore a fitting instrument for the communication of all types of knowledge. If there appeared a "perfect musician," Mersenne argued, that individual "could invent dictions, and a perfect language, which naturally signifies things."[47]

Music was universally constitutive of natural truth because of its relationship to God as divine designer, who works according to harmonies and ratios. Mersenne's *Harmonie universelle* quotes the passage from the *Book of Wisdom* to argue that music, like the rest of mathematics, is capable of comprehending all knowledge of the physical world:

> It is again quite easy to conclude that one can represent all that is in the world, & consequently all the sciences by means of Sounds, for since all things consist in weight, in number, & in measure, & [since] Sounds represent these three properties, they can signify all that one could wish.[48]

Nature, written in the language of mathematics, may be communicated through music, and this dissemination of knowledge was linked to the spiritual importance of the effects of music. It

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[46] Yates's description of Mersenne's intellectual pursuits highlights the importance of Baïf to the Minim. Yates's Mersenne was primarily motivated by the desire to establish a Baïfian academy of music to unify knowledge, but these hopes were disappointed. While Yates mentions Mersenne's large informal "academy" of acquaintances, her examination of Mersenne ends with the year 1635 and the founding of the *Académie Française*. She does not acknowledge (perhaps for lack of the later volumes of Mersenne's *Correspondance*) the "académie toute mathématique," announced in 1635 and that seems to have been a smaller, more organized cadre of individuals, Yates, *French Academies,* 284-290.

[47] Marin Mersenne, *Harmonie vniverselle contenant la theorie et la pratiqve de la mvsiqve* (Paris, 1636), Book 1, "De la nature & de proprietez du Son," 43.

[48] "Il est encore bien aysé de conclure que l'on peut representer tout ce qui est au monde, & consequemment toutes les sciences par le moyen des Sons, car puis que toutes choses consistent en poids, en nombre & en mesure, & que les Sons representent ces trois proprietez, ils peuuent signifier tout ce que l'on voudra . . . ," Mersenne, *Harmonie universelle*, Book 1, "De la nature & de proprietez du Son," 43. Yates sees this idea of Mersenne's as a clear link between Mersenne and the academies of the sixteenth century, which envisioned music as "the image of the whole encyclopaedia," Yates, *French Academies*, 87, 285.

is not only intellectual knowledge that is communicated in this way. Human beings are "musical" creatures because they are spiritually linked to the unified cosmos.[49] The effects of music were spiritual, not just psychological. Human beings could resonate with music as a part of the created order, experiencing moral amelioration and even oneness with God. They could reach a state of blessedness. Mersenne's writings are replete with references to possible devotional uses of music.[50]

Mersenne pled for Étienne Pascal to make use of his particular aptitude for the study of music, therefore, based on an appeal to the religious ends of the culmination of mathematical knowledge. Mersenne clearly stated his hopes for and the expectations that he had of the elder Pascal, whom he considered one of the "best minds" [*meilleurs esprits*]. He represented Étienne Pascal as the advocate for an important cause.

In his dedication to the elder Pascal, Mersenne presented the image of music as one among a number of conferees in "the company of the . . . sciences", and this designation underscores Mersenne's goal to bring every area of mathematics to a state of fulfillment. By working for the completion of all of the subdisciplines of mathematics, the certainty of the entire domain would be actualized. Throughout his life, Mersenne expressed the hope that music would become a

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[49] There is here the continuation of the macrocosm/microcosm idea that is articulated at length in medieval and Renaissance literature about position of humanity within God's creation. Ernst Cassirer sees Nicolas of Cusa as an important point of departure, being followed in turn by Marsilio Ficino, Pomponazzi, and others, *The Individual and the Cosmos in Renaissance Philosophy* (New York, 1963), 40, 64, 109ff.

[50] For example, Mersenne writes in a dedicatory letter in his *Harmonie universelle*: "That it fills with joy those who are already carried to rejoicing, comforts those who are in sadness and, what is further, it explains through a marvelously efficacious eloquence the mysteries of Religion in singing the praises of God, which is the sole means that we have been able to invent in order to express the recognition of the benefits that we receive from his liberal hand and the only thanks that we can say to him for it," Mersenne to Coutel (September 1627), Dedicatory letter to Mersenne, *Harmonie universelle*, Book 2, in Mersenne, *Correspondance*, 1:577.

"certain" field of knowledge.[51] He appealed to Étienne Pascal as one whose talent had not yet been put to full use.

Recovering Ancient Analysis: Searching for "New Archimedeses"

Mersenne's description of "what is necessary in order to be an excellent Geometer", in Book IV of *La vérité des sciences*, provides further evidence for his approach to perfecting all of mathematics. As with music, the baseline is the ancients. Mersenne states that being "an excellent Geometer" begins with knowledge of a large number of ancient mathematical works. The final aim, he states, is to comprehend all of the works (31 books total, including ones by Euclid, Apollonius, Aristae, and Eratosthenes) and combine them into a summary and reconstitution of the so-called "Analyse des anciens." The discovery of this analytical method, or the means by which the ancients discovered results, would complete what was available through the synthetic presentation of those ideas in their works. With such knowledge would come the ability to solve all sorts of problems "in what pertains to corporeal & visible things, & to their properties."[52] The process begins with one's understanding all of the component parts of ancient geometrical knowledge. Then, one must attempt to simplify and "perfect" them through the discovery of general methods and theorems, which may then be used to solve a multitude of problems.

A recovery of this ancient method of analysis was pursued, among others, by François Viète, that pioneer in algebraic notation, and his disciple, Alexander Anderson. Both of them died, Mersenne says, before bringing the project to fruition. The language Mersenne uses to describe these two individuals suggests their position as modern-day "prophets" in the divine

[51] Numerous letters within Mersenne's correspondence attest to Mersenne's status as "Un moine passionné de musique," Beaulieu, "Un moine passionné."

[52] "en ce qui appartient aus choses corporelles, & visibles, & à leur proprietez," Mersenne, *La vérité des sciences*, 749.

cause of the perfection of mathematics. Much like biblical prophets, however, their work was rejected. By way of response, God removed these sources of revelation:

> [T]hese torches having been extinguished at nearly the same moment that they had begun to explode through the universe, as if the night of our ignorance, or the ingratitude & misunderstanding of men had been unworthy of being enlightened by such excellent lights.[53]

The loss of these great men was due to the general unresponsiveness of their time; nevertheless, it "left the learned [*savant*s] in regret," the faithful remnant in the cause of completing the ancients.[54]

Mersenne, a representative of this little mathematical band, invokes a divinely ordained nativity of successors to the cause:

> May it please God to cause to be born again in this century some new Archimedeses, who [will] lead Mathematics to their last perfection, & who [will] impose an eternal silence on the many ignorant [people] who want to persuade the world through their sophisms, & paralogisms, that they have found the *quadrature of the circle, the duplication of the cube, the trisection of the angle*, and have recognized several errors in the definitions & propositions of Euclid, even though most of these reckless [ones] not know either the very first terms of Geometry, or the [proper] way of speaking about it.[55]

Mersenne is thus alert for talent that might contribute to the perfection of mathematics and thereby provide a strong weapon against the skeptics. When this talent is discovered, as Mersenne later makes clear, it must be "employez" and "caressez" through patronage.

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[53]"ces flambeaux ayant esté quasi aussi tost esteints, qu'ils ont commencé à éclatter par l'vniuers, comme si la nuict de nos ignorances, ou l'ingratitude, & m'escognoissance des hommes eust esté indigne d'estre esclairée par de si excellentes lumieres," ibid., 750.

[54] "[I]ls ont laissé vn regret aus sçauans, & une perte forte signalée a toute l'Europe," ibid.

[55] "Plaise à Dieu de nous faire renaistre en ce siecle quelques nouueaux Archimedes, qui conduisent les Mathematiques iusques à leur derniere perfection, & qui imposent vn silence éternel à quantité d'ignorans qui veulent persuader par leurs sophismes, & paralogismes, qu'ils ont treuué la *quadrature du cercle, la duplication du cube, la trisection de l'angle*, & reconu plusieurs erreurs dans les definitions, & propositions d'Euclide, bien que la pluspart de ces temeraires ne scachent pas seulement les premiers termes de la Geometrie, ni la maniere d'en parler," ibid., 750.

Throughout his life, Mersenne lent intellectual support to talented individuals through his letters and writings. In his *académie*, he solidified a group of individuals that could be recognized as authoritative by those with political power and influence.[56] Moreover, the group could be an instrument through which his project of expanding upon the methods and work of ancient Greek mathematicians could be propagated. The project would unite learned mathematicians in common cause. But it would exclude those who ignorantly and rashly claimed superiority over Euclid and other ancients.[57]

By including a young man such as Pascal, Mersenne's academy prepared for the future elaboration of its mathematical goals. Mersenne's desire to find "new Archimedeses" indicates not merely those whom he already considers to be fine mathematicians, but also those, such as Pascal, who were not yet known.[58] His attitudes toward those located in the provinces and his involvement with young people highlight the importance he accords to harvesting undiscovered talent.

Promoting Provincial Talent

Mersenne was well-acquainted with a number of individuals throughout France and his epistolary exchanges reveal the value he assigned provincial savants. Some of his learned correspondents were renowned scholars: Gassendi, Fermat, Peiresc, and Florimond de Beaune (at Blois). But he also exchanged ideas and encouraged the work of a host of less well-known

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[56] This recognition was already begun by the time of Mersenne's announcement to Peiresc, for it was among these individuals that were chosen the mathematical experts for the official judgment of Morin's method of obtaining longitudes.

[57] Mersenne follows the preceding passage with a direct statement of exclusion: "C'est pourquoy ie scay fort bon gré aux excellents Geometres de ne vouloir pas conferer auec eux, ni mesme les écouter, de peur que par ceste condescendence on croye qu'ils approuent l'ignorance de ces temeraires," Mersenne, *La verité des sciences*, 750.

[58] Mersenne writes of the current crop of mathematicians: "Nous auons maintenant quantité de personnes qui pourroient faire quelque chose de bon touchant la resolution, & la composition, mais il n'y a personne, qui les employe, & qui leur fournisse ce qui est necessaire pour venir à bout d'vn tel oeuvre," Mersenne, *La vérité des sciences*, 751.

individuals, among them Christophe Villiers at Sens (particularly interested in music) and L. Meyssonier at Lyon (medicine). Mersenne communicates his admiration of provincial intellects in a letter written to Peiresc in 1635:

> I have seen a short time ago two men, one raised with the Toulousians since 12 years of age, although Champenois [by birth], and the other from Bar-sur-Seine, who have through their discourse confirmed me in my opinion, that there are often from small towns some gentlemen who surpass nearly all those that are esteemed knowledgeable, particularly in certain parts of the arts and science, which they have found through their fine genius rather than in books.[59]

Mersenne was already convinced that there was genius ripe to be harvested in the provinces, and he cites as evidence these two men who were gifted in the connections between music and mathematics. The intellectual ability to undertake and solve complex and important questions does not require living in Paris, usually viewed as the center of learned society. Mathematical learning was not "native" to a particular region and natural talent could not fully impart the characteristics necessary to progress in mathematics.

Mersenne wrote that what these provincials attained was accomplished primarily through personal initiative and was superior to many who were taught in schools.[60] Self-education through experience and reason was the result of concerted application and was preferable, Mersenne stated, to the bookish learning emphasized in the schools. The training of Pascal, it will become clear, followed this informal mode of training. It stressed the compatibility of individual inclination with purposeful study and disciplined exercise.

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[59]" J'ay veu depuis peu deux hommes, l'un nourri avec les Toulousains depuis l'age de 12 ans, quoyque Champenois, et l'autre de Bar-sur-Seine, qui m'ont confirmé par leur discours dans mon opinion, qu'il y a souvent es petites villes des gens qui surpassent quasi tous ceux qu'on estime sçavoir particulierement en de certaines parties des arts ou des sciences qu'ils ont plustost trouvees par leur bon genie qu'apprises dans les livres," Marin Mersenne to Nicolas-Claude Fabri de Peiresc, 15 July 1635, Mersenne, *Correspondance*, 5:301. In his footnote, Cornélis de Waard identifies the probable identity of the two men of which Mersenne writes: Jean le Maire and Jean Gallé, n. 2, 3.

[60] Mersenne to Peiresc, 15 July 1635, Mersenne, *Correspondance*, 5:301.

For those who lived in Paris conferences such as those hosted by Mersenne were a central form of communication. For inhabitants of the provinces, books served as one means to organize learned culture.[61] A form of communication not considered by Eisenstein is personal correspondence, such as that carried on by Mersenne. It could communicate essential problems with greater currency than print, and could also be used as a gauge of potential, still unknown savants.[62] This undiscovered talent was not dependent on bookish learning, Mersenne suggests in his discussion of provincials. Results and quality of mind were the determinate factors for significant contributors to learning and specifically to mathematics.

Mersenne hoped that the maturation of knowledge would occur through the application of fine minds to an array of significant questions. He guided individuals to those questions through his correspondence and published works. Pascal would write, after Mersenne's death, that "he has provided the occasion for several fine discoveries, which perhaps would never have been made if he had not excited the savants to them."[63]

The talented child was the archetype of those whose knowledge was, as Mersenne wrote, "through their fine genius rather than learned in books."[64] Who more appropriate to "excite" to fine discoveries than the young, whose interests and talents may more readily be shaped?[65]

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[61] Elizabeth Eisenstein has provided the most provocative statement of the importance for print culture on the emergence of new views of nature, Eisenstein, *The Printing Revolution in Early Modern Europe* (New York, 1983), 187-254.

[62] J. L. Pearl emphasizes the significance of letters, providing a corrective for Eisenstein's narrow focus on books in J. L. Pearl, "The Role of Personal Correspondence in the Exchange of Scientific Information in Early Modern France," *Renaissance and Reformation* 8 (1984): 106-113.

[63] The full quotation from Pascal's *Histoire de la Roulette* reads: "Il avait un talent tout particulier pour former de belles questions; en quoi il n'avait peut-être pas de semblable. Mais encore qu'il n'eût pas un pareil bonheur à les resoudre, et que ce soit proprement en ceci que consiste tout l'honneur, il est vrai néantmoins qu'on lui a obligation, et qu'il a donné l'occasion de plusieurs belles découvertes, qui peut-être n'auraient jamais été faites s'il n'y eût excité les savants," "Histoire de la roulette," Mesnard *OC* 4:214.

[64] Mersenne to Peiresc, 15 July 1635, Mersenne, *Correspondance* 5:301.

Mersenne's Investment in Youthful Talent

Mersenne's metaphorical description of music seeking to be accepted in "the company of the other sciences" provides a clue to his approach to undiscovered talent. Up to the time of his dedicatory letter to Étienne Pascal, Mersenne contends, music could only be considered as a junior member of the conference of the sciences because it was not yet a "participant in the certitude of geometry and arithmetic."[66] While clearly showing promise, music awaited a publication (e.g., from the elder Pascal's pen) that would articulate its principles and uses with a rigor not yet fully achieved. The personification of music as an understudy to other more certain disciplines parallels the position of the younger Pascal, who was viewed as a mathematical apprentice, not yet fully proven. The members of the Mersenne Circle groomed him to participate fully in the scope of its activities and in its prestige. But young talent had to be protected and cultivated. Mersenne did both.

Mersenne expressed his "intérêt pour la jeunesse" on both religious and intellectual levels.[67] From a religious perspective, the youthful tendency to spiritual deviancy awoke Mersenne's concern. Libertinage, in both belief and behavior, held a particular attraction for youths and made them susceptible to the "impiety of the deists."[68] In fact, recognizing that some youths are attracted to impious beliefs because they "see that this is the sentiment of the

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[65] Mersenne's approach to exposing promising minds to important problems seems to prompt Robert Mandrou's description of him as "no less a teacher than a savant," Mandrou, *From Humanism to Science, 1480-1700* (New York, 1978), 191.

[66] Mersenne, *Harmonie universelle*, "Traité des instruments à chordes," Dedicatory letter for the "Traité des orgues," excerpted in Mesnard, *OC,* 2:121

[67] The phrase is Beaulieu's, Mersenne, *Correspondance*, 15:35. Beaulieu considers Mersenne's relationship with young people more extensively in Beaulieu, "Un moine passionné," 181. He explores the characterization of Mersenne as pedagogue in idem, *Mersenne*, 50, 120-121, 129, 157, 294-295.

[68] The theme of godless youths is repeatedly found in Marin Mersenne, *L'impieté des deistes, athees, et libertins de ce temps combatuë, & renuersee de point en point par raisons tirees de la philosophie, & de la theologie* (Paris, 1624).

most learned [*sçavans*]," Mersenne made a particular effort to demonstrate the compatibility of learning and religion.[69] The literature of early modern Europe has many references to this youthful vulnerability to both moral and intellectual excess. Those sent away from home to study need oversight to protect them from the "licenses" of youth. Mersenne was keenly aware of this need. Indeed, when Descartes first met him in Paris, Mersenne's guidance helped "to detach him from the habits that he had for gaming and useless pastimes."[70] Worldly diversions were but a single step from religious libertinage.

Beaulieu's work on Mersenne also mentions frequent visits to the Minim convent by the young André Pineau, nephew of André Rivet, in order to deliver letters from the Dutch savant.[71] While there is no evidence to suggest a particularly close acquaintance between Mersenne and Pineau, Mersenne was certainly willing to sacrifice time for the young man: "I have seen and entertained Father Mersenne for the space of two good hours."[72] Thanks to the esteem in which the monk held his father, Claude Rivet (known as de Montdevis) also received Mersenne's attention. Their relationship was close enough that Mersenne could reprimand Claude for not showing respect to his father.[73] At the moment of their meeting, Mersenne was 40, Rivet 26.

Besides these passing but meaningful interactions, some also saw Mersenne as one who might take pains to locate a place of service for talented youth. In 1624, Claude Bredeau made appeal to Mersenne on behalf of an educated young man whose father had died:

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[69] "voyent que c'est le sentiment des plus sçavans," ibid., 122.

[70] "le détacher des habitudes qu'il avoit au jeu et aux passe-tems inutile," Baillet, *Vie de M. Descartes* (Paris, 1691), 1: 37.

[71] Beaulieu, "Un moine passionné," 181.

[72] "[J]'ay veu et entretenu l'espace de deux bonne heures le P. Mersenne," André Pineau to Claude Rivet, 21 December 1646, Mersenne, *Correspondance*, 14:694.

[73] Marin Mersenne to André Rivet, 17 September 1632, Mersenne, *Correspondance*, 3:332.

> [H]is mother believed that because of the frequent meetings that you have with so many learned [*doctes*] and rare persons, you could easily find work for him, where by doing service, he could augment the understanding that God has given to him.[74]

Jean-Baptiste van Helmont also wrote to Mersenne about his young son's unusual talent for artistically cutting paper with scissors, believing that Mersenne would find it fascinating. He was not disappointed.[75]

Two "New Archimedeses": Pascal and Christiaan Huygens

The above examples provide episodic evidence of Mersenne's eye for potential young talent. They are suggestive enough to have been noticed by Mersenne scholars, but incomplete enough to be questionable as a key factor in the narrative of his biography. But when one considers the role of Mersenne and his *académie* in Pascal's youth, and the parallels to Mersenne's mentoring of Christiaan Huygens, the pattern of circumstances stands out. Pascal and Huygens (two bright, young "Archimedeses") were the incarnations of Mersenne's hope for carrying out the project of the "completion" of mathematics. For both of these men, Mersenne was a challenging voice, an encouraging mentor, and a tireless promoter.

Mersenne and the youthful Pascal

Mersenne's acquaintance with Blaise Pascal began in 1635. Around this time, according to Pascal's sister and biographer, Gilberte Périer, Étienne's unexpected discovery of his son's

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[74]" . . . sa mere a creu que pour la frequentation que vous avez avec tant de doctes et rares personnages, facilement vous pourriez luy trouvez party, où en faisant service, il pourroit accroistre ce que Dieu luy a donné d'entendement," Claude Bredeau to Marin Mersenne, 11 December 1624, Mersenne, *Correspondance*, 1:186.

[75] Van Helmont is himself unclear about the boy's age - in the first letter, he says he is twelve; in the second, only eleven. The first passage is from a letter dated 12 January 1631: "je dis que les jolités que mon petit garçon d'un capriccie taille, n'est pas pour en tirer prouffict, mais ce n'est qu'une rarité en un enfant de douze ans, sans patron et sans art, qu'il couppe cela, signe qu'il seroit propre à desseigner," Jean Baptiste Van Helmont to Marin Mersenne, 12 January 1631, Mersenne, *Correspondance*, 3:31. The second letter reads: "Mon petit eagé de 11 ans prend d'une main le ciseau et de l'autre une loppe de papier ou parchemin sans estre deline ou pourtraict, coupe selon l'idee luy proposee, soit une histoire ou aultre phantasie. Et n'est merveille que l'on ne le croid pas, veu que les painctres d'Anvers le sont venu voir, ne croyant pas possible; toutefois il leur couppoit l'histoire d'Acteon," Jean Baptiste Van Helmont to Marin Mersenne, 30 January 1631, Mersenne, *Correspondance*, 3:53.

aptitude for geometry led to his attending meetings "where all the able gentlemen of Paris assembled to bring their works or to examine those of others."[76] Undoubtedly, this account refers to the Mersenne Circle. According to his sister, Pascal soon began submitting his own works to the group, while offering observations and critiques of others' productions. Sometimes, she writes with obvious pride, "he has discovered faults which the others had not perceived."[77] The problem of taking Gilberte's account of Pascal's life at face value is obvious when one considers the narrative as a whole and its attempts to sanctify every aspect of his character. It is possible that Pascal's performance was less thoroughly astounding than she portrays. In any case, Pascal's attendance at the meetings at that early age seems unproblematic. By the time of his *Essai pour les coniques* he was clearly held in high regard by Mersenne.

Blaise's father facilitated his entry to the group and his introduction to Mersenne. Étienne Pascal was associated with several of Mersenne's circle before the time at which Blaise supposedly joined them in their weekly meetings. The affair of Jean-Baptiste Morin's supposed discovery of a new method for calculating longitudes (1634-1635), reveals Étienne's close contact with Claude Hardy, Roberval, Le Pailleur, and Montmor, among others. Finally, the dedication of Mersenne's *Traité des orgues* in the *Harmonie universelle* (1635/1636) to Étienne, demonstrates a significant acquaintance between the two, especially since the elder Pascal was not a published writer.

The first recorded evidence of Mersenne's knowledge of Blaise's work is in late 1639, just prior to the printing of the *Essai pour les coniques* (1640). In a letter to Descartes (November 1639), the response to which is cited early in this chapter, Mersenne praises the young man's

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[76] "où tous les habiles gens de Paris s'assemblaient pour porter leur ouvrages ou pour examiner ceux des autres," "Vie de Pascal," Mesnard, *OC* 1:575.

[77]" il a découvert des fautes dont les autres ne s'étaient point aperçus," "Vie de Pascal," Mesnard, *OC* 1:575.

efforts in projective geometry. Though now lost, the content of this letter likely parallels another sent approximately one year later to Theodore Haak:

> [W]e have here a young man, a folio of whose *Coniques* I believe that I sent to you, who is such an excellent geometer, being only 18 years old, that he has brought together all the conic sections and the *Apollonius* in a single proposition, from which he derive 400 corollaries in such a way that not one depend on the other, but all, the last as well as the first, from that one proposition.[78]

Mersenne expresses in this passage the outlines of a project that is in harmony with his own goal to complete mathematics through seeking principles that encapsulate the massive learning of the ancients. In his later *Cogitata physico-mathematica* Mersenne states that Pascal's contribution to geometry is his all-encompassing method:

> [O]ne may note that Pascal the younger . . . has found a general method by means of which one ends by understanding what ratio the spaces limited by straight lines and conic curves have among them.[79]

In his response to Mersenne's letter, Descartes, the great advocate of the algebraic method, minimizes the significance of the young Pascal's accomplishments. Mersenne had been enthusiastic about the author's age; Descartes was lukewarm. In the letters to Descartes, Haak, and one to Constantin Huygens, Mersenne makes prominent mention of Pascal's youth.[80] Descartes, in contrast, downplays the positive comparison to the propositions of Apollonius. The

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[78] "[N]ous avons ici un jeune homme, dont je crois vous avoir envoyé une feuille des *Coniques*, lequel est si excellent géomètre, n'ayant que 18 ans, qu'il a compris toutes les sections coniques et l'*Apollonius* dans une seule proposition, de laquelle il dérive tellement 400 corollaires que pas un ne dépend l'un de l'autre, mais tous, aussi bien le dernier que le premier, de la dite proposition," Mersenne to Theodore Haak (18 November 1640), Mesnard, *OC*, 2:239. A similar characterization of Pascal's work is given in Mersenne, *Cogitata Physico-Mathemtica*, who says that Pascal the son has "through a single most general proposition, armed with 400 corollaries, the entire Apollonius is embraced," preface to *Hydraulica, pneumatica, arsque navigandi*, n.p. [11]; cf., French translation in Mesnard, *OC*, 2:299.

[79] "notare possis juniorem Paschalem . . . generalem methodum invenisse, cuius beneficio innotescat quam inter se rationem habeant spatia quaecumque lineis rectis et curvis conicis comprehensa," *Ballistica et Acontismologia*, in *Cogitata physico-mathematica in quibus tam naturae quam artis effectus admirandi certissimis demonstrationibus explicantur*, 102; cf., French translation in Mesnard *OC* 2:299.

[80] Mersenne also sent a copy of the *Essai* to John Pell, though the letter with which it was delivered is no longer extant. Mersenne makes reference to it in Marin Mersenne to John Pell, 7 March 1640, Mersenne, *Correspondance*, 9:184. It may be imagined that Mersenne would also have mentioned Pascal's age to Pell.

real accomplishment would be taking on even more difficult problems in conic sections, which Descartes could propose and that "a child of 16 years would have difficulty untangling."[81]

Descartes' restraint underscores Mersenne's enthusiasm for those whom he perceived as having talents that could serve his mathematical goals. In the case of Pascal, as the young man matures, Mersenne's admiration grows. A few years later, when Pascal was in the throes of his work on the arithmetic machine, Mersenne hopefully declares Blaise as one "from whom can be expected marvelous discoveries not only in pure, but in mixed mathematics."[82] Pascal's promise for the present and the future was obvious.

Because the interactions between Mersenne and Pascal were primarily face-to-face, rather than through correspondence, it is impossible to know precisely Mersenne's hopes and expectations. Mersenne makes brief references to Blaise's work in his published books as well as in his correspondence.[83] But one particularly fruitful approach to the question of the Mersenne-Pascal relationship appears indirectly, through Mersenne's correspondence with Constantin and Christiaan Huygens. These exchanges indicate that Mersenne drew a close connection between Blaise Pascal and Christiaan Huygens. In both prodigies he saw the aptitude necessary to further the progress of mathematics. By labeling each "Archimedes," Mersenne drew them into his vision for mathematical perfection, as foreshadowed in *La vérité des sciences*. Mersenne's relationship with Huygens sheds light on his interactions with Pascal.

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[81] Descartes to Mersenne, 25 December 1639, Mersenne, *Correspondance*, 8:697.

[82] "mira possis expectare cum in puris, tum in mixtis Mathematicis," *Ballistica et Acontismologia*, in *Cogitata physico-mathematica*, 102.

[83] These are considered in the current chapter and in Chapter 3.

Pascal's counterpart: Christiaan Huygens

Christiaan Huygens was born at The Hague on 14 April 1629. He was thus nearly six years Pascal's junior. Like Pascal, his introduction to Mersenne came through his father, though in this case through correspondence. When he was seventeen, the age at which Mersenne had praised Pascal's *Essai pour les coniques*, Christiaan's father wrote: "I proceed to copy a letter that the younger (17 years of age) writes . . . on the subject of his mathematical studies in which this boy succeeds admirably."[84] Mersenne responded by sending several problems to Christiaan and asking for his clarification of a question regarding the fall of bodies, mentioned by Constantin in his letter. Mersenne's initial contact with Christiaan, then, was a simple favor to his father, as his tone in the first letter suggests. He certainly does not coddle him for his father's sake:

> As I greatly honor Monsieur your father, and I believe it will give him pleasure [for me] to speak to you about your propositions of which you say you have the demonstration, I will tell you only about the last [of them], that I do not believe that you have the demonstration of it, if I do not see it.[85]

Mersenne proceeds to outline the difficulties he finds in the proposition in question. He thus begins the relationship by issuing a challenge and offering suggestions of possible angles to consider. He tests the mettle of his young correspondent's mind.

For Pascal, the familial biography offers only hazy details regarding his early participation in the Mersenne group. It is reasonable to infer, however, that like Huygens, he too had to demonstrate his perceptiveness and strong reasoning to Mersenne and his friends. Between his

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[84] "[J]e faij copier une lettre que le cadet (aagé de 17 ans) escrit . . . sur le subject de ses estudes mathematiques où ce garcon reuscit à marueilles," Constantin Huygens to Marin Mersenne, 12 September 1646, Mersenne, *Correspondance*, 14:451.

[85] "Comme i'honore grandement Monsieur vostre pere, et que ie croy luy faire plaisir de vous parler de vos propositions dont vous dites auoir la demonstration, ie vous diray seulement sur la derniere, que ie ne croie point que vous en ayez la demonstration, si ie ne la voy," Marin Mersenne to Christiaan Huygens, 12 October 1646, ibid., 538.

entry into the group around 1635-1636 and the *Essai pour les coniques* of 1640, Pascal's status changed. He went from an unexpected talent, attested by an influential father, to one whose work earned consideration from the learned world.

Christiaan Huygens impressed Mersenne with his response to the queries of his Parisian correspondent. In a letter to Constantin, Mersenne described the young man as "clear-sighted" [*clair-voyant*].[86] But he was particularly interested in Christiaan's age.[87] Constantin had mentioned it in the first letter about his boys, but Mersenne's request for confirmation indicates how important it was to him.[88] Constantin obliges with his reply:

> He has entered into his 17th Year and in keeping with what he knows promises me very much. Do not fear that I hurry him [when it comes to his] mind [*le presse d'esprit*]: I have never done so with my children, no more than my parents [did] to me.[89]

Constantin Huygens, like Étienne Pascal, was keenly aware of his son's talents and took charge of his education and intellectual formation. Mersenne's evident concern that Constantin not "presse d'esprit" his son may reflect Mersenne's experiences as Pascal's mentor. Pascal's father followed the dictates of humanistic pedagogical theory, which warned that a child should only be exposed to the learning for which his mind had acquired readiness. As such, Étienne tried in vain to keep Blaise from mathematics. According to Blaise's sister, this was because their father

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[86] According to Constantin's letter, Mersenne made this characterization. But Mersenne does not use this term in any extant letter. Perhaps the letter to which Constantin refers has been lost. This is even more probable because none of Mersenne's extant letters asks for Christiaan's age either.

[87] "Vous prenez la peine de demander l'aage de mon fils et luy faictes trop d'honneur," Constantin Huygens to Marin Mersenne, 19/26 November 1646, Mersenne, *Correspondance*, 14:637.

[88] Constantin had written in his 12 September 1646 letter: "I have two young galants, my eldest and he who follows him, who have great desire to see your quadrature of the hyperbola and your centers of percussion. And in order to tell you that they are capable of judging of it, I make to copy a letter that the younger one (aged 17 years) wrote to his said Elder (who is here in charge with me) on the subject of his mathematical studies where this boy raises some marvels," Const. Huygens to Mersenne, 12 September 1646), ibid., 451.

[89] "Il est entré dans sa 17e Année et à l'aduenant de ce qu'il sçait me promect beaucoup. Ne craignez pas que je le presse d'esprit: jamais je ne l'ay faict à mes enfans, non plus que mes parens a moij," Const. Huygens to Mersenne, 19/26 November 1646, ibid., 637.

knew the all-consuming nature of mathematical studies. But it could also be attributed to a belief that such studies might affect health.[90] By 1646, at the age of twenty-three, Pascal's health was already failing.[91] For Mersenne, the personal comparison between the two mathematical prodigies had already begun.

The response from Constantin reassured Mersenne that he could further encourage him about his son's talent without endangering Christiaan's well-being. In a letter of 3 January 1647, Mersenne makes an important prediction connecting Huygens to the geometrical invocation in *La verité des sciences*: "I do not believe that if he continues, he will not someday surpass Archimedes, relative of King Gelon."[92] Constantin had until this time referred to his son as "my scholar" and "my little mathematician."[93] Henceforth, following Mersenne's lead, his favorite moniker for Christiaan would be "my Archimedes."[94] A few days later, Mersenne writes to Christiaan with the same complimentary comparison:

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[90]In 1635, a tutor of an aristocratic young man writes to the mother of mathematics, "to which I haven't yet dared to introduce him, for fear of straining his mind, which weakens with too much work . . . ," Chamizay to Madame de Trémoille, 16 May 1633, Archives Nationales, Series 1 AP, 648, quoted in Jonathan Dewald, *Aristocratic Experience and the Origins of Modern Culture: France, 1570-1715* (Berkeley, CA, 1993), 95. Samuel Sorbière gives a warning to Abbé Tallemant regarding the danger to health involved in the over-stimulation of the mind in the area of languages, Samuel Sorbière to Abbé Talemant , 1 June 1659, Bibliothèque Nationale, Paris, fonds français 20612, folio 221 recto.

[91] In the biography, Blaise's sister writes: "il nous a dit . . . que depuis l'âge de dix-huit ans [1641] il n'avait pas passé vn jour sans douleur," "Vie de Pascal," Mesnard, *OC* 1:577. Certainly by fall 1647, when Descartes made his visit to him, Blaise was in poor health to require attentive care and a great deal of bed-rest, as attested by Jacqueline Pascal to Gilberte Périer, 25 September 1647, Mesnard *OC*, 2:480-482.

[92] "Je ne croy pas s'il continue, qu'il ne surpasse quelque jour Archimede, cousin du Roy Gelon," Marin Mersenne to Constantin Huygens, 3 January 1647, Mersenne, *Correspondance*, 15: 17.

[93] Const. Huygens to Mersenne, 19/26 November 1646, ibid., 14:635; Constantin Huygens to Marin Mersenne, 23 December 1646, Mersenne, ibid., 14:717.

[94] U. Frankfourt and A. Frenk also recognized this as the turning point for Constantin's identification of his son as "Archimedes," Frankfourt and Frenk, *Christiaan Huygens*, trans. I. Sokolov (Moscow, 1976), 45. For "mon Archimedes" in letters from Constantin to Mersenne, see Constantin Huygens to Marin Mersenne, 14 January 1647, ibid., 15: 46; Constantin Huygens to Marin Mersenne, 6 April 1648, ibid., 16: 219; Constantin Huygens to Marin Mersenne, 3 May 1648, ibid., 16: 296; Constantin Huygens to Marin Mersenne, 20 July 1648, ibid., 16: 430; Constantin Huygens to Marin Mersenne, 14 August 1648, ibid., 16: 477. For the elder Huygens's mention of his son to other correspondents, see Constantin Huygens to J. J. Stöckar, 13 October 1654, Huygens, *OC* 1:298;

> I ask God, Monsieur, to keep you this entire year in very good health and that be the Apollonius and the Archimedes of our days, or rather of the century to come, since your youth could give you an entire century.[95]

The above passage reinforces the link between Mersenne's hope for "some new Archimedeses" and his interest in young talent, including Huygens. To be sure, it is not unusual for Mersenne and other early modern authors to offer the hyperbole of comparison with Archimedes or some other ancient figure.[96] Father Mersenne gives similar adulation, for example, to Roberval and Fermat.[97] But Huygens belongs in a category reserved for those who show potential in youth. Because of his age, he has "vn siecle entier" to contribute to Mersenne's hope for the completion of mathematics. Mersenne was deeply enthusiastic about the prospect of young mathematicians capable of extending his agenda beyond his lifetime.

The assertion that Mersenne makes a mental parallel between Huygens and Pascal is not based solely on circumstantial similarities. Pascal's shadow falls decidedly across Mersenne's correspondence with the Huygens's. In a subsequent letter to Constantin, Mersenne draws attention to this other mathematical talent:

Constantine Huygens to Princess Palatine Elisabeth, 25 December 1654, Christiaan Huygens *Oeuvres complètes de Christiaan Huygens*, 22 vols. (The Hague, 1888-1950), 1:313, hencefort Huygens *OC*, [vol#]: [page#].

[95] "Je prie Dieu Monsieur, de vous conseruer toute cette année en tres bonne santé, et que vous soyez l'Apollonius et l'Archimede de nos iours, ou plustost du siecle à venir, puisque vostre jeunesse vous peut donner vn siecle entier," Marin Mersenne to Christiaan Huygens, 8 January 1647, Mersenne, *Correspondance*, 15:34.

[96] Archimedes is a much more likely candidate than Apollonius as a historical figure for comparison. Archimedes's life was more thoroughly documented in narrative form. Biographical information about Apollonius is virtually nonexistent. Archimedes's extant work was also of greater breadth and volume, with surviving work in both pure and applied mathematics. Nevertheless, it should be noted that Apollonius was called "The Great Geometer" by an early commentator (Geminus), Fried and Unguru, *Apollonius of Perga's* Conica, 5. A number of early modern mathematicians judged their own works against those of Apollonius, Jean Dhombres, "La culture mathématique au temps de la formation de Desargues: Le monde des coniques," in *Desargues en son temps*, ed. Jean Dhombres and J. Sakarovitch (Paris, 1994), 62.

[97] For the comparison between Fermat and Archimedes, see Bonnel to Marin Mersenne, April 1646, Mersenne, *Correspondance*, 14:252. For a comparison between Roberval and Archimedes, see Pierre Desnoyers to Gilles Personne de Roberval, 18 March 1648, ibid., 16:186.

> If your Archimedes comes with you, we will cause him to see one of the finest treatises of geometry that he has ever seen, which has come to be completed by the young Paschal.[98]

In a postscript to the same later, Mersenne adds:

> Your Archimedes will see here the invention of the said Pascal to calculate without pain and without knowing anything.[99]

Significantly, of the extant letters from to Constantin, Mersenne only uses the designation "your Archimedes" [*vostre Archimedes*] in these two passages. In both cases, Mersenne is writing about Pascal. Is Mersenne implying that these youngsters represent two great possibilities for the future of mathematics?

The co-identity implied in their earlier correspondence is finally made explicit in a letter written in May 1648. Mersenne writes to Christiaan of "Sieur Pascal, who is another Archimedes."[100] There remains no doubt, then, of Mersenne's conscious pairing of Pascal and Huygens. These two "Archimedeses," whose years of birth (1623 for Pascal and 1629 for Huygens) bracket the publication of Mersenne's *La vérité des sciences* (1625) are thus neatly linked to his vision that there would be "born again in this century some new Archimedeses."[101] Both Pascal and Huygens were conscious of the debt they owed Mersenne for encouraging their mathematical potential. While Huygens never met Mersenne personally, he acknowledged later the part that Mersenne played in his "first apprenticeship": "Father Mersenne honored me with his correspondence in order to incite me to the study of mathematics, to which he saw me

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[98] "Si vostre Archimede vient auec vous, nous luy ferons veoir l'un des plus beaux traitez de geometrie qu'il aye jamais vû, qui vient d'estre achevé par le jeune Paschal," Marin Mersenne to Constantin Huygens, 17 April 1648, ibid., 16: 230.

[99] "Vostre Archimede verra ici l'inuention dudit Pascal pour suputer sans peine et sans rien scauoir," Mersenne to Const. Huygens, 17 April 1648, ibid., 232. Mersenne refers here, of course, to Pascal's arithmetic machine.

[100] "Sieur Pascal, qui est un autre Archimède," Marin Mersenne to Christiaan Huygens, 15 May 1648, ibid., 314.

[101] Mersenne, *La vérité des sciences*, 750. See above, p. 67.

naturally inclined [*il me voyoit portè naturellement*]."[102] Pascal had a more personal relationship with the Minim monk and Mersenne's formulation of unsolved problems profoundly shaped Pascal's work. Mersenne's influence marks his efforts in geometry, number theory, combinatorics, physics, and perhaps even apologetics. Pascal is sparing in his praise of Mersenne as a mathematician, but lauds him, with Huygens, because "he has provided the occasion for several fine discoveries, which would have never been made if he did not excite the *savants* to them.[103]

The Mersenne Circle and Pascal's Mathematical Apprenticeship

Pedagogical Interests and Activities of the Participants

Pascal's training as a mathematician was not accomplished by the Minim alone. The members of Mersenne's mathematical academy collectively participated in the education of Pascal. Having recognized his talent, they sought ways to encourage him, through discipline and exercise, to cultivate that geometrical talent. A number of scholars have examined Pascal's debts to the members of the Mersenne Circle. Pierre Humbert's work is particularly important. Humbert argues against an interpretation of Pascal as a loner, emphasizing instead his connections with other mathematicians and philosophers of the time. As evidence, Humbert excavates Pascal's mathematical and philosophical influences not merely through textual analysis, but by attending to the personal connections developed through the Pascal family. Among those most prominent within the group, and personally connected with Pascal, are Girard Desargues, Gilles Personne de Roberval, Jacques Le Pailleur, and of course Étienne Pascal.

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[102] "Le Pere Mersenne m'honoroit de sa correspondance pour m'inciter a l'estude des mathematiques a la quelle il me voyoit portè naturellement," Christiaan Huygens to Pierre de Carcavy, 1 June 1656, Huygens, *OC*, 1:428.

[103] "il a donné l'occasion de plusieurs belles découvertes, qui peut-être n'auraient jamais été faites s'il n'y eût excité les savants," "Histoire de la roulette", Mesnard *OC* 4:214.

Desargues: self-taught master

Pascal's debt to Girard Desargues is clear from his earliest work.[104] It was obvious enough to Descartes on the reading of the *Essai pour les coniques*:

> [H]aving read only half of it, I judged that he had learned from Monsieur Desargues, which was confirmed to me at once through the confession that he [Pascal] himself makes.[105]

Pascal's *Essai* praises Desargues as "one of the great minds of our time" and in it he admits that "I owe the little that I have found on this matter to his writings."[106] Pascal especially refers to Desargues' *Brouillon Projet,* published not long before the *Essai*.[107] Pascal's work follows the example of Desargues in using geometrical projection to generalize properties and results from conic sections.[108] The connection is so strong that René Taton remarked that Pascal "is shown to be the first and the only true discipline of Girard Desargues in the field of geometry."[109] Jean Mesnard examines Pascal's use and expansion of Desargues in depth. Desargues' influence is not only evident in projective geometry, Mesnard argues, but in the

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[104] Desargues was born 21 February 1591 in Lyon and died October 1661. The best source of introductory information on his life is René Taton, "Girard Desargues," in *Dictionary of Scientific Biography*, ed. Charles C. Gillespie, vol. 4 (New York, 1971), 46-51; see also Marcel Chaboud, *Girard Desargues, Bourgeois de Lyon, Mathématicien, Architecte* (Lyon, 1996).

[105] "[A]vant que d'en avoir lu la moitié, j'ai jugé qu'il avait appris de Monsieur Desargues, ce qui m'a été confirmé incontinent après par la confession qu'il en fait lui-même," René Descartes to Marin Mersenne, 1/2 April 1640, Mesnard *OC*, 2:238-239.

[106] "Nous démontrerons aussi cette propriété, dont le premier inventeur est M. Desargues, Lyonnais, un des grands esprits de ce temps. [J]e dois le peu que j'ai trouvé sur cette matière à ses écrits," "Essai pour les coniques," Mesnard *OC* 2:234.

[107] Girard Desargues, *Brouillon Project d'une Atteinte aux Evenements des Recontres du Cone avec un Plan* was published in 1639, in Girard Desargues, *Oeuvres*, ed. Noël-Germinal Poudra, vol. 1(Paris, 1864), 103-230. Pascal's *Essai pour les coniques* was printed in early 1640.

[108] Pascal avoids, however, the abstruse terminology that prompted criticism of the *Brouillon Project*.

[109] "[Pascal] se révèle comme le premier et le seul disciple véritable de Girard Desargues dans le domaine de la géométrie," René Taton, "L'oeuvre de Pascal en géométrie projective," *L'oeuvre scientifique de Pascal*, ed. Pierre Costabel (Paris, 1964), 20. Robert Allard, *La jeunesse de Pascal: de la légende à l'histoire* (Paris, 1994), argues with this traditional conclusion, stating that Philippe de la Hire was the "véritable continuateur" of Desargue's work, 70.

geometrical elements of philosophy, including the importance of the infinite.[110] The relationship between the Desargues and Pascal, Mesnard concludes, "furnishes perhaps a one-of-a-kind example of fertilization of one mind by another."[111]

Significant claims of influence aside, Pascal's language in the *Essai* only directly suggests a familiarity with Desargues' writings. He makes no mention of a personal relationship with his "master" in projective geometry. Yet if Pascal was a regular attendee of the Mersenne group, as seems likely, then he also would have had a more personal acquaintance with the work of the Lyonnais mathematician. His familiarity with Desargues' work was gleaned from the oral give-and-take of conferences instead of simply read in a book. If contemporary accounts of the group's activities are accurate, the attendees, including Pascal, would have discussed the contents of the book at their meetings.

Alexandre Koyré addresses the personal relationship between Desargues and Pascal, characterizing the latter as a "student" of the former. In his seminal article, "Pascal Savant," Koyré writes:

> I am inclined to think that the influence of Desargues is exercised through personal contact. I do not believe, in fact, that anyone, even a genius like Pascal, would have been capable of understanding and assimilating the ideas and the methods of the great Lyonnais geometer by a simple reading of the *Brouillon project*.[112]

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[110] "Pour en venir à l'essentiel, et reprendre un terme qui n'a cessé de s'imposer à nous, la grande invention de Desargues a été celle d'une géométrie de l'infini, ou de l'application de l'idée d'infini à la géométrie pure," Jean Mesnard, "Desargues et Pascal," in *Desargues en son temps*, ed. Jean Dhombres and J. Sakarovitch (Paris, 1994), 98. Later in the article, Mesnard writes: "Si l'on aborde la 'métaphysique de la géométrie', un rapprochement très précis s'impose entre Desargues et Pascal," ibid., 98.

[111] "[Il] fournit un exemple peut-être unique en son genre de fécondation d'un esprit par un autre esprit," ibid., 99.

[112] "Je suis enclin à penser que l'influence de Desargues s'est exercée dans un commerce personnel. Je ne crois pas, en effet, que quiconque, même un génie comme Pascal, ait été capable de comprendre et d'assimiler les idées et les méthodes du grand géomètre lyonnais par la simple lecture du *Brouillon project*," Koyré, "Pascal Savant," 262.

Koyré continues by claiming that "we can see in Pascal a true student of Desargues."[113]

Importantly, the supposed teacher-student relationship is used by Koyré as evidence against the received tradition of Pascal as child prodigy and mathematical genius. Koyré provocatively suggested the marginality of Pascal to the contributions of seventeenth-century science and, in turn, his position in the history of science. Koyré downplayed the deterministic role of inborn talent and thereby encouraged consideration of the influences that developed that talent.[114] Koyré's argument that Desargues' educational influence was central to Pascal's success is convincing. His iconoclastic tendencies serve as a helpful corrective to an overly optimistic view of Pascal's inborn talents, though it also remains clear that Pascal's work in geometry was creative, not just derivative.[115]

Desargues' own educational background and his writings harmonize with a concern for pedagogy. The first thirty years of his life are obscured by lack of documentation. His two older brothers became *avocats* at the Parlement of Paris.[116] It is possible, though never recorded, that he too received some kind of university education. According to the opponents of his *Brouillon Project*, however, Desargues "went about saying everywhere that he owed his instructions only to his particular studies, that he read no work."[117] His insistence on his absolute self-education

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[113] "[N]ous pouvons voir dans Pascal un véritable élève de Desargues," Koyré, "Pascal Savant," 262. Likewise, André Bord writes: "Blaise restera lié à Roberval et Carcavy, mais il se considérera comme le disciple de Desargues . . . . La mort de son maître, en septembre 1661, dut affecter Pascal," André Bord, *La vie de Blaise Pascal: une ascension spirituelle; suivi d'un essai, Plotin, Montaigne, Pascal* (Paris, 2000), 200.

[114] Here Koyré provides a subtle reinforcement of Mersenne's view about the relationship between natural talent and disciplined exercise, Koyré, "Pascal Savant." See below, pp. 111-116.

[115] "Descartes avait certainement tort de douter ainsi l'originalité de cet *Essay*; si Pascal reconnaît très objectivement que Desargues inspira ses recherches, il est incontestable que certaines des idées nouvelles qu'il présente sont de lui-même," René Taton, *L'oeuvre mathématique de G. Desargues* (Paris, 1951), 34.

[116] What little that is known about Desargues' early life is summarized in René Taton, "Desargues et le monde scientifique de son époque," in *Desargues en son temps*, ed. Jean Dhombres and J. Sakarovitch (Paris, 1994), 25-26.

[117] "[Il] allait disant partout qu'il ne devait son instruction qu'à ses études particulières, qu'il ne lisait aucun ouvrage," Desargues, *Oeuvres de Desargues*, ed. Poudra, 1:12.

is not surprising or unique. His detractors were claiming that he had plagiarized other writers on perspective, and Desargues' statement represented a hyperbolic defense technique. The ideal of learning mathematics through one's own genius is characteristic of the seventeenth century in general, but is especially important to the core members of the Mersenne group.

Desargues' interest in education did not cease with autodidacticism. It extended to the development of pedagogical methods. In *Harmonie universelle* (1636), Mersenne writes:

> I begin thus through a very easy method, which Monsieur des Argues, [an] excellent geometer, has given in some terms that he has recognized as proper for insinuating it into the mind of children, and in order to make it be understood in little time and with much facility.[118]

Desargues' interest in discovering the best way to instruct children reinforces the pedagogical element of the Mersenne Circle. He is particularly concerned to formulate language appropriate for the young, anticipating his use of terminology in the *Brouillon Project*. In that work, Desargues introduces a naive terminology based upon the natural world, using words such as *tronc* (trunk), *rameau* (branch), and *souche* (stump) to refer to geometrical elements.[119] Ironically, the new terms that he used in projective geometry made his work not more, but less accessible to experienced mathematicians. The conscious effort to create parallels between the visible natural world and abstract geometrical entities seems to signal a conscious attempt to instruct beginners.[120]

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[118] "Je commence donc par une méthode fort aisée, laquelle Monsieur des Argues, excellent géomètre, a dressé en des terms, qu'il a reconnu propres pour l'insinuer dans l'esprit des enfants, et pour la faire comprendre en peu de temps avec beaucoup de facilité," Mersenne, *Harmonie universelle*, "De l'art de bien chanter," 331.

[119] Desargues' nineteenth-century editor, Noël-Germinal Poudra, even compiles a list, "Vocabulaire des termes employées par Desargues dans cet ouvrage," *Oeuvres de Desargues*, ed. Poudra, 99-102.

[120] Descartes describes the distinction between mathematical writing for mathematicians and for the curious, René Descartes to Girard Desargues, [4] January 1639, René Descartes, *Oeuvres de Descartes*, ed. Victor Cousin, vol. 8 (Paris, 1824), 67-69; see also, Dominique Descotes, *Blaise Pascal: littérature et géométrie* (Clermont-Ferrand, France, 2001), 57-58. On the reception of Desargues' *Brouillon Project* by French mathematicians generally, see Taton, "Desargues et le monde scientifique," 39-40.

Desargues' insistence on the role of the mathematician in the perfection of architecture and perspective is a further extension of his concern with pedagogy. Desargues portrays the geometer as the teacher; practical architects and artists are students.[121] He sees geometry as the disciplinary pedagogue of the arts of drawing and design. On the other hand, Desargues recognized inherent limitations associated with his own lack of technical dexterity. With this in mind, he cultivated a student, Abraham Bosse, who had superior technical skills. Bosse was assigned the task of bringing to fruition Desargues' whole system of techniques based on the theoretical geometry of perspective. Desargues' writings and his attempts to reform practical arts demonstrate the prominence of the teacher-student relationship for Desargues.

These links between Desargues and pedagogy do not provide direct evidence of a teacher-pupil relationship with Pascal. This association, however, strengthens the link between the members of the Mersenne Circle and an interest in pedagogical theory and practice in various realms. Such connections provide indirect support for the claim that the group's training of Pascal was not merely an unintended by-product, but an assumed goal.

Roberval: university connection

Gilles Personne de Roberval, another major participant in the Mersenne group, is more closely linked to formal educational practices. One historian labels him "a pedagogue living a precarious existence on the proceeds of his lessons."[122] Before his arrival in Paris in 1628, he gave private lessons to Francois du Verdus, among others, in order to support himself.[123] His

[121] Chapter 3 examines the hierarchical relationship between theory and practice suggested by Desargues, comparing it with Pascal's own relationship with practitioners.

[122] D. T. Whiteside, "Un savant méconnu: Gilles Personne de Roberval (1602-1675): Son activité intellectuelle dans les domaines mathématique, physique, mécanique et philosophique (Book Review)," *Isis* 54 (1963), 303.

[123] Kokiti Hara, "Gilles Personne de Roberval," *Dictionary of Scientific Biography*, ed. Charles C. Gillespie, vol. 11 (New York, 1975), 486.

personal education was not in a traditional university setting. Instead, he attended classes while in his role as itinerant tutor.[124] In 1632, he attained the position of professor of philosophy at the Collège de Maître Gervais. Two years later he won the competition for the Ramus chair of mathematics at the Collège Royal in Paris, a position of great prestige that he held until death. Later, he filled the chair of mathematics left vacant at Gassendi's death.[125] Roberval did not receive his position in the university community because of family status, having been born and raised, as he says, "*inter multos*."[126] Like the provincials for whom Mersenne expressed admiration, Roberval acquired his mathematical expertise not through birth, but through the concerted effort of self-education.

Roberval demonstrates his skill as a teacher, argues Léon Auger, through the large number and prominent status of individuals who attended a presentation that he delivered in 1658.[127] Gassendi recommended Roberval as his successor to the chair in mathematics based on the observation that "he teaches this fine science with so much success."[128] On the other hand, his competition for the chair may not have been extremely fierce. One of his fellow competitors in

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[124] Pierre Costabel and Monette Martinet, *Quelques savants et amateurs de Science au XVIIe siècle*: *Sept notices bibliographiques caractéristiques* (Paris, 1986), 21. Costabel and Martinet especially note Roberval's attendance at Bordeaux.

[125] Léon Auger, *Un savant méconnu: Gilles Personne de Roberval (1602-1675), Son activité intuellectuel dans les domaines mathématique, physique, mécanique et philosophique* (Paris, 1962), 151. Auger's work is a key work concerning the biographical elements of Roberval's life, including his chapter, "Roberval, Professeur au Collège Royal de France," ibid., 149-153. See also, Costabel and Martinet, *Quelques savants et amateurs de Science au XVIIe siècle*, 21-31, especially the bibliography.

[126] Hara, "Roberval," *Dictionary of Scientific Biography,* 11:486.

[127] Auger, *Un savant méconnu*, 152. Auger's book on Roberval is the only published work entirely devoted to this important seventeenth-century mathematician. The recent publication of Gilles Personne de Roberval, *Éléments de géométrie*, ed. Vincent Jullien (Paris, 1996), signals a welcome interest in his career and work.

[128] "[Pierre Gassendi] eut soin en mourant de recommander sa chaire de Professeur du Royaux Mathematiques, pour M. de Roberual Geometre, qui enseigne cette belle science auec tant de succez," Michel de Marolles, *Les memoires de Michel de Marolles*, vol. 1 (Paris, 1656), 275.On Roberval's success as a teacher, see also Costabel and Martinet, *Quelques savants et amateurs de Science au XVIIe siècle*, 22.

1659 drew the ridicule of the jury when he simply read from Euclid's *Éléments* when asked to give a lesson.[129] Roberval's eloquence, however, had its limits. Some who heard his address to inaugurate his position in Gassendi's chair remarked that "he was as bad at oratory as he was good at geometry."[130]

As a university professor, Roberval operated in a culture that thrived on debate and disputation. This suited his disposition, as Roberval's constant, virulent contentiousness with Descartes clearly demonstrates. At universities, theses were customarily announced and then debated by a number of eminent individuals. Pascal's *Essai pour les coniques*, a single sheet of paper in which he merely outlines the work (definitions, lemmas, and propositions), bears some resemblance to a university thesis print, as Mesnard observes.[131] On another level, Roberval habitually kept his work secret, exposing it only to "initiates" among his friends, such as the inner circle of the Mersenne group. This behavior suggests parallels with the secret knowledge of guilds and crafts, with which the origins of the university are associated.[132] As Chapter 6 will attempt to show, the Roberval-like secrecy that would characterize Pascal's last efforts in mathematics distanced him from the rest of the learned community of the late 1650s.[133]

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[129] Auger, *Un savant méconnu,* 150.

[130] Abraham du Prat to Thomas Hobbes, 1 April 1656, Mersenne, *Correspondence*, 1:246.

[131] "On pourrait . . . comparer l'*Essai* avec les placards de thèses. Aussi bien l'opuscule de Pascal est-il appelé 'thèse' en 1670 par le théoricien de la perspective Grégoire Huret . . . Plus significative encore l'expression 'les thèses de M. B. P.' employée par Beaugrand, dans une lettre imprimée du 20 juillet 1640," Mesnard *OC* 2:220, n. 3.

[132] Pamela O. Long, *Openness, Secrecy, Authorship: Technical Arts and the Culture of Knowledge from Antiquity to the Renaissance* (Baltimore, MD, 2001), argues that the simple association of secrecy with craft traditions and openness with learned communities is inadequate and that elements of both openness and secrecy are evident in the burgeoning scientific community of the seventeenth century. The questions of artisanal knowledge and its relationship to theory is also of importance to this dissertation. On questions of this relationship, see below, pp. 128-148.

[133] See below, pp. 339-341.

Le Pailleur: fatherly poet

Roberval's polar opposite is Jacques Le Pailleur, who would become the mid-1650s host of the remnants of the original Mersenne gatherings.[134] Roberval's intensity and technical proficiency stand in stark contrast to the light-hearted Le Pailleur, who was skilled in music, poetry, and humor. René Pintard labels him: "*Honnête homme*, playful, pleasing singer and distinguished dancer, [a] no less practiced poet, especially in humorous verse."[135] He was close friends with Charles Vion Dalibray, the celebrated poet of libertinism, who wrote a number of poems to his friend Le Pailleur.[136] Dalibray's light-hearted, bacchanalian behavior, which seems to extend to Le Pailleur, is playful and good-natured.

Unlike Roberval, Le Pailleur evidently had little formal training in mathematics. With his varied interests and the emphasis that he placed on his social life, he is the clearest example of the *honnête homme* among Mersenne's mathematicians. Like Pascal, he demonstrated mathematical aptitude from a young age. Tallemant des Réaux, one of his long-time friends, writes:

> He was devoted to mathematics from his childhood: he learned it by himself. He had only twenty-nine *solz* when he began to read the books of this science, and he exchanged the books [for others] as soon as he had read them.[137]

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[134] Michel de Marolles records the existence of this group: "chez feu Mons. le Pailleur, il y en auoit vne autre tous les Samedys, pour parler des Mathematiques, où i'ay vû Mess. Gassendi, Boüillaud, Pascal, Roberual, Desargues, Carcaui, & autres illustres en cette science," Marolles, *Memoires de Michel de Marolles* (Paris, 1656), 272. Taton clearly believes that this gathering was a continuation of that which had been begun with Mersenne, Taton, *Les origines*, 21.

[135] "Honnête homme, badin, plaisant chanteur et danseur émérite, rimeur non moins exercé, surtout en vers pour rire," René Pintard, *Le libertinage érudit dans la première moitié du XVII siècle* (Paris, 1943; repr., 1983), 349.

[136] See Charles Vion Dalibray, *Oeuvres poétiques du sieur de Dalibray*, ed. Ad. Van Bever (Paris, 1906), 97-100.

[137] "Il s'estoit addonné aux mathematiques dez son enfance: il les appris tout seul. In n'avoit que vingt-neuf solz quand il commença à lire les livres de cette science, et il eschangeoit les livres à mesure qu'il les lisoit," Tallement des Réaux, *Historiettes*, 2: 101.

Étienne Pascal, understanding that Le Pailleur would be sympathetic to his son's blossoming attraction to mathematics, went to his old friend first when he discovered Blaise drawing geometric figures on the playroom floor. [138]

Blaise acknowledged both Le Pailleur's talent in mathematics and his influence over his own career. In a letter written to Le Pailleur during the controversy concerning the void in the 1640s, Pascal calls him "an excellent geometer" who has "as much skill in discovering the faults of reasoning as [he has] strength to avoid them."[139] His combination of the art of conversation with careful reasoning could have provided Pascal with a model for bringing together careful reasoning and the art of conversation. Moreover, Le Pailleur's relationship with Blaise was both personal and intellectual, just as it had been with his father. Pascal affirms this when he writes that through him, "I was always raised with an uncommon method and care [that was] more than paternal."[140]

Étienne Pascal

The fatherly figure of Le Pailleur was a double of his close friend Étienne Pascal. He was, properly speaking, both Pascal's tutor and confidant. Gilberte Périer, in her biography, claims that Étienne resigned his post as President of the Cour des Aides in Clermont and moved to Paris for the sole benefit of his son's education:

> As he had no other son than that, this quality of only son, and the great marks of intellect [Fr. *esprit*] that he recognized in this child, gave him such great affection for him that he could not determine to commit his education to another, and resolved to instruct him

[138] Le Pailleur and the elder Pascal had already been friends for a number of years by the time Pascal's geometrical talent manifested itself. Étienne Pascal calls Le Pailleur "un de mes intimes amis, depuis trente ans et plus," Étienne Pascal to Étienne Nöel, April 1648, Mesnard *OC* 2:587.

[139] "un excellent geomètre . . . [qui a] "autant d'adresse pour découvrir les fautes de raisonnement que de force pour les éviter," Blaise Pascal to Jacquels Le Pailleur, February 1648, Mesnard *OC* 2:569.

[140] "[J]'ai été toujours élevé avec une méthode singulière et des soins plus que paternels," Pascal to Le Pailleur, February 1648, Mesnard *OC* 2:576.

> himself, as in fact he did, my brother having never entered a *collège* and having never had any master but my father.[141]

This account of Étienne's attitude, as with the rest of the details provided by Périer, must be considered with some caution. In particular, Périer's dedication to the educational values of Port-Royal certainly influenced this "memory." Nevertheless, all the indicators suggest that Pascal was never formally schooled. The memoires of Blaise's last confessor, Father Beurrier, offer an explanation of Étienne's own educational background and thus of his choice of education for his son:

> He had learned, through his own father [and] without having had another master, the Greek and Latin languages, philosophy, mathematics, history, canon and civil law, and especially positive theology through the reading of the Bible and the Holy Fathers.[142]

Being thus himself a man educated by his father, he chose a similar path for Blaise.

The *Académie* as an Educational Alternative

Few would dispute that Étienne was Blaise's only master, in the sense of directly guiding his education. As has been shown, however, Pascal may also be viewed as Desargues' pupil, at least in the important sense of his technical training in projective geometry. In his overall preparation for a mathematical and natural philosophical career, the Mersenne Group also played a collective role as an informal educational institution. For some, this meant simply allowing him to interact as a junior member of the discussion circle, facilitating his self-study. Others, such as Claude Mydorge, may have seen their role as more active. Mydorge writes that in

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[141] "[C]omme il n'avait point d'autre fils que celui-là, cette qualité de filz unique, et les grandes marques d'esprit qu'il reconnaissent en cet enfant, lui donnèrent une si grande affection pour lui qu'il ne put se résoudre de commettre son éducation à un autre, et se résolut dès lors de l'instruire lui-même, comme il a fait, mon frère n'ayant jamais entré en pas un collège et n'ayant jamais eu d'autre maître que mon père," Mesnard *OC* 1:571.

[142] "[I]l avait appris par son propre père, sans avoir eu autre maître, les langues grecque et latine, la philosophie, les mathématiques, l'histoire, le droit canonique et civil, et surtout la théologie positive par la lecture de la Bible et des Saints Pères," Mesnard, *OC*, 1:870.

mathematics, one "cannot learn without a tutor [*precepteur*], because of the Demonstrations that one must contemplate and to keep in proportion."[143]

Blaise recognizes the role that the Mersenne Circle played in his training in a brief summary of mathematical and physical work written in 1654.[144] It is addressed to a new group that had supplanted Mersenne's after his death, which met weekly at Le Pailleur's home.[145] He acknowledges his indebtedness for their investment in his formation: "I confess in fact as yours what I would not have made mine, if I had not been educated in your midst."[146] Later in the same paragraph he goes to on to acknowledge "the benevolence that has sustained me from my youngest years in this learned School [Lyceo]." [147] Labeling the group a "learned School" [*erudito Lyceo*] could be viewed as merely an honorary nod to the savants who graced it. However, when Mersenne chose to use the word "académie" to describe to Peiresc the group of learned men who gathered regularly in Paris, he invoked rich intellectual connotations, including those associated with the university and with the arts.

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[143] "ne se peut apprendre sans precepteur a cause des Demonstrations qu[']il faut faire contempler et proportionner," Mydorge, *Traité de géométrie*, BN, Paris, fonds français 656, 2.

[144] There are two extant copies of this Latin piece, one by Leibniz in the *fonds Leibniz* at Hanover and another by Father Guerrier in a private collection. Leibniz's bears the title *Celeberrimis matheseos professoribus*, but Brunschvicg and Mesnard have agreed that the original designation of the work was likely that of the other copy: "Celeberrimae matheeseos academiae parisiensi," Brunschvicg *OC*, 3:293, 305; Mesnard *OC*, 2:1022. The text of the piece is in the original Latin in Brunschvicg *OC*, 3:305-308 and in Latin and a French translation in Mesnard *OC*, 2:1031-1035.

[145] There has been some debate about the identity of the group to whom the piece is addressed. Brunschvicg believed that it was written to the Académie de Montmor because of a mistaken date for Le Pailleur's death (1651), Brunschvicg *OC*, 3:296-297. Subsequent research has established Le Pailleur's death in 1654 and thus Mesnard argues that the piece was addressed to the group meeting in his home, the most direct successor to Mersenne's "académie mathématique," Taton, *Les origines*, 21; Jean Mesnard, "Pascal à l'Académie Le Pailleur," in *L'oeuvre scientifique de Pascal*, ed. Pierre Costabel (Paris, 1964), 7-16; Mesnard *OC* 2:1022-1023.

[146] "vestra enim esse fateor quae non, nisi inter vos educatus, mea fecissem." Mesnard *OC* 2:1031.

[147] "benignitas quae me a junioribus annis in erudito Lyceo sustinuit." Mesnard *OC* 2:1032.

When Mersenne announced his group to Peiresc, he called it "la plus noble académie du monde." ("the noblest academy in the world").[148] The most obvious reason for him to give it the label "académie" is that the Académie Française was instituted by Cardinal Richelieu in that same year. Perhaps Mersenne had the foundation of this governmentally-sponsored group in mind when he wrote to Peiresc. The designation could be viewed as the expression of a desire for the legitimation that the literary community had received in the political arena. It is a mistake, however, as Simone Mazauric makes clear, to consider French academism of the seventeenth century only in terms of governmental institution of learned conferences. To do so is to privilege a later definition of the word "académie," with the foundation of various academies such as the Académie Royale des Sciences.[149] Jean-Robert Armogathe avers that Mersenne's group should not, in fact, be labeled an "académie," as it does not have the formalized structure and rules that such a name indicates.[150] But this opinion, if accepted, would devoid the word of some of the educational connotations it undoubtedly had in the seventeenth century.

When Pascal addressed his 1654 work to the "Celeberrimae matheseos academiae parisiensi" there was a suggestion of formality. The name invokes the educational institution of the University of Paris, known as "academiae parisiensis." But when Peter-Eckhard Knabe writes in his "L'histoire du mot 'Académie'," that "French makes a strict distinction between

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[148] Marin Mersenne to Nicolas-Claude Fabri de Peiresc, 23 May 1635, Mersenne, *Correspondance*, 5:209.

[149] "[D]uring the whole first half of the century, the contemporaries of Louis XIII have used in a very much larger sense and concurrently with other terms with similar acceptance/understanding in order to designate any sort of relevant meeting of private initiative, a meeting more or less regular, more or less regulated, more or less formalized destined to favor the 'commerce of minds'," Simone Mazauric, "Aux origines du mouvement académique en France: Proto-histoire des académies et genèse de la sociabilité savante (1617-1666)," in *Académies et sociétés savantes en Europe*, ed. Daniel-Odon Hurel and Gérard Laudin (Paris, 2000), 36-37.

[150] Jean Armogathe, "Le group de Mersenne et la vie académique Parisienne," *Dix-Septième Siècle* 44 (1992), 136.

académie and *université*,"[151] he offers chronologically indistinct data that does not take account of its cultural connotations, including its use as the Latin designation of the university. Knabe argues for the distinction, and even opposition, of these two words, based largely on an entry from the *Encyclopédie* of 1734. A strict distinction between the Latin "academiae" and the French "académie," however, is misleading. Knabe's argument that the word "académie" is used for organizations arrayed in opposition to traditional educational institutions reinforces the supposition that these informal groups worked to displace the university, while maintaining similar goals.

Frances Yates's study of sixteenth-century French academies argues that they were the heirs of the projects of Ficino and Ramus.[152] Ficino's famed academy had borrowed the terminology of Plato's own educational endeavors to refer to what may well have been an informal school where the Florentine Neo-Platonist tutored students.[153] In 1567, Ramus called on the memory of Ficino's work in Florence in an attempt to convince Catherine de Medici to help sponsor his reform of the universities.[154] Thus, while "académie" is not, as Knabe correctly asserts, a synonym of "université," it maintains associations with an educational agenda.

These connotations are further attested by developments in sixteenth and seventeenth-century France. Yates points out the wide-ranging educational undertaking of Baïf's musical

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[151] "[L]e français opère une distinction stricte entre 'académie' et 'université', Peter-Eckhard Knabe, "L'histoire du mot 'académie'," in *Académies et sociétés savantes en Europe*, ed. Daniel Odon Hurel and Gérard Laudin (Paris, 2000), 30.

[152] The relationship between the Italian academies (beginning with Ficino) and those of sixteenth century France is the subject of Yates, *French Academies*, Chapter 1, 1-13.

[153] James Hankins presents a critique of the traditional understanding of Ficino's Academy as a "center of Florentine intellectual life," arguing instead that the documentary evidence suggests that the academy was "an informal gymnasium or school attended by his pupils," and highlights Ficino's "unofficial role" at the university at Florence, in James Hankins, "The Myth of the Platonic Academy of Florence," *Renaissance Quarterly* 44 (1991), 448-449; 454; 454, note 85. Hankins also discerns seven different categories of meaning for the Latin *academia* in the Renaissance, ibid., 433-436.

[154] Yates, *French Academies*, 20-21.

academy, which included a general study of mathematics. Mersenne provides an account of this academy in his early commentary on Genesis.[155] This royally-sponsored musical academy provided a model for Mersenne to follow, a model that stressed education.

The schools for French gentlemen, which adopted the designation of "académies" and appeared during the late sixteenth and early seventeenth century, provide further evidence of the educational connotations of the term.[156] These schools taught practical arts, such as horsemanship, fencing, and dancing. In addition, many instructed their pupils in the basics of mathematics. Such knowledge was a prerequisite for the art of fortification, which those destined to the military would undertake. In these academies, the emphasis was on practical rather than pedantic knowledge, in opposition to the universities. But instruction for young men remained their focus. In Italy, likewise, academic terminology was allied with the teaching of the crafts, perfected through the application of theory to practice:

> Painters form, together with glass-makers, engravers, cabinet-makers, and even saddlers and stationers, a corporation, placed under the patronage of Saint Luke and which has responsibility for the training of apprentices. Alberti and Leonardo da Vinci demand, in their treatises on painting, a fundamental modification of practical teaching both scientific and theoretical. It is this requirement that engenders the corresponding *académies*. In 1577, the corporation of Saint Luke of Rome becomes an *académie*.[157]

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[155] Yates, *French Academies*, 23-25. Yates provides an English translation of Mersenne's passage from *Quaestiones celeberrimae in Genesim* (1623) and argues for its importance as a source for information about Baïf's approach to his musical academy.

[156] See Knabe, "L'histoire du mot 'académie'," 31; H. C. Barnard, *The French Tradition in Education: Ramus to Mme Necker de Saussure* (Cambridge, 1922), 116; Philippe Ariès, *Centuries of Childhood: A Social History of Family Life*, trans. Robert Baldick (New York, 1962), 203-208.

[157] "[L]es peintres forment avec les verriers, les doreurs, les ébenistes et même les selliers et les papetiers une corporation, placée sous le patronage de saint Luc et à laquelle incombe la formation des apprentis. Alberti et Léonard de Vinci réclament dans leur traités sur la peinture une modification fondamentale: que le fondement de l'enseignment pratique soit une formation scientifique et théorique. C'est de cette exigence que naissent les académies correspondantes. En 1577, la corporation de saint Luc de Rome devient une académie," Knabe, "L'histoire du mot 'académie'," 32-33.

Academies devoted to specific arts or crafts, such as those of Baïf's, the gentlemen of France, and the craftsmen of Italy, informed Mersenne's understanding of the term. In this vein, Mersenne suggests, in *La vérité des sciences*, the formation of an academy of alchemists in each province so that they might be well-guided by the "master" of their craft:

> But I desire that this art was treated more faithfully, and with a finer order than it is: and that there would be raised up in each Realm, or even in a town of each province, an academy for alchemy, as well as for the other arts, and that the master of the Academy, and the magistrate, take care that the Alchemists point out all that could serve the health of man, for whom God has created the heavens and the earth. This would be the means of preventing the abuses which are committed in this art, and to punish all of the charlatans, who run throughout all the towns, so that no one may be ruined, and lose time in huffing and puffing, that each one ought to be employed in serving God, the King, and the public.[158]

Like the proposed alchemical group, Mersenne's "académie" thus provided a means for continuing legitimate mathematical activity. The Minim sought to provide intellectual encouragement and guidance to those who worked toward the "completion" of mathematics in its diverse forms. Without governmental support for his academy, Mersenne served as organizer and "master." As the example of Pascal demonstrates, Mersenne's academy also served as an informal place of training based on cooperative research. This community of savants, as other academies of its time, played a "role de suppléance," as Jean Mesnard argues, to provide for the lack in universities.[159] It was, indeed, a "new form of education"[160] one whose substitution was preferable both morally and intellectually:

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[158] "Mais ie desirerois que cét art fût traitté plus fidelleme[n]t, & auec vn plus bel ordre qu'il n'est pas: & qu'on dressât vne academie pour l'Alchymie dans chaque Royaume, ou mesme dans vne ville de chaque prouince, aussi bien comme pour les autres arts, & que le maistre de l'Academie, & le magistrat eussent soin que les Alchymistes remarquassent tout ce qui pourroit seruir à la santé de l'homme, pour lequel Dieu à crée le ciel & la terre. Ce seroit le moyen d'empescher les abus qui se commettent dans cét art, & de punir tous les charlatans, qui courent parmy les villes, afin d'empescher qu'aucun ne se ruinât, & perdît le temps à souffler, qu'vn chacun doit employer à seruir Dieu, le Roy, & le public," Mersenne, *La vérité des sciences*, 105-106.

[159] Jean Mesnard, "Le XVIIe siècle, époque de crise universitaire," in *La culture du XVIIe siècle: enquêtes et synthèses* (Paris, 1992), 103. Another informal group, with a somewhat different audience, also met during the first half of the seventeenth century. Théophraste Renaudot viewed his weekly conferences, which drew a wide crowd of amateurs, as the most profitable means of providing instruction. In the conference entitled "Of the conference and if

There issued from the Minims Mersenne faithful friend,
A savant man, wise and outstandingly good.
His cell was to be preferred to all the schools.
(All of the masters [there] are swelled with ambition).
. . .
Around Mersenne turned, as around an axis,
each star of knowledge in its proper sphere.[161]

Pascal's Model of Mathematical Success

The evidence in this chapter concerning the educational background and pedagogical experiences of several members of the Mersenne Circle provides support for the argument that, in its relationship with Pascal, the group manifested specifically educational tendencies. The training of the young cannot be viewed as the primary or perhaps even a major motivation of this early scientific society. But there is ample reason to believe, especially in the case of Pascal, that the group attempted to cultivate and promote someone who represented its future. This is further attested by Adrien Baillet, in his *Vie de M. Descartes*, regarding "the prodigy who appeared around the same time among the Mathematicians of Paris":[162]

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it is the most instructive type of teaching" (4 March 1641), various views are put forward about teaching. The final states that the conference is most amenable to learning because it places all of the options before a group, leaving the decision of the correct one to "the silent votes of the company," Théophraste Renaudot, *De la petite fille velue et autres conférences du Bureau d'Adresse (1632-1642)*, ed. Simone Mazauric (Paris, 2004), 13-17. A recent work has examined the format and subject matter of the conferences, Kathleen Wellman, *Making Science Social: The Conferences of Théophraste Renaudot, 1633-1642* (Norman, OK, 2003).

[160] "une forme nouvelle d'education," Mesnard, "Le XVIIe siècle, époque de crise universitaire," 110.

[161] "Adfuit e Minimis Mersennus fidus amicus; / Vir doctus, sapiens, eximieque bonus. / Cujus cella scholis erat omnibus anteferenda; / Professorum omnes ambitione tument. / Illi portabat, si dignum forte porisma / Reppererat quisquam, principiumve novum. / Perspicuo et proprio sermone, carente figuris / Rhetoricis gnomis, ambitione, dolo, / Ille dedit doctis, qui vellent, rursus ut illud / Vel statim possent, vel trutinare domi. / Edidit e multisque inventis optima quaeque; / Signans authoris nomine quidque sui. / Circa Mersennum convertebatur ut axem / Unumquodque artis sidus in orbe suo," Thomas Hobbes, *Opera philosophica quae latine scripsit omnia*, ed. William Molesworth, vol. 1 (London, 1839), xci.

[162] "le prodige qui parut vers le meme tems parmy les Mathématiciens de Paris Baillet," Baillet, *Vie de M. Descartes*, 1:39.

> The prodigy was that a young boy of sixteen years had composed a Treatise on Conic Sections, which was a cause of astonishment to all the old Mathematicians to whom it had been shown.[163]

When Descartes replied somewhat indifferently to the copy of the *Essai* sent by Mersenne, Baillet continues, "M. de Roberval, M. le Pailleur, & the other friends of Messieurs Pascal exclaimed against an opinion which did not appear to them [to be] obliging enough for a child of such rare merit."[164] If Mersenne and the "amis de Messieurs Pascal" were too enthusiastic about Pascal's achievements, Baillet's account of their reaction to Descartes nevertheless reiterates their concern to see their young protégé succeed within the larger savant community.

Pascal's early life is inextricably tied to both the educational approach of his father and the clear interest of the Mersenne group in nurturing and encouraging the talent of a teenage mathematician. His experiences as a youngster in the group would provide a core identity as he progressed through his mathematical and natural philosophical career. He made every effort to move beyond his identification as a promising child, but the members of the Mersenne group would continue to consider him as their protégé.

Pascal's involvement in the weekly Parisian mathematical conferences also signals that the development of posterity was a concern of at least part of the nascent scientific movement. Little effort has been made to understand how learned communities viewed their future, especially as it involved educating a new generation. The foundation of the official Académie Royale des Sciences included a group of members known as *élèves*, but little research has been carried out on these individuals or the role that they played in the daily life or long-term strategy of that

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[163] "Le prodige…étoit qu'un jeune garcon de seize ans avoit compose un Traité des Coniques, qui faisoit le subjet de l'étonnement de tous les vieux Mathématiciens à qui on l'avoit fait voir," ibid.

[164] "M. de Roberval, M. le Pailleur, & les autres amis de Messieurs Pascal se recrient contre une opinion qui ne leur paroissent assez obligeant pour un enfant d'un si rare mérite," ibid., 40.

institution.[165] Within the different manifestations of the Mersenne group, Pascal continued to be an important participant and symbol. His early mentors would continue to promote and protect him, even after he had achieved scientific stardom.

For Pascal, the Mersenne group offered a vision of what it meant to be learned, and equally, a model of what it meant to train in a particular field. Coming of age in this atmosphere, Pascal was reminded of the privileges he had received, the intellectual gifts, the nurturing exercise, and his responsibility to honor those privileges. While he was praised as a promising young geometer, Pascal's education combined disciplined work with natural talent and inclination. Throughout his life, notions of childhood, maturity, and hard work played a key role in every phase of his intellectual life, from mathematics and physics to philosophy and religion. Pascal's early training within the Mersenne group laid the foundation for his mathematical career and his spiritual life. When he left Paris with his family in 1640, he took with him the sense of mission he learned as an apprentice to the Parisian mathematicians.

[165] David Sturdy is able to give brief summaries of the work of some of the élèves, but also notes the paucity of study on them, Sturdy, *Science and Social Status: The Members of the Academie des Sciences, 1666-1750* (Rochester, NY, 1995), 127-137. Of the goal of training new scientists, Sturdy writes: "It may also have been assumed that as they gained experience within the Académie they would eventually provide the core of the next generation of academicians. If this aspiration indeed was held by Colbert and by senior members of the Académie then it was realised only in part, for two of the élèves, Pivert and La Voye-Mignot, made so little impact that even today almost nothing is known about them," ibid., 127.

CHAPTER 3
PAINFUL LEGITIMATION: NATURE, DISCIPLINE, EXERCISE

The previous chapter showed that Mersenne saw Pascal and Huygens as "new Archimedeses" poised to contribute to the perfection of mathematics. This potential was based on sound training from their fathers, Mersenne recognized, not just on raw talent. This chapter will seek to show that Mersenne recognized that Pascal and Huygens required continued hard work and clear direction to be consummated as Archimedeses. I argue that Mersenne's works dealing with music demonstrate his belief that training in the arts and the sciences is as important as natural inclination, the influence of bodily humors, or powers exerted by stars at birth or conception. Building on this background of his early mentor and other contemporary sources, the chapter goes on to argue that Pascal's writings about craftsmen in Rouen and about opponents of his views on the void resonate with the primacy of discipline and exercise (rather than nature) expressed by Mersenne. During this period, this chapter suggests, Pascal's writings highlight the virtues of maturity in ways that, although in harmony with Mersenne's views of the acquisition of learning, distance him from the childlike role that had characterized his identity in the Mersenne group.

This chapter will begin with a brief consideration of the early modern notion of intellectual inclinations. This will provide a backdrop to the consideration of questions of the relationship between nature and nurture in the work of Mersenne. Then, Mersenne's general views on the limitations of natural inclinations will be explored, with a subsequent detailed investigation of his evaluation of the relative importance of natural inclination and concerted application in the realm of music.

These first two sections define the set of problems and issues that will be discussed vis-à-vis Pascal's life. The balance of the chapter consists of an analysis of Pascal's work and writings

dealing with the arithmetic machine and the problem of void, in order to uncover patterns of expression that support the hypothesis that Pascal's position as an emerging star prompted him to seek legitimation by placing himself in contrast with those who worked only by natural inclination or instinct.

Inclinations and Intellectual Pursuits in Context

Classification of Inclinations

In seventeenth-century France, references to inclinations were multifaceted. The still-predominant Aristotelian worldview was teleologically oriented, with all things (rocks, animals, human beings, heavenly bodies) having inclinations according to their respective "natures." As it refers to human beings, inclination was seen as a general category of internal factors affecting behavior. Pascal's contemporary, Marin Cureau de la Chambre (1594-1669), wrote a work entitled *L'art de connoistre les hommes* in 1659. One of the chapters of the work is "Des inclinations." In it, Cureau de la Chambre describes inclination as seated within the *appetit* of the human soul, where it brings about a "disposition to be moved" to a particular action.[1] He continues by stating that an inclination is "a disposition [that is] constant and which has spread long and deep roots in the soul."[2] Such constant dispositions come from nature or habit. If the origins of dispositions were multifarious so were the actions to which inclination disposed one. Cureau de la Chambre subdivides inclinations into those that have to do with the body, mind, or moral actions. This chapter's content is related to the significance of bodily and intellectual inclinations. The question of moral inclinations will be pursued in Chapter 5, in the context of Pascal's later association with Port-Royal.

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[1] Marin Cureau de la Chambre, *L'art de connoistre les hommes* (Paris, 1669), 64, 60.

[2] Ibid., 61.

The first set of inclinations was understood to be rooted in the body. Inclinations of the body may be instinctual, as in the case of sheep, which butt heads even before they have sprouted horns. These inclinations were thought to be morally neutral and tended only to the continuation of the natural order of things.[3] But they might also be learned through habit, as with the disposition of an artisan effectively to use a tool.[4] Such actions could be motivated by good or evil intentions and could be used well or poorly. As this chapter will show, Pascal saw little difference between these two types of bodily inclinations. In his writings on the arithmetic machine, he equated the habitual inclinations of the body with the instinctual inclinations of animals. By doing this, he stressed the inferiority of craft knowledge compared to creative, mathematical inventions. Neither of these bodily inclinations, he suggests, is sufficient for developing the expertise of a savant.

Intellectual Inclinations and the Choice of Career

Huarte's *Examen* and types of *esprit*

Attitudes about intellectual inclinations are particularly important for understanding Pascal's efforts to assume the role of a new Archimedes. Such inclinations were believed to be those that led individuals to pursue different kinds of knowledge and that determined an individual's potential for success in some field. One of the works that influenced seventeenth-century thinking most was Juan Huarte's *Examen de ingenios para las ciencias*. Huarte (1530-1592), a physician, first published his work in 1575 in his native Spanish. By the middle of the seventeenth century, there were editions in Italian, Latin, English, Dutch, and French.[5] By

[3] Other examples that Cureau de la Chambre gives are of snakes that bite before having venom and birds that try to fly before their wings are ready, ibid., 64.

[4] Ibid., 63.

[5] The different editions are catalogued in Gabriel A. Pérouse, *L'Examen des esprits du docteur Juan Huarte de San Juan: sa diffusion et son influence aux XVIe et XVII^3siècles* (Paris, 1970), 217-218.

Pascal's death, the work had appeared in seventeen French editions by two French translators: Gabriel Chappuis (twelve editions between 1580 and 1633) and Charles Vion Dalibray, poet friend of the Pascal family (five editions between 1634 and 1661).[6]

The subtitle of Huarte's work attests to its purpose: "in which is shown the differences of Minds [*Esprits*], which are found among men, and to what type of science in particular each one is suited."[7] Huarte argues that some people are suited by nature to the study of oratory, some to law, some to theology, some to medicine or another discipline, while others are not fit to any type of learning.[8] Drawing on the work of Galen concerning humors and their qualities, he insists that "From these three Qualities alone, Heat, Moisture, and Driness, proceed all the differences of Wit [*esprit*] observ'd among Men."[9] Thus, natural qualities are absolutely necessary for proficiency in any subject, and any attempts to train someone contrary to these natural inclinations will be "Vain and Fruitless."[10] The role of the teacher, argues Huarte is "to

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[6] Dalibray's translation would appear in four more editions before the end of the seventeenth century, Pérouse, *L'examen des esprits*, 218.

[7] Juan Huarte, *L'examen des esprits povr les sciences, ou se monstrent les differences d'esprits, qui se trouuent parmy les hommes, & a quel genre de science chacun est propre en particulier*, trans. Charles Vion Dalibray (Paris, 1645).

[8] The titles of some of the chapters, in Juan Huarte, *The Tryal of Wits, Discovering the great Difference of Wits among Men, and what Sort of Learning suits best with each Genius*, trans. Edward Bellamy (London, 1698), include: "What Wit is, and what Differences of it are ordinarily observed among men" (Chapter 1), 1; "That the Theory of Divinity belongs to the Understanding, and Preaching (which is the Practic) to the Imagination" (Chapter 12), 214; "That the Theory of Laws pertains to the Memory; Pleading Causes and Judging them (which is Practic) to the Understanding; and Governing of a Commonwealth to the Imagination" (Chapter 13), 244; "The Differences amongst men unqualified for Sciences" (Chapter 2), 22.

[9] Huarte, *Tryal of Wits* (1698), 129 (Chapter 18 title). Carlos G. Noreña, "Notes and Discussions: Juan Huarte's Naturalistic Humanism," *Journal of the History of Philosophy* 10 (1972), includes a chart that associates the predominance of the qualities of Humidity, Heat, and Dryness with particular intellectual endeavors: 1) Humidity (Memory)–Languages, Theory of Law, Positive Theology, Geography, Arithmetic; 2) Heat (Imagination)–Poetry, Eloquence, Music, Practice of Medicine, Politics; 3) Dryness (Intelligence)–Theology, Theory of Medicine, Philosophy, Practice of Law, 73.

[10] This is in spite of Cicero's examples of philosophers, who seemed slow and inept in their childhood yet by the hard work of their masters became important thinkers in those fields that had once confounded them: "if the Youth has not a pregnant Intellect susceptible of proper Rules and Precepts appropriated to the Art he Studies, even the

open the way to Learning" based on natural capacities and inclinations, and students who seek a master to instruct them in something for which they do not have the right *esprit*, "do but plague themselves and their Teachers."[11]

Central to Huarte's educational philosophy, then, was the discovery of a person's temperament at a young age:

> [I]t is convenient before the Child be sent to School, to discover his Inclination, and the tendency of his Parts, to find out what Study is most agreeable to his Capacity, so to order Matters, that he wholly apply himself to that.[12]

Such a discovery would be beneficial for the state as well as the individual.[13] Such a procedure was followed in the utopia of Tommaso Campanella (1568-1639), an Italian Dominican theologian and philosopher, and sometimes considered a child prodigy.[14] In his *City of the Sun*, Campanella writes that children are evaluated for their potential proficiency in arts and sciences by exposing them to different subjects one after the other:

> In order to find out the bent of the genius of each one, after their seventh year, when they have already gone through the mathematics on the walls, they take them to the readings of all the sciences.[15]

Bartoli and the relationship between inclination and effort

The Jesuit Daniel Bartoli, in his *The Learned Man Defended and Reform'd*, published in Italian in 1645 (translated into French in 1654 and English in 1660), approves of a pedagogical

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Roman Orator's diligent care of his Son, as also all the Prudence of the best of Fathers prove Vain and Fruitless," Huarte, *Tryal of Wits* (1698), 34.

[11] Ibid., 35.

[12] Ibid., 37.

[13] Ibid., 38.

[14] Campanella's early years, including the evidence of his precocious intellect, his life-shaping illness at 13, and his training at a Dominican monastery are described in John M. Headley, *Tommaso Campanella and the Transformation of the World* (Princeton, 1997), 14.

[15] Tomaso Campanella, "City of the Sun," in *Famous Utopias,* ed. Charles McLean Andrews (New York, 1901), 284.

practice similar to Huarte's and Campanella's. Bartoli, a teacher of mathematics, emphasized the role of discipline and hard work, as subsequent evidence will show. But he also stressed the importance of uncovering inclinations to arts and sciences at an early age. The method of encyclopedic exposure to different types of labor may be traced, Bartoli claimed, to ancient Greece:

> The Wise *Athenians* esteemed it a foundation of never knowing any thing, not to know from the beginning to apply ourselves to that for which Nature design'd us. Thence it was that before they applyed their children to any profession, they curiously inquired into their Inclinations; of which the Desires commonly are Truth-telling-Interpreters: and that they did, by laying before them the implements of all the Arts.[16]

For Bartoli, inclination must be the point of departure for the pursuit of the status of an individual learned in arts or sciences: "it is necessary to consult the *Genius*, and from its inclinations to take directions."[17] According to Bartoli, those attempting to work contrary to their inclinations are like planets moving in retrograde, they "make but small progress."[18]

On the positive side, Bartoli asserts, some individuals are so particularly inclined to a single type of work "not by the election of the Will but by instinct of *Genius*," that denying them such an activity would remove an essential aspect of them.[19] "[O]therwise they have nothing considerable, and indeed seem Monstrous."[20] For Bartoli, it is imperative to discover these natural tendencies. To study in one area while having natural talent in another is self-defeating and produces misshapen knowledge. It is a warping of God-given purpose and an insult to the Creator. On the other hand, the inhabitants of Thomas Campanella's *City of the Sun*, for

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[16] Daniel Bartoli, *The Learned Man Defended and Reform'd*, trans. Thomas Salusbury (London, 1660), 275-276.

[17] Ibid., 274.

[18] Ibid., 274.

[19] Ibid., 297.

[20] Ibid., 297.

example, produce good work and it gives them pleasure, because they are trained in precise accordance with their inclinations:

> Since from childhood they are chosen according to their inclination and the star under which they were born, therefore each one working according to his natural propensity does his duty well and pleasantly, because naturally.[21]

The *Ratio studiorum* and selection through inclination

The *Ratio Studiorum*, the guiding document of early-modern Jesuit schools, is less overt about the necessity of well-matched inclinations, yet the judgment of students' talents is an integral part of the educational program. According to the *Ratio*, those who exhibit certain abilities should be given specific opportunities. For example, while all second-year philosophy students are required to attend a forty-five minute public lecture in mathematics, "if some have some abilities and the inclination for this study, they will exercise themselves after the course in private lessons."[22] In the same way, the rule appoints "two or three men eminent in letters and eloquence" in each province with the task of identifying individuals with the "abilities and inclination" conducive to the position of master of humanities. This cultivation of natural talent will provide, the rule states, "a sort of harvest of good professors."[23]

Mersenne and the Limits of Intellectual Inclinations

Mersenne's attempts to develop the talent of Pascal and Huygens should be seen in light of the evidence that exists regarding his views on the relative importance of natural inclination and the development of that inclination through training and intellectual application. Mersenne does not fully explain his perspective on this relationship in his writings. His position may be explored,

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[21] Campanella, "City of the Sun," 300.

[22] Adrien Demoustier, Julia Dominique, and Marie-Madeleine Compère, eds., *Ratio Studiorum: Plan raisonné et institution des études dans la Compagnie de Jésus*, trans. Léone Albrieux and Dolorès Pralon-Julia (Paris, 1997), 82.

[23] Ibid., 83.

however, through some of his opinions regarding "Naturalism" and by making some cautious generalizations from Mersenne's views on inclination and application in music.

Mersenne's Rejection of Determinism for Intellectual Inclinations

Astrological determinism

Robert Lenoble's massive study, *Mersenne ou la naissance du mécanisme*, situates the Minim's philosophy between Renaissance Naturalism and Scholasticism, both of which he rejected for a kind of mechanism. Mersenne could not accept the deterministic character of sorcery and Kabbalah. The spells of sorcery and the correspondences of Kabbalah, with their emphasis on hidden, ineluctable processes, threatened the place of divine providence and human free will.[24] More to the point, Mersenne rejected the determinism of judicial astrology as embodied in the work of Girolamo Cardano (1501-1576), who argued that Christ's birth and other miraculous events were the result of the natural forces of astrology.[25]

Mersenne could not accept deterministic astrology, but such previous Christian thinkers as Augustine and Thomas Aquinas had allowed the influence of the stars over human temperament, which influences human possibilities, but leaves room for freedom.[26] Without contradicting key Christian axioms, then, he could endorse an astrologically-influenced version of Huarte's temperamental scheme regarding types of mind. Mersenne remained cautious about astrology,

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[24] "Car, et c'est là le suprême danger de la Cabale, dans l'universelle correspondance qu'elle imagine entre les noms, les astres, les éléments et les personnes, la destinée humaine n'est plus qu'un élément de l'histoire cosmique," Lenoble, *Mersenne*, 108.

[25] Marin Mersenne, *L'impiété des déistes, athées et libertins de ce temps* (Paris, 1624), 212. Lenoble provides an analysis of Mersenne's views on astrology in Lenoble, *Mersenne*, 128-133. Astrological nativities are but one small aspect of early modern astrology, claiming to be able to predict the future of a person based on the alignment of the planets at the moment of their birth. This most extreme claim for astrological determinism may be compared with the more general, widely-accepted view in early modern Europe, that the heavenly bodies somehow influenced the course of terrestrial events; see Lynn Thorndike, "The Place of Astrology in the History of Science," *Isis* 46 (1955): 273-278. The classic work on the history of astrology is Lynn Thorndike, *History of Magic and Experimental Science*, 8 vols. (New York, 1923-1958).

[26] Lenoble, *Mersenne*, 128-129.

however, because of its associations with determinism, but also because of the lack of decisive evidence for connections, a problem that had prompted some empirical investigation.[27] His caution echoed a similar hesitancy on the part of Huarte. For Huarte, the acceptance of astrological causes of different types of mind would destroy his project of attempting to show how parents might shape the intellectual inclinations of their children. [28]

Mersenne's questioning of astrological predictors was expressed in the context of music, but with an argument that could be generally applied to other endeavors. In the first question of his *Preludes de l'harmonie universelle ou questions curieuses* (1634), Mersenne asks whether or not a talented musician is determined by the influence of stars and planets. He provides a detailed description of three different "nativities" that astrologers claim might produce this "perfect Musician." He explains the rationale used by those who claim that such talent arises through the particular stellar configurations present at the time of birth. He then objects to each nativity, demonstrating its manifest ambiguity. He argues that the combined influence of the planets is so complex that the same positions of the stars that seem to portend the perfect musician also countermand that possibility. Astrology is self-contradictory, Mersenne claims, untrustworthy in predicting someone's "inclination" to an occupation or science. He does not

[27] Ibid., 132-133. A manuscript in the Bibliothèque Nationale, Paris, fonds français 12293, attributed to Jean-Baptiste Morin, provides a number of diagrams and descriptions of the nativities of individuals of renown, including Étienne Pascal, who appears with Desargues preceded by the following description: "esprit des hommes principalement ceux qui son plus destaches des employs comme mathematiciens poetes musicians." The entire collection is presented as a collection of empirical data to test questions of the influence of nativity, which the author seems to doubt: "il y a Dans Vn de mes manuscrits Vn traicté que J[']ay faict de mes opinions sur L'astrologie et en son préambule mes sentiments de la medecine et de La Chimie et mes experiences. ce discours est pour preuuer que les astres n'agissent que par les qualites naturelles, et que les Iugements n'en peuuent estre que generaux et Incertains, encore que L[']examen n'en puisse estre trop exacte," f. fr. 12293, folio 6r.

[28] "The Astrologers hold, that the Child being born under such an Influence of the Stars will be Wise, Witty, Well or Ill-condition'd, happy or unhappy, with a thousand other qualities, and properties, which we see and observe every day among Men. But if this were true, we could not here prescribe any Rules; for all would depend on Chance, and not be our Choice," Huarte, *Tryal of Wits* (1698), 443. Huarte argues that parental nutrition, the timing of intercourse, and other physical factors relating to the parents' bodies determine the type of child that will be produced.

dismiss Judicial Astrology entirely, probably because of Thomas Aquinas's endorsement of it, but he concludes that a simplistic determination of effectiveness in music through the stars is not a satisfactory hypothesis:

> I would say . . . that it seems that nothing assured may be predicted about the inclinations or perfection of the child, because of the matter of which its body is formed, the milk and the meat with which it is nourished, the air that it breathes, the diverse company among which it is raised, and a thousand other circumstances, which are greatly significant, and more than sufficient to prevent all the predictions of the Astrologers, even if these had a perfect knowledge of nature and the effects of all the Stars, which they never have.[29]

Temperament and inclination

Mersenne agreed with Huarte's dismissal of astrological determinism, but he also went a step beyond it. He did not agree with Huarte about the determinative influence of the qualities of heat, dryness, and humidity. The argument (from the same source as the passage above) deals with music, but his appeal to empirical complexity could well be applied to other pursuits.

Mersenne argues that there is no one temperament suited to the "Perfect Musician." It is impossible, he states, to determine who will be able to compose or play good music based on theories of bodily composition. This conclusion seems obvious, "experience causing us to see excellent Musicians of all sorts of temperaments."[30] He thus denies that the whims of nature

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[29] "Je diray . . . qu'il semble qu'on ne peut rien predire d'asseuré des inclinations, ou de la perfection de l'enfant, à raison de la matiere, dont son corps est formé: du laict, et des autres viandes, dont il est nourry; de l'air qu'il inspire, des diverses compagnies parmy lesquelles il est élévé, et de mille autres circonstances, qui sont grandement considerables, et trop suffisantes pour empescher toutes les predictions des Astrologues, encore qu'ils eussent une parfaite connoissance de la nature, et des effects de tous les Astres, laquelle ils n'auront jamais," Mersenne, *Questions inouyes; Questions harmoniques; Questions théologiques; Les machniques de Galilée; Les préludes de l'Harmonie Universelle* (Paris, 1634; repr. 1985), 560. Jean Mesnard takes note of a set of lists of individuals compiled perhaps between 1650-1660 (originally associated with Jean-Baptiste Morin) that "consiste à chercher, après coup, le rapport qui peut exister entre la desitnée d'un homme et la position des astres à sa naissance, puis, par comparaison de plusieurs cas, à dégager des constantes, des lois," One of the people mentioned in these lists, under the category *Esprit des hommes, principalement ceux qui sont plus détachés des emplois, comme mathématiciens, poètes, musiciens, etc., car les autres sont partout sous les autres chapitres, et principalement des honneurs*, is Étienne Pascal: "Monsieur Pascal, excellent en mathématique, musique, esprit prompt, subtil, entendu aux affaires," Mesnard *OC* 459-460.

[30] "l'experience nous faisant voir d'excellents Musiciens de toutes sortes de temperaments," Mersenne, *Questions inouyes*, 601.

produce learning or exclude it. Mersenne claims that the responsibility for success is not with the parents, as Huarte had asserted, but with the individual acting in perfect freedom. Mersenne claims that application of the mind makes a successful musician in the same way that self-discipline creates the possibility of a morally righteous life:

> It is very easy to conclude from all of the preceding discourse, that the temperament and the humours do not so dominate reason that it does not keep its freedom or cannot overcome vices and imperfections, for it is as easy to correct the temperament or inclination that moves one to theft or some other bad action as it is for the melancholy Musician to compose songs, and gay tunes; he does this through the rules of art, which arm reason against sense, and mind against temperament.[31]

"Nature, Discipline, Exercise": Necessary Components for Learning

Another passage that deals with music further develops Mersenne's ideas about the place of personal initiative in acquiring expertise. In a section of his monumental work *Harmonie universelle* (1636), Mersenne borrows a section from a treatise by a Parisian lute teacher named Basset, which develops the principles needed for skill in playing the instrument. His analysis of the project of becoming skilled, however, is generalized:

> Most of those who have considered the arts & sciences require three conditions to acquire the perfection of them, that is, Nature, Discipline, & Exercise, without which one cannot arrive at the end that one proposes for oneself.[32]

This statement helps justify, to a degree, the general parallel that this chapter tries to draw between Mersenne's approach to musical proficiency and Pascal's application to mathematical

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[31] "Il est tres-aysé de conclurre de tout le discours precedent, que le temperament, et les humeurs ne dominent pas tellement à la raison, qu'elle ne demeure dans sa liberté, et qu'elle n'en puisse surmonter les vices, et les imperfections, car il est aussi aysé de corriger le temperament, ou l'inclination, qui porte au larrecin, ou à quelqu'autre mauvaise action, comme il est aysé au Musicien melancholique de composer des chants, et des airs gays; ce qu'il fait par les regles de l'art, qui arment la raison contre le sens, et l'esprit contre le temperament," Mersenne, *Questions inouyes*, 602-603.

[32] "La pluspart de ceux qui ont traicté des arts & des sciences, requierent trois conditions pour en acquerir la perfection, à sçauoir la Nature, la Discipline & l'Exercice, sans lesquelles on ne peut arriuer au but que l'on s'est proposé," Mersenne, *Harmonie universelle*, "Livre second des instrumens," 76.

learning. Caution is warranted in making the leap, but with the further development of the argument it is hoped that the connection will appear plausible, if not compelling.

The discussion of musical talent and application by Basset recognizes the existence of a natural inclination that makes for an easier path in musical accomplishment. Some individuals have "such a sensitive ear," Basset argues, that they are able to hear the distinctions in notes, thus having an advantage in learning music.[33] In another passage, Mersenne considers the gift of a fine voice, linking it to other gifts given by God, including the intellectual skill of an Aristotle:

> There is no difficulty in teaching those who have a good voice [to sing], because it is within them [naturally] to imitate, and to do all that is wanted; which happens similarly with all other Apprentices, who have more need of a brake than a spur, as was said of Aristotle, when he was still a student: from there comes the Latin proverb *gaudeant benè nati* [rejoice you well-born], because of the good qualities that nature & birth give to some & that they deny to others; which one must attribute to the order of Divine Providence.[34]

Nevertheless, Mersenne's writings on music indicate that he was not willing to accept the view that "nature" preselected those that would be talented at singing, playing the lute, or composing music:

> The Art of making good Songs on all sorts of subjects does not depend only on the genius, whim, & inclination of those who make them, but also on the judgment that ought to provide guidance to Composers, as to other Artisans, in all that they undertake, in order that they be able to give the reason for the chords, the degrees, the intervals, the passages, & the trills that they employ in their compositions.[35]

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[33] "l'oreille si delicate," Mersenne, *Harmonie universelle*, "Livre second des instrumens," 77.

[34] "Il n'y a nulle difficulté à enseigner ceux qui ont vne bonne voix, parce qu'ils se portent d'eux-mesmes à imiter, & à faire tout ce que l'on veut; ce qui arriue semblablement à tous les autres Apprentifs, qui ont plus besoin du frein [brake] que de l'osperon [spur], comme l'on disoit d'Aristote, lors qu'il estoit encore escolier: de là est venu le Prouerbe Latin *gaudeant benè nati*, à raison des bonnes qualitez que la nature, & la naissance donnent à quelques vns, & qu'elles denient aux autres: ce que l'on doit rapporter à l'ordre de la Prouidence Diuine," Mersenne, *Harmonie universelle*, "Embellissement des Chants," 2: 354.

[35] "L'Art de faire de bons Chants sur toutes sortes de sujets ne dépend pas seulement du genie, de la caprice, & de l'inclination de ceux qui les font, mais aussi du iugement qui doit seruir de conduite aux Compositeurs, cõme aux autres Artisans, en tout ce qu'ils entreprennent, afin qu'ils puissent rendre la raison des chordes, des degrez, des interualles, des passages, & des tremblemens, qu'ils employent dans leur compositions," ibid., 2: 360.

Mersenne stresses in this passage the importance of an intellectual capacity (judgment) that should be exercised in order to have success in composition. Such an application of mind would ostensibly help to improve those who were already talented.

Perhaps even more significantly, the passage by Basset disputes the idea that the "naturally" talented have an unquestionably privileged position. But those who lack such traits could take heart:

> As the most sterile earth is made fertile by the care and diligence of the laborer, so those who believe themselves to be incapable of learning this art ought to be assured that they can overcome the defects of nature, & inclination, by putting into practice the teachings that we set forth.[36]

The language in the passage evokes the figure of cultivation that was often a part of describing the educational process. Growth comes through the diligence of both teacher and pupil. Even if nature has granted advantages to some, the passage suggests, those without such advantages could become accomplished. The talents, or the deficiencies, of the child had to be improved and matured in order to attain perfection.

Only the lack of proper learning and exercise, the above passage suggests, would finally disqualify someone as a lute player. The need for application rather than dependence on natural inclination may be linked to the broader theme of a rejection of *ignorants*. Although the topic is addressed in his writings on music, it also appears in other works. Considering these works together helps to provide a sense of the relative importance attached to hard work and studied effort to attain to one's full potential.

[36] "[C]omme la terre la plus sterile est renduë fertile par le soin & la diligence du laboureur, ainsi ceux qui croyoient estre incapables d'apprendre cet art, doiuent s'asseurer qu'ils peuuent surmonter les defauts de la nature, & l'inclination, en mettant'en pratique les enseignemens que nous allons donner," Mersenne, *Harmonie universelle*, "Livre second des instrumens," 76.

In his *Questions harmoniques*, Mersenne addresses a claim made by some of his contemporaries that "the truth is found by the ignorant and not by the savants."[37] According to this opinion, the *ignorants* were those who relied on the simple judgment of the senses in the practice of an art, believing that the application of the opinions of the ancients were an unnecessary burden. They believe that those who apply themselves diligently to principles of the art "are most often preoccupied with and have their minds so attentive to the authority of the Ancients."[38] It is the senses, the *ignorants* declare, "through which it would be necessary to begin to reestablish the sciences if they were lost."[39] Even mathematicians, according to the claim recorded by Mersenne, have had to admit this and submit to the notion of common sense.[40]

Mersenne's critical response to this opinion upholds the importance of becoming learned. He emphasizes that specialized fields are the result of time and effort. While the common person or child who is unlearned in an art or science may be able to discern the most banal principles of that art or science, Mersenne claims that there are limitations to the final ability-level of these *ignorants*:

> The light of reason, which is nearly all alone in the mind of the ignorant, could well give to them some light tincture of the truth, but it is not great enough to make them penetrate into particular truths, which contain very many difficulties, as are those which serve as object to the arts, and to the sciences, and which have need of several experiences/experiments.
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> From there it comes that they are mistaken the most often when they want to extend too much the little knowledge that they have, being similar to those who believe to be able to uncover all this that there is in a town, or in a large country with the light of a little candle,

[37] Mersenne, *Questions inouyes*, 171.

[38] "[Ils] sont le plus souvent preoccupez, et ont l'esprit tellement prevenu de l'autorité des Anciens," ibid., 167.

[39] "par lesquels il faudroit commencer à rétablir les sciences si elles estoient perdües," ibid., 170.

[40] The privileging of the "ignorants" over the "savants" is, ironically, a characteristic of both libertine and devout. The libertine quotes Lucien: "Le meilleur mode de vie . . . une vie toute d'or, est celui des ignorants et des simples particuliers," "Theophrastus redivivus III," *Libertins du XVIIe siècle*, vol. 2, 331; think also to the title of a dialogue by La Mothe Le Vayer: "De l'ignorance louable." Some devouts, for their part, "blasment ou mesprisent les sciences . . . sous pretexte de piété," Mersenne, *Harmonie universellem,* "De l'utilité", 20.

> where a thousand torches would not be sufficient; or to those who judge colors in the shadows, or by the light of the fire, which are constrained to be withdrawn in the clear light of day: for the knowledge of the savants with respect to that of the *ignorants* is as the light of day and of the Sun compared to that of a candle, or of a shiny piece of glass.[41]

Mersenne's claim against the praise of the ignorant ties the discussion in the context of music to other comments that he makes about mathematics. In *La vérité des sciences*, for example, Mersenne's "Christian Philosopher" distances himself from those who claim to be learned in mathematics, but do not have the proper training. He describes them as:

> the many ignorant [people] who want to persuade the world through their sophisms, & paralogisms, that they have found the *quadrature of the circle, the duplication of the cube, the trisection of the angle*, and have recognized several errors in the definitions & propositions of Euclid, even though most of these reckless [ones] know neither the very first terms of Geometry, nor the [proper] way of speaking about it.[42]

Mersenne argues that such foolish ones should not have any attention given to them by geometers, "for fear that by such condescension it would be believed that they approve of these reckless [ones]."[43]

Ignorance is, for Mersenne, a state of nature. It is the unimproved state. The analysis of lute-playing in *Harmonie universelle* summarizes this view in its assertion that without the aspects of Discipline and Exercise, "nature is imperfect and blind."[44] Mersenne sought to safeguard the claim to learning from the "flock of ignorant [people] who speak as parrots in a

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[41] Mersenne, *Questions inouyes*, 175.

[42] "quantité d'ignorans qui veulent persuader par leurs sophismes, & paralogismes, qu'ils ont treuué la *quadrature du cercle, la duplication du cube, la trisection de l'angle*, & reconu plusieurs erreurs dans les definitions, & propositions d'Euclide, bien que la pluspart de ces temeraires ne scachent pas seulement les premiers termes de la Geometrie, ni la maniere d'en parler," Mersenne, *La vérité des sciences* , 750.

[43] "de peur que par ceste condescendence on croye qu'ils aprouuent l'ignorance de ces temeraires," ibid.

[44] Mersenne, *Harmonie universelle*, "Livre seconde des instrumens," 77.

cage, often without knowing what they say."[45] For Mersenne, nature is clearly limited in its ability to comprehend the full range of knowledge of an art or a science.

Mersenne's mathematical academy provided a forum for establishing legitimate specialized learning. The group would provide, by way of its exclusivity, an endorsement to those who were within its ranks. They would be one of the group of "our Geometers" [*Nos Geometres*] mentioned so often in their letters. Mersenne sought to establish the role of the savant in mathematics so that they might ultimately be financially protected and patronized by governmental authority.[46] But in order to do this, he had to counteract those who claimed that "it is worth as much to say 'this is a Mathematician', as if one said, 'this is a fool'."[47] Many people viewed mathematics as being unrelated to practical matters. It was abstract and few of its claims could be verified by the senses. Mathematics was the epitome of uselessness, and this created a lower status for mathematicians. It was precisely the division between mathematics and physical reality that Galileo sought to overcome by combining the roles of philosopher and mathematician under the courtly patronage of the Grand Duke of Tuscany.[48] Mersenne also worked for legitimacy, for himself and for his circle of friends. He desperately sought to overcome the perceived uselessness of mathematics in *La verité des sciences*.

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[45] Mersenne, *L'impiété des déistes*, 187.

[46] Mersenne's attempts to establish a means of legitimtion in seventeenth-century France is rooted in issues similar to those that troubled Italian mathematicians during the fifteenth and sixteenth centuries. Mario Biagioli considers the questions of how mathematicians sought to gain more social legitimacy in Biagioli, "The Social Status of Italian Mathematicians, 1450-1600," *History of Science* 27 (1989): 41-95. Biagioli stresses the attemps of mathematicians to reiterate the "certainty" of their discipline as a means to well-defined professionalization measures, ibid., 54. Mersenne's emphasis on mathematics in *La verité des sciences* is an echo of this concern.

[47] "Mais vous n'auez pas répondu à ce que i'auois dit des autres sciences naturelles, particulierement des Mathematiques, qui me semblent de pures réueries, cest pourquoy ce n'est pas sans suiet qu'on appelle ceus qui s'en meslent, Maistres Mates, car ils sont quasi tous fols, & vaut autant dire c'est vn Mathematicien, comme si on disoit, c'est vn fol," Mersenne, *La verité des sciences*, 66. The argument is attributed to one of the oppositional voices ("The Skeptic") in Mersenne's book.

[48] Mario Biagioli, *Galileo Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: University of Chicago Press, 1993), 105-106, 203-209.

Becoming Archimedes: Working for Legitimacy

During the years that Pascal lived in Rouen (1640-1647), he expressed himself in ways that emphasized his mathematical learning. In this section I argue that during this period Pascal emerged out of the shadow of the Parisian group and that he worked to move beyond his position as an apprentice to one of legitimacy in his own right. Through his work on the arithmetic machine and the experiments on the void, he was moving from potential young star to accomplished savant. He was becoming Archimedes.

During this period of self-legitimation, Pascal's writings emphasized that his work depended on concerted practice and intellectual application. As this section will show, Pascal expressed a contrast between himself and his opponents that suggest an attempt to move away from being identified as child-prodigy. In his work with the arithmetic machine, lack of manual skill forced him to cooperate with artisans, but he vehemently maintained the superiority of the savant theoretician to the habituated worker. In his experiments and writings on the void, by contrast, Pascal battled established "scholars" who unblinkingly relied on the expertise of the ancients to decide a physical question. In the first case, he upheld the master-servant relationship of the "super-natural" mathematician and the "natural" artisan. In the second, he opposed those who denied the cumulative aspects of physical knowledge. They thereby preferred the state of the beasts, or the "natural" state, to that of the human being, "made only for infinity." In both cases, through the disciplined and trained imitation of God's works (the mind through the arithmetic machine, the display of a void in the tube) he interacted with pedagogical nature. By learning *from* nature, through his interaction with observed phenomena, he transcended the original, unimproved state of nature.

Pascal became a full-fledged savant during the Rouen period, which will be attested by changes in the ways members of the learned community referred to him. During this time, he

used mathematics to create amazing effects and to promote philosophical reflection. In short, he displayed the God-imitating quality of the learned mathematician, not the animal-like quality of those who focused on shaping matter or those who idolized the ancients. In his youth, Pascal's mentors were amazed by the mature thinking of the child. During this period, this section will propose, Pascal left childhood behind in favor of maturity and expertise.

Imitating the Creator: Pascal's Calculating Machine

Narrative summary

In March 1638, Étienne Pascal was marginally involved in an uprising of those who were owed payment for rents on the Hôtel de Ville. The rents were unpaid by the government because the war with Spain had drained the coffers. Several individuals who were involved in this event were arrested including some friends of Étienne, and Étienne went into hiding in the Paris area and probably also in Clermont, Pascal's town of origin.[49] Étienne bided his time, awaiting the return to Richelieu's favor. Meanwhile, the Pascal children remained in Paris, probably under the care of the family nurse, Louise Delfault.

In April 1639, the tide turned for Étienne. One of the elder Pascal's friends, an actor named Montdory, spent time talking with Cardinal Richelieu, specifically pleading the innocence of Étienne in the affair of the rents. Not long after, the youngest of the Pascal children (Jacqueline) performed a role in a play, entitled *L'amour tyrannique*, at Richelieu's home. After the play, Jacqueline, then thirteen years of age, approached the cardinal, who received her with the exclamation, "Here is the little Pascal!" He showered affection on her and heard her pleas on behalf of her father. He consented to her requests, telling her, "Go, I agree to all that you have

[49] This and subsequent events in the Pascal's lives are recorded by Gilberte Périer in her "Vie de Jacqueline Pascal," Mesnard *OC*, 1:660-662.

asked of me; write to your father that he may return in entire safety."[50] Shortly thereafter, by fall 1639, Étienne was appointed as deputy commissary in Normandy for the collection of taxes associated with the sustenance of troops there. In the spring of the following year, the family was reunited in a house in Rouen.

When Blaise left Paris, the seedbed of his savant career, only a few individuals (including the Mersenne Circle and some of Mersenne's correspondents) knew of his mathematical work. As Chapter 2 showed, there is little evidence of great enthusiasm for Pascal's earliest project, except among the small group with whom he met on a weekly basis. During his time in Rouen, however, Pascal initiated work on his arithmetic machine and on his experiments and writings on the void. These two projects would establish his learned reputation during his lifetime and until the posthumous publication of his other works.

Pascal's name became well-known first because of his "machine à calculer," sometimes referred to as the "Paschaline." Its invention was directly related to his father's employment in Normandy. Étienne oversaw the collection of taxes in the region and, as such, had to make large arithmetic calculations. These calculations were extremely time-consuming using the traditional methods. In 1643, the work and strain of these calculations were such that his letters to his eldest daughter (now married and living elsewhere) were irregular. He writes to her:

> My good daughter will excuse me if I do not write to her as I would desire, having no leisure to do so. For I have never been burdened by the tenth part of what I am now . . . In the past four months I have not gone to bed six times before two o'clock in the morning.[51]

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[50] "Allez, je vous accorde tout ce que vvous me demandez: écrivez à votre père qu'il revienne en toute sûreté," Jacqueline Pascal to Étienne Pascal, 4 April 1639, Mesnard *OC*, 2:211. See also Gilberte Périer, "Vie de Jacqueline Pascal," Mesnard *OC*, 1:661-662.

[51] "Ma bonne fille m'excusera si je ne lui écris comme je désirerais, n'ayant aucun loisir. Car je n'ai jamais été dans l'embarras à la dixième partie de ce que j'y suis à present . . . . [I]l y a quatre mois que je [ne] me suis pas couché six fois devant deux heurs après minuit," Étienne Pascal to Gilberte Périer, 31 January 1643, Mesnard *OC*, 2:283.

Blaise began work on his arithmetic machine in order to ease Étienne's load and perhaps his own, since Blaise probably helped his father with these duties:

> The length and difficulty of the ordinary means that are used having made me think to some quicker and easier assistance, in order to help me in the great calculations with which I had found myself consumed for some years in several affaires related to the employ with which it pleased you to honor my father for the service of His Majesty in Haute Normandie.[52]

Since Blaise's father was so busy with his work that he could not go to bed until after midnight, it seems unlikely that he did much to continue his scientific or mathematical interests. There are likewise no extant letters or treatises to suggest that Blaise advanced his work with conic sections or other areas of abstract geometry. It was up to Blaise to put his talent to work. He applied himself to an engineering task: the creation of a machine to assist his father.

Pascal henceforth entered a new phase of his career. In the writings of this time he increasingly distanced himself from his image as a child with adult-like intellectual skill in several ways that this chapter will show. In his writings, he contrasted his own knowledge with the artisans' craft, which he characterized as similar to natural, animal instinct. He described his projects as having put into practice the talents of his nature and applied the principles and methods that he had obtained through good instruction. In so doing, Pascal earned renown in the circles of French intellectual culture.[53]

Pascal tells the story of the arithmetic machine's creation in two documents, written after a number of exemplars of the machine had been created. Blaise began work on the machine when

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[52] "Les longueurs et les difficultés des moyens ordinaires dont on se sert m'ayant fait penser à quelque secours plus prompt et plus facile, pour me soulager dans les grands calculs où j'ai été occupé depuis quelques annés en plusieurs affaires qui dépendent des emplois dont il vous a plus honorer mon père pour le service de Sa Majesté en la Haute Normandie," Blaise Pascal to Chancellor Séguier, 1645, Mesnard *OC*, 2:332; John R. Cole has suggested, in his psychoanalytic study of Pascal, that the arithmetic machine should be seen as an offering to the father, Cole, *Pascal*, 49.

[53] "[J]'employai à cette recherche toute la connaissance que mon inclination et le travail de mes premières études m'ont fait acquérir dans les mathématiques," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

he was nineteen years old (1642-1643). By the age of twenty-one, while visiting Paris, Pascal succeeded in making an appointment, through the mediation of Pierre Bourdelot, to show the prince de Condé a prototype.[54] Following up on this meeting, a dedicatory letter for the machine was written to Chancellor Séguier in 1645, and a "Notice necessary for those who may be curious to see the arithmetic machine, and to make use of it" [*Avis nécessaire à ceux qui auront curiosité de voir la machine arithmétique, et de s'en servir*] was printed in Paris a short time afterward. These two sources, the additional information drawn from the privilege itself, and contemporary writings about the machine suggest Pascal's attempt to establish himself as a full-fledged savant.

The privilege that was eventually granted to Pascal as the sole inventor of the machine provides the best description of its inner workings. There are various ways that the machine might be constructed to do what Pascal wanted, but the main principles of the mechanism seem to be the same in each.[55] The key to its operation was the interlocking of toothed wheels. These wheels were aligned so that a full turn would engage the next wheel in the line, causing it to move one place, thus "counting" the turns of the first wheel. Then, when the second wheel had turned through a full revolution, it would likewise engage the next wheel and move it a single position. For example, with a decimal version of the machine, as are the two examples now located in Clermont and in Dresden, there would be a number of wheels (between six and ten),

[54] Pierre Bourdelot to Blaise Pascal, 26 February 1644, Mesnard *OC*, 2:297.

[55] The privilege that was granted to Pascal for the making of his machine in 1649 describes a number of the different ways in which the machine was attempted: "De laquelle machine il aurait fait plus de cinquante modèles, tous différents, les uns composés de verges ou lamines droites, d'autres de courbes, d'autres avec chaînes; les uns avec des rouages concentriques, d'autres avec excentriques, les uns mouvants en ligne droite, d'autres circulairement, les uns en cônes, d'autres en cylindres, et d'autres tout différens de ceux-là, soit pour la figure, soit pour le movument; de toutes lesquelles manières différentes l'invention principale et le mouvement essentiel consiste en ce que chaque roue ou verge d'un ordre, faisant un mouvement de dix figures arithmétiques, fait mouvoir sa prochaine d'une figure seulement," "Privilege," Mesnard *OC*, 2:713.

each of which have nine arms extending from its center.[56] The spaces between the arms are associated with each of the digits 1-9 and the wheels represent the various powers of ten. The far right wheel represents ones, the next to the left tens, the next hundreds, and so on. When the operator wishes to add a number, he inserts stick or pen into the appropriate space on the wheel and turns it. When the wheel for the ones has rotated through an entire circuit, its tens wheel, which moves a single position, and the machine indicates a single ten. If the ones wheel makes another full circuit, the tens wheel moves to the second position, representing two tens, or twenty. The machine displays the cumulative total on drums labeled 1-9, which rotate in connection with the wheel when the operator moves it with a quill pen or stick.

The interlocking parts of this type of machine had to be made with precision, requiring cooperation between the theorist Pascal and local artisans. While in Rouen, Pascal enlisted the mechanical skills of clockmakers. Clockmaking had been an important trade in Rouen since the fourteenth century. As such, the talent pool from which Pascal could draw was deep. When he enlisted artisans to implement his design, however, "I met obstacles as great as those that I wanted to avoid."[57]

Trouble with clockmakers

Pascal's initial difficulty was the difference in skills of the theorist and the artisan. Unlike the neat interlocking of wheels that Pascal envisioned in his machine, the linkage of practical and theoretical knowledge in this complex task required a nearly impossible fine tuning of communication and personal relationship:

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[56] Some other versions of the machine include wheels that indicate monetary values. For a detailed description of the machine's function, see Vernon Pratt, *Thinking Machines: The Evolution of Artificial Intelligence* (New York: Basil Blackwell, 1987), 48-53.

[57] B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

> Not having the skill to handle metal and hammer as [I do] pen and compass, and artisans having more knowledge of practice of their art than of the sciences on which it is founded, I saw myself reduced to quitting my entire undertaking, through which there came to me only very much fatigue, without any good success.[58]

Pascal does not detail the difficulties he encountered but his writings suggest possible factors. Because Pascal could not use the proper tools to create the gears and box and other parts of this machine with sufficient precision, he had to rely on the artisans' handiwork. But because the artisans were not trained in mathematics, mechanics, and physics, Pascal would have to attempt to communicate to them the means of making these parts without using the customary language of the theorist. He implies that the artisans lacked the intellectual savvy to understand the complex functioning of his machine. It would be ineffective to use the comprehensive design strategy as a means to communicate the technical requirements for the individual parts. Instead, Pascal had to work in piecemeal fashion with his clockmakers. He established rules (with the dual meaning of measurement and method) for the artisan to follow in the making and assembling of parts. The standards for the individual parts were created by Pascal through his knowledge of theoretical disciplines.[59] The artisans had only to follow the rules.

At the heart of Pascal's challenge were the workers' customary mode of learning and the scope of their training, both of which were rooted in habit rather than original thought. A clockmaker's apprentice learned to use a hammer, a lathe, or a file through bodily repetition. This repetition, combined with instruction from the master, instilled a set of guidelines that governed the worker's movements when he made particular common objects, such as the gears of a clock. In the case of a new invention such as the arithmetic machine, Pascal argues, the

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[58] "N'ayant pas l'industrie de manier le métal et le marteau comme la plume et le compas, et les artisans ayant plus de connaissance de la pratique de leur art que des sciences sur lesquelles il est fondé, je me vis réduit à quitter toute mon entreprise, dont il ne me revenait que beaucoup de fatigues, sans aucun bon succès," ibid.

[59] He had, he writes, to "give [to the artisan] the measures and the proportions of all the pieces of which it [the machine] ought to be composed," Mesnard *OC*, "Avis," 2: 339.

worker (even a master) lacked the hands-on experience and inherited rules requisite to proceed unaided. Theory provided the rules by which the physical piece was made. Furthermore, while the function of each piece of a clock is firmly fixed through repeated custom, the fabrication of parts for the arithmetic machine was a first-time event. Only when "continual exercise has given to the artisans the habit of following and practicing these rules [of theory] with assurance" is the worker able to craft the parts of the new invention without assistance.[60]

In multiple senses, then, the craftsman is *reglé.* In the first place, he follows essential instructions that have been passed along by an authority. As such, he is also *reglé* in his status. Just as artisans did not belong to the "ruling" class, so in the realm of knowledge, they must submit to an authoritative power. No matter their level of experience, apprentice and master alike were pupils of the theorist.

Technicians and theorists in the work of Desargues

The idea of technician as disciple or as pupil to the theoretician also appears in the work of Desargues, Pascal's mentor in projective geometry. Like Pascal, Desargues is often praised for his brilliance in both abstract and applied mathematics. He wrote treatises on the technique of perspective in painting, the making of sundials, and architectural practices (e.g., shaping stones for buildings).[61] In a controversy that took place between 1640 and 1644, he was accused of

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[60] "Avis," Mesnard *OC*, 2:338.

[61] Girard Desargues, *Méthode Universelle de mettre en perspective les objets donnés réellement ou en devis, avec leurs propositions, mesures, éloignemens, sans employer aucun point qui soit hors du champ de l'ouvrage*, in *Oeuvres de Desargues*, 1: 55-84; idem, *Maniere Vniuerselle de tracer au moyen du style placé, tous quadrans plats d'heures égales au soleil, auec la reigle, le compas, l'equierre et le plomb*, in *Oeuvres de Desargues,* 1: 352-358 (plus plates); and (using the same beginning of title as his original work on conics), *Brouillon projet d'exemple d'vne maniere vniuerselle du S. G.D. L.* [Sieur Girard Desargues de Lyon] *touchant la pratique du trait a preuues pour la coupe des pierres en l'architecture; et de l'esclaircissement d'vne maniere de réduire au petit pied en perspective comme en géométral, et de tracer tous quadrans plats d'heures égales au soleil*, in *Oeuvres de Desargues*, 1:305-358. For a scholarly look at Desargues' practical works, see Antoine Picon, "Girard Desargues ingénieur," in *Desargues en son temps*: 413-422; François-Régis Cottin, "L'architecte et l'architecture à Lyon au temps de Desargues," in *Desargues en son temps*, 425-432; Joël Sakarovitch, "Le fascicule de stéréométrie: entre savoir et métiers, la fonction de l'architecte," in *Desargues en son temps*: 347-362.

plagiarism, pride, and practical ineptitude. To answer the last charge, Desargues was forced to argue the pedagogical duties of a theorist.[62]

In his defensive treatises, Desargues portrayed himself as a master to those who practiced the arts of drafting architectural plans and cutting stones. Ostensibly, the desire to "aide" practitioners motivated this instructional role. The word "aide" also appears in Pascal's description of his work on the arithmetic machine and the assistance he had to give to the workers and suggests the similarity of the two mathematicians' attitudes toward workers.[63] Desargues' help took the form of a simplification of the instruction that the artisans received from their masters:

> I was touched by the desire to understand, if it were possible to me, the foundations, and the rules of their [the stonecutters'] practice, such as one would find them and see them when in use; I noticed thereby that those who gave themselves to it, had to burden themselves with the memory of a great number of diverse lessons for each of them; and which through their nature and condition, produced an incredible encumbrance in their understanding, and far from causing them to have diligence for the execution of the work, caused them to lose time there.[64]

Desargues' belief that craftsmen's "nature and condition" made learning a vast number of lessons difficult is central to his self-styled position as a teacher of artisans. Mersenne similarly suggests the mental inferiority of technical workers when he attributes the limitations of bell size in part to the "imbecilité de l'artisan."[65] Pascal reemphasizes the same trait in his arithmetic

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[62] A helpful account of the main lines of this extended controversy is found in René Taton, *L'oeuvre mathématique de Desargues*, 48ff.

[63] "[I]t is likewise absolutely impossible to all the simple artisans, as able as they be in their art, to put to perfection a new piece which consists, as this, in complicated movements, without the help [*aide*] of a person who through the rules of theory gives to him the measures and the proportions of all the pieces with which it ought to be composed," "Avis," Mesnard *OC*, 2:338-339.

[64] "Reconnaissance de M. Desargues," in Desargues, *L'oeuvre de Desargues*, 1:487-488.

[65] Mersenne, *Harmonie universelle,* "Livre septiesme des instrumens de percussion," 3.

machine writings when he identifies an artisan as a "simple-minded man."[66] Desargues, Mersenne, and Pascal do not clearly indicate what they mean in declaring artisans to have inferior intellects "by nature." It is probable, however, that there was a significant social factor involved and that the shared characteristics of artisanal classes had to do with a complex of typical educational patterns and habituated subservience.

Desargues compares the artisans of the building industry to children. Their lack of capacity is primarily related to their style of learning, which was habitual and based on simple rules, therefore not developing the memory. Desargues' method of teaching children to sing, recorded in Mersenne's *Harmonie universelle*, likewise stresses the limitations of his young students. Desargues sought to simplify the skill by stressing the imitation of sounds of either the master's voice or an instrument the master played:

> The advantage that comes from this way of learning to read & make the notes of Music is that the understanding is greatly assisted by it, [while] memory and sight are not employed very much, & [it is] almost as if only the hearing and the voice of the Disciple are at work, when he exerts himself thus on a book of Music; from which it arises that the mind is not disheartened in the long exercise necessary for the apprenticeship of the Arts, as it is disheartened when it has several difficulties to combat & to overcome at the same time, as [occurs] in the ancient way of learning to sing, with the subtleties & diverse names that each note receive; such does not occur in this method.[67]

Both child and artisan, then, require a method that is not complex but sufficiently simplified by his superiors. The artisan parallels the child in that both are unlikely to memorize a great deal.

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[66] "Avis," Mesnard *OC*, 2:339.

[67] "L'auantage que l'on reçoit de cette maniere d'apprendre à lire & entonne les notes de la Musique est, que l'entendement s'en trouue grandement soulagé, la memoire & la veuë n'y ont pas beaucoup d'employ, & n'y a quasi que l'oüye & la voix du Disciple qui trauaillent, lors qu'il s'exerce ainsi dessus vn liure de Musique; d'où vient que l'esprit ne se rebute pas dans le long exercice necessaire à l'apprentissage des Arts, cõme il se rebute lors qu'il a plusieurs difficultez à combattre & surmonter en mesme temps, comme en la façon ancienne d'apprendre à chanter à cause des muances & diuers noms que chaque note reçoit: ce qui ne se rencontre point dans cette methode icy," Mersenne, *Harmonie universelle*, "Art de bien chanter," 2: 341.

By "nature and condition," both worker and child are hindered by limited capacity for memorization.

The adult practitioners whom Desargues sought to instruct in perspective did not agree with his evaluation of their limitations nor were they desirous of becoming pupils in Desargues' theoretical classroom. It was, one critic railed, as if Desargues believed that "all the painters who appear there [in Paris], and of which this great city knows the works, understand nothing of their craft."[68] The same critic was appalled that "a man that has never practiced their art wants to make himself their master in it."[69] Desargues' claim to be able to teach painting without being a practitioner upset the traditional master-apprentice hierarchy. Desargues defends his invasion of this order by referring to another art, in a passage from the preface to his *Perspective*:

> For doctors, in order to make themselves savant in their profession, neither go to school nor to the lesson of apothecaries who put in effect their ordinances; but on the contrary the apothecaries, in order to make themselves capable in their profession, go to the school and to the lesson of doctors, in which the doctors are masters, and the apothecaries disciples; also geometers, in order to be advanced in this science, do not go to the school and lesson of masons, but on the contrary, the masons in order to render themselves capable of the geometrical drawings necessary for the practice of their art, and to become more capable of making a masterpiece for their mastership, go to the school and to the lesson of the geometers, in which in the same way, the geometers are masters, and the masons disciples.[70]

Desargues here sets up a hierarchy similar to that which Pascal expresses in his writings on the arithmetic machine. The theoretician holds the position of authority and expertise with respect to the individual that uses his hands to fashion the product. The geometer, Desargues states, is the one to "invent"; the mason is the one to "trace manually, position and mason the said rocks" and

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[68] "Tout Paris sçait comme il va publiant partout, que tous les peintres qui y paroissent, et desquels cette grande ville admire les ouurages, n'entendent rien en leur mestier," Anon., "Advis charitables sur les diverses oeuvres et fevilles volantes dv sievr Girard Desargues Lyonais," in *L'oeuvre de Desargues*, 2: 271.

[69] "qu'vn homme qui n'a iamais pratiqué dans leur art, s'y veuille rendre leur maistre, et les ose faire passer dans les meilleures compagnies pour des ignorants," Anon., "Advis charitables," in *L'oeuvre de Desargues*, 2:272.

[70] "Reconnaissance de Monsieur Desargues, Placée en tête de la Perspective de Bosse, 1618," in *L'oeuvre de Desargues*, 1:491-492.

to "learn by memory and effect the rules of practice of the *trait* [i.e., alignment]"[71] For Desargues, as for Pascal, the artisan has been trained to be, and therefore essentially is childlike, placed under the authority of the theoretical mathematician.

The opinions of Mersenne, Pascal, and Desargues belong to an established tradition that sees theory as superior to practice. During the early modern period, however, the theoretician and practitioner increasingly interacted and experience and experimentation grew as key values in natural philosophy. As a result, the relationship between artisan and theorist grew increasingly ambiguous. Pamela H. Smith explores the implications of this renegotiation of traditional categories in her work, *The Body of the Artisan*. Smith argues for the importance of artisans to the developing epistemology of the Scientific Revolution. Their engagement with the natural world provided the ground upon which "liminal practitioners" could seek legitimacy.[72] One Rouennais artisan attempted to establish his legitimacy by creating an arithmetic machine like Pascal's. Pascal writes about his machine primarily to protect his interests from such imitations.

Pascal's defense

According to Pascal's "Avis," the integrity of his machine was threatened by counterfeits. A "false execution" of his invention was attempted by "a worker of the town of Rouen, clockmaker by profession."[73] None of the scholarship on the various exemplars of Pascal's

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[71] "Reconnaissance," in *L'oeuvre de Desargues*, 1: 492. The term "trait" is used in architecture to indicate the lines that guide carpenters and masons in their construction. The phrase "pièce de trait," according to the a nineteenth-century dictionary of architectural terms, refers to "[a] piece of which all the parts have been cut according to the rules of the art; it is a masterpiece of cutting, Ernest Bosc, "Trait," *Dictionnaire raisonné d'architecture et des sciences et des arts qui s'y rattachent*, vol. 4 (Paris, 1880), 348.

[72] "Artisans or craftspeople were, I believe, central in establishing and articulating the epistemology that gave such liminal practitioners authority and that helped bring about this new philosophy," Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago, 2004), 19.

[73] "un ouvrier de la ville de Rouen, horloger par profession," "Avis," Mesnard *OC*, 2: 339.

machine has been able to ascertain the identity of the indicted clockmaker, much less locate the device that he constructed. Pascal himself makes no attempt to identify or discuss this worker. He may have withheld the identity of the offending party to ensure that the artisan received no further advertisement and to ensure that practitioners did not usurp the position of the theoretician. Perhaps Pascal himself was not aware of the name of this clockmaker, a signal of the inherent namelessness of artisanal professions at that time.[74] In either case, it is clear that the counterfeiter is in direct contrast to Pascal, the disciplined and learned mathematician.

Novelty, rashness, and daring

As learned inventor, Pascal corresponds to Mersenne's *maistre*, who knows the theory of music and can thus create new "compositions." In contrast, the worker is portrayed as the "ignorant" who presumes to exercise what is not within the scope of his training. Furthermore, because the training of the worker is based on memorization and habit, the artisan remains in the state of nature. The artisan's training and education does not lead from natural inclination to mature completion, as Mersenne claims for the musical savant.[75]

Artisan and mathematician alike experience limitations with novelty, but Pascal makes a distinct contrast regarding the possibility of each one overcoming those limitations. The learned

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[74] Edgar Zilsel cites this lack of recognition during the Renaissance in his important article, Zilsel, "The Sociological Roots of Science," *American Journal of Sociology* 47 (1942): 544-562. The humanist "literati" mostly ignored workers: "If they mentioned them, they did so in an exceedingly careless and inaccurate way. From the present point of view the culture of the Renaissance owes its most important achievements to the artists, the inventors, and the discoverers. Yet these men entirely recede into the background of the literature of the period," ibid., 551. The education level of these artisans also contributed to namelessness: "They were uneducated, probably often illiterate, and perhaps for that reason, today we do not even know their names," ibid., 551-552. Zilsel argues for a profound change that took place by 1600, which brought artist-engineers to greater intellectual prominence. He rightly points out the key connection between the emergent inductive methods and the artisans' give-and-take with matter. Nevertheless, as Pascal's language shows, the division between the work of the savant and of the artisan is still important during the first half of the seventeenth century.

[75] I was helped in this distinction between types of education by a section in a paper by Natasha Gill, "'Second Nature: The Nature/Nurture Debate in Enlightenment Pedagogical Thought, From Locke to Rousseau, http://se1.isn.ch/serviceengine/FileContent?serviceID=PublishingHouse&fileid=4DA8669A-60E3-77B9-3ABB-2B2E6666B645&lng=en (accessed 7 October 2008). Gill explores the 18th century educational connotations of the relationship between natural inclination and habit/custom

inventor ultimately has the capability "to undertake and execute . . . new works," if he makes a disciplined application of knowledge.[76] Such effort would be wasted for the artisan. On the one hand, Pascal calls his own attempt to create the machine "a bold action" [*une action téméraire*] in which "I dared [*osé*] to attempt a new path through a field strewn with thorns, and without having a guide to clear the way for me."[77] On the other hand, he condemns in similar terms the workers' attempts to imitate his creation, saying that it represents their "ignorance" and "rashness" [*témérité*][78] "of daring [*oser*] to undertake more than their equals"[79] "Temerity" and "daring" were virtues for one equipped to take on the challenge of new works, but were vices for the worker. This is based not merely on an absolute social barrier between theoretician and practitioner or even on what Bartoli calls the "imprudence" of pursuing certain disciplines "against the inclination of [one's] *Genius*."[80] The artisan's transgression is to make something for which only years of mathematical training would suffice. The imperative that workers remain "in their place" is an assertion of political and social power, and the attempt to usurp the position of the theoretician is a type of social upheaval, similar to the killing of the mistress's cat as recounted by Robert Darnton.[81] More importantly for Pascal, it is also a safeguarding of the process through which a person becomes a savant.

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[76] "d'entreprendre et d'exécuter . . . ouvrages nouveaux," "Avis," Mesnard *OC*, 2: 338.

[77] "[J]'ai osé tenter une route nouvelle dans un champ tout hérissé d'épines, et sans avoir de guide pour m'y frayer le chemin," B. Pascal to Séguier, 1645, Mesnard *OC*, 2: 333.

[78] "Avis," Mesnard *OC*, 2: 338.

[79] "d'oser entreprendre plus que leurs semblables," "Avis," Mesnard *OC*, 2: 338.

[80] Bartoli, *Learned Man Defended and Reform'd*, 274.

[81] Robert Darnton, "Workers Revolt: The Great Cat Massacre of the Rue Saint-Séverin," in *The Great Cat Massacre and Other Episodes in French Cultural History* (New York: Vintage, 1985): 75-104..

Imitating God in the act of creation

Pascal's reaction to the workers of Rouen is linked to the pursuit of Mersenne's agenda for mathematical knowledge. Pascal argues that the artisans should confine themselves to the manipulation of matter rather than dabbling in the complex and creative work of invention, or even the copying of invention. Mersenne had outlined his desire for mathematics to reach perfection and, by extension, for the mathematician to "imitate the most admirable works of God."[82] Pascal tackles this task by attempting to imitate the mind through his arithmetic machine. The artisan is fixed in the creaturely realm of the second nature of habit.

The theoretician's God-imitating posture and status as master is a part of Mersenne's response to those who argue that musical practice is master of musical theory. Mersenne's *Questions harmoniques* features the voice of an objector to this relationship between theory and art. Desargues' painters had rejected the mathematician's role as pedagogue. Here, likewise, theory is considered dependent on practice. Mersenne's objector states: "the Theoreticians know nothing but what they learn from practitioners, whose maxims and experiments they presuppose."[83] Mersenne counters, in a classical move, by linking his own hierarchical scheme to the superiority of God's contemplation of himself. In Platonic fashion, the act of creation is an expression of that contemplation:

> It is necessary to conclude from all of this that the theory of sciences and of arts, and consequently of Music, which in some way correspond to the inward operations of God, ought to be preferred to practice, which corresponds to the works of God, which we call external.[84]

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[82] Mersenne, preface to *La vérité des sciences*, n.p.

[83] "[L]es Theoriciens ne sçavent autre chose que ce qu'ils apprennent des praticiens, dont ils supposent les maximes, et les experiences," Mersenne, *Questions inouyes*, "Questions harmoniques," 184.

[84] "D'où il faut conclure que la theorie des sciences et des arts, et consequemment de la Musique, qui respond en quelque maniere aux operations interieures de Dieu, et à ses divines idées, doit estre preferée à la pratique, qui respond aux oeuvres de Dieu, que nous appellons exterieures," ibid., 190.

Thus, Mersenne argues that "the Theory of the sciences . . . is in some way similar to the divine ideas, for it is the exemplary cause of practice."[85]

Pascal's echoing of Mersenne's articulation of the master-pupil, God-creature relationship of theoretician to artisan suggests that his self-legitimation in the matter of the arithmetic machine is an expression of the attempt to pursue a continuation of Mersenne's agenda. His invention would prove him to be the new Archimedes, as Mersenne had hoped. In his work on the arithmetic machine, Pascal denies to the clockmaker the dignity of the imitation of God's works. The best that he can do is to *re*-produce the works already in existence, since he cannot transcend the habits that create a "second nature" unless he has someone who has theoretical knowledge to instruct him and inculcate a new habit, which might be called a "second second nature." On the other hand, Pascal, by applying mathematical principles to the creative process, can create "a thing new in nature," which "produces effects closer to thought than anything done by the animals."[86]

Monstrosities: Trial and error

Pascal clarifies the possibility of the theoretician's imitation of God and its impossibility for the artisan in the way that he describes their approach to the invention process and their respective aptitude for give-and-take with matter. Pascal describes the artisans' attempts to copy the novelty of his machine as hit or miss. He compares them to someone who is drunk. The workers are "intoxicated by the false persuasion" that they are able to extend themselves beyond the limited scope of their skills with the hammer, turn, and file. As a result, "they work

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[85] "[L]a Theorie des sciences . . . est en quelque façon semblable aux idées divines, car elle est la cause exemplaire de la pratique," *Questions harmoniques*, Question 4, 186. To be sure, Mersenne does not discount the importance of reducing theory to practice, "afin d'aider le prochain, et de profiter à tout le monde," ibid., 187.

[86] "Vie de Pascal," Mesnard *OC*, 1:576; Brunschvicg, no. 340: "La machine arithmétique fait des effets qui approchent plus de la pensée que tout ce que font les animaux," Brunschvicg *OC*, 13:258, trans. A. J. Krailsheimer, in Pascal, *Pensées*, trans. Krailsheimer, no. 741, 229.

gropingly," a metaphorical evaluation that suggests how muddled and clumsy the attempts of the workers are in this enterprise.[87]

In describing the result of blind trial-and-error by the artisans, Pascal uses the metaphor of monstrosity to reinforce their lack of correspondence to the creator. Pascal considers the "mauvaises copies" of his machine to be a deformed infant:

> It happens that after very much time and work, either they produce nothing which corresponds to what they have attempted or, at most, they cause a little monster to appear, whose most important parts are missing, the others being formless and without any proportion.[88]

Pascal thus suggests that the "monsters" or "abortions" [*avortons*] produced by the artisans were the result of illegitimate unions engendered by a warped nature.[89]

Pascal uses the language of monstrosity to portray the direct link of artisans to corrupt, postlapsarian creation, in contrast with the impeccability of original creation, which was an unmarred expression of God's creative ideas. Although the "monster" that was the counterfeit machine looked similar to the genuine article, this very similarity could damage the reputation of the original. This, in turn, would threaten Blaise's position as an imitator of the perfectly creative God.

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[87] "ils travaillent en tâtonnant," "Avis," Mesnard *OC*, 2:338.

[88] ".[I]l arrive qu'après beaucoup de temps et de travail, ou ils ne produisent rien qui revienne à ce qu'ils ont entrepris, ou, au plus, ils font paraître un petit monstre auquel manquent les principaux membres, les autres étant informes et sans aucune proportion.," "Avis," Mesnard *OC*, 2:338.

[89] Pascal calls them "avortons illégitimes" and contrasts them with children produced from "la légitime et nécessaire alliance de la théorie avec l'art," "Avis," Mesnard *OC*, 2:340. Bartoli uses the language of monstrosity to argue against those whose natural "Genius" does not match up with the field to which they apply themselves: "[I]f it happen, that the interests of honour, and profit permit not men to surcease that which they badly began; you shall see as many Monsters in a *Learned Academy*, as in *Affrican Lybia*: a Poetical Physician, a Phylosophical Historian, a Mathematical Civilian; in which those in-nate *Seeds* which are derived from the *Womb*, into the *Instinct* of the *Mind*, confounding and inter-mingling themselves with those, that are acquired by *Study*; whilst neither those nor others prevail; by being one and the other; they are neither one nor the other," Bartoli, *Learned Man Defended and Reform'd*, 281-282.

From antiquity through the early modern period, the question of monsters haunted those attempting to understand the relationship between God and nature. A monster was a creature or human being that was born with uncommon characteristics that often mixed the traits of a "normal" creature or human with those of other creatures. They also included animals and people born as conjoined twins, those with enlarged body parts, and hermaphrodites. The appearance of these shocking creatures issuing from animal or human wombs required explanation, in part because it seemed to implicate God in imperfection.[90] Pascal experienced a similar difficulty in his relationship with the workers. He was the creator of the machine, in the sense of the one who designed it, but his own work was implicated in the failure of the presumptuous artisans to duplicate it:

> These imperfections, making it ridiculous, never fail to draw the scorn of all those who see it, of whom most unreasonably place the fault on he who has first had the thought of such an invention, rather than clarifying it with him and then blaming the presumption of those artisans who, through a false boldness [*hardiesse*] daring to undertake more than their equals, produce useless abortions.[91]

Pascal argues that those who, without proper knowledge, presume to imitate the work of a true inventor will ultimately fail to create a functional, well-proportioned instrument. Both the beauty and usefulness of proper proportionality will be lacking. A true creator, Pascal suggests, makes viable productions, not still-born infants. A genuine imitator of God produces inventions that derive beauty from their marvelous function, not mere outward adornment. For Pascal, the

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[90] My discussion of monstrosities is especially indebted to Lorraine Daston and Katharine Park, *Wonders and the Order of Nature: 1150-1750* (New York, 1998), Chapter 5, "Monsters: A Case Study," 173-214. On this issue, see also Alan W. Bates, "Good, Common, Regular, and Orderly: Early Classifications of Monstrous Births," *Social History of Medicine* 18 (2005): 141-158; Alan W. Bates, *Emblematic Monsters: Unnatural Conceptions and Deformed Births in Early Modern Europe* (Amsterdam, 2005); Laura Lunger Knoppers and Joan B. Landes, eds., *Monstrous Bodies/Political Monstrosities in Early Modern Europe* (Ithaca, NY, 2004).

[91] "[C]es imperfections, le rendant ridicule, ne manquent jamais d'attirer le mépris de tous ceux qui le voient, desquels la plupart rejettent sans raison la faute sur celui qui, le premier, a eu la pensée d'une telle invention, au lieu de s'en éclaircir avec lui et puis blâmer la présomption de ces artisans qui, par une fausse hardiesse d'oser entreprendre plus que leurs semblables, produisent ces inutiles avortons," "Avis," Mesnard *OC*, 2:338.

pseudo-creations of counterfeiters, on the other hand, appear to have the same function and utility as the genuine article, but are deceitful. An article well-made on the outside but without function is comparable to the deceitfulness of an idol, which though externally beautiful is powerless and useless. This problem plagues Pascal's nemesis clockmaker:

> He makes only a useless piece, truly handsome, shaped and well filed on the outside, but so imperfect within that it is of no use.[92]

In the clockmaker's usual line of work, this kind of monster would be akin to the clock that has a wonderfully crafted shell, and an ornate face, but is unable accurately to indicate the time.

For Pascal, the non-functionality of the artisan's clock is a sign of inauthenticity and lack of correspondence with the works of God. Lorraine Daston and Katharine Park have categorized the responses to monstrosities into three "complexes" of interpretation, signifying the various emotional responses to these irregularities.[93] Pascal's response to the clockmaker's machine is situated between the categories of "horror" and "repugnance." Monsters were a cause of horror by some accounts because they were signs of human sin that presaged divine wrath. This was further reinforced by the fact that these monsters most often died soon after birth.[94] For Pascal, the monstrous, malfunctioning machine signified the transgression of the artisan in attempting the work of the mathematical engineer. But his response is also repugnance at the machine's falling short of the perfect design of the godlike designer. It "violated the standards of regularity and decorum."[95]

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[92] "[N]e fit-il qu'une pièce inutile, propre véritablement, plieé et très bien limée par le dehors, mais tellement imparfaite au-dedans qu'elle n'est d'aucun usage,"Avis," Mesnard *OC*, 2:339.

[93] Daston and Park, *Wonders and the Order of Nature*, 173-177.

[94] Ibid., 177-190.

[95] Ibid., 202.

Pascal's machine, by contrast with the counterfeit item, is a worthy imitation of God's creation because it is both wonderful in function and striking in beauty. One may perform, "with it alone and without any effort of mind, the operations of all the parts of arithmetic."[96] Pascal does not ignore aesthetics. He takes care to match the outward appearance of the machines to their marvelous usefulness. Their simple, boxy design does not lack a certain earthy attractiveness and to some of the machines he added particular embellishments. For example, he ordered silver flanges attached to the number wheels of the machine destined for Queen Christina of Sweden.[97] But whereas the Rouennais clockmaker's focus was on the showy part of the piece (i.e., the box), the "elegance" of Pascal's machine, as Jean Mesnard assesses it, comes from "a desire for beauty" that "has constantly inspired the design of the most necessary pieces."[98] No doubt much of the credit for the machine's beauty should be given to the artisans who worked for Pascal, since their hands crafted the pieces under his supervision. In his critique of the clockmaker's copy, however, Pascal draws a stark contrast between the outside and the inside of the machine, which symbolizes the difference between him and the clockmaker. Indeed, Pascal made it simple for someone to examine the inside of the machine. A panel on the underside of the machine, if taken off, revealed the gears. The lack of functionality would be shown physically if the wheels did not line up correctly with one another. Beauty and function

[96] B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

[97] Here, I follow Jean Mesnard's argument that one of the two exemplars of Pascal's arithmetic machine found in the Conservatoire des Arts et Métiers is the one that was sent to Christina. Part of the evidence that he uses to establish this provenance is the unique feature of the silver flanges: "les roues de cette machine a été enrichies de collerettes en argent: luxe véritablement royal, dont tous les autres exemplaires sont dépourvus," ibid., 2: 324.

[98] "un désir de beauté . . . [qui] a constamment inspiré le dessin des pièces les plus nécessaires," ibid., 2: 326.

should coincide at the interior of the instrument, providing an authenticating stamp to the machine.[99]

The artisan produces, through drunken groping, a monstrous sham of a creation, which the royal privilege that Pascal requests should "smother before [its] birth."[100] The "blindness" that characterizes the methodology of the second nature of habit is contrasted with Pascal's approach to the problem of making the machine, which emerges from mathematical theory. Instead of a random trial-and-error approach, he begins with a "profound meditation" informed by the combination of his natural inclination and his study in mathematics.[101] Then, when his original designs encountered difficulties, Pascal writes, it was theoretical knowledge that enabled their correction:

> I began the execution of my project with a machine very different from this [one] both in its material and in its form, which . . . did not however entirely satisfy me, so that in correcting it little by little I gradually made a second one, in which, again encountering inconveniences that I could not tolerate, I composed a third as a remedy to them . . . and however, in the process of perfecting it, I found reasons to change it, and finally . . . I mustered the patience to make more than fifty models, all different . . . before having attained the accomplishment of the machine that appears before you now.[102]

Through successive attempts, Pascal's machine approached optimal performance.

Although the project was not without difficulties, his method of dealing with failure contrasts with the artisans' dependence on trial-and-error. Pascal emphasizes his ability to

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[99] In a more tangible effort to maintain the integrity of his machines, Pascal placed written certifications of their authenticity on the inside panel of some versions, Jacques Payen, "Les exemplaires conservés de la machine de Pascal," in *L'oeuvre scientifique de Pascal*, ed. Pierre Costabel (Paris, 1964): 229-247. The inscription reads: "Esto probati Intrumenti symbolum hoc., Blasius Pascal aruernus, Inuentor, 20 may 1652."

[100] "Avis," Mesnard *OC*, 2:340.

[101] B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

[102] "J'avais commencé l'exécution de mon projet par une machine très diffente de celle-ci et en sa matière et en sa forme, la quelle . . . ne me donna pas pourtant la satisfaction entière; ce qui fit qu'en la corrigeant peu à peu j'en fis insensiblement une seconde, en laquelle rencontrant encore des inconvénients que je ne pus souffrir, pour y apporter le remède, j'en composai une troisième . . . et toutefois, en la perfectionnant toujours, je trouvai des raisons de la changer, et enfin . . . j'ai pris la patience de faire jusques à plus de cinquante modèles, tous différents . . . avant que d'être venu à l'accomplissement de la machine que maintenant je fais paraître," "Avis," Mesnard *OC*, 2:340.

mentally recognize the ways his machine might be improved, so that through theory and with the knowledge that his training provided, it would reach perfection. Like Mersenne's vision for attaining God's archetypal knowledge of mathematics, Pascal's invention of the arithmetic machine was through successive approximations. He corrected and modified. But the ability to discern error is precisely what is missing from the presumptuous worker who brings his monster into the world. The Christian narrative of the fall implicated animal, artisan, and intellectual alike. It is only through reason, Pascal suggests, that inevitable errors may be superseded. Reason, he says, is the mark of mature humanity.[103]

Endorsements compared

Having contrasted the functionality of his machine and his methodology with the counterfeit and its maker, Pascal's final step was to highlight the difference between the endorsements that he and the worker of Rouen had received. The artisan had gained recognition because of his instrument's inclusion "in the cabinet of a curious [*un curieux*] of the same town [i.e., Rouen]."[104] By contrast with this "popular" acceptance, Pascal's recognition came from his old academy, the learned mathematicians in Paris. The minimization of the importance of the opinion of the curious is puzzling, since Pascal's "Avis" explains, defends, and presents his machine specifically to "les curieux." Indeed, the Mersenne Circle was closely allied to the culture of the curious amateur. The majority of them were not members of intellectual institutions such as the university, but were non-professionals that had taken up books at their leisure in order to engage in knowledgeable conversation. In the "Avis," Pascal carefully avoids

[103] In the *Pensées*, written late in his life, Pascal will write of the paradox of human weakness and human greatness: "Through space the universe grasps me and swallows me like a speck; through thought, I grasp it," Pascal, *Pensées*, trans. Krailsheimer, no. 113, 29 (Brunschvicg, no. 348, Brunschvicg *OC*, 13:263). He will reiterate this regarding the distinctive character of human beings: "All man's dignity consists in thought," Pascal, *Pensées*, trans. Krailsheimer, no. 756, 231 (Brunschvicg, no. 365, Brunschvicg *OC*, 13:278).

[104] "dans le cabinet d'un curieux de la même ville," "Avis," Mesnard *OC*, 2: 339..

directly insulting the collector of "rare and curious pieces." Instead, he invites his "dear reader" [*cher lecteur*] to demonstrate good judgment by echoing the approval of the machine pronounced by those, such as his own mentors, who had established a reputation of mathematical learning.[105] Without undermining his appeal to the curious, then, he urges them to prefer the verdict of those they already recognize as learned to the tacit endorsement of an anonymous collector.

Pascal thus rejects the claim that these collections are an authoritative source of legitimation in the savant world. The requisitioning of the "little abortion" by a "curious" certainly indicated the notoriety that Pascal's genuine machine had already received in the town, but the acquirer fell short of true learnedness, for the machine had "essential defects" made clear through a testing of its function.[106] The inclusion of the non-functioning copy of Pascal's machine in the collection of a curious reinforced the comparison with natural monstrosities. Daston and Park describe a response to monsters that is rooted in pleasure and even delight.[107] But Pascal argues that the true machine calls for wonder, while the monstrosity does not. The delightful design can be most clearly appreciated by those who are aware of the theoretical efforts that were involved. He calls on his audience of curious readers to defend him against "imperfect savants," even of their own number, who do not have adequate skill in mathematically-based disciplines.[108]

Pascal takes for granted that the reader will respond favorably to the learned status of his first tutors. Prior to Mersenne's announcement of the group in 1635, Cardinal Richelieu called

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[105] Ibid.

[106] Ibid.

[107] Daston and Park, *Wonders and the Order of Nature*, 190-214.

[108] "Lors donc que ces savants imparfaits te proposeront que cette machine pouvait être moins composée, je te conjure de leur faire la réponse que je leur ferais moi-même s'ils me faisaient une telle proposition . . . ," "Avis," Mesnard *OC*, 2:336.

upon several of its participants to render a verdict to the governmental authorities as to the legitimacy of Jean-Baptiste Morin's method of determining longitudes.[109] Pascal likewise appeals to the mathematicians of Paris as authoritative. They, more than the run-of-the-mill curious, would be able to judge the merits of his machine, because its invention required facility in geometry, mechanics, and physics. "[I]n Paris," he writes, "those who are the most well-versed in mathematics have not judged it [the machine] unworthy of approbation."[110] His work was certified as legitimate because of their approval:

> I already have the satisfaction of seeing my little work, not only authorized by the praise of some of the principle [individuals] in this true science . . . , but even honored by their esteem and their recommendation.[111]

This excerpt from Pascal's dedicatory letter to Chancellor Séguier demonstrates that such an appeal to well-known specialists was potentially effective in gaining, not only public acceptance, but governmental support. Mersenne's hopes of seeing savants officially recognized had begun to succeed.

While Pascal appealed to the intellectual authority of the group of Parisian mathematicians in general, he reached beyond the learned amateurs to focus more specifically on Roberval, who had an official position as a professor at the Collège Royal. Roberval, "he among them whom the greatest part of the others admire always and acquire his productions," agreed to demonstrate

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[109] The official statement appointing the members of the committee was issued 6 February 1634: "Nous souhaittant la connaissance particulière d'un si grand secret . . . , Nous avons commis, ordonné et constituté, commettons, ordonnons et constituons par ces présentes Messieurs l'abbé de Chambon, le président Pascal, Mydorge, Boulenger, professeur royal de mathématiques, et Hérigone, aussi professeur," Morin, "Diploma Primum," Mesnard *OC*, 2:90. G. Bigourdan gives a brief account of the Morin affair of the longitudes in Bigourdan, "La conférence des longitudes de 1634," *Comptes rendus hedomadaires des séances de l'Académie des Sciences* 163 (1916): 229-233. See also, Monette Martinet, "Jean-Baptiste Morin (1583-1656)," in *Quelques savants et amateurs de Science au XVIIe siècle: Sept notices biobibliographiques caractéristiques*, ed. Pierre Costabel and Monette Martinet (Paris, 1986), 72-73; 76-77.

[110] "Avis," Mesnard *OC*, 2:334.

[111] "[J]'ai déjà la satisfaction de voir mon petit ouvrage, non seulement autorisé de l'approbation de quelques-uns des principaux en cette véritable science . . . , mais encore honoré de leur estime et de leur recommendation," "Lettre Dédicatoire," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:333.

the machine and arrange for its sale to interested parties.[112] The endorsement of a professor of mathematics was a far cry from that of an anonymous "curious" in Rouen and a step beyond the informal, though clearly attested, expertise of the Mersenne group. Roberval was one of the few in the Parisian mathematical community who attained a post in the echelons of formal French education.[113] The mere fact that he held the title "professor of mathematics" would have recommended him to those not knowledgeable in mathematics. He was a particularly useful ally for Pascal because he combined worldly recognition with impressive erudition. Roberval's authority, together with that of the rest of the mathematicians in the capital, helped Pascal gain the support and approval of Chancellor Séguier. With that further endorsement in place, he could impress those who judged savants on the appearance of power, rather than their intellectual credentials.[114]

Through the ongoing contrast between artisans and himself, Pascal sought to safeguard his authoritative position as creator of the arithmetic machine. While he admits that "with all the theory imaginable" he could not have succeeded without them, the workers remained mere tools. In fact, the anonymity of the workers (not a single one is named) indicates their interchangeability and thus their individual dispensability as unwitting cogs. Pascal views their reliance on habit as like the instinct of beasts. By contrast, his ability to meditate on the

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[112] "celui d'entre eux de qui la plupart des autres admirent tous les jours et recueillent les productions," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:333.

[113] There are, of course, other examples. Pierre Gassendi, Roberval's predecessor to one of his chairs of mathematics, is the best example.

[114] Pascal would develop the notion of three orders (bodily, intellectual, spiritual) in his *Pensées* written through the last years of his life. In it, he mentions that it is custom, or habit (i.e., second nature) that trains one to consider someone to be important who has a large train of lackeys. Intellectuals should not be judged at this level; nevertheless, sometimes those steeped only in habit do judge based on the honors of those who wield political power, esp. Brunschvicg no. 93, Brunschvicg *OC*, 13: 20-21.

problem, arrive at a solution, and provide corrections based upon a plan, emphasizes the function of reason and thus the character of the Creator.

The machine as transcendent

The *coup de grâce* of Pascal's accomplishment, as he sees it, is the use of his creative powers to transcend the limitations of those, like the artisans, whose training is limited. He designed the arithmetic machine to ease the pain of calculation that comes from the effort and habituation needed to perform calculations using the traditional methods of *plume* (pen) and of *jetons* (counters):

> You know how, using the counters [*jeton*], the calculator (especially when he is lacking in habit) is often obligated, for fear of falling into error, to make a long continuation and extension of counters, and how necessity constrains him afterward to shorten and to pick back up those which are uselessly extended, which shows two useless inconveniences, with the loss of two [lengths] of time . . . You know likewise how, in using the pen [*plume*], one is at all moments obligated to retain or borrow the necessary numbers, and how many errors creep into these retentions and borrowings, unless having a very long habituation and, moreover, a profound attention and which fatigues the mind in a short time.[115]

In the methods of *plume* and of *jetons*, Pascal writes, the mind of the individual performing the calculation is placed under great mental strain.[116] Just as Desargues' artists and the children learning music had their memory taxed, so the one calculating with a pen or with counters needed to maintain "profound attention." In place of this, Pascal substituted his individual

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[115] "Tu sais, comme, en opérant par le jeton, le calculateur (surtout lorsqu'il manque d'habitude) est souvent obligé, de peur de tomber en erreur, de faire une longue suite et extension de jetons, et comme la nécessité le contraint après d'abréger et de relever ceux qui se trouvent inutilement étendus; en quoi tu vois deux peines inutiles, avec la perte de deux temps . . . . Tu sais de même comme, en opérant par la plume, on est à tous moments obligé de retenir ou d'emprunter les nombres nécessaires, et combien d'erreurs se glissent dans ces rétentions et emprunts, à moins d'une très longue habitude et, en outre, d'une attention profond et qui fatigue l'esprit en peu de temps," "Avis," Mesnard *OC*, 2:337.

[116] The methods of *jetons* and *plume* are described, some years after the invention of Pascal's machine, in Jean François, *L'arithmétique ou l'art de compter toute sorte de nombres, auec la plume, & les iettons* (Rennes, 1653). He knows of Pascal's machine, acknowledging its rarity and ultimate failure of utility: "The instrument named the Pascaline wheel does them with assurance and promptitude through a small local movement: but the expense of this instrument which is sold for 100 livres, & of the danger that some wheel will fail, & the ignorance that it leaves of Arithmetic makes it very rare," ibid., 22, my translation.

"profound meditation" on theory and design. For those limited in their expertise and mental strength, the arithmetic machine "supplied for the defect of ignorance or of little habit," and all of this "without any work of the mind."[117] It does not even require the knowledge of how arithmetic operations are performed.[118] Gilberte would write that Blaise had discovered "the means of doing all the operations [of arithmetic] with an entire certainty, without any need of reasoning."[119]

Pascal insists, then, that the machine stands as a substitute for the operators' thought. Through the mechanism of the gears, the Pascaline approximates human thought, an accomplishment that imitates one of God's most profoundly mysterious creations. A mechanical philosophy that understood natural phenomena by way of mathematically-describable processes had already begun to emerge by the time that Pascal created his machine. Machines created by human beings as objects of wonder provided additional plausibility to such a view of nature.[120] Descartes' notion of animals as beast-machines suggested that actions usually attributed to immaterial thought could be reduced to matter in motion. Descartes further articulated a mechanistic model of human sensation and memory, though he would always maintain the

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[117] "supplée au défaut de l'ignorance ou de peu d'habitude . . . sans aucun travail d'esprit," "Avis," Mesnard *OC*, 2:337.

[118] Ibid.

[119] "le moyen d'en faire toutes les opérations avec une entière certitude, sans avoir besoin du raisonnement," "Vie de Pascal," Mesnard *OC*, 1:577. Paradoxically, she adds that the work which was meant to reduce the fatigue of others served to undermine his own bodily constitution: "Ce travail le fatigua beaucoup, non pas pour la pensée ni pour le mouvement, qu'il trouva sans peine, mais pour faire comprendre aux ouvriers toutes ces choses," ibid.

[120] Derek J. De Solla Price, "Automata and the Origins of Mechanism and Mechanistic Philosophy," *Technology and Culture* 5 (1964): 9-23. De Solla Price writes that "simulacra (i.e., devices that simulate) and automata (i.e., devices that move by themselves) . . . offered tangible proof, more impressive than any theory, that the natural universe of physics and biology was susceptible to mechanistic explanation," ibid., 9.

existence and importance of immaterial *res cogitans*.[121] Descartes stopped at the machine-like quality of the human body and Julien Offray de La Mettrie's *L'homme machine* was still nearly one hundred years away, but thinkers began to postulate ways that human thought might be analyzed into constituent parts. Hobbes viewed all thinking as reducible to the four arithmetic operations and Leibniz sought to widen the scope of calculating machines in his vision (ultimately unrealized) of a machine that reasons, a "thinking machine."[122]

Pascal's later reflections on his calculator in his *Pensées* maintain the limitation of his machine, transcended as it is by the nobility of human will. But while he suggests that it cannot approach the transcendence that is godlike human thought, it is certainly a good approximation to lower-order operations of the human mind, which surpass the level of animal thought and the habituated working of the artisan-clockmaker. Furthermore, this machine, the result of the profound deliberation of the godlike engineer, was for Pascal the result of discipline *and* served to discipline the childlike artisan so that he could find results that were beyond his natural capacities.[123]

With the arithmetic machine, the effort of mind needed to perform calculations was reduced to the speed of the hand: "if you want a still more specific explanation of its quickness, I

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[121] Descartes explained much of human memory as a process of physical imprinting, but objections and problems with the complexity of these processes prompted him to settle for a much more limited conception of mechanistic memory, John Morris, "Pattern Recognition in Descartes' Automata," *Isis* 60 (1969): 451-460.

[122] Leibniz's vision is in agreement with Mersenne's goals to provide some means of encyclopedic knowledge in a universal language. The importance of Leibniz's place in the history of artificial intelligence is highlighted in Pratt, *Thinking Machines*, especially Chapter 5 ("Leibniz: Mechanizing Reason"), 70-80; Chapter 6 ("The Failure of Leibniz' Project"), 81-90.

[123] Carolyn Merchant describes the profound importance of the metaphor of machine as "order" and "power" in Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (San Francisco: Harper and Row, 1980), 216-235. Merchant suggests that Mersenne sought "to replace *The Imitation of Jesus Christ* by *The Imitation of the Divine Engineer*," 226. The godlike engineer was first and foremost a mathematician and for Pascal, the control that he exerted was not merely over the work required to do his calculations, but also over the childlike and beast-like artisans.

will tell you that it is like unto the agility of the hand of the one who operates [it]."[124] The fatigue that Pascal experienced because of his attempts to communicate to the workers the proper way to create the machine contrasts sharply with the lack of effort required by its operator. The habituated hand took on an ironic primacy. Pascal the savant had created an invention that could not be imitated by those whose primary training was tactile. Through his intellectual application, however, he reduced the task of arithmetic to the point that those most agile with their hands could use it best. Pascal superintended [*reglée*] his workers in order that he would create, through their hands, what would transcend the limitations of their habit. The artisans had not been habituated to be good calculators, but Pascal "deskilled" calculation by removing the element of concentration and memory required for traditional methods.[125] By doing so, the skilled arithmetician was placed on equal footing with the manually dexterous. If it is only the speed of the hand that determines the speed of calculation, Pascal himself would have performed more slowly than a manual laborer. This leveling puts an ironic twist on Pascal's insistence on the hierarchical relationship between designer and craftsman.[126] But Pascal's characterization of the artisan's skill as habituated and thus less than human prefigures the deskilling that resulted from industrialization.

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[124] "[S]i tu veux encore une plus particulière explication de sa vitesse, je te dirai qu'elle est pareille à l'agilité de la main de celui qui opère," "Avis," Mesnard *OC*, 2:337.

[125] Desargues was ostensibly motivated by this same concern that workers not be taxed in their memory, as he states in "Reconnaissance de Monsieur Desargues," Desargues, *L'oeuvre de Desargues*, 1:477-478.

[126] The Marxist roots of the term deskilling also highlights the irony, with such a leveling further hardening the socio-cultural distinction between those who have non-duplicatable skills (as Pascal claims for the mathematical savant) and those whose expertise may be imitated by a machine. The terminology of "deskilling" is especially associated with the indictment of capitalism in Harry Braveman, *Labour and Monopoly Capitalism: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974), although it was already in use in the 1940s, *Oxford English Dictionary*, http://dictionary.oed.com/cgi/entry/50061915?single=1&query_type=word&queryword=deskill&first=1&max_to_show=10 (accessed 7 October 2008).

Pascal carefully distinguished his role from that of the artisan in order to protect his position as the author of his machine. The distinction was meant to ensure that he would receive credit for the renown of the machine. But it also served a larger protective function for Pascal and the group of mathematicians with whom he was associated. Mersenne had engaged in an argument with those who claimed that the state of the *ignorants* was sufficient to engage in learned pursuits. Pascal's rejection of the capability of artisans to create something new served as evidence against this opinion and protected the privileged position of trained theoreticians.

Childlikeness and the Arithmetic Machine

By classing artisans as non-entities in the learned world, Pascal parted ways with Mersenne's *Harmonie universelle*, which ascribes moral virtues to their skill. Mersenne writes, for example, that the tool of the "manual" laborer is such that "several have called it one of the principal instruments of wisdom & reason."[127] The hand is not merely put at the service of reason, it transcends reason. The movements of the hand on the strings of the lute are a case in point, writes Mersenne:

> They are so marvelous that reason is often constrained to admit that it is not capable of encompassing the lightness & quickness, which surpasses the swiftness of the liveliest imagination that may be met, as is experienced when one wishes to number the sounds that it makes, or the chords that it touches, or its trills [*tremblemens*] during the space of a measure.[128]

But Pascal gave little credit to the "wisdom of the hand" that the artisans possess, or to the worker's contribution to refining his design. Pascal did not demonstrate the resourcefulness of

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[127] "[P]lusieurs l'ont appellée l'vn de principaux instrumens de la sagesse & de la raison," Mersenne, *Harmonie universelle*, "Livre second des Instrumens," 3:76.

[128] "[I]ls sont si merueilleux que la raison est souuent contrainte d'aduoüer qu'elle n'est pas capable d'en comprendre la legereté & la vitesse, qui surpasse la promptitude de l'imagination la plus viue que l'on puisse rencontrer, comme l'on experimente lors qu'on veut nombrer les sons qu'elle fait, ou les chordes qu'elle touche, ou ses tremblemens dans le temps d'vne mesure," Mersenne, *Harmonie universelle*, "Livre second des Instrumens," 3:76.

Robert Hooke, who exchanged ideas with masterful artisans in the coffee houses of London and appropriated them for his and the Royal Society's use.[129]

When it came to the presentation of the machine to the curious of Paris, Pascal excused himself from giving a full written account of its functioning. He claimed instead that such an explanation is "of the number of those which can be taught only orally."[130] Pascal thus suggests that the physical presence of the machine is necessary for effective "teaching" about its proportions and use. Learning by experience is taken for granted in our historical accounts of the scientific revolution and bears the marks of an "artisanal epistemology."[131] Pascal associates habits acquired through hands-on teaching with the need for instruction from theoreticians, yet the method of instruction in the use of the machine is strikingly similar. Pascal admits that he does not employ the usual geometrical method, which is:

> to represent through figures the dimensions, the disposition, and the connection of all the pieces, and how each one ought to be placed in order to compose the instrument, and to put its movement to perfection.[132]

Finally, when Pascal asserted his imitation of God and denied it to the worker, he upset a traditional analogy of God as Divine Artisan, as Mersenne expresses in *L'usage de la raison*.[133]

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[129] Rob Iliffe, "Material Doubts: Hooke, Artisan Culture and the Exchange of Information in 1670s London," *British Journal for the History of Science* 28 (1995): 285-318. Iliffe argues that Hooke was a strategist and technique-merchant who was able to capitalize on his ability to communicate with natural philosophers and artisans alike within the space of London's coffee houses. Hooke was, Iliffe writes, "more than a middleman flitting between what have occasionally been portrayed as two rather static realms of the genteel and the artisanal. He was a central player in the exchange of philosophical and technical goods who was uniquely at home in all the spaces and worlds described in the *Diary*," ibid., 317. Hooke also had a unique ability to build relationships with artisans: "From the spring of 1674, he was able to interact with Tompion to an extent that is possibly unparalleled by any other combination between a British craftsman and a natural philosopher in this period," ibid., 311.

[130] "lors tu jugeras que cette doctrine est du nombre de celles qui ne peuvent être enseignées que de vive voix," "Avis," Mesnard *OC*, 2:335.

[131] Smith, *Body of the Artisan*, 59-93.

[132] "représenter par figures les dimensions, la disposition et le rapport de toutes les pièces, et comment chacune doit être placée pour composer l'instrument, et mettre son mouvement en sa perfection," "Avis," Mesanrd *OC*, 2:334-335.

Clearly, despite the efforts of Pascal, Desargues, Mersenne, and others to create a master/disciple relationship between the theorist and the artisan, complexities problematized identification of savants in opposition to the ignorant, especially those untrained in mathematics.

Pascal's work on the arithmetic machine continued after he left Rouen. He used his inventiveness and industry as leverage to promote his maturity and to demonstrate that he was no mere child genius coasting on natural talent. Nevertheless, his work continued to require the support of the Parisian community, which he used to certify his status as a savant. His dependence on early mentors demonstrates that, despite his efforts, he remained tied to his previous identity as a child prodigy. Pascal's other major project during these years, his experiments and writings on the void, demonstrate that the same goals and limitations embodied his arithmetic machine permeated his other work.

The Controversy of the Void: Neither Beast nor Child

Pascal's goal to establish himself as a mature savant fortified the contrast between his work and that of artisans. During his involvement in the conflict about the existence and character of the void, this section will argue, he developed additional contrasts in which he identified himself with disciplined application and philosophical maturity. Again making use of the work of artisans, this time the glassmakers of Rouen, Pascal styled himself an instructor in natural philosophy, through the theatrical display of the void in tubes. This section also argues that Pascal's language suggests that he has taken up his proper position within the adulthood of humanity, moving beyond scholastic infantilism to new opinions that are based on cumulative observation. Finally, in his handling of the polemical exchange with the Jesuit Father Noël, Pascal demonstrates the coupling of childlike deference and mature communication. By the

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[133] Mersenne, *L'usage de raison*, 79-80.

conclusion of his work on the void, the transition from "the young Pascal" to the "illustrious Pascal" was virtually complete.

Empty arguments

The question of the possible and actual existence of a vacuum, empty space, or "void," was one of the most controversial topics of the 1640s and 1650s. The conflict was at least as old as the ancient atomists, Democritus and Lucretius.[134] The problem was at once philosophical and empirical and especially concerned definitions attached to observed phenomena. The void was not a space filled with invisible matter called "air," thus casually called "empty." In the context of this controversy, the void lacked *any* substance. Aristotle had argued against the existence of any kind of void, for void was defined as an empty place into which an object might move; but for Aristotle the notion of place could not be divorced from the dimensions of a body. Aristotle's cosmos is a plenum.[135] The terminology of the *horror vacui*, nature's resistance to empty space, emerged in the Middle Ages to describe a principle noted by ancient Greek pneumatists.[136] The *horror vacui* explained, for example, a device called the clepsydra, which when plugged at the top does not allow liquid to flow out through the holes in the bottom.[137]

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[134] W. E. Knowles Middleton, *The History of the Barometer* (Baltimore, MD, 1964), 4.

[135] Aristotle's key discussion of the void, his examination of prior theories, and his arguments against it, are in *Physics*.IV.6-9.213^{a}11-217^{b}28. The definitive work on the concept of the void in medieval and early modern Europe is Edward Grant, *Much Ado about Nothing: Theories of space and vacuum from the Middle Ages to the Scientific Revolution* (Cambridge: Cambridge UP, 1981). Grant briefly discusses Aristotle's views on this subject in Chapter 1, "Aristotle on void space," ibid., 5-8.

[136] Grant, *Much Ado about Nothing*, 67-68. The Middle Ages saw the flourishing of this terminology: "Although the full significance of this famous principle would be described and explicated on in the fourteenth century, it had already emerged in the thirteenth, when expressions such as *natura abhorret vacuum*, *horror vacui*, and *fuga vacui* began to appear. The origin of the principle is, however, unknown. But already in the first half of the twelfth century, Adelard of Bath expressed the fundamental idea of nature's resistance to a vacuum . . . ," Grant, *Much Ado about Nothing,* 68.

[137] "Basically a decanting vessel, the clepsydra is characterized by a narrow, open neck and wide body with small holes at the bottom, which is the part first submerged into the liquid to be decanted, usually water or wine. When all the air in the vessel is expelled and replaced by the incoming, rising water, the narrow orifice at the top is stopped up, usually by covering it with the thumb. Upon lifting the vessel from the water, one observes that the water

While the natural tendency of water is toward the center of the earth, nature's tendency to prevent the void is stronger. During the Middle Ages, most philosophers believed that only through God's omnipotent power could the *horror vacui* be overcome, and God had never done so.[138]

Early-modern consideration of the void began in Italy. Hero of Alexandria's work *Pneumatica*, translated into Latin in 1575, provided descriptions of various machines that illustrated this puzzling phenomenon.[139] Galileo Galilei's work on limits to which water could be raised in a pump for fountains was at the genesis of the Italian preoccupation.[140] In 1639 or 1640, Rafaello Maggiotti and Gasparo Berti built upon Galileo's observations, devising an apparatus that used a lead tube closed at the top by a glass bulb and submerged in a cask of water. With this apparatus, they were able to make a rough estimate of the greatest height (18 cubits) at which water would stand in the tube. These observations facilitated discussion of what was at the top of the tube when the water descended to that height. In 1644, Evangelista Torricelli, a Galilean disciple, substituted mercury for water, allowing the use of smaller tubes made of glass. Mercury, or quicksilver, remained elevated only to a level of about 19.6 inches. The smaller apparatus, in contrast with the lead pipe, provided a better view of the entirety of the tube, and the smaller tube facilitated manipulation. For example, the experimenter could move the tube up and down in the basin and observe that the empty space at the top of the tube would grow larger, and vice versa. In June 1644, Torricelli and Michelangelo Ricci wrote a series of

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remains in the now elevated clepsydra despite the expectation that it would fall through the tiny holes at the bottom," Grant, ibid., 83.

[138] Middleton, *History of the Barometer*, 4.

[139] See the important article, Marie Boas, "Hero's *Pneumatica*: A Study of Its Transmission and Influence," *Isis* 40 (1949), 38-48.

[140] Significantly, Boas calls Galileo "the most important follower of Hero's atomism," ibid., 48. See also Mesnard *OC*, 2:346.

letters discussing the demonstration. They corresponded with one another about its implications for the question of the existence of the vacuum and the relationship between the weight of a liquid and the height of the liquid in the tube.[141]

French interest in the problem began when Mersenne received fragmentary communication from François du Verdus concerning Torricelli's work on the void. Mersenne attempted similar demonstrations with no success, because obtaining the necessary quality of glass was difficult in France. Later that autumn, Mersenne departed for Italy, where he observed Torricelli's demonstration and spoke with several of Torricelli's collaborators. When Mersenne returned to France in July 1645, he was determined to repeat the experiment for himself.[142] Mersenne and Pierre Chanut attempted it again in Paris, but once more, the brittle French glass, not as strong as the Italian, broke under the weight of the quicksilver during the inversion of the tube.[143] It is possible that this experiment was discussed during the conferences at Mersenne's Minim cell.[144] Continued work was further slowed by Chanut's departure to Sweden on a mission from the king.[145] Sometime between the summer of 1645 and the fall of 1646, Pierre Petit (1594?-1677) became involved with the problem, finally succeeding in an *expérience* with a smaller tube that left only a small, apparently empty space at its top.[146] This was unsatisfying to Petit, since there

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[141] See the translation of these letters in I.H.B. and A.G.H. Spiers, eds., *The Physical Treatises of Pascal: the Equilibrium of Liquids and the Weight of the Mass of the Air* (New York, 1937; repr. 1973), Appendix III, "Torricelli's Letters on the Pressure of the Atmosphere,": 163-170.

[142] Humbert, *Cet effrayant génie*, 71. Consult the important work by Cornelius De Waard, *L'expérience barométrique, ses antécédents et ses explications* (Thouars, 1936).

[143] Humbert, *Cet effrayant génie*, 71.

[144] Roberval explains the reason Mersenne did not succeed in the *expérience* as follows: "neither this year nor the following, was he able to procure for himself appropriate tubes in Paris, both because they did not make them there, and because, during nearly all that time, he traveled in the southern provinces of the realm of France," "De vacuo narratio," Mesnard *OC* 2:461.

[145] He was named "résident de France," *OC* 2:347.

[146] Pierre Petit to Pierre Chanut, 19/26 November, 1646, *OC* 2:350.

was then a greater chance that this space was only an air bubble. He therefore sought a way to make a larger tube that would contain more mercury and create a larger void.[147]

Pascal joined the debate on the void partly because of where he lived. Rouen was the location of an important French glassworks. In 1598, the French monarchy established it in an attempt to compete with the fine glass being produced in Venice.[148] The d'Azémar family, with a 250-year history as glassmakers, had run the glassworks since 1619.[149] The business benefited from a monopoly in the region granted by royal authority, and from the surrounding forests, which provided the necessary fuel. It had a prime location near the Seine River that facilitated transportation to Paris. This combination factors made its potential for productivity and sales quite high.[150]

The type of glass the d'Azémar family produced would be especially important for experiments on the void. Their glassworks specialized in Venetian-type crystal, and according to a report on the renewal of letters patent in 1642, they were the first to introduce this kind of glassmaking to France.[151] Claude Mazauric makes a strong argument that the Rouen glassworks, in 1646, was "not a business of modest artisans, more or less needy, but powerful manufacturers."[152] Italian glass, to which Torricelli had access and that was necessary for his

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[147] Ibid.

[148] This account of the history of the Rouen glassworks follows from Claude Mazauric, "Note sur la verrerie de Saint-Sever au temps d'Étienne Pascal," in *Les Pascals à Rouen*, ed. Jean-Pierre Cléro (Rouen, 2001): 159-178.

[149] Ibid., 172.

[150] "One can also imagine that the abundance of forests in Upper Normandy, notably the forests of ducal origin that had become royal forests, rendered much more sustainable the installation project of an industry of glass, since it is, as everyone knows, an 'art of fire', a great consumer of combustibles, that is, essentially, wood," ibid., 162-163. For the importance of transportation by water, see Warren C. Scoville, *Capitalism and French Glassmaking, 1640-1789* (Berkeley, CA, 1950), 98.

[151] The d'Azémars were, however, not locals. Their family originally came from Languedoc and only came to Rouen when they took over the glassworks, C. Mazauric, "Note sur la verrerie," 170, 172.

[152] Ibid., 175.

experiments, was superior to anything produced around Paris.[153] Pascal lived in a town where conditions were right to produce adequate material for the performance of the Torricelli phenomenon.[154]

Prompted by a suggestion from Mersenne that proper glass for Torricelli's experiment might be found there, Petit decided to make a stop in Rouen on his way to visit Dièppe on other matters.[155] While there, he met with Étienne and Blaise Pascal, explained his desire to perform the experiment, and arranged to procure the glass before his return. Petit recorded the details of the subsequent experiment's performance in a letter to Chanut written in November 1646. In that same year, Pascal the son performed the same type of demonstration of the void, to which "He summoned [as] witnesses the most learned men of this town."[156] Pascal was not merely giving a theatrical display of a curious phenomenon. He stated a clear preference for the view that nature permitted a void. Jacques Pierius, professor of philosophy in the college of the archbishopric of Rouen, wrote a work that mentions Pascal, the "not unworthy son of a very

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[153] Even in 1660, there were no good glassworks in the Paris area: "besides that, as we have no glassworks in Paris or its neighborhood we could not get appropriate vessels made [for experiments on smoke and sound in the vacuum]," Pierre Petit to Henry Oldenburg, 23 October 1660, Henry Oldenburg, *Correspondence of Henry Oldenburg*, ed. Rupert A. Hall and Marie Boas Hall, vol. 1(Philadelphia, 1965), 398.

[154] C. Mazauric, "Note sur la verrerie," 177.

[155] Roberval says that Mersenne had already written to some friends at Rouen (the Pascals, or someone else?) to ask about procuring some tubes. Of Rouen, Roberval writes: "there, indeed, were found greatly celebrated glass and crystal manufacturies," "De vacuo narratio," Mesnard *OC*, 2:461. The way to Dièppe from Paris often went through Rouen. A work published in 1643 gives an account of a trip through (among other regions) northern France. The route for this tour includes Paris to Rouen and Rouen to Dièppe. Each leg of the trip is said to take two days hard riding on horseback, Louis Coulon, *L'Ulysse françois, ou Le voyage de France, de Flandre et de Savoye: contenant les plus rares curiosités des pays, la situation des villes, les moeurs & les façons de faire des habitants* (Paris, 1643), 328-329; 340-341.

[156] "Advocavit testes viros hujus urbis doctissimos," Jacques Pierius, *An detur vacuum in rerum natura*, excerpted in Mesnard *OC*, 2: 361. Pierius was convinced of Aristotle's opinions on nature's horror of the void, and probably was an attendee at Pascal's Rouen demonstration. Pierre Guiffart, author of a *Discours du vide*, to be discussed below, likewise writes of the performing of "plusieurs expériences en cette ville en la présence de tous les plus savants hommes de sa connaissance," Pierre Guiffart, *Discours du vide* (Rouen, 1647), 7, excerpted in Mesnard *OC*, 2:423.

illustrious and very learned father," as an objector to his own theory that the space at the top of the tube was occupied by vapors from the quicksilver.[157]

Pierius's *An detur vacuum in rerum natura* may have prompted Pascal to respond by expanding his simple duplication of the Torricelli experiment. Pascal aimed to demonstrate what he called nature's "limited horror of the void" through a number of demonstrations using various apparatus, including syringes, bellows, and tubes of various shapes and sizes.[158] Pierre Guiffart (1597-1658), provided another Rouennais response to Pierius's critique that was supportive of both Pascal's experiments and his arguments about the void. Guiffart, a physician in the town, had attended some of the experiments and public discussions.[159]

Meanwhile, in Paris, Roberval and Mersenne became aware of Pascal's work with the void, and attempted their own versions of the experiments, apparently with apparatus received from Rouen.[160] Roberval also communicated with Pierre Desnoyers, Secretary to the Queen of

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[157] "illustrissimi et doctissimi patris non degener filius," Pierius, *An detur vacuum*, Mesnard *OC*, 2:360-361.

[158] A description of the *expériences* and apparatus used in them are recorded in Blaise Pascal, *Experiences nouuelles touchant le vide* (Paris, 1647), 1-18. Alexandre Koyré argued that these were only thought-experiments, Koyré, "Pascal Savant" (1956), 276. Since then, Shozo Akagi and Kimiyo Koyanagi have undertaken to consider the question of whether the experiments were actually performed by Pascal, Akagi, "Comment interpréter les *Experiénces nouvelles touchant le vide,*" in *Pascal Port-Royal Orient Occident: Actes du colloque de l'Université de Tokyo, 27-29 septembre 1988*, ed. Thérèse Goyet et al. (Paris, 1991): 199-209; Koyanagi, "Cet effrayant livret . . . *Expériences nouvelles touchant le vide* de Blaise Pascal," in *Les Pascals à Rouen*, ed. Cléro: 137-157. The *expériences* in Pascal's 1647 work also provide examples for Peter Dear in his discussion of the relationship between English and French attitudes toward miracles and the "ordinary course of nature," Dear, "Miracles, Experiment, and the Ordinary Course of Nature," *Isis* 81 (1990): 663-683.

[159] Guiffart, *Discours du vide*, excerpted in Mesnard *OC*, 2:421-433. Guiffart advocated Harvey's theory of the circulation of the blood in idem, *Cor vindicatum, seu tractatus de cordis officio* (Rouen, 1652). In 1654, he wrote a work that recounted his reasons for converting from the Protestant to the Catholic faith, idem, *Les Vérités catholiques, ou les Justes motifs qui ont obligé le Sr Guiffart, . . . de quitter la religion prétendue réformée pour se ranger à l'Église catholique, apostolique et romaine* (Rouen, 1654). For biographical information about Guiffart and especially his work on circulation and on religion, see See René Le Clerc, "Un medecin théologien," *Notices, mémoires et documents* 27 (1909): 17-35.

[160] See letters from Auzout and Hallé de Monflaines to Mersenne.

Poland, where the question of the void subsequently became a hot topic.[161] Roberval sent him a *Narration* regarding the developments in France on this issue, including Pascal's Rouen activities. He also transmitted copies of Pascal's *Expériences nouvelles touchant le vide* to Desnoyers, who praised it to Hevelius. Hevelius, in turn, requested a full copy of the work, which furthered Pascal's recognition.[162]

The main goal of Pascal's experiments in Rouen was to test the possibility of creating a void. Upon his return to Paris in the summer of 1647, however, he read the correspondence between Ricci and Torricelli and shifted his focus to the *raison des effets* of the experiments (i.e., the weight of the air). In Paris, Pascal also engaged in a lively polemic with Étienne Noël, a Jesuit, who criticized Pascal's *Expériences nouvelles* and eventually published an oppositional treatise entitled *Le plein du vide*. This exchange, including Pascal's response to Noël, his letter to the old family friend Le Pailleur, and Étienne Pascal's attack of the Jesuit's treatise constitute key primary sources the discussion and analysis that follows.

Pascal's illness during this time curtailed his activities and writing. Despite difficulties, however, he arranged for his brother-in-law to perform the celebrated experiment of the Puy-de-Dôme, which accounts for the only mention of Pascal in most textbooks. In September 1648, Florin Périer took measurements in a glass tube at the bottom and at the top of a mountain situated at Pascal's natal town of Clermont. This experiment helped to establish the principle of the weight of the air, which Robert Boyle later cited as an *experimentum crucis* for the spring of

[161] In particular, the Capucin Valerian Magni wrote a work describing an experiment identical to that performed by Torricelli, Magni, *Demonstratio ocularis* (Warsaw, 1647), discussed in Mesnard *OC*, 2:455-459.

[162] Pierre Desnoyers to Johannes Hevelius, December 18, 1647, Mesnard *OC*, 2:454; Johannes Hevelius to Pierre Desnoyers, 17 January 1648, Mesnard *OC*, 2:454.

the air.[163] It was not decisive, however, for all those who constituted the learned circles of Paris. Boulliau, for example, wrote of those who attributed the phenomena observed on the Puy de Dôme to air pressure: "I believe that they are mistaken, and that it is necessary to have recourse to other reasons."[164] Furthermore, Descartes questioned whether the idea for the experiment was Pascal's own, claiming he had suggested it during meetings with Blaise in the autumn of 1647. Despite debates during the past century, Pascal retains his place as the original mastermind of the test.

New roles, old roles: childlikeness and maturity in the question of the void

The time during which he worked on the question of void was the most active period of Pascal's scholarship, though it was punctuated by periods of ill health. Although these times of infirmity prevented voluminous publication, the experiments that he performed and suggested were central to the discussions that took place in Paris. Pascal was also becoming increasingly well-known outside Paris.

While praise of his geometrical work as a teenager came from the Mersenne Circle in Paris, his work on the arithmetic machine and his experiments with the void gained attention from around Europe. Several savants mention Pascal's machine during this time, including Petit, who praised it to Jacques Buot (162?-1675?) as a "Piece truly invented with as much good

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[163] In his "Defense Against Linus": "such an Experimentum cCucis (to speak with our Illustrious Verulam) is afforded us by that noble Observation of Monsieur Paschall, mentioned by the famous Pecquet, and out of him by our Author: namely, that the Torricellian Experiment being made at the foot and in divers places of a very high Mountain, (of the altitude of five hundred fathom or three thousand foot) he found, that after he had ascended a hundred and fifty Fathom, the Quicksilver was fallen two Inches and a quarter below its station at the Mountains foot; ande that at the very top of the Hill it had descended above three Inches below the same wonted station. Whence it appears that the Quicksilver being carried up towards the top of the Atmosphere, falls down the lower, the higher the place is wherein the observation is made: of which the reason is plain in our Hypothesis," Robert Boyle, *The Works of Robert Boyle*, ed. Michael Hunter and Edward B. Davis, vol. 3 (London, 1999), 50-51.

[164] "Decipi ipsos puto, et ad alias rationes confugiendum esse," Boulliau to Hevelius (11 December 1648), Mesnard *OC*, 2:700. Just prior to this comment, he provides a brief description of the phenomena observed during the Puy de Dôme experiment, ibid.

fortune and speculation as its author has of mind and knowledge."[165] Jean François's 1653 published work on arithmetic also mentions the "Pascaline."[166] Both Petit and François express reservations about the production cost of the machine, but even their qualified praise demonstrates the calculator's widespread recognition. But these notices of Pascal pale in comparison with the accolades received by Pascal's work on the void.

The learned reception of Pascal's work demonstrates a dual character that highlights the tension between Pascal the child and Pascal the mature savant. On the one hand, he continued to be recognized by some primarily for his youthful talent. In part, his father's status as a learned man overshadowed the son's adult progress. On the other hand, he was beginning to earn his own identity, a mature respectability that distinguished him from his father and his now burdensome reputation as a child prodigy. Once a promising genius, Pascal was now "illustrious" in his own right.

When Petit wrote the initial letter to Pierre Chanut regarding his performance of the experiment on the void in Rouen, he gave priority of place to Étienne Pascal, since he was, as Petit writes,

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[165] "Pièce véritablement inventée avec autant bonheur et de spéculation que son auteur a d'esprit et de science," Pierre Petit to Jacques Buot, 23 September 1646, Mesnard *OC*, 2:345. Buot was probably approximately Pascal's age and had similar interests. He taught and wrote on mathematics and introduced a device known as the *Roue de proportion*, for arithmetic calculations just two years prior to the granting of the privilege for Pascal's machine. He would become a member of the newly-formed *Académie des Sciences* in 1666, Sturdy, *Science and Social Status*, 111. Petit demonstrated knowledge of mathematical tools prior to this letter, in Pierre Petit, *L'usage ou le moyen de pratiquer par une règle toutes les opérations du compas de proportion* (Paris, 1634). Interestingly, Petit's letter to Buot calls the machine merely "la boîte ou instrument de Monsieur Pascal," rather than "de Monsieur Pascal le fils" or "de Monsieur Pascal le jeune," Petit to Buot, 23 September 1646, Mesnard *OC*, 2:345. This is striking because in his letter to Pierre Chanut two months *later* his references to Monsieur Pascal are to the *father*, while he makes a separate, distinct reference to the son, P. Petit to Chanut, 19/26 November 1646, Mesnard *OC*, 2:350-351. Was Petit perhaps under the impression, during his brief visit to Rouen, that the machine was of Étienne's invention? Alternately, this difference may be the result of the addressees' level of acquaintance with the Pascals. Perhaps Buot was unfamiliar with the elder Pascal, while Chanut's knowledge of him required Petit to make the distinction.

[166] "The instrument named the Pascaline wheel does them [arithmetic operations] with assurance and promptness through a small local movement: but the expense of this instrument which is sold for 100 livres, & the danger that some wheel will come to fail, & the ignorance that it leaves of Arithmetic renders it very rare," François, *L'arithmétique ou l'art de compter*, 22.

"your good friend and mine."[167] It is Étienne, Petit claims, that "for a long time . . . has admitted the [existence of] the void."[168] Furthermore, the six-folio letter mentions the young Pascal only once, though in that context he suggests the sophistication of Pascal's grasp of the nuance of experimental interpretation.[169] Pierius, who opposed Blaise's interpretation of the experiment, identifies him as "Monsieur Pascal the younger, a not so unworthy son of a very illustrious father," thus making reference to Étienne's reputation.[170] But his description of Blaise in *An detur vacuum in rerum natura* (1646) also suggests admiration of the son as distinct from the father: "most celebrated and in all types of sciences well-versed, more than his age would seem to allow." [171] Clearly, Pierius's praise of Pascal was based largely on Blaise's learning in light of his youth. As with his first efforts at geometry, he was praised for the quality of his work, but more specifically because of his precocity.[172]

Pierre Guiffart, unlike Pierius, basically agrees with Pascal's verdict on the void. Ironically, however, he does not give the same kind of personal praise as Pascal's opponent. Instead, he focuses his favor on Blaise's experiments, which play a prominent role in the

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[167] "[J]'en fis le récit, en passant à Rouen, à votre bon ami et le mien, Monsieur Pascal," P. Petit to Chanut, 19/26 November 1646, Mesnard *OC*, 2:350.

[168] "Monsieur Pascal . . . fut ravi d'ouïr parler d'une telle expérience, tant par sa nouveauté que parce que vous savez qu'il y a longtemps qu'il admet le vide," ibid., 2:350. According to Petit, Étienne's belief in the void was encouraged through the reading of, among others, Hero of Alexandria. The elder Pascal was "longtemps persuadé de cette opinion de Héron et de plusieurs autres philosophes," ibid., 2:354. For the importance of Hero, see Boas, "Hero's *Pneumatica*," 38-48.

[169] "le fils de Monsieur Pascal objectait que les simpliciens pourraient dire que cet espace qui paraissait vide était de l'air, lequel, pour éviter le vide, aurait pénétré le verrre, et serait entré par ses pores," P. Petit to Chanut, 19/26 November 1646, Mesnard *OC*, 2:352.

[170] "Dominus Paschal junior, illustrissimi patris non degener filius." Pierius, *Ad experientiam,* 13, excerpted in Mesnard *OC*, 2:642.

[171] "nobilissimus et in omni scientiarum genere plusquam ejus aetas pati videretur versatissimus," Pierius, *An detur vacuum*, 2, Mesnard *OC*, 2:361.

[172] As Pascal was, by this time, already in his mid-twenties, this reference to wisdom beyond his years seems somewhat puzzling. It should be borne in mind, however, that early modern culture drew on a notion of adolescence and youth that extended through one's twenties.

argument of Guiffart's treatise: "Those who are philosophers cannot see them without admiration, and those who are not become so by considering them."[173] Guiffart, however, appended to his treatise a poem by Jean-Baptiste Porée. In his celebration of Guiffart's work, Porée refers to Blaise as "the ingenious Pascal" who "establishing the Void / Has filled our minds with a sweet astonishment."[174]

Pascal's early mentors also added their voices of affirmation during this period. Roberval refers to him as "the most celebrated Mr. Pascal" and "the most expert Mr. Pascal" in his first *Narration* on the void, which was addressed to Desnoyers and passed along to others, including Hevelius.[175] Roberval expands on these designations in the second *Narration*. Pascal, he states, fulfilled the needs of the occasion presented by the question of the void:

> [What is] necessary is a man not only sharp and zealous for the truth, but especially magnificent and capable in his search for what is true, in order to properly organize all the expenses which would be justified: we have found such a person for this affair in the person of noble Mr. Pascal.[176]

Desnoyers, in turn, refers to the *Expériences nouvelles touchant le vide* as "very fine and very well reasoned."[177] Pascal's virtues are praised; his youth is not mentioned.

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[173] "Ceux qui sont philosophes ne les peuvent voir sans admiration, et ceux qui ne le sont pas le deviennent en les considérant," Guiffart, *Discours du vide*, excerpted in Mesnard *OC*, 2:427.

[174] "L'ingénieux Pascal établissant le Vide / A rempli nos esprits d'un doux étonnement," ibid., 2:423. Guiffart's openness to novel ideas is clear from his ready acceptance of Harvey's theory on the circulation of the blood, despite opposition by many physicians in the town, Guiffart, *Cor vindicatum* (1652). Le Clerc, "Un médecin théologien," records a number of excerpts from Guiffart's works, including a statement concerning his own legitimacy: " . . . depuis vingt-cinq ans que je la professe [le medecin], l'envie la plus industrieuse n'a pu jusques icy trouver de légitime matière pour m'imputer à négligence, à ignorance ou à temerité quelque malheureuse reüssite," quoted in Le Clerc, "Un medecin théologien," 19.

[175] "nobilissimo viro D. de Paschal;" "solertissimus D. de Paschal," excerpted in Mesnard *OC*, 2:462, 469.

[176] "sed idem ut exhibeatur, virum requirit non sagacem modo ac veritatis studiosum, sed praeterea magnificum, et qui inquirendo vero quosvis sumptus bene impensos statuerit; qualem hoc in negotio habuimus nobilissimum virum Dominum de Pascal... "Narratio ad nobilem virum dominum," excerpted in Mesnard *OC*, 608.

[177] "fort beau et fort bien raisonné," Desnoyers to Hevelius, 18 December 1647, Mesnard *OC*, 2:454.

In his *Novarum observationum physico-mathematicarum* (1647), Mersenne continued his promotion of Pascal, begun in the late 1630s, mentioning him several times with reference to the question of the void. He grants him a designation reserved for learned men of the time: "the most illustrious man M. Pascal."[178] Just three years earlier, in his *Cogitata physico-mathematica*, Mersenne identified him with reference to his father, as "Pascal the younger."[179] Pascal does not escape connection with his father in Mersenne's later work, but *Novarum observationum* uses language that suggests equality: "the two Pascals, excellent geometers and philosophers."[180] Blaise is his father's colleague, not his pupil. Mersenne also touts the young man as the one who has "made . . . more observations on this void than any other" and assures the reader that if Blaise would print his work in a treatise as planned, "he will oblige the philosophers to himself."[181] With this final remark, Mersenne indicates his belief that Pascal is coming of age and ready to assume his place among the *philosophes* who elucidate the principles of natural phenomena.

Gassendi also lent his voice to the general acclamation of Pascal's success, though for this older savant Pascal's age was still worth mentioning. Among the savants living in Paris in the 1640s, few were as well-respected as Gassendi. From 1628-1632 he lived in Paris, where he made a number of learned friends. Gassendi was fully involved in the intellectual life of Paris during his residence in the 1640s, and had particularly close acquaintances with Boulliau and Mersenne. He refers to Pascal as the "amazing adolescent Pascal" when writing about the

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[178] "clarissimo viro D. Paschal"; when both he and his father are mentioned together, they are "clarissimo D. Paschali," Mersenne, *Novarum Observationvm Physico Mathematicarvm*, 218.

[179] The Latin phrase reads "juniorem Paschalem," "De Ballistica et Acontismologia sev de Sagittarvm, Iacvlorvm et Aliorvm Missilivm . . . „" Mersenne, *Cogitata Physico Mathematica,* 102.

[180] The original Latin reads "Paschalium, eximios geometras et philosophos," first preface to Mersenne, *Novarum Observationvm Physico Mathematicarvm*, folio 2v; cf. French translation in Mesnard *OC*, 2:487.

[181] "[S]i faciat satis clarissimus Paschalius . . . philosophos sibi maxime obstricturus est," Mesnard *OC*, 2:489.

quicksilver experiments performed in Rouen.[182] In the context of the Puy de Dôme experiment, he refers to "Pascal, this outstanding, or rather incomparable, young man [*adolescente*]."[183] Gassendi's praise of Pascal using the Latin term *adolescente* is noteworthy for the classical connections that it invoked. This term referred to a time of life that extended through young adulthood and indicated association with great ancients, such as Cicero, who saved Rome while still an *adolescente*.[184]

Gassendi's praise for Pascal demonstrates what Valerian Magni (who claimed his own preeminence in the experiment on the void) also recognized by the middle of 1650: Pascal was a "man of eminent reputation in France."[185] Pascal owed his fame, however, not simply to his great abilities, but to the general interest in his subject matter. For Jean Pecquet, whose interests centered on medicine, Pascal was important because "he did put in all the Devotaries of true wisdome through all *Europe* an eager desire to try the Experiments of Vacuity."[186] Pascal's

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[182] "mirifico adolescente Paschalio," Pierre Gassendi, *Animadversiones in decimvm librvm Diogenes Laertii, qvi est de vita, moribus, placitisque Epicvri,* vol. 1 (Lyon, 1649), 426. Gassendi calls him "mirificus Paschalius" again, this time without a reference to his youth, Pierre Gassendi to François Bernier, 6 August 1652, Pierre Gassendi, *Opera omnia*, vol. 6 (Stuttgart-Bad Cannstatt, 1964), 318, col. 2.

[183] "eximii, seu incomparabilis potius adolescentis PASCHALII," Gassendi, *Animadversiones,* vol. 1, Appendix, III. See also, Simone Mazauric, *Gassendi, Pascal et la querelle du vide* (Paris, 1998).

[184] The Latin word "adolescente'"was still in use positively to speak of an individual, while in French this word seems to have been used as an insult, as is suggested by Le Maistre's desire in 1636 that Balzac not refer to him with such a term, since it "is said only in an ironic way of speaking, from which he [Le Maistre] is quite glad, by your good pleasure, to save himself, avowing certainly that, in the Latin sense, it would be too glorious for him that you you had spoken of him in such a way, as he knows up to what [point] the limits of adolescence went for the Romans, and reminds himself that Cicero, somewhere, is credited with saving Rome while still an adolescent," Jean Chapelain to Guez de Balzac, Feb. 17, 1636, Jean Chapelain *Lettres de Jean Chapelain de l'Académie Française*, vol. 1 (Paris, 1968), 108.

[185] "vir inter Gallos praecipuae nobilitatis," Valerian Magni, *Principia et specimen philosophiae* (Cologne, 1652), 90-91.

[186] Jean Pecquet, *New Anatomical Experiments of John Pecquet of Diep* (London, 1653), 102.

experiments on the void were important for their clarity and for challenging the scholastic view of nature.[187]

The foregoing testimonies are not unusually adulatory for the seventeenth century. Descriptors such as "marvelous" and "illustrious" were used to maneuver and advance socially in the learned world. Nevertheless, that he received praise from significant sources indicates that Pascal had effectively taken his place among savants in France. Descartes' increased interest in Pascal's work provides no small evidence to the greater position of influence that Pascal had acquired in the learned community.

Descartes had once dismissed Pascal's work on conic sections as a mere aping of Desargues, but by the fall of 1647 he considered Blaise's work significant enough to pay him two personal visits. The meetings are recorded by Jacqueline, Pascal's younger sister, in a letter to Gilberte, his older sister. Jacqueline clearly perceived the honor of the visit and wanted to share her pride with the family. Descartes desired to visit Pascal, Jacqueline writes, "because of the great estimation that he had always heard people make of Monsieur my father and of him."[188] The mention of Étienne reiterates the relationship between Pascal's status as savant and as son. It also points to a key claim of this study. The trajectory of this part of Pascal's career suggests both a continued childlike dependency on his elders and an assertive drive to validate his identity as a mature savant. While some scholars view this period in Pascal's life as an assertive drive

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[187] Pascal's role as a challenger of scholasticism is a part of the traditional narrative of his experiements on the void. Alexander William Stewart Baird, "Pascal's Idea of Nature," *Isis* 61 (1970): 296-320, describes Pascal's simultaneous rejection of the Aristotelian "animism" of nature as emobodied in the *horror vacui* and his maintenance of nature as an "active principle." Pascal's critique of Aristotle, Baird argues, does not lead him to the reductive mechanism of Descartes. Instead, his idea of nature "falls . . . between Renaissance hylozoism, which regards nature as something divine and self-creative, and the Cartesian idea of the world as a sort of giant clockwork," ibid., 318.

[188] "M. Descartes, son compatriote et intime ami, lui avait fort témoigné avoir envie de voir mon frère, à cause de la grande estime qu'il avait toujours ouï faire de Monsieur mon père et de lui," Jacqueline Pascal to Gilberte Périer, 25 September 1647, Mesnard *OC*, 2:480.

for glory, it is clear that Pascal's ill health and his childhood influences placed him in a position of dependence.[189]

Descartes' meetings with Pascal provide an exemplary episode of Pascal's dependency that also reflects the possessiveness of one of his mentors. Pascal's health had recently suffered in part, as Gilberte suggests, because of assiduous application to his arithmetic machine. He was so infirm that he had to remain in his bed while talking with Descartes. Also present at the meeting was Roberval, a central member of the Mersenne group and one of Étienne Pascal's old friends. Roberval likely helped to demonstrate the calculator for the invalid Blaise, and thereafter, discussion turned toward the void. Descartes and Pascal exchanged a few words about their conflicting interpretations of Blaise's experiments. In the midst of this discussion, Roberval jumped in to finish Blaise's thoughts, ostensibly because he believed the young man "would be caused pain by speaking" because of his illness, disputing Descartes' theory of subtle matter "heatedly."[190]

At this point in the conversation, Pascal became a mere bystander. The record suggests that Descartes bristled impatiently at Roberval's interruption, saying that he would talk to Blaise as much as he wanted "because he spoke with reason," and that he would not talk with Roberval, who "spoke with preoccupation."[191] These words did not serve their stated purpose, but

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[189] Cousin remarks on Pascal, who "adored glory," and who was as head-strong as Descartes. Cousin views Descartes as Pascal's archrival, Victor Cousin, *Études sur Pascal* (Paris, 1876), 80-83. Mesnard depicts a Pascal for whom his scientific work was a source of pride and which had to be abandoned at his conversion, Jean Mesnard, "Les conversions de Pascal," in *Blaise Pascal, l'homme et l'oeuvre*, ed. M. A. Bera (Paris, 1956): 46-63. Strowski recognizes Pascal's project of the arithmetic machine as driven by the expectation of "glory and fortune," Fortunat Strowski, *Pascal et son temps*, 3 vols. (Paris, 1921), 2: 57. Of particular importance for Pascal as assertive and driven is Nelson, *Pascal, Adversary and Advocate*.

[190] "M. de Roberval, croyant que mon frère aurait peine à parler, entreprit avec un peu de chaleur M. Descartes," J. Pascal to G. Périer, 25 Sept 1647, Mesnard *OC*, 2:481.

[191] "[Descartes] lui répondit avec un peu d'aigreur qu'il parlerait à mon frère tant que l'on voudrait, parce qu'il parlait avec raison, mais non pas à lui, qui parlait avec préoccupation," ibid.

escalated the verbal conflict between Pascal's talented elders. Jacqueline's letter describes how the rivals argued their way out the door and into a carriage, where they continued their heated dispute on their way to a mutual lunch date undoubtedly fraught with indigestion.[192]

While Jacqueline characterizes Roberval's actions as motivated by concerns for Blaise's health, the exchange also indicates that Pascal's identity as protégé of the Mersenne group continued into adulthood. Roberval demonstrates a sense of ownership over Pascal's person and ideas, while Descartes also seeks to align himself with the young man's reasonableness. The image is striking. Two great representatives of learned Europe stood over Pascal, the dependent child, arguing to claim a commodity (Pascal's genius) caught between two warring factions.

Pascal's deferential approach is even more prominently displayed in a conflict with the Jesuit father, Étienne Noël. Noël initiated a correspondence with a letter to Pascal, in which he stated several arguments against the *Expériences nouvelles touchant le vide*. Pascal's lengthy reply to Noël's points prompted a further riposte from the Jesuit. Noël suggested through his courier that he did not want to endanger Pascal's already fragile health. He was urged by Noël not to respond to his letter. Not long after, however, Father Noël published a work entitled *Le plein du vide*, which essentially expanded on the arguments that he had made in his second letter to Pascal. This transformed their differences from a private to a public debate. It was an affront to Pascal as savant.

Noël's work suggested that Pascal's lack of response to his letter was an admission of defeat. Significant issues of reputation were at stake. Jacques Le Pailleur, one of the Pascals' old friends and one of the original participants in the Mersenne group, showed his concern

[192] "[Descartes], voyant à sa montre qu'il était midi, il se leva, parce qu'il était prié de dîner au faubourg Saint-Germain, et M. de Roberval aussi, si bien que M. Descartes l'y mena dans un carrosse où ils étaient tous deux tout seuls, et là ils se chantèrent goguettes, mais un peu plus fort que jeu à ce que nous dit M. de Roberval," ibid.

through a letter to Pascal, in which he asked the reason for his silence. In a more offensive tactic, Étienne Pascal wrote a scathing epistle to the Jesuit, in which he took him to task for both the disingenuous treatment of his son and for the philosophical deficiencies in Noël's work. As father and teacher, he intercedes on behalf of his son and pupil.

Étienne's letter to Noël presents Blaise as childlike in his humility and innocence and mature in his virtue. By contrast, Noël's outward marks of learning, Étienne suggests, are combined with childish rhetoric and natural ignorance. In the letter, Étienne portrays Pascal as a meek figure. When wronged in this heated discussion, he had seen two possibilities: either to answer the Jesuit in a similarly ironic tone or, "practicing the instruction of the Gospel," to confront Noël in a direct and brotherly way.[193] However, Blaise considered neither of these appropriate. Instead, his father continues, he assumed the role of the inferior party, citing "the disparity between your age and his."[194] In his response to Noël, according to Étienne, Blaise exhibited submissiveness. He also showed that he continued to entrust matters of his learned career to his father:

> He has considered it more appropriate . . . to ask me, as he has done, to take the pain to practice for myself the command of the Gospel, causing you to understand his just complaint, having provoked him without reason, and the lack of an appropriate correspondence between the type of writing that you have used and the condition that you profess, judging that you will receive that more readily from me than from him.[195]

The young Pascal was probably wise to respond to Noël as he did. He certainly could not have written the scathing letter penned by his father. The acids of Étienne's critique had to be

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[193] "en pratiquant le précepte de l'Évangile," É. Pascal to É. Noël, April 1648, Mesnard OC, 2:587. The *Provincial Letters* demonstrate conclusively that Pascal's ability to be irenic was matched by his ability to be ironic.

[194] "[Il] [a] eu égard à la disparité de votre âge et du sien," ibid.

[195] "il a estimé plus à propos . . . de me supplier, comme il a fait, de prendre la peine de pratiquer moi-même ce précepte de l'Évangile, vous faire entendre sa juste plainte de l'avoir, sans occasion quelconque, provoqué, et le peu de convenance qu'il y a entre le genre d'écrire dont vous avez usé et la condition que vous professez, jugeant que vous recevrez cela avec plus d'agrément de ma part que de la sienne," ibid., 2:587-588.

delivered from a position of social power.[196] His status was already secured within the learned circle of Paris, and as a former President of the Cour des Aides at Rouen, within the political hierarchy of the governing class.

In responding to Étienne Noël, Étienne Pascal first confronts the Jesuit because of his style of writing. He uses "invective" in his work to such an extent, Étienne remarks, that

> It is difficult to judge if you have invented invective because it was useful for continuing the allegory, or if you have invented the allegory in order to have a reason let this invented invective creep in.[197]

Blaise's father suggests that Noël is quite proud of himself for being able to insult the work and thus the person of the younger Pascal in various ways. But such pride is misplaced:

> What glory can a man of honor claim from the art of invective, which is in itself nothing but a pure weakness, and so natural to man that it is almost as if one has the need to study in order to become ignorant of it.[198]

Pascal presents Noël as having, like the artisans of Rouen, demonstrated himself to be in a state of unlearned nature. In the attempt to establish his eloquence and learning, he had instead proven that he had not unlearned a weakness for giving insults. The heavy-handed correction that the elder Pascal offers in this letter is remarkably like the hard discipline of the pedagogue to his students. Indeed, Étienne gives the Jesuit a lesson in antithesis, complete with examples and counterexamples, to show the unlearned nature of the title of Noël's work: *Le Plein du Vide*.

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[196] The indispensibility of the patronage of someone in social power is a theme of early modern science and culture more general and is the subject of a vast literature. Lisa T. Sarasohn, "Nicolas-Claude Fabri de Peiresc and the Patronage of the New Science in the Seventeenth Century," *Isis* 84 (1993): 70-90, reiterates the importance of intercessory writing in the learned culture of seventeenth-century France.

[197] "[I]l est difficile à juger si vous avez inventé les invectives pour trouver expédient de continuer l'allégorie, ou si vous avez inventé l'allégorie pour prendre sujet d'y faire glisser ces invectives inventées," E. Pascal to E. Noël, April 1648, Mesnard *OC*, 2:598.

[198] "[Q]uelle gloire peut un homme d'honneur prétendre de l'art d'invectiver, qui, de soi-même, n'est rien qu'une pure faiblesse, et tellement naturelle à l'homme que tant s'en faut qu'il ait besoin d'étude pour y devenir ignorant," ibid., 2:601.

Furthermore, he provides a subtle educational commentary suggesting that the traditional "School" was too indulgent towards the natural state of man:

> [The title of the work] would truly be acceptable in the Schools [*dans l'École*], where it is not just permitted, but necessary (so much is the nature of man imperfect) to begin by doing ill, in order to learn little by little to do good.[199]

By contrast, "in the world, where nothing is excused," Noël's title would be rejected because it lacked any "perfect sense."[200] The traditional schools compromise with the natural state of humanity, and do not discipline it enough, Pascal's father asserts. Among the "world" (i.e., the broad group of the learned "public") the schools had little respect because of this lack of true intellectual discipline. The Jesuit father's position as a teacher (he had instructed Descartes at La Flèche) did not prevent him from being fundamentally ignorant, at least in the judgment of Étienne.

The elder Pascal's criticism of Noël ironically expresses what he considers a key truth: that while Étienne's son was hesitant to approach his older offender, the Jesuit was more of a "child" than Pascal. When provoked, Blaise did not retaliate but had recourse to a more mature response:

> And certainly, my Father, although I am not so happy as to have the benefit of your understanding, I cannot conceal from you that you have been quite fortunate to have undertaken, so cheaply, to carry out these type of injuries against a young man who, finding himself provoked without reason-I say without any reason-could, through the bitterness of the injury and through the rashness of his age, endeavor to push your invectives back onto you . . . in terms that would be capable of causing you to eternally repent . . . . You have . . . not been unfortunate to have been involved with a young man who, through a moderation of nature which is not always in agreement with that age,

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[199] "[Le titre] peut véritablement passer dans l'École, où il est non seulement permis, mais aussi nécessaire (tant la nature de l'homme est imparfaite) de commencer par faire mal, pour apprendre peu à peu à faire bien," ibid., 2:591.

[200] "[M]ais certainement dans e monde, où l'on n'excuse rien, elle ne saurait passer, puisque par elle-même elle n'a point de sense parfait," ibid., 2:591.

> instead of coming to these extremities-disadvantageous to both of you, but very much more to you-has taken another way in order to have you hear his complaint.[201]

According to Étienne, Noël had acted the part of the youngster, surrendering to the slightest test of nature. Blaise, by contrast, had demonstrated the restraint associated with maturity. He exemplified precocity in manner and bearing, not just in natural philosophy and mathematics. Thus, paradoxically, by assuming the role of the meek child in this quarrel, Pascal demonstrated maturity. He had not remained in the state in which nature created him, but had exercised the art of self-control.

Pascal exhibited characteristics of childlikeness and submission in his disagreement with Noël about the void. At the opposite end of the spectrum, however, his father asserted his maturity by claiming that Blaise's self-discipline distinguished him from his opponents. His work on the void was characterized in similar terms as had been his work on the arithmetic machine during the same period. He was not a mere prodigy but a mature savant.

Pascal's "Preface": mature thinking

After recovering from the bout with illness that had plagued him during the meeting with Descartes and probably during his debate with Noël, Pascal worked to complete a lengthier treatise on the void, which he had promised in the 1647 text of *Expériences nouvelles touchant le vide*. Only fragments of the body of this treatise remains, but a draft of the preface to the treatise survives and provides, as Eric Koch suggests, "Pascal's most extensive statement on the New

[201] "Et certainement, mon Père, quoique je ne sois pas assez heureux pour avoir le bien de votre connaissance, je ne puis vous dissimuler que vous l'avez été beaucoup d'avoir entrepris, à si bon marché, de vous commetre en style d'injures contre un jeune homme qui, se voyant provoqué sans sujet, je dis sans aucun sujet, pouvait, par l'amertume de l'injure et par la témérité de l'âge, se porter à repousser vos invectives . . . en termes capables de vous causer un éternel repentir . . . . Vous n'avez . . . pas été malheureux d'avoir eu affaire à un jeune homme, lequel, par une modération de nature qui ne s'accorde pas toujours avec cet âge, au lieu d'en venir à ces extrémités désavantageuses à l'un et à l'autre, mais beaucoup plus à vous, a pris une autre voie pour vous faire entendre sa plainte," ibid., 2:590.

Science."[202] The preface reflects Pascal's views on the structure of different types of knowledge and has close connections with ideas of Francis Bacon. The essay uses the language of pedagogy to describe interactions with nature and suggests the contrast between instinct and true learning, between childishness and maturity. A comparison of the preface with Pascal's account of the clockmaker's abortive inventions and Mersenne's *Harmonie universelle*, concerning the limitations of nature in the art of playing the lute, shows the common themes that Pascal used to secure his legitimacy.

The purpose of the preface is to validate Pascal's consideration of the void by establishing the acceptability of novelty in physics. He therefore reiterates a division between knowledge established by authority and knowledge established by sense and reason. He seeks to discredit those who confound the two categories. Unwilling to dismiss authority altogether, Pascal acknowledges authority in questions of "simple facts or divine or human institutions."[203] This is the case in history, geography, jurisprudence, languages, and especially theology. But authority must not decide questions in mathematics, physics, architecture, and, indeed, "all the sciences", "which are self-evident to the senses and to reasoning."[204] Many of his contemporaries, Pascal claims, have reversed the relationship with authority. Novelty is acceptable in theology, but it is rejected in physics.[205] Pascal's main concern is, of course, the simple acceptance of the

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[202] Erec R. Koch, *Pascal and Rhetoric*: *Figural and Persuasive Language in the Scientific Treatises, the* Provinciales *and the* Pensées (Charlottesville, VA, 1997), 38. Mesnard argues for a date of 1651 for the fragments and the preface, based on a letter written by Pascal which refers to the work in progress, Mesnard *OC*, 2:773, 786. The text of the preface is in Mesnard *OC*, 2:777-785 and the fragments are in Mesnard *OC*, 2:787-798. Both were published for the first time in Blaise Pascal, *Oeuvres*, ed. C. Bossut, vol. 4 (La Haye, 1779).

[203] "Fragment of a Preface to the Treatise on the Vacuum," in *Great Shorter Works of Pascal*, ed. Émile Caillet and John C. Blankenagel (Philadelphia, PA, 1941), 51.

[204] Ibid., 51-52.

[205] " . . . the misfortune of our world is such that we encounter many new opinions on theology that were unknown to antiquity, but which are now upheld with obstinacy and received with applause. On the other hand, though their number is small, new opinions advanced in physics seem perforce to be convicted of error as soon as they shock

authoritative opinion of Aristotle and other ancient authorities that "nature will not suffer a void," or at least that "nature abhors the void."

Pascal attempts to clarify the mistake of revering the ancients by drawing on a developmental analogy that had become popular among advocates of the "New Science." To this purpose, he uses Bacon's notion of humankind as a single individual, growing in knowledge from the beginning of its existence up to the present, so that "the same thing happens in the succession of men that happens in the different stages of an individual."[206] Pascal further argues, "Those that we call ancients were veritably new in all things, and actually constituted the childhood of mankind."[207] This parallel between the accumulation of all of human knowledge and the development of an individual was a pedagogical and not an organic metaphor:

> In such a way that the whole of mankind, during the course of so many centuries, ought to be considered as the same man, who always remains and who continually learns . . . . Those that we call ancient were truly new in all things, and made up the childhood of man properly speaking, and as we have joined to their knowledge the experience of the centuries that have followed them, it is in us that one can find the antiquity that we revere in others.[208]

Pascal's use of a pedagogical metaphor for the development of human knowledge emphasizes, once again, the contrast between undeveloped natural inclination and its augmentation through exercise. Pascal argues that those who consider ancient opinions in physics as authoritative are

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accepted opinions. It is as if the respect we have for ancient philosophers were a duty, and the respect we have for the most ancient of the church fathers were merely a courtesy," ibid., 52.

[206] Ibid., 54. Bacon's statement of this idea is in Francis Bacon, *Novum Organum*, book I, chapter LXXXIV. Foster E. Guyer, "C'est nous qui sommes les anciens," *Modern Language Notes* 36 (1921): 257-264, traces the expressions of this notion from ancient Greece through the eighteenth century and makes the case for Pascal's reading of Bacon. See also Mesnard *OC*, 2:772-777 and LeGuern *OC*, 1:1094-1097.

[207] "Fragment of a Preface," in *Great Shorter Works*, 54.

[208] "De sorte que toute la suite des hommes, pendant le cours de tant de siècles, doit être considérée comme un même homme qui subsiste toujours et qui apprend continuellement . . . . Ceux que nous appelons anciens était véritablement nouveaux en toutes choses, et formaient l'enfance des hommes proprement; et comme nous avons joint à leurs connaissances l'expérience des siècles qui les ont suivis, c'est en nous que l'on peut trouver cette antiquité que nous révérons dans les autres," "Préface sur le traité du vide," Mesnard *OC*, 2:783.

attempting to sidestep the normal road to knowledge. They were following the opinions of the "childhood" of humanity even though chronologically they belonged to its age of maturity.

But this natural state of the intellect, Pascal claims, is characterized by blindness. He suggests that those who misunderstand the place of authority and use it in improper contexts have faulty sight. He laments the "blindness of those who rely on authority alone for proof in physical matters, in place of reasoning or experiences."[209] This is similar to the point that Mersenne made concerning the perfect lute-player in *Harmonie universelle*. Natural inclination to such an art (or to a science) without discipline and exercise is "blind and imperfect." This same accusation is present in Pascal's description of the Rouennais artisan who copied his arithmetic machine. The worker did not have the resources necessary to complete the project successfully because he relied on habit or second nature. Fumbling like a drunken man, he could only create a misshapen mass.

Pascal's description of authoritative teaching about physics, stated in his preface, shares other features with Mersenne's statements about nature and lute-playing. Mersenne's *Harmonie universelle* had argued that, in playing an instrument, good instruction and practice would make up for a lack of musical inclination. The naturally-talented musician with a "delicate" ear might believe that his own talents were the only guide needed to perfect his art, but inborn deficiencies believed to determine the "perfect musician" were in fact improved by discipline. In a similar, though more extreme case, Pascal stated that the artisan of Rouen, excellent as he was in the habituated art of clockmaking, could not create a properly working machine without instruction in mathematics and physics. The artisan falsely presumed that he could draw on his "natural"

[209] Ibid., 2:779.

abilities and thereby short-circuit the cumulative effects of instruction in mathematics, mechanics, and physics.

For the artisan, the musician, and the natural philosopher, remaining in one's natural state co-opts the individual created in God's image. As Pascal states, it is "to treat the reason of man unworthily, and to put it alongside the instinct of the animals."[210] Memory and accumulation of skill allow the human being to transcend the limitations of nature. For someone who wishes to play music well, writes Mersenne, the "most sterile earth is rendered fertile by the care and diligence of the laborer." Thus, one "can overcome the defects of nature."[211] In the case of physics, as Pascal points out, humanity's improvement is a process that takes place throughout the life of the individual and throughout human history. But knowledge was not viewed as built in a strictly linear fashion. It is built indirectly, through facts and *expériences*.[212] Reasoned analysis eventually leads to simple principles that make sense of those *expériences*.[213] Pascal's handful of principles for dealing with conic sections elegantly produced numerous theorems. Similarly, many experiences derive from an elegant principle in physics. In physics, as in mathematics, such a discovery is a true imitation of the Creator. It is "thinking his thoughts after him."[214]

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[210] "N'est-ce pas indignement traiter la raison de l'homme, et la mettre en parallèle avec l'instinct des animaux," Ibid., 2:781.

[211] Mersenne, *Harmonie universelle*, "Livre second des Instruments," 77.

[212] The French *expérience* indicates both "experience" and "experiment." The use of the word here arises from the goal of portraying both as essential to humanity's learning over time.

[213] The similarity between such simple rules and the "rules of thumb" of artisans is important for the development of inductive method. Zilsel argues of the Renaissance artist-engineers: " . . . their quantitative thumb rules are the forerunners of the physical laws of science," Zilsel, "Sociological Roots of Science," 553. Pascal's relationship with the Rouennais artisans, however, demonstrates a recognition that, although feedback from the artisans was necessary for its construction, only the savant could reason properly about that feedback.

[214] This quotation is attributed to Johannes Kepler, though its origins are obscure.

To show deference to authority in certain subject matters, such as physics, the "Preface" argues, is to renounce true humanity, as a bearer of God's creative image. It is like the action of animals. Pascal illustrates his point with a particular example from the world of the beasts. Bees, he observes, have constructed their hives with the same level of perfection for thousands of generations.[215] "Nature" he writes, "instructs to the extent that necessity presses them."[216] But like the lute-player who relies on *imparfait* natural inclination, the hive-making of bees remains at a "restricted perfection," imposed by nature.[217] This truth does not, however, minimize the marvelous beauty and exactness of honeycombs. But the bee operates within natural constraints and despite indications to the contrary it does not have genuine theoretical knowledge of construction.[218] It does not have the same capacity to construct a lutes and glass tubes as does a man. Pascal asserted this same type of restriction in his account of workers at Rouen. Artisans who attempt to build an arithmetic machine like Pascal's, but without his help, undertake "more than their equals"[219] Their apprenticeship confines them to skills that have been learned through habit. Pascal claims that their limitation, at heart, is the inability to handle all of the proper theory and thereby determine the proportions of a large number of interconnected parts.

The bee and the naturally skilled musician "receive without study" their respective gifts for hive-making and lute-playing.[220] The artisan likewise receives his skill in working with tools

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[215] "Les ruches des abeilles étaient aussi bien mesurées il y a mille ans qu'aujourd'hui, et chacune d'elles forme cet hexagone aussi exactement la première fois que la dernière," Mensard *OC*, 2:781.

[216] "La Nature les instruit à mesure que la nécessité les presse," "Preface sur le traité du vide," Mesnard *OC*, 2:781.

[217] The French reads, "perfection bornée," "Preface sur le traité du vide," Mesnard *OC*, 2:782.

[218] In delineating the various failures of *esprit*, Huarte refers to Aristotle's labeling of those who "speak by Natural Instinct, and say more than they know" as "Brute-beast-like," Huarte, *Tryal of Wits* (1698), 30.

[219] "plus de leurs semblables," "Avis," Mesnard, *OC*, 2:338.

[220] "Comme ils [les abeilles] la reçoivent sans étude, ils n'ont pas le bonheur de la conserver; et toutes les fois qu'elle leur est donnée, ell leur est nouvelle," "Preface sur le traité du vide," Mesnard *OC*, 2:782.

through repetition and not through study. Restricted to the resources of unimproved nature, there is no possibility, Pascal suggests, of accumulating improvements that approach perfection. But while nature restricts the bee absolutely, the natural philosopher, made in God's image, has his memory to "draw advantage not only from his own experience but even from that of his predecessors, because he always keeps in his memory the knowledge that he has once acquired."[221]

The effectiveness of the analogy between bees and the man who trusts authority in the question of the void relies upon the assumption that human nature and animal nature are essentially distinct. Mersenne uses the word "nature' in his discussion of lute-playing to indicate an individual's inclination toward music. Inclination might come from the keenness of one's sense of hearing, the relative concentration of one's humors, the position of the stars at one's birth, or even the type of people encountered in one's developmental years. But even in such cases, nature is not the final word for the human being. The limitations Pascal and Mersenne ultimately deride are self-imposed. In Pascal's opinion, as expressed in the "Preface to a Treatise on the Void" and elsewhere, the key truth about humanity is that it is "made only for infinity."[222] By contrast, the nature of animals exists in "limited perfection." [*perfection bornée*].[223] Animals will not regress but neither will they progress.

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[221] "[L'homme] tire avantage non seulement de sa propre expérience, mais encore de celle de ses prédécesseurs, parce qu'il conserve toujours dans sa mémoire les connaissances qu'il s'est une fois acquises," "Preface sur le traité du vide," ibid. On the cumulative nature of music, Mersenne writes in his second book of Instruments in the *Harmonie universelle*: "Encore que les siecles passez ayent produit des hommes tres-excellens en toutes sortes d'arts & de sciences, & particulierement en celuy dont nous traitons, l'on peut neantmoins dire qu'elles se perfectionnent d'autant plus qu'elles vont plus en auant: comme is est aysé de prouuer par l'vsage des tremblemens, qui n'auoit iamais esté si frequent qu'il est maintenant," Mersenne, *Harmonie universelle*, "Livre second des instrumens," 3:79.

[222] "Il n'en est pas de même de l'homme, qui n'est produit que pour l'infinity," "Preface sur le traité du vide," Mesnard *OC*, 2:782.

[223] "[L]a nature n'ayant pour objet que de maintenir les animaux dans un ordre de perfection bornée," "Preface sur le traité du vide," ibid.

When Pascal writes that "Nature instructs animals," he refers to a one-time lesson administered at birth. For human beings, instruction "by nature" is quite a different story. Nature, in the external sense of the universe (not an internal state of nature) unveils itself. Revelation may occur through reading or hearing about a predecessor's experiences. It may take the form of autodidacticism through one's own experiences. And the process is both active and passive. On the one hand, human beings actively participate in the multiplication of experiences (or experiments). On the other, Pascal depicts external nature not merely as yielding to the discoveries of man but as an active pedagogue:

> The secrets of nature are hidden; although it always acts, one does not always uncover its effects: time reveals them from age to age, and although always equal in itself, it is not always equally known.[224]

Humanity in general and individuals in particular must be attentive to nature's lessons in order to gain the knowledge she actively distributes.

But the learned natural philosopher, Pascal claims, is not merely a student. Those who are learned in physics are qualified to detect what nature teaches and to structure experiences of nature as knowledge. The *Expériences nouvelles touchant le vide* seeks to structure nature's lessons in proper order to allow others access to knowledge.[225] Similarly, Pascal's work on the void in Rouen included a public demonstration in the court of the glassworks, similar in style to

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[224] "Les secrets de la nature sont cachés; quoiqu'elle agisse toujours, on ne découvre pas toujours ses effets: le temps les révèle d'âge en âge, et quoique toujours égale en elle-même, elle n'est pas toujours également connue," "Preface sur le traité du vide," ibid., 2:780-781.

[225] The importance of the order of the experiments is stressed in Jean-Paul Fanton d'Andon, *L'horreur du vide: expérience et raison dans la physique pascalienne* (Paris, 1978) and Dominique Descotes, "La rhetorique des expériences sur le vide," in *Les Pascals à Rouen*: 237-261. Descotes argues that the presentation of the experiments in their particular order as baaed in a "dramatic strategy," comparing the *Nouvelles expériences* to the tragedies of Racine, Descotes, "La rhetorique des éxperiences sur le vide," 250-261.

theaters of medical demonstration.[226] Here Pascal dramatically allowed the spectators to see nature's lessons by using forty foot tubes of glass.

Pascal thus acted the part of intermediary between nature and humans. He played the active role of the natural philosopher that complemented nature's work as pedagogue. He used his mathematical training and hard work to draw conclusions about the principles of nature, thus securing his legitimate place as a savant. He no longer received acclaim as a youthful boy-wonder. He pushed beyond natural talent. The true savant, as Pascal presents himself, transcends nature in two ways. He does not rely on natural inclination as a valid means to knowledge; instead, he overcomes the limitations of nature's pedagogy by ordering experiences to reveal the principles of the universe.

Pascal underscored that he was human, not a passive animal, by imitating the Creator. He used apparatus (tubes, syringes, and bellows) to transcend the mere observance of nature and to actively re-create the void, which he believed was consistent with nature. Guiffart writes of the experiences of Pascal in this way, emphasizing the controlled display of a natural phenomenon:

> In them is seen a miniature abridgement of the world, in which keeping the elements enclosed in our hands and at our disposal, they allow us to understand what they are and what they can do.[227]

In this godlike demonstration, Pascal creates an outside-looking-in perspective of the phenomenon and creates effects within the tube at will. The experiments on the void are thus a means by which Pascal imitates the Creator and distances himself from mere creatures.

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[226] A scene from such an anatomical demonstration is pictured on the title page of Andreas Vesalius, *De fabrica* (Basel, 1543).

[227] "En elles on voit un petit raccourci du monde, dans lequel tenant les éléments enfermés entre nos mains et à notre disposition, ils donnent à connaître ce qu'ils sont et ce qu'ils peuvent faire," Guiffart, *Discours du vide*, excerpted in Mesnard *OC*, 2:427.

Pascal's opponents argued that this God-imitating re-creation yielded an absurdity. Instead of a creation *out* of nothing (*ex nihilo*), it was a creation *of* nothing. If Pascal's work had come to nothing, was this not a pitiful task for the imitator of the Creator? Pascal believed that a display of the *effects* of creation was equivalent to re-creating nature's works. For the imitator of God, this was a pedagogical tool, an exhibition of the wonders of the world. In his defense against the argument of creating nothing, he claims that he merely makes a negative hypothesis: "*that this space is void, until such time that one has shown that some matter fills it*."[228] Pascal thus balances an assertion of creative possibilities with humble skepticism.

Pascal, however, used a similar tactic to criticize Father Noël during their exchange. In an ironic tone, he accuses the Jesuit of having "created" a kind of Cartesian subtle matter. But while the true creation of matter belongs only to God and requires great power, Noël effortlessly creates this matter with just his imagination:

> Imagination has that proper to itself that it produces with as little effort and time the greatest things as the smallest; some have made it [i.e., the substance filling the void] of similar substance as the heavens and the elements; and others, of a different substance, following their fantasies, because they use it as if it were their own work.[229]

Pascal portrays the fruits of Noël's imagination as ridiculous, comparing him to a bungling creator. Like the artisan who worked on the counterfeit arithmetic machine, the Jesuit cobbles together the efforts of earlier philosophers to identify the matter that fills the apparent void. He thereby "makes a monster of nature."[230] This monster is made up of "the great number of

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[228] "*que cet espace est vide, jusqu'à ce que l'on m'ait montré qu'une matière le remplit*," Blaise Pascal to Jacques Le Pailleur, [February 1648], Mesnard *OC*, 2:560.

[229] "[L]'imagination a cela de propre qu'elle produit avec aussi peu de peine et de temps les plus grandes choses que les petites; quelques-uns l'ont faite de même substance que le ciel et les éléments; et les autres, d'une substance différente, suivant leur fantaisie, parce qu'ils en disposaient comme de leur ouvrage," Blaise Pascal to Étienne Noël, 29 October 1647, Mesnard *OC*, 2:522.

[230] "Car on ne peut les croire toutes ensemble, sans faire de la nature un monstre, et comme la raison ne peut pencher plus vers une que vers l'autre, à cause qu'elle les trouve également éloignées, elle les refuse toutes, pour se défendre d'un injuste choix,"ibid., 522-523.

different opinions" and is "a divided body, of which the contrary members tear each other apart from the inside out."[231] As with the clockmaker's calculator, the contradictory aspects of the concepts that make up Noël's notion of subtle matter show it to be unintelligible. Neither the artisan's machine nor Noël's subtle matter functions in the way that their creators had hoped. Both have ill-fitting parts.

Noël's attempts to imitate the Creator, Pascal argues, result in a ridiculous monster. Pascal clearly indicates that Noël has presumptuously invented new matter. He writes, for instance, of "the matter with which the Father fills it [the void]" and of "the matter that he puts in the tube."[232] Furthermore, unlike the Creator, who operates in harmony and order, the Jesuit creates and destroys matter at random:

> But I would indeed like to know from this Father where his ascendancy over nature comes from, and this dominance that he exercises so absolutely over the elements, which serve him with so much dependency that they change properties in the same measure that he changes thoughts, and that the universe accommodates its effects to the inconstancy of his intentions. I do not understand what blindness could be to the proof of this light, and how one could give assent to some belief in things that are made to arise and are destroyed with an equal facility.[233]

Pascal suggests that Father Noël mirrors creatures acting according to blind instinct, not God. By accepting various ambiguous accounts of the void from his predecessors, Noël does no more than the bees, which simply operate according to their instinctive hive-making. He thus

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[231] "Aussi est-il étrange de voir parmi ceux qui soutiennent le plein le grand nombre d'opinions différentes qui s'entrechoquent"; "Ils composent un corps divisé, dont les membres contraires les uns aux autres se déchirent intérieurement," B. Pascal to Le Pailleur [February 1648], Mesnard *OC*, 2:575.

[232] Ibid., 2:566; 570. He also writes: "vous voyez que le P. Noël place dans le tuyau une matière subtile répandue par tout l'univers . . . ," ibid., 2:571.

[233] "Mais je voudrais bien savoir de ce Père d'où lui vient cet ascendant qu'il a sur la nature, et cet empire qu'il exerce si absolument sur les éléments, qui lui servent avec tant de dépendance qu'ils changent de propriétés à mesure qu'il change de pensées, et que l'univers accommode ses effets à l'inconstance de ses intentions. Je ne comprends pas quel aveuglement peut être à l'épreuve de cette lumière, et comment on peut donner quelque créance à des choses que l'on fait naître et que l'on détruit avec une pareille facilité," ibid.

abdicates his place as a human being who is "made for infinity" and who is capable of learning from reason.

The letters of Pascal and his father against Noël, the preface to the treatise on the void, and the writings on the arithmetic machine all placed emphasis upon Pascal's maturity. This commonality demonstrates, in part, the way that Pascal and his circle defined themselves as savants. The development of legitimate learning, they believed, required improving on natural inclination. Neither inborn talent nor the intellectual instinct of *ignorants* sufficed to attain "perfection" in a discipline, whether in music, geometry, mechanics, or physics. A "perfect musician" may have natural talent, but few of the musically gifted reached perfection. The geometrical *wunderkind* produced disciplined work in order to be recognized in the Parisian mathematical academy. The inventor of the arithmetic machine, through his efforts at the frontier of theory and practice, blazed a trail through "a field . . . strewn with thorns."[234] The natural philosopher, "with very much expense, pain, and time," re-created nature's processes and organized them to reveal truths about the universe.

This period of Pascal's life demonstrates that childlike characteristics continued to be central to Pascal's identity. Blaise's illness and his history as the protégé of the Mersenne group helped reinforce relations of dependency. While this had the potential of undermining Pascal's assertions of full-grown maturity, his father transformed it into another device for legitimacy by characterizing his son's innocent approach to disputation with Noël as maturity's hallmark. The tension between dependency and assertion is also displayed in the ambiguous relationship between Pascal and the artisans, with Pascal creating clear contrasts yet still relying on the

[234] "[J]'ai osé tenter une route nouvelle dansun champ tout hérissé d'épines," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:333.

workers' skill. With the artisans, Pascal had admitted his limitations. He attempted to emphasize the importance of overcoming a "restricted perfection" but the tension remained.

It will be argued in the following chapter that although Pascal portrayed himself as a mature, sophisticated mathematician, in time he had to come to terms with limitations attributed to his work by religious and worldly friends. This transformation unfolded under the continuing influence of earlier roles: the childhood protégé of the Mersenne group and his father's only son. The issue of dependency lingered. Pascal's association with childhood remained multifaceted and tenacious, despite his attempts to distance himself from it. Through his involvement with the religious movement of Port-Royal, however, his views on the relationship between childhood and maturity shifted focus. A new phase of development slowly emerged, a new view of "restricted perfection" that reflected the biblical complementarity of the two poles of age-related virtues. His new identity was "religious savant."

CHAPTER 4
"A MAN BETWEEN . . . ": THE STRUGGLE FOR A YOUNG TALENT (1647-1654)[1]

Pascal returned to Paris from Rouen in 1647 with his sister Jacqueline. By the late 1640s, as we have seen, savants throughout learned Europe knew of Pascal's work. The attempts that he made to justify his position showed some success. He had established his position as savant through his favorable comparison of himself with those of mere natural inclination. But as this chapter will show, by this time Pascal had already begun to reconsider his identity as a mathematician and the status of reasoning, mathematical and otherwise. Chapter 2 shows that Mersenne had viewed the "perfection" of mathematics as a goal in itself and as an effective defense against the threats of the skeptics. This chapter highlights the ways that Jansenism provided resources whereby Pascal came to understand the limitations of the field of mathematics. Meanwhile, his status as a mathematical savant placed him in a position of leadership within the Le Pailleur Circle, which continued the work of Mersenne. This chapter claims that Pascal's father's friends supported his continued efforts in mathematics as the best use of his natural talent and as a continuation of the hopes they had for him when he was young. But Pascal's new religious influences suggested that he needed to lay aside the expectations of his earthly childhood and to assume his position as a child of God. When he accepted the "vocation" of the religious devout instead of the "*métier*" of mathematician, Pascal had to embrace the humility of the child while continuing to exercise the discipline of the savant.[2]

[1] The title is taken from a quotation by the Chevalier de Méré, see below, p. 232, n. 146.

[2] The French *métier* originates in the tradition of manual laborers and designates a particular type of craft.

Encountering the Limits of Savant Pursuits

Experiments on the Void

Part of the genesis of Pascal's questioning of the sufficiency of mathematics probably arose from the controversy of the void. When Blaise began his research into the question in 1646, he left the abstract but logically tight geometrical realm of his *Essai pour les coniques* for the ambiguities of natural philosophy, especially physics [*la physique*]. Doctors, philosophers, and theologians hotly debated the question and Blaise was therefore forced to interact at that level. During the first experiment in Rouen with his father and Petit, Blaise demonstrated his ability to grasp the nuances of the philosophical objections that might be raised. But Pascal's first work on the void (*Experiences nouvelles touchant le vide*) offers only a few comments about the philosophical implications of his experiments. It is difficult, especially within the work's introductory note, "Au lecteur," to distinguish between the voice of the father and the voice of the son. Blaise writes that his consideration of the experiments "confirmed me in the thought that I had always had that the void was not a thing impossible in nature."[3] The statement is a close parallel to Petit's comment to Chanut concerning Étienne Pascal's own prior anti-scholastic belief. The elder Pascal was, Petit wrote in 1646, "for a long time persuaded of this opinion of Hero and several other philosophers," that is, of the existence of the void.[4] It is not surprising, considering Étienne's close supervision of his son's first studies, that Blaise adopted many of his opinions. Moreover, the *Expériences nouvelles* is dedicated to Blaise's father, who

[3] "[E]lle me confirma dans la pensee où i'auois tousiours esté, que le vuide n'estoit pas vne chose impossible dans la Nature, & qu'elle ne le fuyoit pas auec tant d'horreur que plusieurs se l'imaginent," Pascal, *Experiences nouuelles*, "Au lecteur," n.p. [2].

[4] P. Petit to Chanut, 19/26 November, 1646, Mesnard *OC*, 2:354.

probably backed the project financially.[5] Pascal's natural philosophy began as a continuation of his father's.

While the *Expériences nouvelles* is relatively aphilosophical, the seeds of foundational questions about knowledge are clearly present. Within the public forum of the glassworks, he had to interact with individuals about their questions. He tried out different means of persuasion and sought to anticipate the responses of his listeners.[6] His involvement pushed him beyond the safely demonstrative bounds of mathematics into regions of cautious hypothesis, reasoned argument, and intellectual appeal.[7] He had to lock horns with the authoritative presence of "the ancients," instead of merely perfecting them, as he had done in his geometrical work. He had to make arguments for the legitimacy of the augmentation and fundamental correction of accepted ancient views on physics.

Jansenism and the Evaluation of Mathematics

Pascal's work on physics helped introduce a philosophical dimension to his life that would continue to develop during the stormy period between 1646 and 1654. However, he experienced another powerful influence during the same year. For it was in 1646 that the Pascal family met the Deschamps brothers and, through their influence, had a personal experience with the spirituality of Port-Royal.

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[5] This is Mesnard's opinion, Mesnard *OC*, 2:495.

[6] Consider, for example the experiment with the water and the wine, in which he had his auditors predict whether the wine or the water would descend further in the tube.

[7] Pascal's contribution to a method of scientific inquiry has sometimes been described by describing his careful performance of experiments and his unwillingness to accept questionable hypotheses, Dijksterhuis, *Mechanization*, 450-451; Hooykaas, *Fact, Faith, and Fiction*, 347.

Jansenism: the first conversion

In January 1646, Étienne Pascal took a fall on some ice and broke his leg.[8] He required medical care and was in recovery from the accident for three months. Monsieur Pascal hired two talented doctors, the Deschamps brothers.[9] These brothers had been converted to a particular type of spirituality, associated with Cornelius Jansenius, which had an Augustinian emphasis on penance and on the necessity of grace for conversion and Christian living. After their exposure to Jansenism, the brothers had begun to live lives of exemplary piety and to perform acts of charity on behalf of the poor, including the opening of two hospitals in which they cared for the sick.[10] The example of their lives and the books of Jansenist piety that they brought to the Pascals' house prompted the family to consider their need of a new approach to Christianity.[11]

Prior to their association with the Deschamps, the Pascals were far from irreligious. If the accounts of the family members post-conversion are believed, Blaise's life had no hint of libertinage, either morally or religiously. He was "preserved, through a particular protection of

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[8] According to Marguérite Périer, Étienne Pascal was on his way to witness a duel that was about to occur in one of the faubourgs of Rouen, "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1098.

[9] One brother had the title Seigneur des Landes, the other Seigneur de la Bouteillerie, Henri Gouhier, *Pascal et les humanistes chrétiennes* (Paris, 1974), 12. For very brief biographical entries on Adrien Deschamps de la Bouteillerie (dates unknown) and Jean Deschamps des Landes (?-1688), see Frédéric Delforge, "Adrien Deschamps de la Bouteillerie," in *Dictionnaire Port-Royal*, ed. Jean Lesaulnier and Antony McKenna (Paris: Honoré Champion, 2004), 324; Frédéric Delforge, "Jean Deschamps des Landes," in *Dictionnaire Port-Royal*, 325.

[10] "They had from their youth studied perfectly in medicine, in surgery, and in anatomy, in order to not take a chance, by trusting their instinct, of making a mistake, for want of understanding the general rules and the formation of the human body. When these two Messieurs had resolved to give themselves entirely to God, each one of them determined to build a little hospital at the end of their park, where their lands touched one another. M. Deslandes, who had ten children, put ten beds in his hospital, and M. de La Bouteillerie, who had no children, put in twenty," Jacqueline Périer, "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1098; Delforge, "Jean Deschamps des Landes," in *Dictionnaire Port-Royal*, 325.

[11] They were further instructed in their religious devotion by Guillebert, the Jansenist curé of Rouville. For this detailed account of the Pascal conversion, from a verbal family tradition recorded by Blaise's niece Marguérite Périer, see "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1097-1099. Jean Guillebert (1605-1666), met Antoine Arnauld during his studies at the Sorbonne. Arnauld, in turn, placed him in contact with Jean Duvergier de Haranne, the abbé de Saint-Cyran; see Jean Lesaulnier, "Jean Guillebert," in *Dictionnaire Port-Royal*, 495-496.

God, from all the vices of youth."[12] The father Étienne taught him to differentiate between what can be known by reason and what can be known by faith. Étienne Pascal was a virtuous man, though according to Blaise's niece Jacqueline Périer, he did good works out of "a moral virtue, but not at all from a Christian virtue."[13] Through their exposure to Jansenist spirituality, however, Étienne and his family received "true piety."[14]

Jansenism and the question of priorities

An important aspect of Jansenist spirituality was the reevaluation of priorities. While Blaise attempted to establish himself as a geometrical and inventive savant, the Deschamps believed that such knowledge was ultimately worthless. They considered its results (ironically, given Pascal's recent work) as "nothingness and the void" [*néant et le vide*].[15] Nevertheless, as Pascal's niece recounts, the Deschamps were very much impressed by the "beaux talents" that were being misused.[16] They sought to enlist Pascal's mind in the pursuit of pious goals, for it would be unfortunate if he only used it in what they considered the ephemeral productions of mathematics.

The 1646 "conversion" is only one moment in the transformation of his religious perspectives and his way of life. Even the familial accounts of his life mark several key changes. Most scholars accept at least two distinct conversions. The first is the conversion to Jansenism with his family in 1646. The second is the mystical 1654 "Night of Fire," which confirmed for

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[12] "La vie de Pascal," Mesnard *OC*, 1:578. This, of course, further suggests a view of Pascal as being mature, or adultlike, even in his youth, which was generally considered a time of dissolution.

[13] "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1097.

[14] "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1097.

[15] "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1099. It is possible that Marguérite Périer uses this phrase in order to highlight some spiritual connection between Pascal's endeavors in physics and his religious devotion.

[16] "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1099.

him the importance of recognizing the "God of Abraham, God of Isaac, God of Jacob, not of philosophers and *savants*."[17] Many biographers construct a narrative in which the interval between the two consists, in part, of a worldly period, out of which Pascal emerges with the "Night of Fire." I would argue, however, that the period of 1646-1654 was a time in which Pascal was negotiating the terrain of his identity. It was a time of personal upheaval, with his father's death and his sister's determination to enter a convent. He was in a process of choosing a mode of living. It was also a time of uncertainty for the mathematical community of Paris, which lost Mersenne, while the political specter of the Frondes heightened a sense of fear and instability.

During this period, Pascal experienced a variety of tensions that shaped his career. Historians of science have often simplified his career in one of two ways. Some have examined his views of mathematics and natural philosophy and stopped there, thus ignoring the evolution of his ideas about his scientific work. Others have focused attention on his "renunciation" of mathematical work because of his religious conversion. Shunning both of these simplifications, this chapter seeks to highlight the ways that Jansenism provided resources whereby Pascal came to understand the limitations of the field of mathematics.

Pascal had spent his formative years under the influence of those who praised the virtues of mathematics and the life of the savant. He would later write: "From hearing people praise these trades [*métiers*] in our childhood and running down all the others we make our choice."[18] But as an only son of a widower, he had also matured under the strong influence of his father, and while Étienne was "recognized by savants of all of Europe," he was also a public official and a man

[17] "Le Mémorial," Mesnard *OC*, 3:50. A third conversion is also often ascribed to Pascal near 1660, after which he performed no more work in mathematics. My interpretation contests this notion of a third conversion. For further treatment of Pascal's "Memorial," see below, pp. 239-242.

[18] Pascal *Penséés*, ed. Krailsheimer no. 634, 209.

concerned with the future of his family and the strength of his financial assets.[19] Thus, Blaise represented the hope for a Mersennien completion of mathematics, but he also embodied the future of the Pascal family's reputation and material goods. Furthermore, his close relationship with his sister Jacqueline and the evolution of her religious devotion kept Pascal under the questioning influence of Port-Royal's spiritual values. Each of these factors affected the way Pascal viewed his previous work and the relationship between his natural inclinations and his concerted efforts.

Much of Pascal's work on the void occurred after his exposure to Jansenism, and coincided with issues raised by this religious community about learning. The previous chapter focused on ways that Pascal asserted his legitimacy as a savant through these writings and his ability to transcend the limitations that hindered those who relied on ancient authorities. But the later writings on the void demonstrate Pascal's concerns with even more basic restrictions on the reach of knowledge. In particular, the preface to Pascal's planned treatise on the void makes distinct claims regarding the rejection of novelty in theology: "it is necessary . . . to confound the insolence of these rash [ones] who produce novelties in theology."[20] And while he maintains his ability to overcome the "restricted perfection" of natural philosophic hive-building, he admits a higher-order boundary:

> [Theology's] principles are above nature and reason, and, the mind of man being too weak to arrive there through its own efforts, it cannot manage to this high understanding if it is not carried there by an all-powerful and supernatural force.[21]

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[19] "Épitaphe d'Étienne Pascal," Mesnard *OC*, 2: 843. Pascal had been supported by his father's assets during his life and would live from those assets and the investments that he made with them, including his business venture (late in life) of the first omnibuses in Paris.

[20] "[I]l faut . . . confondre l'insolence de ces téméraires qui produisent des nouveatés en théologie," "Préface sur le traité du vide," Mesnard *OC*, 2:779.

[21] Ibid., 2:778-779.

On the one hand, then, Pascal again emphasizes the folly of reliance upon "natural" capacity. In this case, however, he indicates the futility of humanity's attempts to improve upon this ignorance "through its own efforts." The application of mathematical skill cannot bring mature understanding in this realm. Instead, humanity must accept its position as a child and submit to be "carried" to such knowledge by God.

The Boundaries of Orthodoxy: The Saint-Ange Affair

Pascal's critique of religious novelty had roots in his experiences. His preface does not identify the names of those who hold "very many new opinions in theology, unknown to all antiquity, sustained with obstinacy and received with applause."[22] It is likely, however, that one of the individuals that he had in mind was a man named Jacques Forton, also known as sieur de Saint-Ange. Pascal's personal involvement in a controversy involving this theologically novel clergyman exposed him to the pitfalls of attempting to establish theological truths through reason.[23] Saint-Ange's self-proclaimed expertise, and his belief that children could gain theological knowledge by providing them with a prefabricated structure of religious reasoning, jolted Pascal. He was able to recognize and dismiss Saint-Ange's theological errors in part because Pascal had specific views on the acquisition of physical knowledge. In physics, Saint-Ange claimed that knowledge of the natural world was accessible through a process of reasoning from theological truths. The pathway was not one of religious reasoning of well-planned experiments, and the use of mathematical reasoning. Saint-Ange's claim to be dually-learned in theology and natural philosophy could not, therefore, be taken seriously.

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[22] Ibid., 2:779-780.

[23] Because it is the way that most scholars and contemporaries referred to him, as a rule I will employ the name Saint-Ange.

Background to the Conferences

Saint-Ange, a former Capuchin monk who in 1647 anticipated receiving a clerical benefice in Rouen, was the author of works entitled *La conduite du jugement naturel* (1637-1641) and *Discours sur l'alliance de la raison et de la foi,* (1642).[24] In these works, Saint-Ange offered a comprehensive view of the universe through reasoning from theological first principles. He believed that the theological doctrine of the Trinity could be proved through reason and that from this single truth, decidedly less "clear and distinct" than Descartes' *cogito*, all of God's decrees regarding the natural world could be determined. By this means he claimed to know the secrets of the physical universe and purposed to dispense them to enlighten the ignorant.

Saint-Ange arrived in Rouen in early 1647, a year after Étienne's accident on the ice and in the midst of Pascal's continuing work on the void. The primary source for what is known as the "Affaire Saint-Ange" is a document recounting two conferences in which Saint-Ange, Pascal, and two of Pascal's friends participated.[25] The two friends, Adrien Auzout and Raoul du Mesnil (also known as Hallé de Monflaines), were approximately the same age as Pascal and each would be involved with the natural philosophical argument concerning the void.[26] The document that the three young men produced describes the conferences in detail, as a means of

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[24] Jacques Forton, *La conduite du jugement naturel où tous les bons esprits de l'un et l'autre sexe pourront facilement puiser la purité de la science* 2 vols. (Paris, 1637-1641). The work is in two part. For the first part, published in 1637, the author's name is given by the initials "S. D. S. A." This was made more transparent with the publication of Part Two in 1641, which provides the author's name as "Sieur de Saint-Ange Monteard," cf., Jacques Forton, *Discours sur l'alliance de la raison et de la foy* (Paris, 1642). Later there would be even further authorial identity: "M. Jacques Forton, sieur de S. Ange," in Jacques Forton, *Discours sur l'alliance de la raison et de la foi, ensemble les questions de toute la philosophie et de la théologie, répondues par les escoliers de Monsieur de S.-Ange-Monteard* (Paris, 1653). These works are rare, with editions at the Bibliothèque Nationale in Paris. The authorial distinctions, in the case of *La conduite* . . . , may suggest a hesitancy about publishing his opinions under a name by which he was easily identifiable, progressively offering more information.

[25] This document is entitled "Récit de deux conférences ou entretiens particuliers tenus les vendredit premier et mardi cinquième février 1647." The original, preserved by Father Guerrier, is in the Bibliothèque Nationale, Paris, fonds français 12449, 559-595. Citations in this dissertation are from Mesnard *OC*, 2:376-394.

[26] Auzout would later be a member of the Académie des Sciences. Both of these young men corresponded with Mersenne about the void. For this correspondence, see Mesnard *OC*, 2:622-632.

supporting accusations of theological novelty that they brought against Saint-Ange. Despite the main aim of the document, Saint-Ange's natural philosophical opinions, which astonished the young thinkers, are integral to the account.

Saint-Ange's Religious Reasoning

The first shock to Pascal and his friends was Saint-Ange's rejection of experience as the basis of reasoning about the physical universe. He begins his departure from the young natural philosophers' views by questioning connections between causes and effects. He argues that explanations of the effects experienced in the world should be based not on efficient, natural causes but on final causes, the decrees of God: "thus, in order to understand the effects it is necessary to understand the decrees."[27] To ascertain the decrees, he continues, only the doctrine of the Trinity is needed. Saint-Ange portrayed himself as a prophet, to whom God had entrusted this method of finding the truth. [28] According to him, his theological knowledge of the Trinity gave him ultimate mastery over the other "sciences," for they all depended upon that one key principle. He claimed:

> [I]t is necessary to understand the Trinity before having other knowledge [*les autres sciences*], that it was its antecedent and that on this understanding depended his theology and his physics.[29]

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[27] "[D]onc que, pour connaître les effets, il fallait connaître les décrets," "Récit de deux conférences," Mesnard *OC*, 2:376.

[28] Gouhier, *Pascal et les humanistes chrétiennes*, 31.

[29] "[I]l fallait connaître la Trinité devant que d'avoir les autres sciences, qu'elle était son antécédent et que de cette connaissance dépendait sa théologie et sa physique," "Deux conférences," Mesnard *OC*, 2:377. Saint-Ange's use of a single principle from which all the processes of the universe flow reflects a general approach to natural philosophy that focuses on God's omniscience as opposed to his omnipotence, as Margaret Osler has suggested. The omnipotence viewpoint, recognizing God as the ultimate freely acting being, limits itself to the particulars which such a God might produce in Creation. The former, on the other hand, emphasizes God's eternal reason. The natural philosopher could hypothetically discern underlying principles about creation by which predictions may be made.

What seems to have most shocked Auzout, Monflaines, and later Pascal, was that Saint-Ange began his deduction of the nature of the universe with a theological truth that seemed to be the most mysterious one of all: the Trinity. Pascal was not at all opposed to the abundant fruitfulness that a single principle or proposition could have. Mersenne praised Pascal, for example, for his ability to distill the work on conic sections into a single proposition "from which he thus derives 400 corollaries, which do not depend on one another but all on the single proposition."[30] Indeed, Pascal would refer to the figure which embodied this proposition, and was so fruitful for its many productions, as the "mystic hexagon."[31] For Pascal and his mentors, mathematics was a way to imitate the works of the Creator and to plumb the depths of God the geometer. But these efforts to discover the hidden thoughts of God did not extend to understanding the mysteries of God's decrees or of the Trinity.

The record of the conferences illustrates how Saint-Ange's attempt to avoid the truly difficult work of physics by deducing all of it from theology yielded absurd results. Like the artisan of Rouen, who could only create a monstrous machine because of his limitations, Saint-Ange's methods were so faulty that his opinions were ridiculous.

Failure of Saint-Ange's Appeal for Legitimacy

Although it was Saint-Ange's religious claims that prompted the three friends' accusations to authorities, his opinions in physics gave further evidence of how unfounded his claims to learning were. His preposterous natural philosophical claims would have led to his rejection by the three friends, even if his religious opinions were not so peculiar. For Pascal, Auzout, and Monflaines, Saint-Ange's arguments were like the ranting of a silly child. He claimed, for

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[30] Marin Mersenne to Théodore Haak, 18 November 1640, Mesnard *OC*, 2:239.

[31] For a French translation and introductory notes to Leibniz's notes, see Pierre Costabel, "Traduction française de notes de Leibniz sur les 'Coniques' de Pascal," in *L'oeuvre scientifique de Pascal*, ed. Pierre Costabel (Paris, 1964), 85-101. On the mystic hexagram, see especially Harrington, *Pascal philosophe,* 12.

example, that the universe had a certain amount of "masse corporelle" and that all of it eventually had to be united with spirits to make human beings. "[A] geometer," he therefore stated, "could calculate approximately the number of men who ought to be from the beginning of the world until the end."[32] His listeners responded by "turning away in laughter, as much as civility would permit."[33] He also stated an analogy between men and bottles floating in the sea which, when broken, return their common matter to the ocean of universal matter. Once again, the young men were not in rapt awe of his clever comparison. Instead, they sarcastically poked fun at him: "This thought elicited shared laughter, and some pleasant words were said about this comparison between men and bottles."[34] Finally, he claimed that a grown man did not contain more substance than a young child, but only appeared larger. At this, the group "could not keep from laughing at all this strange discourse," an experience which repeated itself when Saint-Ange denied that children received substance from their parents.[35] Thus, Saint-Ange's attempts to impress the three friends by his excited claims of astonishing knowledge backfired. With each new audacious claim they only found more at which to shake their heads and smile to themselves. He was the polar opposite, for them, of the respectable, mature savant.

Saint-Ange also tried to argue that he had the support of savants, much as Pascal did in appealing for a privilege for his arithmetic machine. The sieur de Saint-Ange boasted of the initial incredulity of the audiences in Paris who had eventually been converted to his views,

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[32] "Il dit donc ensuite de cela que un géomètre pourrait supputer à peu près le nombre des hommes qui devaient être depuis le commencement du monde jusques à la fin," "Récit de deux conférences," Mesnard *OC*, 2:382.

[33] "[T]ournant en risée, autant que la civilité le pouvait permettre, cette proposition, on lui fit quelques doutes sur cela," ibid.

[34] "Cette pensée excita une risée commune, et on dit quelques mots agréables sur cette comparison des hommes et des fioles," ibid., 2:383.

[35]Ibid., 2:391; in the second case, the group's reaction to Forton's statement is recorded as follows: "Tout cela acheva de surprendre la compagnie, à quoi l'on ne se put empêcher de tourner en risée, autant que la civilité le permettait, tous ces étranges discours," ibid., 2: 392.

including the Augustinian scholars Monsieur Hallier and Hersent.[36] More importantly, perhaps, he also dropped the name of "M. Petit," which likely was Pierre Petit, with whom Pascal first performed the experiments on the void.[37] According to Saint-Ange, after making a public mockery of his philosophy, Petit had been won to his side through argument and the supposed claimed that "he had never heard anything so powerful."[38] Saint-Ange's clearest attempt for legitimacy in Pascal's eyes was his mention of an appearance "in a company at which there was a great deal of to-do made about the said sieur Pascal."[39] While there, he had heard about the latter's recent experiments at Rouen. Pascal was likely significantly chagrined when Saint-Ange claimed that they supported Saint-Ange's unusual views on the behavior of the "masse corporelle" that is discussed above. Saint-Ange had unwisely attempted to equate his learned credentials with Pascal's. From the events that followed, it is clear that Pascal and his friends were not impressed by these references and were hard-pressed to believe that he had received approval for his ideas from authoritative centers of learning.

Knowledge without Effort

Perhaps the most troubling aspect of Saint-Ange's philosophy, however, was his claim that the deep secrets of his "knowledge" could be easily communicated and learned. In his *Discours sur l'alliance de la raison et de la foi*, Saint-Ange argues that at the original creation faith and

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[36] For the career of François Hallier (1585-1659), see Louis Ceyssans, "François Hallier,"*Bulletin de l'Institut Historique Belge de Rome* 40 (1969): 157-264. Charles Hersent (?-1660) is described as "un enfant infidèle" of the Oratorians in Pierre Feret, *La faculté de théologie de Paris et ses docteurs les plus célèbres*, vol. 5 (Paris, 1907): 343-352.

[37] Henri Gouhier, Jean Mesnard, and Michel Le Guern all agree that it is to this Petit, and not to a Petit who was a theologian, as Brunschvicg and Urbain had claimed. Gouhier writes: "connaissant les recherches des Pascal sur le vid . . . , il peut juger habile d'ajouter le témoignage d'un homme de science," Gouhier, *Pascal et les humanistes chrétiens*, 141, note 10; Mesnard *OC*, 2:377, note 4; Le Guern *OC* 1:1114, note 3.

[38] "Récit de deux conférences," Mesnard *OC*, 2:377.

[39] "[Il] dit qu'il avait entendu parler de cette expérience [du vide] à Paris, devant que de venir en cette ville, en une compagnie où on avait fait très grand état dudit sieur Pascal," "Récit de deux conférences," ibid., 2:382.

reason had a "marriage" that allowed for perfect knowledge of the world and of God. This was the state of knowledge of the first man. When sin entered the world, however, the union between faith and reason was dissolved. It is this "fatal dissolution" [*funeste dissolution*] that caused the difficulties of attaining true knowledge.[40] This original union may be restored by simply asking God for wisdom. And although Saint-Ange emphasized that the human beings' request constituted "working" to attain wisdom, once it was received learning was extremely easy. For those who, like Pascal, were trained in savant culture, this confounded theological and natural philosophical truth, and clearly represented an invalid and ineffective means of becoming truly learned. Saint-Ange demonstrates this confusion of spiritual and intellectual maturity by illustrating his point through the examples of Saint Catherine, Saint Teresa, and the originally unlearned and ignorant twelve apostles. For Saint-Ange, maturity and learning were attained through a method that restored the original state of Adam, who was "born" fully-grown. Even a child could attain maturity in knowledge of religion and other sciences if a proper method was followed.

Saint-Ange thus sought to "catechize" children in his system in an attempt to amaze others with a maturity gained with ease and which lifted children to a position of intelligence, understanding, and even expertise that was far beyond their years. His goal was both scientific and religious pedagogy. The purpose of Saint-Ange's *Discours sur l'alliance de la raison et de la foi* was to make clear his "plan of having his Scholars have an experience of a short and easy

[40] "C'eust esté là l'heureux estat de tous les esprits, si ce diuin mariage [entre raison et foy] eust esté indissoluble tout à fait, mais comme Dieu ne l'auoit fait qu'à condition que la liaison n'en dureroit que iusques à la mort d'vn des deux mariez, le memse moment qui vid le peché des Anges & des hommes en vid vne funeste dissolution," Forton, *Discours sur l'alliance*, 26.

method that God had given to him to teach the sciences of Philosophy and Theology."[41] He explicitly claims that he has the shortcut to knowledge that Pascal decries during this period:

> If [his method] finds complete minds [*esprits*] & [those] in which the judgment is solid, it produces fruits as ripe as one could pluck from them through great and long work.[42]

Saint-Ange believed that he could demonstrate the success of this "easy" method through a trial before learned individuals. According to the preface of the work, Saint-Ange's group of young scholars thoroughly impressed the attendees of the Viscountess d'Auchy's academy. Allowing those present to question these youngsters, they "responded beyond what one could hope from the little time that they had spent with him [Saint-Ange]."[43] The language used here is strikingly similar to admiration of Pascal as a savant, learned beyond his years, suggesting Saint-Ange had created child prodigies through his method.

By contrast Tallemant des Réaux, in one of his *Historiettes*, narrates a much less admiring scene of a very similar gathering featuring Forton and his charges. He interprets Saint-Ange's work teaching children philosophy and theology as like that of an animal trainer:

> In order to finish the history of the academy of the Viscountess d'Auchy, I will say that l'Esclache, who gives philosophy in French, spoke there often. That made one named Saint-Ange (who proved, according to his claim, the Trinity by natural reason, and who whistled for young children on Philosophy and Theology, and made them respond in return in French), to want to introduce himself also among the Viscountess. Several persons, men and women, went to hear these parrots; but M. de Paris, having by chance some business

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[41] "[Son] dessein de faire voir dans ses Écoliers une expérience d'une méthode courte et facile, que Dieu lui a donné pour enseigner les sciences de Philosophie et de Théologie," Forton, *Discours sur l'alliance*, preface, quoted in Gouhier, *Pascal et les humanistes chrétiennes*, 31.

[42] "Si elle [ce méthode] trouue des esprits faits & dont le iugement soit solide, elle y produit des fruits aussi meurs qu'o[n] en puisse cueillir, par de gra[n]ds & de lo[n]gs trauaux," Forton, *Discours sur l'alliance*, 40. The "fruits of labor" analogy is a long-standing one, and is used by Pascal in his address to the Parisian academy, see below, p. 227.

[43] Forton, *Discours sur l'alliance*, preface, quoted in Gouhier, 31.

> with the Viscountess, was there one day when Saint-Ange and his little disciples were babbling.[44]

Des Réaux, like Pascal, disapproves of this manner of teaching as merely habituating children like beasts. Philosophy and theology, like the mathematics and physics required for the arithmetic machine, cannot, Pascal believed, be relegated to the beastly realm of mere habit and repetition. The claim that one may become savant without the requisite effort was a betrayal of intellectual order. And like the Rouennais artisan, the theological and philosophical adepts created through Saint-Ange's accelerated course were counterfeit. François du Verdus, using the metaphor of des Réaux, links such "natural" approaches to knowledge with the rejection of geometry:

> These philosophers who belong to certain schools, I mean these sophists, or rather, these parrots who have been whistled into their cages, without ever thinking about the intentions of the pedants, their masters, who have beguiled them into captivity in order to keep them for a long time under their rods, these people hate a philosopher who is a geometer more than one can imagine.[45]

The unthinking students of Saint-Ange, mere "babblers," thus paralleled Pascal's blind groping clockmaker from Rouen. They may indeed have had the capacity to vocalize reasoning that sounded learned beyond their years. However, the ridiculous natural philosophical views and the dangerous doctrines revealed during Saint-Ange's meeting with Pascal and his friends revealed the monstrosity of their education, both from the standpoint of a mathematician and from that of an adherent of Jansenist spirituality. Pascal was concerned for these children because Saint-Ange boiled religious truth down to a series of propositions. For Pascal, religious

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[44] "Pour achever l'histoire de l'academie de la vicontesse d'Auchy, je diray que l'Esclache, qui monstre la philosophie en françois, y parloit souvent. Cela fit envie à un nommé Saint-Ange (qui prouvoit, à ce qu'il disoit, la Trinité par raison naturele, et qui siffloit de jeunes enfans sur la Philosophie et Théologie, et les en faisoit respondre en françois), de s'introduire aussy chez la Vicontesse. Plusieurs personnes, hommes et femmes, alloient entendre ces perroquets; mais M. de Paris, ayant par hazard quelque affaire avec la Vicontesse, s'y rencontra un jour que Saint-Ange et ses petits disciplines babilloient," Tallemant des Réaux, *Historiettes*, 1: 135-136.

[45] François Du Verdus to Thomas Hobbes, 23 December 1655, in Thomas Hobbes, *The Correspondence, Volume 1: 1622-1659*, ed. Noel Malcolm (Oxford, 1994), 223-224.

truth, unlike physics and mathematics, transcends reasoned statements. Even though theological truth is authoritatively delivered, as Pascal's preface argues, Christianity is primarily about virtuous response to God that cannot be produced through a natural, habitual repetition of words. Saint-Ange's approach was, therefore, dangerous for children's souls. Indeed, Gilberte Périer's account of her brother's involvement in the Saint-Ange affair suggests that he was motivated in his denunciation of the priest by his concern for the children whom Saint-Ange might catechize in his clerical position.[46]

Saint-Ange's approach to knowledge is, in part, an attempt to demonstrate the ease of becoming learned in philosophy and theology. Pascal emphasized the difficulty, time, and effort that his major projects required of him and therefore Saint-Ange's results proved unlearned. However, Saint-Ange's suggestion of a child's ability to be theologically learned beyond his years necessitated a thoughtful response, since Christian teaching commanded childlikeness. In this regard, Pascal had to separate intellectual learnedness from religious devotion. He had to continue to argue for his disciplined learning while recognizing the importance of humble submission in both religion and science. As the rest of this chapter will show, his experiences opened new windows to the relationship between childlike limitations, submissiveness, and the efforts of maturity.

Forging a New Identity: "Une Personne Qui N'est Plus Mathématicien"

Awareness of Limitations

The letter that recounts Descartes' visits to Pascal in 1647 suggests that by that time he was already considering the possible limitations of mathematics. His father's friends, including

[46] "Ils [Pascal and his two friends] voulurent . . . contredire [Saint-Ange], mais il demeura ferme dans ses sentiments; de sorte qu'ayant considéré entre eux le danger qu'il y avait de laisser la liberté d'instruire la jeunesse à un homme qui était dans des sentiments erronés, ils résolurent de l'avertir premièrement, et puis de le dénoncer s'il résistait à l'avis qu'on luy donnerait," "La vie de Pascal," Mesnard *OC*, 1:579.

Roberval, sought the continued preeminence of his scientific and mathematical work. But the letter also indicates that he had begun to shed the notion of mathematics as his *métier*, or "craft," without devaluing its importance. Jacqueline writes in the letter to her sister:

> Say to M. Duménil, if you see him, that a person who is no longer a mathematician, and others who have never been so, kiss their hands to one who is one anew. M. Auzoult will explain all that to you, I have neither the time nor the patience.[47]

No previous communication between Duménil (i.e., Hallé de Monflaines) and Pascal exists, leaving the occasion for this passage in mystery.[48] That the "person who is no longer a mathematician" is Pascal, however, there can be little doubt, as Mesnard affirms. But Mesnard further remarks that this sentence suggests Pascal's desire to "renounce the sciences after his first conversion" in Rouen, and this is perhaps a bit too extreme. To be unwilling to be identified as *merely* a mathematician does not imply that he gave those occupations no value whatsoever. To interpret the line as such perhaps hews too closely to Pascal's earliest biographers by reading into events of the 1640s an attitude toward the world that existed only beginning in the mid-1650s, if indeed it ever did. Nevertheless, Pascal's abandonment of his principal *identity* as "mathematician" is significant.

The letter also recounts the subject of Pascal's conversation with Roberval, which suggests Pascal's continued movement toward a focus on theological matters. On the afternoon of Descartes' second visit, Roberval and Pascal "disputed a long time concerning very many things

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[47] "Dis à M. Duménil, si tu le vois, qu'une personne qui n'est plus mathématicien, et d'autres qui ne l'ont jamais été, baisent les mains à un qui l'est tout de nouveau. M. Auzoult t'expliquera tout cela; je n'ai ni le temps ni la patience," Jacqueline Pascal to Gilberte Périer, 25 September 1647,, Mesnard *OC*, 2:482.

[48] As Auzout is a co-resident of Rouen, and supposed to be able to explain the cryptic sentence, he is the likely source of the anecdote to which Jacqueline refers.

which appertained as much to theology as to physics."[49] The clear interest in new avenues of thought and his unwillingness to be identified as a mere mathematician suggests a move away from a Mersennien view, in which the mathematician's contemplation and proliferation of geometrical propositions was a spiritual work in itself. The influence of Port-Royal helped facilitate a shift in the relationship: from the discipline and exercise of the mathematician to those of the devout believer.

Discovering "Restricted Perfection": Port-Royal Spirituality

In the months following the visit from Descartes, Blaise placed himself under the tutelage of those associated with Port-Royal. In so doing, he continued to encounter criticisms for the scourge of his mathematical talent. In January 1648, Blaise wrote to Gilberte to recount his several meetings with Monsieur de Rebours of Port-Royal. During one of their first conversations, Pascal suggested that he had ideas for writing against the Jansenists' opponents:

> I said to him then that I thought that following the same principles of common sense, one could show very many things that the adversaries [of the Jansenists] say are contrary to it, and that well-directed reasoning leads one to believe them, although it is necessary to believe them without the help of reasoning.[50]

But Rebours discouraged Pascal in his attempt to embark on a project as a religious savant, as one who sought to express his devotion through study and discipline. Rebours believed him to be motivated by an intellectual pride that claimed too much strength for itself. A large part of this suspicion came from the fact that Pascal, although already eschewing the label of

[49] "il parla fort toute la journée, le matin à M. Descartes, et l'après-dînée à M. de Roberval, contre qui il disputa longtemps touchant beaucoup de choses qui appartiennent autant à la théologie qu'à la physique," Jaccqueline Pascal to Gilberte Périer, 25 September 1647, Mesnard *OC*, 2:481.

[50] "Je lui dis ensuit que je pensais que l'on pouvait, suivant les principes mêmes du sens commun, montrer beaucoup de choses que les adversaires disent lui être contraires, et que le raisonnement bien conduit portait à les croire, quoiqu'il les faille croire sans l'aide du raisonnement," Blaise Pascal to Gilberte Périer, 26 January 1648, Mesnard *OC*, 2:555. This project would only finally commence with the 1656 printing of the first of the *Provincial Letters*.

mathematician, was known by Rebours to have been involved in the study of geometry.[51] This suggests that Rebours considered it misguided for geometry to hold a significant place in spiritual exercises.

By meeting with Rebours, Pascal took mincing steps toward submission to Port-Royal and inched away from his early mathematical apprenticeship. He also made an abortive attempt to bring forth a fruitful exercise in defense of a Jansenist position. He was unsuccessful in his attempt to earn legitimacy through exercising "common sense" in the defense of Port-Royal. Instead of convincing Rebours, he reinforced the spiritual director's belief that worldly desires and pride underlay Blaise's religious project. Pascal remained too assertive in spiritual matters. He must be more like a child.

The Coexistence of Childlikeness and Maturity

Blaise nevertheless continued his quest to attain a new level of "learning" in Jansenist piety. In a letter dated 1 April 1648, and co-authored with his sister Jacqueline, Blaise expressed this desire using language that mirrors his arguments in his work on the arithmetic machine and in physics.[52] The beginning of the letter mentions that the two have been reading a letter by Saint-Cyran on "vocation" and through it have reached a new zenith of zeal. Their letter describes in detail the condition of the fallen human being and one's responsibilities toward God. In Pascal's works on the machine and the void, he contrasts the limited skills of the artisans and the "restricted perfection" [*perfection bornée*] of those who yield to ancient authorities with the

[51] Blaise Pascal to Gilberte Périer, 26 January 1648, Mesnard *OC*, 2:555.

[52] The letter is incomplete in the copy made by Father Guerrier and Mesnard assumes this is a result of an incomplete original, Mesnard *OC*, 2:580. Guerrier's copy is preserved in a "Collection particulière," as Mesnard states (labeled "Le Premier Recueil Guerrier"), Mesnard *OC*, 1:309. This copy has been virtually inaccessible to twentieth-century scholars, who do not mention the name of the collection's owner, only a simple statement that it remains in the hands of descendents of Madame de Bellaigue, who received it from Guerrier. Le Guern writes of the letter: "Nous avons localisé le manuscrit, mais sans pouvoir en obtenir la communication," Le Guern *OC*, 2:1097. Mesnard's and Le Guern's publication is based on the original publication in Blaise Pascal, *Pensées, fragments et lettres de Blaise Pascal*, ed. Armand Prosper Faugère, vol. 1 (Paris, 1844), 7-11.

intellectual breadth and efficacy represented by savants in mathematics, physics, and mechanics. While he acknowledges his need for skilled artisans, the character of their productions and the moral degeneracy of their repugnant plagiarism demonstrate their ultimate inferiority. They are wrong to reach higher than their position warrants. The Pascal siblings state that the Christian, however, must accept limitations while reaching beyond his natural state to perfection:

> [T]hose whom God, through regeneration, has graciously retrieved from sin (which is true nothingness, because it is contrary to God, who is true being) in order to give to them a place in his church which is his true temple, after having graciously retrieved them from the nothingness at the point of their creation in order to give a place in the universe, have a double obligation to serve him and to honor him, since as creatures they ought to keep themselves in the order of the creatures and not profane the place that they fill, and that as Christians they ought ceaselessly to aspire to make themselves worthy to take part in the Body of Jesus Christ. But while the creatures which compose the world are acquitted of their obligation by keeping themselves within a restricted perfection, because the perfection of the world is also restricted, the children of God ought not to put any limits on their purity and their perfection, because they take part in a body entirely divine and infinitely perfect; as one sees that Jesus Christ does not at all limit the commandment of perfection, and that he proposes to us a model where it is found to be infinite, when he says: 'Therefore be perfect as your heavenly Father is perfect.' Also it is a very detrimental and very ordinary error among Christians, and even among those who make a profession of piety, to persuade themselves that there is a certain degree of perfection in which one has assurance and that it is not necessary to surpass, since there is nothing at all which would be evil if one stops there, and in which one can avoid falling only by climbing higher.[53]

The Pascals' letter is significant, in part, because the spiritual values it expresses parallel language and ideas similar to those used by Blaise in his interactions with the artisan of Rouen and his preface to the treatise on the void. While the two scientific writings stress the way that one develops skills in the mathematical sciences, the above passage indicates a developing understanding of the characteristics of someone who wishes to "make a profession of piety," to be learned in religion. The parallel expressions of limitation and transcendence provide a

[53] Blaise and Jacqueline Pascal to Gilberte Périer, 1 April 1648, Mesnard *OC*, 2:583.

context in which to consider Pascal's comparison of the *métier* of mathematics with the *vocation* of the religious.

In the first place, the Pascals describe the Christian as having a dual nature. The limited, creaturely nature that resembles the ignorance of a child coexists and yet contrasts with a potential "super-nature" that strives for the maturity of perfection. The creaturely aspect of human existence cannot properly evaluate the physically created world. The one who lacks the "supernatural light of God" cannot attain the transcendent vision and the possibility of perfection that are revealed in creation.[54] Instead, they grope for knowledge with "brutal blindness", but succeed only in the idolatrous substitution of material things, the "images of their liberator," for the reality of God.

The limitations of this natural state parallel the strivings of the artisan of Rouen. The worker, unlike Pascal, lacked "the lights of geometry, physics [*la physique*], and mechanics [*la mécanique*]."[55] The counterfeit arithmetic machine, undertaken without heed to limitations, thus represented an idol. It was "well-filed on the outside," but a nonfunctional, useless monstrosity.[56]

Pascal's genuine creation, on the other hand, mirrors the knowledge of God gained by looking at the world with the help of a "supernatural light." His training in mathematics, physics, and mechanics facilitated his striving for perfection. His recognition that he could not proceed, like the artisans, from "natural" skill alone, kept him from fruitlessly groping in the

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[54] "De sorte que nous devons nous considérer comme des criminels dans une prison toute remplie des images de leur libérateur et des instructions nécessaires pour sortir de la servitude. Mais il faut avouer qu'on ne peut apercevoir ces saints caractères sans une lumière surnaturelle; car, comme toutes choses parlent de Dieu à ceux qui le connaissent, et qu'elles le découvrent à tous ceux qui l'aiment, ces mêmes choses le cachent à tous ceux qui ne le connaissent pas," ibid., 2:582.

[55] "Les lumières de géomètre, de la physique et de la mécanique m'en fournirent le dessein," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

[56] "bien limée par le dehors," "Avis," Mesnard *OC*, 2: 339.

dark. As a result, the machine transcended its physical form and imitated the thought processes of the human mind.

Pascal's writings on the void also mirror the Pascals' statements about the efforts toward perfection made by the Christian who refuses to rest in his natural state. In his preface, Pascal equates trust in ancient authority to unwillingness to improve upon natural inclination. Unlike the beasts, "man is produced only for infinity" and thus can "advance from day to day in the sciences."[57] Furthermore, the ancients are not superior to the moderns because the individual human being can surpass the limitations of his own life span by assimilating the body of experiences recorded by his predecessors. Likewise, as children of God, who "partake of a body entirely divine and infinitely perfect" (i.e., the sacrament of Christ's body), Christians "ought not to put limits on their purity and on their perfection."[58] The Pascals claim the possibility of transcending limitations in an approximation to moral perfection. This contrasts with the "very detrimental and very ordinary error" held even by some "who make profession of piety," that an individual is utterly determined by his natural inclinations.[59]

The movement toward perfection is continuous and gradual, just as Pascal's work on the arithmetic machine had been. "The lights of geometry, physics, and mechanics" enabled Pascal to design his arithmetic machine with reasonable hopes of success.[60] His ultimate success, however, only occurred through "correcting it little by little" and "perfecting it," even to the point of creating "more than fifty models."[61] Similarly, the "supernatural light" [*lumière*

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[57] "Préface sur le traité," Mesnard *OC*, 2:782.

[58] B. and J. Pascal to G. Périer, 1 April 1648, Mesnard *OC*, 2:583.

[59] Ibid.

[60] "Les lumières de la géométrie, de la physique, et de la mécanique m'en fournirent le dessein, et m'assurèrent que l'usage en serait infaillible," B. Pascal to Séguier, 1645, Mesnard *OC*, 2:332.

[61] "Avis," Mesnard *OC*, 2:340.

surnaturelle] enables one to perceive in the world the good images with which God originally filled it.[62] These illuminated images "serve as a continually present lesson," providing correction so that human beings may transcend the imprisonment, blindness, and sin of their natural condition.[63] Like Pascal's approximation of mechanical perfection, spiritual maturity is a continuous process, for "we avoid falling only by rising higher."[64]

There is a resonance, then, between Pascal's vision of the one who is savant in mathematics and the one who is learned in religious devotion. Neither can rest upon natural inclination, but must strive for further but gradual perfection. However, the Pascals' letter of April 1648 places importance on the Christian recognizing his continuous status as a "creature," and not making efforts to rise above that status. True spirituality did not mean simply rising above the limitations of the natural state. It required that strivings for perfection be accompanied by a constant recognition of one's creatureliness and weakness. The Christian, write the Pascals, must be childlike, yet growing to maturity.[65] The intellectual realm was a key area of human

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[62] "[N]ous devons nous considérer comme des criminels dans une prison toute remplie des images de leur libérateur et des instructions nécessaires pour sortir de la servitude. Mais il faut avouer qu'on ne peut apercevoir ces saints caractères sans une lumière surnaturelle; car, comme toutes choses parlent de Dieu à ceux qui le connaissent, et qu'elles le découvrent à tous ceux qui l'aiment, ces mêmes choses le cachent à tous ceux qui ne le connaissent pas," B. and J. Pascal to G. Périer, 1 April 1648, Mesnard *OC*, 2:582.

[63] "C'est pourquoi nous devons bien ménager l'avantage que la bontéde Dieu nous donne de nous laisser toujours devant les yeux une image des biens que nous avons perdus, et de nous environner, dans la captivité même où sa justice nous a réduits, de tant d'objets qui nous servent d'une leçon continuellement présente," ibid.

[64] "[O]n puisse éviter de tomber qu'en montant plus haut," ibid., 2:583.

[65] William J. Bouwsma explores the relationship between the Christian idea of "adulthood" and the imperative to childlikeness in Bouwsma, "Christian Adulthood," in *Adulthood*, ed. Erik H. Erikson (New York, 1978): 81-96. Most of Bouwsm's article focuses on the importance of growth in maturity in both biblical and historical Christianity. But he also explores the paradoxical childlike/mature duality. "[T]he ideal of Christian adulthood is not control but spontaneity," which is related to childhood. Furthermore, "Childhood . . . assumes growth, and it is in this respect fundamentally different from childishness, which rejects it; in this sense childhood is a model for adulthood," ibid., 89. For the Christian adulthood, maturity should be characterized by a "capacity for growth," ibid., 87.

limitation. As the meeting with Rebours had suggested, this was a less-than-subtle indictment of Pascal's early devotion to mathematical perfection.

Pascal's journey toward religious devotion is very closely linked to his relationship with his sister, who seems to have led the way. By the time of the April 1648 letter that the two co-wrote, Jacqueline was already clearly committed to the idea of entering the convent of Port-Royal. The letter is a testimony to the strength of those nascent desires. Later in the year, Jacqueline would seek permission from her father to take a religious retreat at Port-Royal. From their still-extant correspondence, it appears that Étienne was against any such designs.[66] Jacqueline nevertheless persisted and was able to carry out her plan, albeit in hiding. Blaise evidently supported his sister's plan, in her designs, although his father's disapproval would likely have been deeply troubling to his only son. In fact, following Étienne's death in 1651, Blaise opposed the entry of his sister into the convent, at least for a time. It finally took place on 26 May 1652.

Pascal's Continuing Role as Protégé Mathematician

Blaise's own movement toward the rigors of progressing in spiritual expertise was not steady and not without setbacks. He alternately expressed great enthusiasm for it and demonstrated resistance, as his foot-dragging over Jacqueline's vocation demonstrates. These uneven strivings coexisted with continued efforts to improve upon his work on the void and to establish his arithmetic machine as a worthwhile device in the eyes of savants and those in powerful positions. Étienne's friends seconded and encouraged these attempts at self-promotion and thereby probably helped to forestall Blaise's commitment to Port-Royal. His continued

[66] All of the extant correspondence is written from the children to their father. Very little of Étienne's correspondence still exists. One has to wonder, given the care displayed toward Blaise's personal writings, whether Étienne's opposition to the religious ambitions of Blaise and Jacqueline prompted certain letters to be destroyed.

position of apprentice to his original mentors, ironically reinforced his attempts to assert himself in mathematics and natural philosophy, and thus to distance himself from his identification with the natural talent of that childhood.

Influence of the Mersenne Circle

The influence of Pascal's father's friends during this period is suggested in Jacqueline's letter of 25 September 1647, recounting the visits of Descartes. Chapter 3 describes Roberval's attempts to maintain control of the young man's talent against his rival, Descartes. Jacqueline's letter also mentions Dalibray, a companion of Étienne's long-time friend Le Pailleur and a neighbor of the Pascal's. Dalibray spent time with Pascal on the day of Descartes' first visit. By 1653, he had written two adulatory poems to Pascal, encouraging him and praising him in his efforts on the arithmetic machine and in physics.[67] In the sonnet that celebrates the arithmetic machine, Dalibray recognizes the universal attraction his inventiveness should have:

> Your mind [*esprit*] is like unto this second soul
> Which flows everywhere in the world
> And presides over and supplies all that is done there[68]

By substituting his own genius for others' efforts to calculate sums, writes Dalibray, Pascal allowed them to partake of his talents as a mathematical genius. The machine, Dalibray continues admiringly, is "Of a marvelous genius a durable proof."[69] His praise of Pascal's work was a reminder to the young man of his need to pursue the fields to which he was most naturally suited. Dalibray had been recently occupied with the Spanish author Juan Huarte's *L'examen des esprits*, which he translated in 1645, and of which re-editions would be published in 1650

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[67] Dalibray, *Les Oeuvres poétique de Sr Dalibray* (Paris, 1653), 31-33. The poems are entitled, "A Monsieur Pascal le Fils sur Son Instrument pour l'Arithmétique" and "Au Même sur le Vide."

[68] "Ton esprit est semblable à cette âme seconde / Qui va s'insinuant par tout dedans le monde / Et préside et supplée à tout ce qui s'y fait," ibid., 31.

[69] D'un merveilleux génie une preuve durable," "Sur son instrument pour l'arithmétique," ibid.

and 1655. Huarte (1530-1592) insisted that an individual should not divide his efforts but give himself to the bent of his *esprit*. The thought of encouraging Pascal to make focused use of his mathematical mind may have been a contributing motive in Dalibray's poems about Pascal.[70]

On the afternoon of his first meeting with Descartes, Pascal asked Dalibray to inform Le Pailleur to let his drinking companion know of the planned second meeting with Descartes that would occur the following morning.[71] Étienne Pascal was the friend to whom Étienne had gone when he discovered Blaise's mathematical genius. He would also take up Mersenne's mission at the latter's death in 1648.[72] Pascal's request and the presence of Dalibray and Roberval drive home his continued tendency to consult with his father's friends. They visited his home even during the time when Étienne did not live in Paris. Pascal continued to have respect for his father's friends and they had an unyielding influence over his life. Their expectation was that he would continue the work he had begun in his youth.

Pascal's close contact with members of the savant community would have been a strong reinforcement to Pascal as he pursued recognition for his work. These designs would have been only further strengthened, and the religious ones moderated, by Étienne's return to a life in Paris from Rouen beginning in August 1648.[73] Étienne's acerbic attack on Father Noël at the beginning of 1648, discussed in Chapter 3, proves his interest in his son's reputation as a savant.

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[70] Huarte's influence on seventeenth-century thought was significant. Michel Le Guern highlights Huarte's influence over Bacon and Jansenius regarding the soul's faculties, Le Guern *OC*, 1:1095. See also, Pérouse, *L'examen des esprits . . . :sa diffusion*. For further treatment of this subject, including remarks on Pascal and Huarte, see Jean Molino, "L'éducation vue à travers *L'examen des esprits* du docteur Huarte," in *Le XVIIème siècle et l'éducation: colloque de Marseille* (Marseille, 1971), 105-115.

[71] The close relationship between Dalibray and Le Pailleur is explored in Pintard, *Libertinage érudit*, 349.

[72] Marolles mentions Le Pailleur's "Academie," in Marolles, *Mémoires de Michel de Marolles*, 272. Mesnard establishes Le Pailleur's academy as the direct continuation of Mersenne's through the mid-1650s, Mesnard, "Pascal à l'Académie Le Pailleur," 7-16. Tallement des Réaux gives a brief description of Le Pailleur, with some episodes from his life, in Des Réaux, *Historiettes*, 2: 99-101.

[73] Étienne was not irreligious, but we have already seen his opposition to Jacqueline's entry into Port-Royal. He would probably also have opposed a move toward a closer relationship between Blaise and the Jansenists.

The letter was written about the same time as Blaise's letter to Le Pailleur defending his silence. Le Pailleur had written to Pascal, concerned about the damage his silence would cause. Both reactions to the Father Noël situation underscore the perceived importance of reinforcing Pascal's reputation as a precocious talent in mathematics, in physics, and in moral character.

Buoyed by the support and endorsement of his father's old friends, including Mersenne, Roberval, Le Pailleur, and Dalibray, Pascal pursued projects that demonstrated his legitimacy in mathematics and physics. In 1649, he was finally awarded a privilege for his arithmetic machine. It strengthened the reputation that Pascal had for "capacity in several sciences, and especially mathematics." Furthermore, it gave an official royal endorsement and expressly sought "to excite him to communicate more and more of the fruits of it to our subjects." [74]

Pitching the Pascaline and Himself: The Letter to Queen Christina

In 1652, Pascal promoted his work further by presenting it to Queen Christina of Sweden, a great supporter of learned science in the seventeenth century. Pierre Bourdelot, through whom Pascal presented his machine to Prince de Condé in 1644, also managed to introduce it to the queen.[75] In a letter to Queen Christina about the machine, Pascal draws on the language of two "empires" of greatness: one of political power and the other of savant intelligence. Christina, Pascal claims, embodies them both. By the way that he describes the relationship between the

[74] "Privilège pour la machine arithmétique de M. Pascal," Mesnard *OC*, 2:713.

[75] Pierre Bourdelot (1610-1686), personal physician to the Prince de Condé and later of Queen Christina, was labeled as an exemplar of seventeenth-century "libertinage érudit" in Pintard, *Libertinage érudit*, 219-220, 353-355. Bourdelot had organized an informal academy that met at the home of the Prince de Condé sometime during the early 1640s. With his move to Sweden, this Parisian academy was suspended, but resumed in 1664 with his return, continuing until his death. Pascal may have visited this academy, especially as Bourdelot was one of those who addressed the question of the void, René Pintard, "Autour de Pascal: l'Académie Bourdelot et le problème du vide," in *Mélanges d'histoire littéraire offerts à Daniel Mornet* (Paris, 1951): 73-81. On the Académie Bourdelot and its relationship to the Académie des Sciences, see Taton, *Les origines de l'Académie des Sciences,* 16-17, 28. Some of the conversations held at the later meetings are published in Gallois, *Conversations Académiques tirées de L'Académie de Monsieur l'Abbé Bourdelot*, 2 vols. (Paris, 1674).

two empires and the queen's place within them, Pascal expresses thoughts that also apply to his life, especially the relationship between inborn traits and disciplined endeavor.

In his letter to her, Pascal praises Queen Christina. She is a special individual who combines temporal power and strength of mind. She received her position as queen not because of any virtue, but through the natural process of birth. On the other hand, Pascal emphasizes that intellectual prowess does not come, as some claim, "through birth or through fortune," as can the power of earthly rulers. Instead, it "is imparted and preserved through merit."[76]

Although throughout the letter Pascal takes the expected role of the dependent, submissive, and inferior servant, he strategically manages to stress his own concerted exercises in the realm of the mind.[77] For example, he reminds the queen of "the pain and the time that new productions cost, especially when inventors want to bring them to their final perfection."[78] In another place, he characterizes his work as a "great effort of mind."[79] He thus communicates to the queen that he is not devoid of the merits of learning.

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[76] "Ce second empire me paraît même d'un ordre d'autant plus élevé que les corps, et d'autant plus équitable qu'il ne peut être départi et conservé par le mérite, au lieu que l'autre le peut être par la naissance ou par la fortune," Blaise Pascal to Queen Christina of Sweden, [June 1652], Mesnard *OC*, 2:924.

[77] Pascal's expressions of Christina's power highlight his own sense of the importance of savant accomplishments: "Reign therefore, incomparable princess, in an entirely new manner; let your genius subjugate all that is not submitted to your arms . . . . For me, not being born under the first of your empires, I want the world to know that I glory to live under the second; and it is to testify of it that I dare to raise my eyes to my queen, giving to her this first proof of my dependency. It is this, Madame, which has inclined me to give this present to Your Majesty, although [it is] unworthy of her. My weakness has not astonished my ambition. I figured that even though the mere name of Your Majesty seemed to distance from itself all that is disproportionate to it, it nevertheless does not reject all that is inferior to it; otherwise its greatness would be without homage and its glory with eulogies. It is content to receive a great effort of mind, without requiring that it be the effort of a mind as great as hers. It is through this condescension that she deigns to enter into some communication with the rest of men," B. Pascal to Queen Christina, Mesnard *OC*, 925.

[78] "Votre Majesté n'ignore pas la peine et le temps que coûtent les productions nouvelles, surtout lorsque les inventeurs les veulent porter eux-mêmes à la dernière perfection," ibid., 2:923.

[79] Ibid., 2:925.

Pascal sought Christina's recognition of his machine, which would provide him with the backing of power and perhaps financial support.[80] In praising her characteristics, he created an indirect parallel with himself. He had been a young man talented beyond his years and Christina was "a young queen, in whom the advantage of *expérience* is brought together with the tenderness of age," who thereby "furnishes to the universe this unique example which it lacked."[81] Pascal's desire to make a place for himself within the world of the best minds is thus expressed in his praise for the queen who might be able to lend temporal legitimacy. If she wondered whether he had the wherewithal to contribute significantly to science, his machine would be the proof. In addition, she could take the word of Bourdelot, the queen's personal physician and one of Pascal's old acquaintances:

> You are the clearest and most penetrating mind I have ever seen. With the diligence that you have for work, you will surpass both the ancients and the moderns, and will leave to those who follow you a marvelous ease of learning.[82]

Nothing certain is known of the queen's reaction to Pascal's letter and his machine. But Pascal's verbal and physical offerings reveal a man whose desire to be recognized as a mature savant was not yet utterly satisfied.

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[80] Queen Christina's patronage extended to intellectuals and artists, including René Descartes (whose death in 1650 has been attributed to Christina's demands for early morning philosophical discussions) and Gian Lorenzo Bernini. Lilian H. Zirpolo, "Christina of Sweden's Patronage of Bernini: The Mirror of Truth Revealed by Time," *Women's Art Journal* 26 (2005), 38-43, provides an overview of intellectual patronage and an in-depth look at the patronage of Bernini. Bourdelot encourages Pascal about the possibility of the queen's support: "vous êtes un de ces génies que la reine cherche," Pierre Bourdelot to Blaise Pascal, 14 May 1652, Mesnard *OC*, 2:919.

[81] "C'est Votre Majesté, Madame, qui fournit à l'univers cet unique exemple qui lui manquait," B. Pascal to Queen Christina, Mesnard *OC*, 2:925.

[82] "Vous êtes l'esprit le plus net et le plus pénétrant que j'aie jamais vue. Avec l'assiduité que vous avez au travail, vous passerez également les anciens et les modernes, et laisserez à ceux qui vous suivront une merveilleuse facilité d'apprendre," Bourdelot to B. Pascal, 14 May 1652, Mesnard *OC*, 2:919.

Defending Work on the Void

Pascal also sought to promote and protect his work in physics. In late 1647 Pascal commissioned his brother-in-law to perform the barometric experiment on the Puy-de-Dôme around the same time that he was pursuing his interviews with Rebours at Port-Royal. Further writings in physics, including an unfinished work on the void and two other treatises that remained unpublished until after his death (*Traité de l'équilibre des liqueurs* and *Traité de la pesanteur de la masse de l'air*) followed in the ensuing years.[83] The subject of the void and its expansion to the question of the weight of the air became one of the hot topics of natural philosophy in the French capital and was the subject of most widespread interest among Pascal's former mentors. It particularly occupied Mersenne and Roberval, who devised and performed different experiments.[84] As news of the work being done in Paris spread throughout learned Europe, Pascal's priority and originality were challenged. He countered by emphasizing not only his hard work and effort, but also his virtue.

One of the key purposes of Pascal's *Expériences nouvelles touchant le vide* was to secure the results of his experiments against the unvirtuous. Like the artisan of Rouen, they could attempt to profit from his work even though they were not as knowledgeable and had not expended the efforts that he had:

> Having made these experiments with very much expense, pain, and time, I was afraid that another who has not employed neither time, money, nor pain, anticipating me, would give to the public some thing that he had never seen, and which consequently he could not

[83] Mesnard calls the unfinished work "Fragment d'un *Traité du Vide*." The text is in Mesnard *OC*, 2:787-798.

[84] Mersenne continued to procure tubes from Rouen through Hallé de Monflaines and Adrien Auzout. Furthermore, he tried to commission Jacques Le Tenneur to perform the experiments on the Puy de Dôme that Pascal had envisioned. Roberval recounts a number of experiments that he performed on the void in his *Narratio* to Desnoyers.

> report with the exactness and the order that are necessary in order to recount them as is required.[85]

Likewise, in his *Récit de la grande expérience*, he emphasized how the virtue of his method contrasted with that of the opponents of his interpretation of the void. His method consisted of the "little by little" distancing from the ancients through the "force of the truth" and the "evidence of *expériences*" that uncover the "hidden truths" of nature.[86] His opponents espouse "chimerical causes" for the apparent void, which "serve only to cover the ignorance of those who invent them."[87] To be virtuous in natural philosophy requires hard work, not vain invention.

Pascal versus the "ignorant": correspondence with Ribeyre

Pascal displayed his defense of virtue in a number of different writings between 1648 and 1654. A particularly vigorous example appears in his response to writings by Father Médaille, a Jesuit at the college of Clermont. On 25 June 1651, Médaille sustained theses at the college regarding the experiments on the void, and dedicated these theses to Monsieur de Ribeyre, President of the Cour des Aides in Clermont-Ferrand, Pascal's natal town.[88] Médaille raised the accusation, which had already been circulating, that Pascal had claimed Torricelli's experiments for himself. In an initial letter to Ribeyre, Pascal cites his relationship with the savants of Paris

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[85] "[A]yant fait ces expériences avec beaucoup de frais, de peine et de temps, j'ai craint qu'un autre qui n'y aurait employé le temps, l'argent, ni la peine, me prévenant, donnât au public des choses qu'il n'aurait pas vues, et lesquelles par conséquent il ne pourrait pas rapporter avec l'exacteté et l'ordre nécessaire pour les déduire comme il faut," Pascal, *Experiences nouuelles*, "Au lecteur," n. p. [5].

[86] "Ie ne le fais qu'en cedant à la force de la verité, qui m'y contraint. I'ay resisté à ces sentiments nouueau, tant que i'ay eu quelque pretext pour suiure les anciens . . . . Aussi ie ne les ay quittées que peu à peu, & ie ne m'en suis esloigné, que par degrez," Blaise Pascal, *Recit de la grande experience de l'equilibre des liqueurs* (Paris, 1648), 19. Pascal's reference to "les veritez cachées" is in the paragraph which precedes, ibid.

[87] "Il en est de mesme de l'antiperistase, & plusieurs autres causes Chimeriques, qui n'apportent qu'vn vain soulagement à l'auidité qu'ont les hommes, de connoistre les veritez cachées, & qui loing de les descouurir ne seruent qu'à couurir l'ignorance de ceux qui les inuentent, & à nourrir celle de leurs sectateurs," ibid., 18-19

[88] The author of a manuscript attributed to a "M. Lamy" gives the name of the Jesuit as Jean-Paul Médaille, the younger brother of Jean-Pierre Médaille, the founder of the Sisters of Saint-Joseph, who spent most of his adult life of ministry in Clermont and the surrounding towns of Auvergne. No traces of the theses written by P. Médaille have been found, as Mesnard notes, Mesnard *OC*, 2:804, note 1.

and those of Clermont, and claims that they may attest that "I have never failed to say that this *expérience* came from Italy, and that it is of the invention of Torricelli."[89] He does not stop at defense. He reiterates his legitimate claim to learning in physics by recalling the efforts of numerous learned individuals to spread his *Expériences nouvelles* throughout Europe. Mersenne, for example, "not being content to see it all over France, asked me for several [copies] to send them, as he did, to Sweden, Holland, Poland, Germany, Italy, and in all directions."[90]

With the support of well-known savants, Pascal had given his self-defense and produced evidence of renown. Having established this, he questions Médaille's legitimacy in learned matters because of his evident ignorance of the *Expériences nouvelles*, and thus Pascal's public acknowledgment of the Torricelli experiment:

> Thus I believe that this good Father of Montferrand is the only one among the curious of all of Europe who has not had knowledge of it. I do not know through what misfortune, unless it is that he flees the commerce and the communication of savants, for reasons I cannot fathom.[91]

Pascal therefore suggests the importance of being a part of learned correspondence networks for claims to learning. In support of this criterion, Pascal adds later that if Médaille had "a little more commerce with Paris" he would understand that it would be as absurd for him to claim credit for the invention of the mercury experiments as it would be to claim that he invented the telescope.[92]

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[89] "[J]e n'ai jamais manqué de dire que cette expérience est venue d'Italie, et qu'elle est de l'invention de Torricelli," Blaise Pascal to Ribeyre, 12 July 1651, Mesnard *OC*, 2:806.

[90] "Et enfin le P. Mersenne, ne se contentant pas d'en voir par toute la France, m'en demanda plusieurs pour les envoyer, comme il fit, en Suède, en Hollande, en Pologne, en Allemagne, en Italie et de tous les côtés," ibid., 2:809.

[91] "De sorte que je crois que ce bon Père de Montferrand est le seul entre les curieux de toute l'Europe qui n'en a point eu de connaisance. Je ne sais par quel malheur , si ce n'est qu'il fuie le commerce et la communicatioin des savants, pour des raisons que je ne pénètre pas," ibid.

[92] Ibid., 2:810.

Pascal, endorsed by the savants of France and known by all of learned Europe, offers a striking contrast to Médaille, who was completely unknown in these communities. Indeed, Pascal had never heard of him:

> I do not conceal from you, Monsieur, that I was marvelously surprised to learn that this Father, whom I do not have the honor of knowing, of whom I do not know the name, that I have no memory of having ever seen whatsoever, with whom I have nothing at all in common, neither directly, nor indirectly, nine or ten months after I left the province, when I was distanced from it by one hundred leagues, and when I think of nothing less, has chosen me for the subject of his discussion.[93]

In addition to being unknown by the great minds of Europe, Pascal suggests that Médaille does not even know the work of the most important thinkers of the time. Pascal admits no such ignorance. He cites Roberval, "professor of mathematics, who used my book as an indubitable proof" against Valerian Magni, the Polish Capucin who claimed to have repeated the Torricelli experiment prior to Pascal.[94] If the Jesuit does not know the work of Roberval, who happens to be Pascal's close friend, he certainly does not deserve a hearing. In fulfillment of the hopes of Mersenne for a "new Archimedes," Pascal seeks to "impose an eternal silence" on one who is ignorant of geometry:[95]

> If this Jesuit Father of Montferrand knows M. de Roberval, it is not necessary that I accompany his name with the praises which are due him, and if he does not know it, he

[93] "Je ne vous cèle point, Monsieur, que je fus merveilleusement surpris d'apprendre que ce Père, que je n'ai point l'honneur de connaître, dont j'ignore le nom, que je n'ai aucune mémoire d'avoir jamais vu seulement, avec qui je n'ai rien du tout de commun, ni directement, ni indirectement, neuf ou dix mois après que j'ai quitté la province, quand j'en suis éloigné de cent lieues, et lorsque je ne pense à riens moins, m'ait choisi pour le sujet de son entretien," ibid., 2:805.

[94] "M. de Roberval, professeur aux mathématiques, qui se servit de mon imprimé comme d'une preuve indubitable," Mesnard *OC*, 2:811. In the discussion of Roberval, Pascal also drops the name of another savant: "M. Desnoyers, secrétaire des commandements de la Reine de Pologne, homme très savant et très digne de la place qu'il tient auprès de cette grande princesse," ibid., 2:811.

[95] See the discussion in Chapter 2 of the invocation of a "new Archimedes" in Mersenne, *La vérité des sciences*, 750.

> ought to abstain from speaking of these matters, since this is an indubitable proof that he has no entry into high fields of knowledge, neither of physics, nor of geometry.[96]

Geometry overcoming limits

Pascal's letters to Ribeyre demonstrate that virtues and learning go hand in hand. And although by 1651 he had long previously made the claim to be "no longer a mathematician," he continued to appeal to the capacity of mathematics to establish truth and to maintain the exclusionary nature of the mathematical community. In the treatise *L'équilibre des liqueurs*, unpublished during Blaise's lifetime, Pascal points to a particular proof as one that "will be able to be understood by geometers alone, and can be bypassed by others."[97] Those who have not exercised themselves in mathematics are excluded from an important aspect of the argument offered by Pascal. He makes a similar statement with reference to a proof that liquids weigh in proportion to their height and not their width:

> [T]he demonstration of it would be easy, by inscribing in the one and in the other several little regular tubes . . . Those who are accustomed to the inscriptions and circumscriptions of geometry will have no pain to understand that; and it would be very difficult to demonstrate it to the others, at least geometrically.[98]

In both *L'équilibre des liqueurs* and an accompanying treatise entitled *La pesanteur de la masse de l'air*, Pascal presents evidence to show that his explanation of the void is mathematically comprehensible in ways that others are not. The height of the mercury in the tube, he states, is proportional to the amount of air above the basin in which the tube is

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[96] "Si ce Père Jésuite de Montferrand connaît de M. de Roberval, il n'est pas nécessaire que j'accompagne son nom des éloges qui lui sont dus, et s'il ne le connaît pas, il se doit absentir de parler de ces matières, puisque c'est une preuve indubitable qu'il n'a aucune entrée aux hautes connaissances, ni de la physique, ni de la géométrie," B. Pascal to Ribeyre, 12 July 1651, Mesnard *OC*, 2:812.

[97] "Voicy encore une preuve qui ne pourra estre entenduë que par les seuls Geometres, & peut estre passee par les autres," Pascal, *Traité de l'équilibre*, 10.

[98] "Et la demonstration en seroit facile, en inscriuant en l'vn & en l'autre plusieurs petits tuyaux reguliers . . . . Ceux qui sont accoûtumez aux inscriptions & aux circonscriptions de la Geometrie, n'auront nulle peine à l'entendre cela; & il seroit bien difficile de le démontrer aux autres au moins Geometriquement," ibid., 18.

submerged. Thanks to this explanation, he says, there is no longer any need for recourse to explanations (e.g., that nature has a *horror vacui*) that use terms that personify nature. Through mathematical acuity and exercise one moves beyond naive beliefs about nature's passions and transcends the beast-like or childish reliance upon the ancients that Pascal opposes in his preface to the treatise on the void.

A mathematical approach to nature also surpasses the limited knowledge of artisans. Artisans, ancients, and the unsound philosophers who follow them, have ascertained unsound mechanical principles from their own circumscribed experiences. They could not recognize that the created nature that they observed also had limits to its "inclinations":

> All those who have written of these matters have said the same thing; and even all our fountain-makers assure us still today that they will make suction pumps which will draw water to the height of sixty feet if desired.
>
> It is not that Hero, these authors, these artisans, and still less the philosophers, have pushed these tests very far; if they had tried to draw the water only to the height of 40 feet, they would have found it impossible; but it is only because they have seen suction pumps and siphons of six feet, of ten, of twelve, which do not fail to make their effect, and they have never seen that the water failed to ascend there in all the tests that they have happened to perform. In such a way that they did not imagine that there was a certain degree after which it would happen otherwise. They thought that it was a natural necessity, of which the order could not be changed; and as they believed that the water ascended through an invincible horror of the void, they were assured that it would continue to rise, as had occurred with no exception; and thus, drawing a consequence from what they saw to what they did not see, they gave the one and the other as equally true.[99]

[99] "Tous ceux qui ont écrit de ces matieres ont dit la mesme chose, & mesmes tous nos Fonteniers asseurent encore aujourd'huy qu'ils feront des Pompes aspirantes qui attireront l'eau à soixante pieds si l'on veut. / Ce n'est pas que ny Heron ny ces Auteurs, ny ces Artisans, & encore moins les Philosophes ayent poussé ces épreuves bien loing, car s'ils avoient essayé d'attirer l'eau seulement à 40. pieds, ils l'auroient trouvé impossible; mais c'est seulement qu'ils ont veu des Pompes aspirantes & des Siphons de six pieds, de dix, de douze qui ne manquoient point de faire leur effet, & ils n'ont jamais vu que l'eau manquast d'y monter dans toutes les épreuves qu'il leur est arrivé de faire; De sorte qu'ils ne se sont pas imaginez qu'il y eût un certain degré apres lequel il en arrivast autrement. Ils ont pensé que c'estoit une necessité naturelle, dont l'ordre ne pouvoit estre changé; & comme ils croyoient que l'eau montoit par une horreur invincible du vuide, ils se sont assurez qu'elle continuëroit à s'élever, comme elle avoit commencé sans cesser jamais; & ainsi tirans une consquence de ce qu'ils voyoient à ce qu'ils ne voyoie[n]t pas, ils ont donné l'un & l'autre pour également veritable," ibid., 134-135.

The mistake that the ancients, artisans, and philosophers made about suction pumps and fountains arose from their lack of mathematical rigor in the progression from experiences to conclusions. The physical truth about the limitations of water pumps is analogous to the situation of these individuals. They experienced some success in applying their non-mathematical reasoning to physics. However, when one seeks to ascertain a higher level of certainty, such methods lose their efficacy. They can no longer draw accurate consequences from the data of experience.

Pascal's Role in Continuing the Mersenne Circle

The correspondence with Ribeyre, the preface to the treatise on the void, and the two treatises on the weight of the air and its effects, express the gravitational attraction of the Parisian mathematical community for Pascal. He authored all of these writings following the death of Mersenne in September 1648. During the next six years, there continued to be regular meetings of the group's members, but the group experienced other attrition culminating in the death of Le Pailleur in November 1654.[100] The result was an increased sense of necessity for organizing those who had become known as "our geometers." Despite Pascal's new interest in and even pursuit of an exercised and rigorous spirituality, the community that had nurtured him as a young man also continued to have expectations for him. It was during intermittent periods of good health between 1648 and 1654 that Pascal pursued physical and mathematical research. When his health began to revive, Pascal's work even more clearly followed Mersenne's goals for mathematics. Setting forth new connections that multiplied consequences in a number of

[100] Mydorge had died not long before Mersenne, in July 1647, Étienne Pascal died in September 1651, and Desargues had returned to his native Lyon sometime in the mid- to late-1640s to return only sporadically up to his death in 1661. Charles Vion Dalibray died in 1653.

mathematical areas, Pascal approximated to the mathematical state of beatitude and a faithful imitation of the Creator.[101]

The death of Mersenne was a painful loss to the Parisian savant community. Mersenne had been the animating force behind the mathematical conferences of the 1640s. As the "secretary of Europe," he also had an extensive correspondence network that served as a clearinghouse of ideas for the geometers of Paris to consider and as a distribution network for their own work. René Taton, considering the impact of Mersenne's death on the community that would one day become the *Académie des Sciences*, states that Pierre de Carcavy made an effort to take in some of the slack in correspondence. Carcavy's efforts failed to produce as much as he probably hoped. His correspondence had particular personal and philosophical boundaries. Mersenne had been more inclusive.[102] Jacques Le Pailleur's attempt to continue the learned conferences was more successful. Marolles' *Mémoires* testifies that a group gathered every Saturday at Le Pailleur's home "in order to speak of Mathematics."[103] According to Marolles, this regular meeting attracted the members of the core group of Mersenne's original *académie*: Pascal, Roberval, Desargues, and (in fulfillment of Mersenne's prediction of 1635) Gassendi.[104] The mention of other notable savant attendees, such as the

[101] For the importance of discovering "connections" in mathematics as a spiritual exercise, see the chapter entitled "Mathematical Liaisons" in Matthew L. Jones, *The Good Life in the Scientific Revolution: Pascal, Leibniz, and the Cultivation of Virtue* (Chicago, 2006), 89-129.

[102] Taton, *Les origines*, 19-20. Carcavy's failure to fill the gap left by Mersenne foreshadows his inability successfully to promote Pascal's later work on the curve known as the roulette.

[103] Marolles, *Mémoires*, 272.

[104] In his original announcement of his "académie . . . toute mathématique", Mersenne wrote to Peiresc that Gassendi, when he came to Paris, "will see the most noble academy in the world . . . , part of which he will no doubt be, for it is entirely mathematical," Mersenne to Peiresc, 23 May 1635, Mersenne, *Correspondance*, 5:209.

astronomer/mathematician/correspondent Ismaël Boulliau and the English philosopher and geometer Thomas Hobbes, testifies to the strong reputation of the gathering.[105]

It is difficult to assess the extent of Pascal's relationship with the group of savants who met at the home of Le Pailleur until the latter's death in 1654. From the story of the visits of Descartes, it is evident that Le Pailleur was an old family friend and a regular influence in Pascal's life from the time of Blaise's return to Paris in 1647. More concretely, Pascal addresses a summary of his mathematical work to the group. This work, written sometime prior to 1654, refers to the groups as the "learned School" [*erudito Lyceo*] that "sustained me from my youngest years."[106] An examination of this address to the "Illustrious Parisian Academy of Mathematics", and of Pascal's mathematical writings and correspondence of the period, demonstrates that Pascal continued his association with mathematics and his appeal to colleagues in such work. In the mathematical work itself, he exhibits a continuation of Mersenne's project to "perfect" mathematics through the multiplication of propositions and consequences not fully uncovered by the ancients.

Treatise on the Arithmetic Triangle: Continuing Mersenne's Project

Among the mathematical works in which Pascal engaged following his return to Paris is a series of linked treatises unified by the arithmetic triangle. This numerical pattern/figure, often called simply "Pascal's triangle", is made up of a set of rows and columns in which numbers are placed according to a simple rule. The upper left-hand corner of the triangle is occupied by what

[105] See Marolles, *Mémoires*, 272. Du Verdus writes: "We could also tell you something about the Porisms of the Ancients which M. de Fermat has reconstructed; about M. de Pascal's magic numbers; and about the other things which we discuss on Saturday evenings at M. Le Pailleur's house in the rue S. André, where the geometers of this city have kindly invited me," François Du Verdus to Thomas Hobbes, 4 August 1654, in Hobbes, *Correspondence, Vol. 1*, 190. Among those attending the Le Pailleur meetings, Carcavy is a relatively new face among the mathematicians of Paris. He will, like Pascal, have important ties to the Port-Royal community.

[106] "Celeberrimae matheseos academiae parisiensi," Mesnard *OC*, 2:1032.

is called the generator (usually the number 1), and this number is duplicated in the boxes ('cells') immediately to the right and below the generator. The rest of the cells are filled by adding together the number that appears immediately above and to the left of the cell (see Figure 1).[107] Because another set of cells may always be generated from previously determined cells, there is no limit to the size of the triangle. The triangle had been known for some time in its various applications and had a number of interesting properties that related the elements to one another.[108] Pascal provides eighteen "consequences" or ways in which the elements of the triangle are numerically related, in his Latin treatise, *Triangulus arithmeticus*. The French version (*Traité du triangle arithmétique*), completed later, provides nineteen. [109] For example, Pascal shows the number in any cell of the triangle is equal to the sum of the numbers in the preceding column in the rows up to and including its own row.[110] In Figure 4-1, the number in the fourth column from the left, third row from the top is 10. This is equal, as Pascal's consequence has stated, to the sum of the first three rows of the preceding column (1 + 3 + 6).

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[107] The rule for generating the elements of the arithmetic triangle is given as follows: "In the first row: every cell contains unity [i.e., 1] . . . . In the second row: the first cell . . . is unity. The second cell . . . equals the sum of the *first two cells* of the preceding row . . . . The *third* . . . equals the sum of the first three cells of the preceding row . . . . In the third row: the *first* cell . . . is *unity*. The *second* . . . equals the sum of the first *two* cells of the preceding row. . . . The *third* . . . equals the sum of the first *three* cells of the preceding row . . . . In the fourth row: the *first* cell . . . is *unity*. The *second* . . . equals the sum of the first *two* cells of the preceding row .. . . . The *third* . . . , the sum of the first *three* [cells] of the preceding row . . . . Thus, the first cell of any row whatsoever is unity, and any cell equals the sum of the cells of the preceding row, from the coradical to the first inclusively," Pascal, "Triangulus arithmeticus," in Mesnard *OC*, 2:1178-1179.

[108] The best exploration of the manifestations of the numerical patterns of the triangle prior to Pascal is in A. W. F. Edwards, *Pascal's Arithmetical Triangle* (New York, 1987), 1-56.

[109]For the text of the Latin and French versions and the attendant writings considering the application of the triangle, see Mesnard *OC*, 2: 1176-1332. The French version of the treatise on the triangle, with the French and Latin versions of different applications of the triangle were published posthumously, in *Traité du triangle arithmétique avec quelques autres petits traitez sur la mesme matière* (Paris, 1665).

[110] This is the second consequence in the Latin treatise and the third in the French, Mesnard *OC*, 2: 1180, 1290-1291.

Pascal later used the relationships described in this initial treatise on the triangle to develop results relating to the triangle's applications.

1	1	1	1	1	1	1	1
1	2	3	4	5	6	7	
1	3	6	10	15	21		
1	4	10	20	35			
1	5	15	35				
1	6	21					
1	7						
1							

Figure 4-1. Arithmetic Triangle as presented in Pascal's treatise[111]

Multiplication of connections

In a recent study that sheds light on the motivations of individuals involved in what is often called the "Scientific Revolution," Matthew L. Jones provides examples of how Descartes, Pascal, and Leibniz use mathematics as a spiritual exercise. When Jones examines Pascal's treatises on the arithmetic triangle, he focuses on the "mathematical liaisons" that Pascal uncovers. Pascal's work on the triangle is, Jones argues, ultimately a matter of the multiplication of the productivity of an idea in various manifestations. In the first place, Jones shows, Pascal sought to explore the many properties of the triangle itself, including the one mentioned

[111] Adapted from Pascal, *Traité du triangle arithmétique*, n. p.

above.[112] But the declaration of these properties was only the beginning of the process of what Jones calls "Pascal's method of varying enunciations."[113]

The key to the fruitfulness of the triangle was that it had applications that went far beyond a numerical pattern. Pascal showed that the triangle could be applied to figurate numbers, combinatorics, probability theory, and binomial expansion. Two examples, figurate numbers and binomial expansion, will suffice to show these applications.

The idea of figurate numbers went back to at least the time of the Pythagoreans.[114] Numbers were associated with particular two- or three-dimensional figures based on the ability to arrange that number of dots in a regular pattern that created that shape. For example, triangular numbers include 1, 3, 6, and 10, while pyramidal numbers include 1, 4, 10, and 20. Pascal articulated the relationship between these figurate numbers and the arithmetic triangle. The third row of the triangle lists all of the triangular numbers, while the fourth row shows all of the pyramidal numbers. The pattern would continue for higher dimensional figurate numbers as well.

Secondly, Pascal showed that the arithmetic triangle could also be used to write out the expansion of a binomial of the form $(a + b)^2$. Pascal shows that the coefficients of this binomial expansion may be found in the $(n + 1)$th diagonal of the arithmetic triangle. That is, for the expansion of $(a + b)^5$, one may find the coefficients in the sixth diagonal of the triangle (i.e., 1 5 10 10 5 1). The production of the expansion, $a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$ provides a simple alternative to a manual method of producing the expansion.

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[112] Jones, *The Good Life in the Scientific Revolution*, 97.

[113] Ibid., 117.

[114] Edwards, *Pascal's Arithmetical Triangle* (Baltimore, 2002), 1.

The key point that Jones argues about Pascal's work with the arithmetic triangle has to do with the way the discoveries about the applications of the triangle are related to the propositions discovered about the constitutive elements of the triangle. Relationships between the figurate numbers may be ascertained through properties already discovered about the elements of the triangle. This multiplication of "enunciations" is important, as Pascal writes:

> Thus are the propositions multiplied, and not without fruit; indeed different enunciations, although of the very same proposition, produce various uses. This, however, ought to be the study of geometers; indeed those enunciations furnished by this art lead to diverse and great theorems, by connecting propositions which seem entirely alien to the way the first had been understood.[115]

Jones argues persuasively that the mathematical mind that Pascal says is necessary to "turn" these enunciations in different ways is the same mathematical mind that Pascal describes in "De l'esprit géométrique," a mind capable of holding many principles distinct.[116] What is more, Jones concludes, this type of mind is useful for approaching ideas such as space and time that are beyond the scope of mathematical definition and for approaching transcendent theological ideas such as infinity.[117]

Jones makes an important contribution by creating a link between Pascal's work with the arithmetic triangle and with numbers and Christian spirituality. Jones's analysis primarily looks forward to Pascal's works of spiritual apprenticeship, which will follow his November 1654 "Night of Fire." Pascal's mathematical enunciations provide a sense of wonder and

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[115] "Sic multiplicantur propositiones et non sine fructu; variae enim euntiationes, etsi ejusdem propositi, varios praebent usus. Hoc autem studium geometrarum esse debet; ill enim arte aptatae enuntiationes ad diversa et magna ducunt theoremata, connectendo quae omnino aliena videbantur ut primo concept fuerant," Pascal, "Numeri figurati seu ordines numerici," Mesnard *OC*, 2: 1202-1203; cf. a passage of Pascal's "Traité des ordres numériques": "ce sont ces diverses routes qui ouvrent les conséquencces nouvelles, et qui, par des énonciations assorties au sujet, lient des propositions qui semblaient n'avoir aucun rapport dans les terms où elles étaient conçues d'abord," Mesnard *OC*, 2:1329.

[116] Jones, *Good Life in the Scientific Revolution*, 102-106.

[117] Ibid., 117-124.

astonishment, Jones states. The marvelous aspect of these connections breeds respect and prepares the reader for the elements of human existence and religion that surpass human knowledge:

> In his *Provincial Letters* and *Pensées*, Pascal showed that reason could easily expose the paradoxes of the human condition, contradictions that no other philosophy could admit or explain, much less cure. Honest consideration of the best human mathematical and natural-philosophical knowledge should make any reasonable person accept these contradictions, recognize the inability of other philosophies and religions to contend with them, and search in desperation for answers elsewhere.[118]

According to Jones's interpretation of Pascal's mathematical work just prior to his "Night of Fire," he was already pursuing the use of mathematics in service of a religious epistemological agenda. Jones's well-presented argument provides strong evidence for creating some kind of link between Pascal's writings in mathematics and those in religion, an important task for any Pascal scholar. But, considering the tensions and pressures Pascal experienced during the late 1640s and early 1650s about the status of mathematics, it seems difficult to maintain an unruffled continuity between that time and the time that followed his so-called "second conversion."[119] Jones's contributions should therefore be considered together with the continuous influence of the early period of Pascal's life, during which he identified himself primarily as a geometer. Furthermore, they should be evaluated in light of the possibility of geometrical exercise as a spiritual act in itself, rather than a mere preparation for spiritual truths.

Relationship to Mersennien view of mathematics

Pascal could plausibly view mathematics as both spiritual act and as preparation for spiritual revelation. His work on the arithmetic triangle is, in important ways, an extension of the religious view of mathematics articulated in his early mathematical community. As Chapter

[118] Ibid., 132.

[119] This is not to mention that the "Night of Fire" was a significant contributor to Pascal's self-perception, as evidenced by the discovery of his account of it on his person at death.

2 argues, Mersenne, one of Pascal's first mentors, viewed mathematical work as an approximation to a state of heavenly beatitude. Mersenne especially stresses the infinity of mathematical propositions and the generativity of mathematics. In describing the circle in his *La vérité des sciences contre les septiques ou Pyrrhoniens*, he writes:

> [I]f one knew all its properties, and its uses, and all that one could draw and conclude from it, one would know more than all that had ever been written in matter of sciences.[120]

Mersenne focuses in *La vérité des sciences* on the marvelous productions of mathematics in order to confound his opponent, the skeptic.[121]

Mersenne's "Christian Philosopher" in *La vérité des sciences* seeks to impress upon his skeptical conversational partner that the utility and greatness of mathematics is the virtual uncountability inherent in combinatorial mathematics. He calculates, for example, the possible anagrams of a name of a particular length, how many melodies are possible from a specific number of notes, and how many different ways a game of Picquet may conclude.[122] The idea of multiplied "enunciations" is also apparent in Mersenne's interesting claim that "one could represent all that is in the world, and consequently all the sciences by means of Sounds."[123] Similarly, a good enough musician could "explain all the propositions of Geometry through playing any instrument that he would like."[124]

Pascal's treatises on the arithmetic triangle also reiterate Mersenne's emphasis on the generativity of mathematics. Mersenne describes the circle as a simple figure with an infinite

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[120] Mersenne, *La vérité des sciences*, 764.

[121] In this way, Jones's observation of Pascal's desire to create such astonishment is in strong continuity with Mersenne's view of the importance of productivity in mathematics.

[122] Mersenne, *Harmonie universelle*, "Des Chants," 145.

[123] Mersenne, *Harmonie universelle*, Livre premier, "De la nature & de proprietez du Son," 43.

[124] Ibid.

number of marvelous propositions that may be discovered about it. The number one ("unity") likewise produces "all the perfections which are in numbers."[125] It is like God in its simplicity; it is without parts. And it is like him in productivity, able to generate infinite number of integers through the act of counting. Similarly, the arithmetic triangle's elements are produced through a numerical *générateur*, the element at the apex of the triangle.[126] The rule by which this "generator" creates the elements of the triangle is the ultimate source of the marvelous properties that Pascal states.[127] Pascal's efforts to discover the various interconnecting properties of the arithmetic triangle are thus in sympathy with, and even an extension of, Mersenne's belief in the ability, through mathematics, to "raise yourself to the divine perfections."[128]

Pascal describes his work on the arithmetic triangle in terms that highlight the similarity between his approach as a geometer and Mersenne's spiritual view of mathematics. Pascal argues that the geometer is to work toward "multiplied propositions" in order to find "diverse and great theorems."[129] This articulation of the goals of the geometer is harmonious with Mersenne's understanding of the mathematician as imitating God through the proliferation of propositions. Furthermore, Jones links the discovery of unknown connections in geometry is to discerning relationships in God's creation.

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[125] Mersenne, *La vérité des sciences*, 669.

[126] The arithmetic triangle may begin with any element, but traditionally "1" (unity) is at its apex. Pascal only acknowledges the possibility of other generating numbers in his French treatises. However, he only uses unity in his examples and demonstrations of his propositions. He applies these to other generators in an "Avertissement": "*Si le générateur n'était pas l'unité, il eût fallu multiplier le quotient par le générateur*," "Traité du triangle arithmétique," Mesnard *OC* 2:1299.

[127] The rule for generating the triangle is quoted above, p. 220, n. 107.

[128] Mersenne, *La vérité des sciences*, 669.

[129] Pascal, "Numeri figurati," Mesnard *OC*, 2: 1203.

Pascal also continues to affirm Mersenne's opinion, as he did in his writings on the arithmetic machine, that geometry is a talent that requires not just natural inclination but disciplined effort. Pascal continues thus the passage quoted above:

> Whoever lacking this natural capacity for turning things about, the cultivation of geometry will be thankless; because it is not given, but is assisted, it will suffice to reveal the way through this example.[130]

The key difference between this passage and Pascal's writings on the arithmetic machine is its tone. Whereas his earlier work was primarily an attempt to legitimate himself as a geometer, by the time of his work on the triangle, his need to assert legitimacy had lessened. He had already gained a reputation as a mathematician. Instead, this passage depicts Pascal primarily as an instructor. With the arithmetic machine, he had blazed for himself "a new route in a field entirely fraught with thorns."[131] Now, he provides a means by which others, who are not as learned in geometry, may enter into the proper "study of geometers." Pascal's address to the Parisian mathematical academy under Le Pailleur also provides evidence of his transformation. He concludes the address with an appeal for others to imitate his productivity:

> These are the ripe fruits of our geometry: [they are] fertile and realizing an enormous profit, if in imparting these to you, we receive back certain of yours.[132]

Despite assuming the attitude of instructor in geometrical work, Pascal's treatise on figured numbers continues to acknowledge the important influence of the mathematical community:

> [Y]et my efforts have surpassed my expectation and they allowed me this most general method which I relate, and indeed has been most pleasing even to my friends who are very learned amateurs of universal solutions, and spurred on by them, I sought to obtain a

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[130] "Cui versatile hoc deest ingenium ingratus erit geometriae cultus; quia vero non datur sed juvatur, hoc exemplo viam aperire sufficiet," "Numeri figurati seu ordines numerici," Mesnard *OC*, 2:1203.

[131] Mesnard *OC*, B. Pascal to Séguier, 1645, 2: 333.

[132] "Illi sunt geometriae nostrae maturi fructus: felices et immane lucrum facturi, si hos impertiendo quosdam ex vestris reportemus," "Celeberrimae matheseos academiae parisiensi," Mesnard *OC*, 2:1035.

> general solution, of the pure powers, testing it in view of the general solution of orders and happily enough it fell to my lot to discover it.[133]

Pascal still draws upon the praise of these "savant amateurs" as a means of reiterated legitimacy; but he also recognizes that they are major factors in the choice of how Pascal applies his skills. He has felt himself "pressed" by them, and guided by "their counsel." Clearly, the opinions of some of Pascal's friends at Port-Royal about the uselessness of mere mathematics, had not yet overcome the inertia of Pascal's youthful connection with mathematics.

Worldly Values and the Limits of Specialized Learning

If tension between religious and mathematical values characterizes this period of Pascal life, so does the influence of his 'worldly' acquaintances. One of the uses that Pascal articulates for the arithmetic triangle is for the solution of a problem regarding games of chance. In particular, he considers how to divide the initial stakes when players agree to cease playing before a final outcome is reached. This problem brought Pascal into close correspondence with Pierre de Fermat, and is often considered by historians of mathematics as the birth of modern probability theory.

The worldly background of this problem reflects relationships with a circle of friends more interested in social aspects of life than in mathematics or religion. This perspective, together with the influence of Port-Royal spirituality influenced Pascal's questioning of self-identification as a motivation.

According to Gilberte, Pascal began to engage in diversionary activities under the advice of his doctors, who believed that an excessive use of the mind was to blame for a continued illness of his body. These activities brought him under the sway of individuals outside of

[133] "conatus tamen expectationem superantes eam quam tradidi praebuerunt generalissimam, et quidem amicis meis, universalium solutionum amatoribus doctissimis, gratissimam; a quibus excitatus et generalem potestatum purarum resolutionem tentare, ad instar generalis ordinum resolutionis, obtemperans quaesivi, et satis feliciter mihi contigit reperisse, ut infra videbitur," "Numeri figurati," Mesnard *OC*, 2:1214.

mathematical circles and Port-Royal. In fact, many Pascal scholars refer to the time between approximately 1651 and 1654 as Pascal's 'worldly' period.

The shift in the focus of Pascal's activities is most evident beginning with the death of his father in September 1651.[134] Soon after, Pascal sent a letter to his older sister Gilberte, in which he insists that the death of a Christian such as his father is a happy death and that God's ways, even in such circumstances, are as perfect as they are inscrutable. He does not mourn, he claims, as those who have no hope.[135] Indeed, he states that while he could have benefited from his father's presence for the rest of his life, he was in a much better position to handle the loss than prior to his association with Port-Royal. Despite these testimonies of pious faith, the death began a period that Mesnard claims may be characterized as a "true crisis."[136] He had been deprived of his first master, the one who had overseen his intellectual development and encouraged his work in mathematics and natural philosophy.

To add to the loss of his father, only a year later Jacqueline, who had been living with him to that point, finally entered the Port-Royal convent. Pascal's attempts to forestall that entry, as demonstrated through letters written by Jacqueline, may suggest the pain of the separation or a sense of renewed identity with his dead father, who had also entertained objections to Jacqueline's religious vocation. The upheaval of this time also included the financial pressures attached to safeguarding his father's succession and attempting to find ways to invest his assets. Jacqueline requested her share of the estate to donate to Port-Royal upon her entry to the

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[134] Étienne's death was recorded in a document that was copied by Rochebilière prior to the destruction of records contained in the Hôtel de Ville during the Paris Commune of 1871, "Acte de décès d'Étienne Pascal," Mesnard, *OC*, 2:841.

[135] "But we would not have you ignorant, brethren, concerning those who are asleep, that you may not grieve as others do who have no hope," 1 Thess. 4.13, RSV.

[136] Jean Mesnard, *Pascal et les Roannez*, vol. 1 (Paris, 1965), 169.

convent. Blaise again resisted, only relenting in June 1653.[137] Pascal also attempted to establish his income and status through his leasing of an arcade in the marketplace of the Halle au Blés, his promotion of the machine to Queen Christina of Sweden, and his involvement in the project of the draining of the marshes of Poitou undertaken by the Duke de Roannez.[138]

Pascal's business partner, Artus Gouffier, the Duke de Roannez, was an acquaintance of Pascal from his earliest days of living in Paris. He was in Paris when Pascal returned in the summer of 1653 from some business in Clermont, and had himself recently come to the age of majority for his father's estate. Pascal, as Mesnard states, "seeking a new equilibrium of life" since being deprived of two members of his family, found a true companion in the Duke de Roannez.[139] To characterize the relationship with Roannez as "worldly" in character would be to ignore Mesnard's fine scholarship regarding the piety of the Roannez family and their connection with the Jansenists. However, what originally sparked their connection was the duke's appreciation for the sciences.[140]

It was perhaps as the result of a trip to Poitou with Roannez that Pascal first made the acquaintance of the Chevalier de Méré.[141] This chevalier named Antoine Gombaut (but almost always referred to by his title) is well-know for his characterization of the seventeenth-century *honnête homme*. The idea of the *honnête homme* was a development of Renaissance courtly

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[137] See "Donation de Pascal à Port-Royal," Mesnard *OC*, 2:946-949.

[138] The documents relating to the Hallé au Blés are in Mesnard *OC*, 2:1014-1020, 4:706-709.

[139] Mesnard, *Pascal et les Roannez*, 1: 170.

[140] See ibid., 1: 172. All of the information presented here about the Duke de Roannez is indebted to this definitive work of Mesnard. Mesnard's examination of the relevant documents and consideration of the issues surrounding the relationship with Pascal have been able to generate a truly nuanced portrait, not only of the duke himself, but of the entire family.

[141] Pascal writes to Fermat: "J'admire bien davantage la méthode des parties que celle des dés. J'avais vu plusieurs personnes trouver celle des dés, comme M. le Chevalier de Méré, qui est celui qui m'a proposé ces questions, et aussi M. de Roberval," Blaise Pascal to Pierre de Fermat, 29 July 1654, Mesnard *OC*, 2:1137.

manners and emerged as a key virtue of French gentlemen during the middle of the seventeenth century. The *honnête homme* was defined by skill in social interaction and the ability to converse on a wide range of topics in a winsome way. A notoriously difficult idea to define, *honnêteté* gradually worked its way from a primarily aristocratic culture to that of the intellectual culture at large.[142]

Méré's *De l'esprit* and the Limitations of Mathematics

One of the two writings of Méré that allude to Pascal is *De l'esprit.* This work, which does not mention Pascal's name (but is almost certainly about him) contains an account of a trip that the chevalier took with the Duke de Roannez and with "a great Mathematician" who is almost certainly Pascal.[143] Méré's account, published for the first time only in 1677, provides an anecdote that, if taken at face value, would give Méré the full credit for Pascal's turn from mathematics. According to the chevalier, Pascal's scope of interest at this time, approximately 1653 or 1654, was strictly limited to mathematics: he was "a great Mathematician, who knew only that."[144] Despite Pascal's earlier claims to be "no longer a mathematician," Méré perceives Pascal as an example of a talented individual who did not yet demonstrate the breadth of understanding that the chevalier labeled *esprit*. According to Méré's account of events, through a mere few days of discussion with the chevalier and two friends (including the duke de

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[142] On the notion of the *honnête homme*, see Maurice Magendie, *La politesse mondiale et les théories de l'honnêteté, en France au XVIIe siècle, de 1600 à 1660* (Paris, 1925); Jean Mesnard, "'Honnête homme' et 'honnête femme' dans la culture du XVIIe siècle," in *La Culture du XVIIe siècle: enquêtes et synthèses* (Paris, 1992): 142-159; Emmanuel Bury, *Littérature et politesse: L'invention de l'honnête homme, 1580-1750* (Paris: Presses Universitaires de France, 1996).

[143] Once again, the most in-depth examination of the controversy surrounding the identification of Pascal in this account, the date of the trip, and the scope of its accuracy, is in Mesnard, *Pascal et les Roannez*, vol. 1, part 3, chs. 1-2.

[144] The story was published in *De l'esprit: discours du Monsieur le chavelier de Méré à Madame* *** (Paris: Denys Thierry, 1677). The modern complete works is Chevalier de Méré, *Oeuvres Complètes du Chevalier de Méré*, ed. Charles-Henri Boudhours, 3 vols. (Paris: Fernand Roches, 1930). Future references to the Boudhours edition will be cited as Méré *OC*, [vol #]:[pp. ##]. *De l'esprit* is in Méré *OC*, 2:57-95, and the Pascal story in ibid., 86-88.

Roannez) Pascal was converted from having "neither taste, nor sentiment" to one who was able to apply himself to subjects beyond the realm of his natural and developed talents. Pascal's quick conversion suggests that he was already on the edge at the time of this interaction.[145]

The chevalier's depiction of this episode of Pascal's life provides an interesting foil to Pascal's self-legitimation of his work in mathematics and natural philosophy. It is particularly important as it regards inclination, natural talent, and efforts made to develop that talent. Whereas Pascal raised his own status by pinpointing the limitations and restrictions of others in comparison with his own knowledge in the mathematical sciences, Méré applies the language of limitation to Pascal. And while Pascal downplays the importance of his "inclination" for mathematics, Méré emphasizes the role that such inclination plays in the specialized learning that Pascal represents. He claims that natural talent keeps the efforts of the individual hemmed in:

> There are some people who do certain things by inclination, or by instinct, or by habit, and because they do well these sorts of things without knowing however by what [means] they are good, one believes that they have *esprit*, but when one disorients them, and one draws them away from their talent, one dismisses them immediately: for *esprit* and talent are not of the same nature.[146]

In Pascal's writings on the arithmetic machine, it was the artisans who remained in a beast-like state of instinct and operated only within the confines of habituated learning. But for Méré, this is Pascal's situation. Méré's language of the disoriented specialist echoes Pascal's discussion of the Rouennais clockmaker who, taken away from his mastery of turn and file,

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[145] Peculiarly, part of Méré's description of Pascal is that he was "a man between two ages," [*un homme d'entre deux âges*], ostensibly between the traditional age of "youth" and the age of "maturity," Méré *OC*, 2: 86. Could it be that Méré saw this episode as a defining moment for Pascal, in which he moved to maturity? The hypothesis is too weak to assert more. I have, however, chosen to use this quotation as the basis of the title for this chapter, since is language embodies the position that this chapter seeks to emphasize: Pascal as suspended between devotion and learning, childlikeness and maturity, Descartes and Roberval, etc.

[146] "Il y a des gens qui font de certaines choses par inclination, ou par instinct, ou par habitude, et parce qu'ils font bien ces sortes de choses sans sçavoir neanmoins par où elles sont bien, on croit qu'ils ont de l'esprit, mais quannd on les dépaise, et qu'on les tire de leur talent, on les y renvoye aussi-tost: car l'esprit et le talent ne sont pas de mesme nature," "De l'esprit," Méré *OC*, 2:70.

could only work "gropingly." For Méré, as later for Pascal, mathematics is as much a limited *métier* as is clockmaking.

Méré had challenged Pascal on what he considered the "limitations" of mathematics. For Méré, the limitation of mathematics was a limitation of scope. That is, mathematicians were so focused on abstract principles that they could not be meaningfully engaged in other subjects. Mathematics is, Méré would argue, not ultimately satisfying because it is unable to communicate to a variety of people on a variety of topics. It is this limitation that Pascal would have in mind when he wrote in the *Pensées*: "'He is a good mathematician,' you will say. But I am not concerned with mathematics: he would take me for a proposition."[147]

Another of the limitations of mathematics is the inability of geometry to measure up to the infallibly convincing method Pascal describes in "De l'esprit géométrique." This method has two key principles: "one, to use no term of which the sense has not been previous explained; the other, to never put forward any proposition not demonstrated by already known truths."[148] According to Pascal, not even mathematics is able to adhere to these two rules, since the attempt to define all terms would lead to an infinite regress. Instead, mathematics defines all terms except those "clear and understood by all men."[149] Pascal makes clear, however, that mathematics employs the method that is "the most perfect among men," and that "what surpasses geometry surpasses us."[150]

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[147] Pascal's narrator in this fragment goes on to state: "What I need is an all-around good man [*honnête homme*] who can adapt himself to all my needs generally," Pascal, *Pensées*, no. 605; Brunschvicg, no. 36.

[148] "l'une, de n'employer aucun terme dont on n'eût auparavant expliqué nettement le sens; l'autre, de n'avancer jamais aucune proposition qu'on ne démontrât par des vérités déjà connues," "De l'esprit géométrique," Mesnard *OC*, 3: 393.

[149] Ibid., Mesnard *OC*, 3: 395.

[150] Ibid., Mesnard *OC*, 3: 395, 393.

There is a type of limitation to mathematics that Pascal does not suggest. He never admits in his writing that mathematical reasoning employed according to its rules could yield an incorrect conclusion. The limitations of mathematics, for Pascal, are limitations of scope that do nothing to undermine its basic principles. Méré seems to admit that such incorrect conclusions occur in mathematics by refusing to admit the reasonableness of indivisibles.[151]

Méré, Mersenne, and Pascal on Inclination and Exercise

Méré and Mersenne

Despite the contrast in evaluation of mathematical endeavors, Méré's views on inclination with respect to a *métier*, even mathematics, are not entirely at odds with the views of Mersenne and Pascal. *De l'esprit* resonates with the ideas of both on the necessity of the maturation of natural talent. Mersenne's discussions of inclination, as Chapter 2 argues, emphasize the importance of developing and improving natural talents. Chapter 3 established that Pascal's writings on the arithmetic machine and the void stress development from a childlike state of natural talent to the level of established learning. The chevalier, like Mersenne, is not willing to deny the importance of inclination for success in a particular art or science. For Mersenne, some individuals have a good ear and can perceive the slightest variations in pitch. They are thus more readily able to learn the arts of music. Méré admits the role of nature, while also downplaying it. "There are gentlemen who do certain things by inclination, instinct, or habits" but, he continues, they are unlearned in a more significant sense. Furthermore, he also claims that individuals are

[151] A letter, ostensibly from the chevalier de Méré to Blaise Pascal, gives Méré's objections to Pascal about the possibility infinite divisibility of lines. This letter, probably written after Pascal's death, is in Mesnard *OC*, 3: 353-359.

born with varying degrees of what he calls *esprit* [mind/wit], which is the potential to achieve true learning.[152]

Méré also insists, like Mersenne and Pascal, that there must be development, exercise, and education in order to attain true learning:

> It is certain that the first disposition which renders us capable of understanding, comes to us when we come into the world, it is a present from the Heavens, it is a natural light, which cannot be acquired, but it is augmented, it is clear-sighted, it is perfected, and it is this that we call to acquire *esprit*. For in whatever order of *esprit* that is met, one must not doubt that it can be acquired. If the most naturally clear-sighted is reminded with what sight he regarded the things in his childhood, and that he examines how they appear to him in a more advanced age, could it be put in doubt that he had acquired *esprit*?[153]

Méré and Pascal

Pascal, in his works, stressed his improvement on natural talent and on the "lights" of mathematics, physics, and mechanics through diligent application, expense, and effort. Méré praises those individuals, such as Pascal, who draw from their resources of understanding to seek the perfection of their chosen *métier*. Using the language similar to Pascal's regarding the overcoming of restrictions, he writes:

> [I]n any sort of talent and of *métier*, it is an infallible mark of a little *esprit* that of staying always to a certain degree [of perfection]. All the great men, all the excellent workers, have sought means the most hidden in order to attain to perfection; And the people who are

[152] Méré's idea of *esprit* is intimately linked to the ideal of the *honnête homme*, indicating the ability to interact intellectually across boundaries of particular fields of knowledge. This unified understanding of *esprit* is in contrast with that of distinct types of mind, as articulated by Juan Huarte in *L'examen des esprits*, mentioned previously. Méré seems to differentiate only between *esprits* that "understand things in themselves" and those "of a lazier or more negligent nature," "De l'esprit," Méré *OC*, 2:79. To be of the first type, says Méré, is to truly have *esprit*. In the *Pensées*, Pascal will differentiate between "esprit de géométrie" and "esprit de finesse" and again between "esprit de géométrie" and "esprit de justesse," Brunschvicg, nos. 1-2, Brunschvicg *OC*, 12:9-16. See also Mesnard's response to Jean Molino, "L'éducation vue à travers *L'examen des esprits*," 113. Mesnard points out the connection between Huarte's distinction of *esprits* and Pascal's.

[153] "Il est certain que cette premiere disposition qui nous rends capables d'entendre,, nous vient quand nous venons au monde, c'est un present du Ciel, c'est une lumiere naturelle, qui ne se peut acquerir, mais elle s'augmente, elle s'éclaircit, elle se perfectionne, et c'est ce que nous appellons acquerir de l'esprit. Or en quelque ordre d'esprit que l'on se rencontre, il ne faut pas douter que l'on n'en puisse acquerir. Si l'homme le plus éclairé naturellement se resouvient de quelle veuë il regardoit leschosesdans son enfance, et qu'il examine comme elles luy paroissent dans un âge plus avancé, peut-il mettre en doute qu'il n'ait acquis de l'esprit?" "De l'esprit," Méré *OC*, 2:79.

> led by intelligence, and supported on very certain maxims, unceasingly make some progress.[154]

The chevalier's notion of progression toward perfection is similar to Pascal's continuous, gradual attempts to create the ideal arithmetic machine. His insistence on not allowing room for limitations likewise expresses Pascal's sentiments with respect to his machine. Méré criticizes those who merely imitate the work of human masters, "without taking the pain themselves to give to them the *derniere main*."[155] In Pascal's writings on the arithmetic machine, he preempts the attacks of the "imperfect savants" against his invention's complexity, stressing that the version that those critics see is "not the first effect of imagination that I have had on this subject" but the result of progressive improvement.[156] Both Méré and Pascal agree on the linearity of progress.

Pascal's work required him to make extensive efforts that almost caused him to give up. The work was arduous and not for the faint of heart. In contrast, Méré states that progress toward *esprit* does not come by the application of toilsome effort. Pascal's transformation on his journey with the Duke de Roannez and the chevalier is the crowning example of one who acquires *esprit* through only a few days of conversation with those who understand "how to put them in good ways."[157] For Méré, lengthy toil and effort are not as important as they are to Pascal.

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[154] "[E]n toute sorte de talent de mestier, c'est une marque infaillible d'un petit esprit que d'en demeurer toûjours à un certain degré. Tous les grands hommes, tous les excellens ouvrier, ont cherché les moyens les plus cachez pour atteindre à la perfection; Et les personnes qui se conduisent par l''intelligence, et sur des maximes bien certaines, font incessamment quelque progrez," ibid., 2:85.

[155] "sans se mettre en peine de leur donner la derniere main," ibid., 2: 71.

[156] "Avis," Mesnard *OC*, 2:340.

[157] "[I]l en vienne comme par inspiration à quelques-uns, qui faute d'experience ou d'instruction n'en témoignoient pas la moindre apparence, et qui neanmoins deviennent tres-intelligens et tres-habiles, quand on sçait mettre dans les bonnes voyes," "De l'esprit," Méré *OC*, 2:79.

The chevalier thus takes a differently nuanced view of "restricted perfection," and he considers Pascal's practice of mathematics as similar to any other *métier*. While he praises those who overcome the barriers of their *métiers* in order to attain to perfection in those particular areas, his understanding of restricted perfection also refers to the focus on a single discipline at the expense of general understanding. A progression toward general learning is more significant than perfection of a *métier*. What is more, intellectual superiority in one arena, he claims, is often accompanied by ignorance in other areas. Attaining a broad "perfection" that escapes this disciplinary boundedness comes about through proper exposure to other well-rounded men and their conversation.[158] It is not the private act of study, but the public act of communication that makes one truly learned.

Méré and Port-Royal on the limitations of mathematics

Méré's desire to "disabuse him [i.e., Pascal]" of his mathematical *métier* served to reinforce the encouragement that Pascal received from the Jansenists to renounce mathematics and the sciences for the one important duty of being entirely devoted to God and submitted to one's spiritual director. Méré's generalized learning resonated with the comprehensive claim of religious devotion in every aspect of life. Most likely the chevalier's delayed account of his interactions with Pascal overestimates his success in causing Pascal to rethink the importance of mathematics. Nevertheless, as Mesnard writes, "let us seek behind the exaggeration the suggestive and revelatory remark."[159] Méré and other representatives of "worldly" sociability helped to renew to him the importance of escape from the restrictive bounds of the *métier* of

[158] "Il me semble aussi que pour acquerir de l'esprit, et pour se perfectionner en toute autre chose, l'exemple et le commerce des personnes rares est un moyen bien facile et bien assuré," ibid., 2:79.

[159] Mesnard, *Pascal et les Roannez*, 1: 256.

mathematics, within which his earliest training had securely situated him. "[I]n his judgment on the sciences, the lessons of the chevalier came to prepare or complete those of Port-Royal."[160]

On balance, Méré's influence on Pascal was limited. Another of Méré's writings recounts a disagreement between the two about the infinite division of space.[161] Pascal remained endowed with a respect for mathematics. It was "the finest craft [*métier*] in the world, even though only a *métier*, and he was willing to accept a mathematical reasoning that established, for example, the division to infinity, even where Méré found such ideas offensive to common sense.[162] As the following chapters will show, mathematics continued to inform the work of Pascal. It shaped the approach that he took to theological and religious reasoning, even while the childlike and mature virtues of religious devotion provided a model for engagement with the savant world.

This chapter has demonstrated the common themes of inclination, exercise, effort, and restricted perfection during a period of uncertainty and turmoil in Pascal's life. His experience of these tensions and upheavals helped him to forge the relationship between religious "learning," mathematical proficiency, and the life of *esprit* as depicted by Méré. Near the end of

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[160] Ibid., 1: 260. Another Pascal scholar, Charles Baudouin, sees the so-called "worldly period" as also contributing to and preparing the "second conversion": " . . . it is possible, even during that period, to see a secret movement or counterstream, which continues the evolution previously begun. We should like, if it were not a little irreverent, to speak of conversion number one-and-a-half, between the first and the second. Indeed, this period appears at first like a reversal, a real *conversion to worldliness*. but soon it became clear that it was all necessary, and that this too served as fuel to a flame which would finally burn everything clear," "The Process of Individuation in Blaise Pascal," *Journal of Analytic Psychology* 5 (1960), 102.

[161] The disagreement between Méré and Pascal on division to infinity is recounted in the fictive "Lettre de Méré à Pascal," Mesnard *OC*, 3:348-359.

[162] The quotation regarding mathematics as a *métier* is in B. Pascal to Fermat, 10 August 1660, Mesnard *OC*, 4:923.

1654, the various aspects of this tumultuous period of Pascal's life found resolution in what his sister calls a new *entreprise*: to be "tout à [Dieu]."[163]

Redirected Efforts: New Goals and Pascal's "Memorial"

In September, as Jacqueline writes to her sister early in 1655, Blaise came to visit her:

> [H]e opened himself up to me in a manner which made me pity him, vowing to me that in the middle of his occupations, which were great, and among all the things which could contribute to make him love the world, and to which one was right to believe him strongly attached, he thereby sought to leave all that, and by an extreme aversion that he had for the follies and amusement of the world and by the continual reproach that his conscience made to him, that he found himself detached from all things in such a manner that he had never been, nor anything approaching it.[164]

Pascal was not content merely to heed the chevalier's encouragement to leave the restricted bounds of mathematics. He was also constricted by the bounds of the world of diversion and entertainment, which Méré embraced. The concerns of his father's estate, the desire for legitimacy in mathematics and natural philosophy, and the life of *esprit* advocated by Méré, ultimately did not appeal to him.

Pascal sought, through Jacqueline, to identify a spiritual director to whom he might submit himself. This resumed Pascal's attempts of the late 1640s to apply himself to the task of becoming spiritually learned. The most dramatic indication of the changes Pascal underwent during this time is the document that records what is known as Blaise's "Night of Fire."[165] Dated November 23, 1654, this document was carefully conserved by him and was found on his

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[163] Jacqueline Pascal to Gilberte Périer, 8 December 1654, Mesnard *OC*, 3:67-68; the passage from which the second quotation comes reads as follows: "Tout ce que je vous puis dire, n'ayant pas de temps, c'est qu'il [Blaise] est par la miséricorde de Dieu dans un grand désir d'être tout à lui, sans néantmoins qu'il ait encore déterminé dans quel genre de vie."

[164] Jacqueline Pascal to Blaise Pascal, 19 January 1655, Mesnard *OC*, 3:71.

[165] This document is often called the "Le Mémorial" by Pascal scholars.

body at the time of his death eight years later.[166] The first lines following the recording of the date read:

FIRE
God of Abraham, God of Isaac, God of Jacob,
not of the philosophers and *savants*[167]

The third line of Pascal's record of transformation creates a stark break between the world ("of the philosophers and savants") of the learned in which Pascal was nurtured and the world of the religious devotee that he sought to commence. It echoes the sentiments of revulsion that he felt for Saint-Ange in his attempts to discover the secret things of God, but goes further, suggesting the importance of "Forgetfulness of the world and everything besides GOD."[168] It is a rejection of a way of life in which he had been habituated, a break from the restrictive bounds of memorized responses to the world.

The "Memorial" is a classic example of mystical literature and has been studied by numerous scholars. What is most significant for the current study, however, are some lines that indicate a change in the way that Pascal expressed the relationship between mathematics and Christian spirituality. He writes as a student of devout living rather than as a student of geometry. Near the end of the document, Pascal acknowledges a "Total submission to Jesus Christ and to my director."[169] This spiritual director became the tutor through whom Pascal would come to learn of the things of God, and who would instruct him in the disciplines he must

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[166] The following note in the hand of Pascal's nephew, is found on the reverse side of a copy of the "Memorial," and has been transcribed by Mesnard: "I the undersigned, priests, canon of the church of Clermont, certify that the paper attached on the other side of this folio was written in the hand of Monsieur Pascal my uncle and was found after his death sewn into his doublet under the lining with a strip of parchment where were written the same words and in the same form as they are copied here. Performed at Paris, this 25th September 1711 / Périer," "Mémorial," Mesnard *OC*, 3:52.

[167] "FEU / Dieu d'Abraham, Dieu d'Isaac, Dieu de Jacob / non des philosophes et savants," "Mémorial," ibid., 3:51.

[168] "Oubli du monde et de tout hormis DIEU," ibid., 3:51.

[169] Ibid., 3:51.

undertake to become a religious savant.[170] He emphasized the efforts and discipline needed to reach that goal. The joy of the heavenly life to come was, he wrote, certainly worth "a day of exercise on the earth."[171] No longer were his concerted efforts to be used to perfect mathematics, in a vain attempt to attain godlikeness through imitation of his creation. Instead, the "Memorial" suggests a different spiritual goal: personal union with God. "May I never be separated from him!" he exclaims.[172] The hard work of the one who is learned in religion is to discipline himself to seek God "only by the ways taught in the Gospel," including Jesus' command to become like little children.[173]

During the tumultuous period of 1646-1654 Pascal engaged in a diverse range of activities and interests. He was established as a legitimate mathematical savant through the pain and expense of the arithmetic machine and the experiments on the void. He emphasized the exercise required to become genuinely learned in these areas and also began to explore what it would require to become savant in matters of spirituality. Numerous pressures bore down on Pascal during this period, including those extorted by his father's friends, his position as his father's heir, his illness, and his involvement with "worldly" society. Each of these pressures helped to reinforce certain ideas about the limitations of natural inclination, the importance of

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[170] Following the "Night of Fire" experience, Pascal sought out the direction of Antoine Singlin (1607-1664), the main spiritual director at Port-Royal from 1643-1655. Writing to her sister, Jacqueline discusses Pascal's intention to seek out Singlin: "Il est tout rendu à la conduite de M. S[inglin]; et j'espère que ce sera dans une soumission d'enfant, s'il veut de son coté le recevoir, car il ne lui a pas encore accordé," J. Pascal to G. Périer, 8 December 1654, Mesnard *OC*, 3:68. In fact, the spiritual direction of Pascal seems to have been given to Louis-Isaac Le Maistre de Sacy, perhaps because Singlin was quite ill from summer 1653-summer 1655, Antoine Singlin, *Lettres d'Antoine Singlin*, ed. Anne-Claire Josse (Paris, 2004), 111-112. The evidence for Sacy's direction of Pascal is from the conversation between Sacy and Pascal in a document by Sacy's secretary, "Entretien de Pascal avec M. de Sacy," Mesnard *OC*, 3:124-157. Jacqueline writes in a subsequent letter: "Je ne sais néanmoins comment M. de Sacy s'accommode d'un pénitent si réjoui," J. Pascal to G. Périer, 19 January 1655.

[171] "un jour d'exercice sur la terre," "Mémorial," Mesnard *OC*, 3:51.

[172] "Que je n'en sois jamais séparé!," ibid.

[173] Ibid.

improvement and augmentation of those efforts, and an escape from the boundaries of "restricted perfection." They contributed to his decision to submit himself to the direction of Port-Royal. This apprenticeship to a religious movement, which was under duress at the time, placed him in a position to carry out works for their benefit. Indeed, he engaged in works that served to legitimate the type of spirituality that he had embraced. Through the *Provincial Letters* and his contributions to texts intended for the Port-Royal *petites écoles*, Pascal took his place in the world as a mature individual, ready to teach others. He was not just as a student of Jansenist spirituality, but an educational consultant for Port-Royal.

CHAPTER 5
PASCAL, PEDAGOGUE

On March 30, 1656, the Port-Royal *petites écoles*, which educated children of families associated with the convent, were dispersed by official statement of the crown. The dispersion, prompted by religious conflict with the Jesuits, was only temporary and the students returned to the schools a year later. In 1660, however, the educational wing of Port-Royal was closed decisively by royal decree and students were shuttled to various places where they could be cared for and taught.[1] By several indications, Pascal was one of those to whom some of the children were entrusted. In a letter to her brother of 6 November 1660, Jacqueline writes of "the pain that I have given you" and "the care and inconvenience," stating that "M. R. will soon be in a situation to take back these children."[2] Any doubt about the identification of the children may be removed by Jacqueline's desire for her brother "to greet them from me, and M. du Lac also," since du Lac was one of the Port-Royal masters and Jacqueline, a nun at Port-Royal, would have been acquainted with the children as well. Likewise, the chevalier de Méré recollects a situation, quite likely overheard in 1660, in which someone said to Pascal: "You are thus a schoolmaster," on observing him with "seven or eight children in rags."[3] While Pascal may not have been an official master at the *petites écoles*, his care of these children and his substantial contributions to

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[1] Delforge, *Les petites écoles de Port-Royal: 1637-1660* (Paris, 1985), 154. See also H. C. Barnard, *The Little Schools of Port-Royal* (Cambridge, 1913), 39-42.

[2] "pour vous demander pardeon en même temps de la peine que je vous ai donnée en cela; car c'est moi qui vous l'ai procurée, et j'ai bien peur que vous en soyez incommodé.Je l'ai fait dans l'assurance que 'avais que vous en auriez bien de la joie, et que le soin et l'incommodité que vous en auriez ne durerait pas, parce que M. R. serait bientôt en état de reprendre ces enfants," Jacqueline Pascal to Blaise Pascal, 6 November 1660, Mesnard *OC*, 4:963. The identity of "M. R." has not been definitively determined, Mesnard *OC*, 2:961.

[3] Méré, "Divers propos," Mesnard *OC*, 1:824. Mesnard draws on Christiaan Huygens's mention of Méré's presence in Paris in December 1660 to support the chronological evidence that this quotation refers to Pascal's role as an unofficial mentor to the dispersed Port-Royal students, Mesnard *OC*, 4: 961.

the Port-Royal textbooks present Pascal in his pedagogical role as "gardener of children."[4] As a teacher, he had become, Jacqueline writes, "father of a family, in one of the ways that God himself is our Father."[5]

Pascal's 1654 "Night of Fire" signals the submission of Pascal (as mathematical "prophet" and new Archimedes) to Pascal the elect of God. In the years that followed, he was transformed from a spiritual apprentice into a spiritual pedagogue, drawing at once on the imperatives of childlike faith and the necessity of growing in maturity toward perfection, both of which were encouraged by his relationship with the Port-Royal schools. While the resources of his mathematical talent continued to be used in a variety of ways, his identity as geometer was enveloped by his identity as a devout Christian. Despite this profound change, the themes of Pascal's post-conversion writings demonstrate significant continuity with his pre-conversion works. In particular, the complex relationship between inclination and exercise/education, so prominent in Pascal's mathematical and scientific work, is recapitulated in the relationship between the election of the believer and the rigor of the Christian life. Moreover, his writings against the Jesuits in the *Provincial Letters* undercut the members of that religious order in ways similar to those used in the mathematical/scientific writings. Importantly, Pascal's natural talent and training in geometry served as resources on which the Jansenists would draw as they carried out their goals of Christian education in the *petites écoles*.

Children, Moral Inclinations, and Education

Chapter 3 discussed two of three types of inclinations listed by Cureau de la Chambre in his *L'art de connoistre les hommes*: bodily and intellectual. With Pascal's movement toward

[4] Gobry, *Pascal, ou la simplicité*, 116.

[5] "[V]ous êtes devenu père de famille, en une des manières dont Dieu même est notre père," J. Pascal to B. Pascal, 6 November 1660, Mesnard *OC*, 4:962.

religious devotion, however, inclinations of a specifically moral character took on increased significance. Understanding children's moral inclinations and shaping them through habit was arguably more important to the pedagogues of the seventeenth century than was the discovery of ability in arts or sciences. Morally speaking, the status of children was fraught with difficulty. That great authority Aristotle refers to the "self-indulgence" associated with "childish faults."[6] He states that "children in fact live at the beck and call of appetite, and it is in them that the desire for what is pleasant is strongest."[7] As a result, the moral life of child must be subject to an adult, who may temper childish nature with reason.[8] The looming church father Augustine gave an account of the inheritance of sinful nature that characterized children as infected with sinful desires from birth. This bleak view of the child is often all that is highlighted in Augustine. But Augustine also provided a certain place of respect for the child, which he claimed possesses innocence superior to that of adults, as Shulamith Shahar points out.[9] Furthermore, Scriptural texts were clear about the virtues of childhood, with Jesus proclaiming that "to such belongs the kingdom of heaven."[10] Throughout the Middle Ages, that chronological period about which historians of childhood most often argue, the Christian

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[6] Aristotle *Nicomichean Ethics* 3.1119b1, in *The Complete Works of Aristotle: The Revised Oxford Translation*, ed. and trans. Jonathan Barnes (Princeton: Princeton UP, 1984).

[7] Ibid., 3.1119b5-6.

[8] Ibid., 3.1119b11.

[9] Shulamith Shahar, *Childhood in the Middle Ages* (New York, 1990), 16-17. Georges Snyders likewise recognizes in Augustine the "Valeur éminente de l'enfant": "[P]uisqu'il est créature de Dieu, l'homme à sa naissance, et pour ainsi dire à l'état brut, ne s'identifie pas simplement au péché. En réalité, l'existence est valeur et le péché de l'enfance, c'est une direction néfaste imprimée à une force d'exister qui, en elle-même, ne peut être que bonne," Georges Snyders, *La pédagogie en France au XVII*[e] *et XVIII*[e] *siècles* (Paris, 1965), 183.

[10] "Jesus said, 'Let the children come to me, and do not hinder them; for to such belongs the kingdom of heaven'," Matthew 19.14, RSV. Similar statements, referring instead to the "kingdom of God" are in Mark 10.14 and Luke 18.16.

conception of the childhood was ambiguous and ambivalent. Janet Nelson's analysis of the conversion stories of saints provides further support for this ambiguity.[11]

During the early modern period, the ambivalent attitudes toward the morality of children continued. Huarte repeats Aristotle's idea that a child "is no more than a Brute Beast," controlled by desires.[12] But he also states that "The Virtues of Infancy are very many and the Vices but very few." Children are, among other things, "Docile, Tractible, Gentle, . . . Charitable, Frank, Chaste, Humble, Innocent, and Undesigning."[13] Georges Snyders articulates a clearly negative verdict of seventeenth-century educators with respect to children, because of their focus on the child's inability to carry out morally responsible acts consistently.[14] Educators saw these negative qualities of childhood, Snyders argues, because they were working with children on a day to day basis, while artists and writers who proclaim the virtues of childhood did not have to live with their unpredictable behavior.[15]

The question of moral natural inclinations, then, took on a decidedly negative tone. From one educational perspective, Huarte and Bartoli argued for the strength and constancy of inclinations toward specific types of learning and the importance of following them. Other sources, interested in the moral formation of the child, urged the identification of such inclinations to vice in order to correct them.

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[11] Janet L. Nelson, "Parents, Children, and the Church in the Earlier Middle Ages," in *The Church and Childhood*, ed. Diana Wood (Oxford: Blackwell, 1994): 81-114.

[12] Huarte, Tryal of Wits (1698), 59.

[13] Ibid., 81.

[14] Snyders, *La pédagogie en France*, 208ff.

[15] Ibid., 208.

In 1632, Pierre Bardin published *Le lycee dv Sr Bardin ov en plusieurs promenades il était des connoissances, des actions, & des plaisirs d'vn honneste homme*.[16] In this work, Bardin argues for the importance of education and nurturance for the correction of inclination to vice. He claims that proper training of a child can overcome these natural inclinations:

> It is significant to be well born, but it is of still more advantage to be well nurtured: Nature is strong & powerful, yet it must be confessed that Institution overcomes it. For Childhood is pliable to all sorts of habit, & does not know what either vice or virtue are; it is as susceptible to the one as to the other.[17]

It is precisely because a child may be shaped, says Bardin, that education was considered "as the most important piece of a Republic" in the ancient world.[18] It is crucial to weigh the actions and tendencies of a child at an early age "in order to draw from them some prognostications for the rest of his years."[19] Bardin uses the common analogy of farming, as had Mersenne, to stress that nature's gifts cannot preempt effort:

> As there is no earth, as fertile as it may be, that does not demand the hand of the laborer, there is no soul that does not require cultivating if one desires it to produce good fruit.[20]

Like Bardin, Cureau de la Chambre's *L'art de connoistre les hommes*, though considering qualities other than *honnetêté*, also recognized the role that education plays as the modifier of

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[16] This is one example of an expansive seventeenth-century genre known as "manuals of civility."

[17] "C'est beaucoup d'estre bien nay, mais c'est encor dauantage d'estre bien nourry: la Nature est forte & puissante, neantmoins il faut confesser que l'Institution la surmonte. Car l'Enfance est ployable à toute sorte d'habitude, & ne sçachant ce que c'est de vice ny de vertu, elle est autant susceptible de l'vne que de l'autre," Bardin, *Le lycee*, 1: 175.

[18] "Tous les Politiques ont fort racomandé l'education des enfans, comme la plus importante piece d'vne Republique," ibid., 1, 174.

[19] "[A]prés la considertion des parens de quelqv'vn, on s'arreste aux actions qu'il fait en son âge tendre, afin d'en tirer des prognostiques pour le reste de ses années," ibid., 1: 166. To do so is to follow the example of Seneca in his teaching of Nero, ibid., 1: 173-174.

[20] "Comme il n'est point de terroir pour fertile qu'il soit, qui ne demande la main du laboureur, il n'y a point d'ame qui n'ait besoin d'estre cultiuée, si l'on desire qu'elle rpporte de bons fruits," ibid., 1: 380-381. Bardin goes on to say that "Il est necessaie qu'en la composition de ceste Vertu, la Nature y apporte du sien, & que nostre raison y contribuë aussi de son industrie," ibid., 1: 382.

natural tendencies.[21] Quality of training may affect someone's virtues for good or for ill, "Study being able to correct depraved Inclinations, & bad nurturance being able to alter good ones."[22]

The rigorous spirituality of the Jansenists also required overcoming of the natural inclinations, the more so because of their strong Augustinian influences. According to Augustine and those who followed his arguments against the Pelagians, human beings since the fall of Adam were infected with original sin in a way that compromised free will. Prior to the Fall, Adam could freely choose good or evil. Afterwards, the situation changed - for Adam and for his posterity, the whole human race. Postlapsarian human beings, according to Augustine's account, naturally and constantly tend toward evil. The only solution for this problem is God's grace, which cannot be earned. Therefore, for those not elected by God, hard work avails nothing. However, Augustinians argued, the elect are not exempt from efforts toward a holy life and this is the foundation of the rigorous spirituality of Port-Royal. This attitude toward grace and works lay beneath the comments of Pascal and his sister regarding the necessity of pursuing unlimited perfection through unity with Jesus Christ.[23]

The complex relationship between perfidious natural inclinations and the unrelenting effort needed to overcome them is also central to Pascal's first religiously-driven work, the *Provincial Letters*. The issues the letters consider relate to questions of natural tendencies and work. Pascal's ironic dialogue brings to light the inherent weakness of trusting natural inclinations in questions of human morality. In an attempt to discredit his opponents, Pascal contrasts the efforts of the Jansenists to maintain holiness with the pride that the Jesuits take in producing ease

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[21] The relationship of Cureau de la Chambre's work to intellectual inclinations is discussed in Chapter 3 above, pp. 102-103.

[22] "l'Estude pouvant corriger les Inclinations vicieuses, & la mauuaise nourriture pouvant alterer les bonnes," Cureau de la Chambre, *L'art de connoistre les hommes*, 431.

[23] See above, pp. 199-205.

for their "penitents." Finally, the *Provincial Letters* provides evidence of Pascal's instrumental use of the truths of geometry to accomplish spiritual aims. Geometry cannot, by itself, provide mystical union with God and thus is not a legitimate *vocation* in its own right. For Pascal, geometry is, however, acceptable and helpful, since it provides insight and preparation for spiritual truths. Geometry, for Pascal, was a pedagogical tool.[24]

Resisting the "science of sins": Childlikeness and Maturity in the *Provincial Letters*

Considered one of the masterpieces of French literature, *The Provincial Letters* was written by Pascal pseudonymously in response to a theological controversy that had been brewing for years. At its heart were five propositions condemned by the Sorbonne and supposedly contained in *Augustinus*, a work written by Cornelius Jansenius and published in 1640. In short, the propositions dealt with issues of human responsibility and agency in the question of salvation and righteous acts. According to the propositions, God's grace trumped any human efforts to cooperate with it or resist it, even among the *justes.* Antoine Arnauld defended Jansen and the Jansenists from such claims, stating that the propositions were not to be found in *Augustinus*. Arnauld was eventually censured and ousted from the Sorbonne for his resistance to the judgments of the majority.

In response to the controversy, the Jansenists sought to garner public support for their cause. Neither Arnauld nor Pierre Nicole seemed the right choice for the task.[25] According to Nicole, Pascal the newcomer volunteered for the task of sketching the work, innocently unaware

[24] On geometry's role of instructing the believer about the limitations of fallen human nature, see Matthew L. Jones, "Geometry and Fallen Humanity in Pascal and Leibniz," in David Wetsel and Frédéric Canovas (eds.), *Pascal/New Trends in Port-Royal Studies: Actes du 33e congres annuel de la North American Society for Seventeenth-Century French Literature* (Tübingen: Gunter Narr, 2002): 189-202.

[25] Michel Le Guern, *Oeuvres complètes*, 1:1118-1119.

of his latent literary talents.[26] His capacities in mathematics had been proven, but he was still an untried novice in this type of writing. The *Provincial Letters* was to constitute his apprenticeship to religious writing, the test of his inclination and vocation to such work.

The first few letters of the series of *Provincial Letters* represent an ongoing dramatic production in which the narrator, presented as neutral, disinterested, and curious, physically walks back and forth between the locations of several parties involved in a dispute about the content of the five propositions. Pascal deftly situates the narrator as one in whom childlike ignorance is combined with industry and a desire for self-education.[27] He is naive, yet obviously has a keen memory, necessary but not sufficient for facility in learning. This literary device of naiveté differs sharply from Pascal's earlier work on the arithmetic machine and the void, in which he deliberately contrasts himself with such ignorance. He now makes strategic use of positive aspects of childhood, combining them with an emphasis on the necessity of education.

The first letters are didactic, in that both he and the reader accumulate a fuller picture of the crux of the matter. What the narrator (and reader) discover, however, is that the dispute is a mere matter of words. As such, it falls within the realm of geometrical questions of proper argument rather than theological questions of religious truth. Throughout Pascal's opening salvo against the Jesuits, he aims at their ambiguous, imprecise, and equivocal language. Questions regarding the consistency of language are like questions of geometry, arithmetic, music, physics, medicine, and architecture. These subjects must, as the "Préface" to the *Treatise of the Void*

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[26] Michel Le Guern points to Pierre Nicole's preface to the Latin translation of the *Provincial Letters* (1658) as a significant source for the origin of Pascal's choice as the one to write the defense of Jansenism, Le Guern, *Oeuvres complètes*, 1:1119.

[27] For the idea that the *Provincial Letters* uses what M. M. Bakhtin calls "polemical stupidity," or a "strategic failure to understand," see Howells, "Polemical Stupidity in the *Lettres provinciales*," 231-237.

argues, "be augmented in order to become perfect."[28] The narrator accumulates data by collecting information from his friends' arguments. It is a process of educating the childlike author. As it turns out, comparing fundamental rules of geometrical reasoning with the arguments of the theologians demonstrates that the Jansenists' opponents fall short of logical coherence. Geometry becomes the instrument for examining spiritual error.

Pascal's essay "De l'esprit géométrique" gives the basic geometrical rules that inform his attack on the Jesuits in the *Provincial Letters*. In this work, he states that definitions in geometry are "very free" [*très libres*], as long as they are clearly stated and provided also that the same definition is not given of multiple things. The solution to such confusion is "to substitute mentally the definition in place of the thing defined."[29] Pascal had already criticized the faulty definitions of Father Noël regarding the experiments of the void. Pascal took Noël to task for defining light (*lumière*) self-referentially as "a luminary movement of luminous bodies "[30] Now, likewise, the theological doctors employed definitions that were not based on proper rules in questions of grace and obedience. They were unintelligible and immature.

The central concern of the first letter is the theological use of the phrase *proximate power*. During the narrator's visits to various theologians, it becomes apparent that the different opponents of the Jansenists (the Molinists and the Jacobins) use this to refer to quite different ways of understanding the ability that the elect have to perform a righteous action at any given time. For the Molinists, *proximate power* is parallel to the power possessed by a person who is not blind if that person is in a lighted place. For the Jacobins, on the other hand, this individual

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[28] "Preface sur le traité du vide" Mesnard *OC*, 2:779.

[29] "Mais si l'on tombe dans ce vice, on peut lui opposer un remède très sûr et très infallible: c'est de substituer mentalement la définition à la place du défini," "De l'esprit géométrique," Mesnard *OC*, 3:394.

[30] "J'en sais qui ont défini la lumière en cette sorte: *La lumière est un mouvement luminaire des corps lumineux,* "De l'esprit géométrique," Mesnard *OC*, 3:396.

may be said to have the *proximate power* of seeing even if they are currently in the dark. However, they agree on the use of the words *proximate power*, even if those words have no precise meaning. They have done this, at least according to the narrator's Jansenist friend, completely in order to unite themselves in opposition to the Jansenists:

> [T]hey have resolved to agree on this term *proximate*, which both parties might use indiscriminately, though they understand it diversely, that thus, by a similarity of language, and an apparent conformity, they may form a large body, and get up a majority to crush him with the greater certainty.[31]

For both the narrator and indeed any reader, such an equivocal approach to definition violates the rules of geometrical reasoning. And while all those with common sense agree to these rules, Pascal's inclination for and training in geometry especially suited him to judge such matters, as he says in his "De l'esprit géométrique": "among minds equal and with all things alike, he who has geometry wins the day" in questions of proper reasoning.[32] Thus, the 'ignorant' and childlike narrator becomes learned in this supposedly thorny theological question through a simple shuttling between disputants. He thereby untangles the apparent complexity of the issue by unveiling falsely subtle definitions. The strength of childlikeness, as it appears in the *Provincial Letters*, is that it is yet unsullied by scholastic "logic." It matures through the accumulation of experiences. By contrast, Pascal's writing portrays the critics of the Jansenists as childish. Their utterance of the words *proximate power* is mere babbling without proper definition. The similarity to Saint-Ange's animal-like pupils, who mimicked his absurd philosophical squawking, is noteworthy.

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[31] Blaise Pascal, *The Provincial Letters of Blaise Pascal*, ed. O. W. Wight, trans. Thomas M'Crie (New York: Hurd and Houghton, 1864), 147, hereafter *PL*.

[32] "[E]ntre esprits égaux et toutes choses pareilles, celui qui a de la géométrie l'emporte," "De l'esprit géométrique," Mesnard *OC*, 3:391.

The narrator of the *Provincial Letters* resorts to the free and clear rules of geometrical reasoning. The Jansenists' opponents, as portrayed in this work, appeal to their authority as theologians instead of taking seriously the claims of logical reasoning to validate or undermine their expertise. Thus, when the narrator has heard the basics of the argument regarding the power to obey God's commands and claims that there appears to be no difference between the opinions, the theologian seeks to establish his special qualifications:

> One must be a theologian to see the point of this question. The difference between us is so subtle, that it is with some difficulty we can discern it ourselves–you will find it rather too much for your powers of comprehension.[33]

The implication of the passage is that only theologians are equipped to unravel the knot of these issues, even if in so doing they violate clear rules of definition. And when the narrator attempts to confront such theologians with clear thinking, they dismiss him as a simpleton. Likewise, in the fifth letter one theologian reiterates the point: "I have had occasion to remark, two or three times during our conversation, that you are no great scholastic."[34] The theologians thus attempt to dismiss geometry as a legitimate means to undermine their arguments.

In the attempt to discredit his criticisms, one of the theologians with whom the narrator interacts portrays himself as a teacher, with the narrator as his pupil. He views his conversation with this non-theologian as a pedagogical session: "You have got a great deal of instruction to-day; and I should like, now, to see what proficiency you have made."[35] Assuming the superior position of the theological theoretician, much as Desargues did when articulating the teacher/pupil relationship between mathematician and mason, the theologian represents himself

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[33] Pascal, *PL*, 146.

[34] Ibid., 209.

[35] Ibid., 260.

as having a just mastery over the Jansenist.[36] But what is it that he is teaching and what is its end result? The abstruse opinions that are supposedly only understood by qualified doctors of theology are precisely the grounds by which they claim legitimacy for their learning. And yet, as the details of the censure of Arnauld come to light throughout the work and the theologians attempt to explain them to the narrator, it becomes clear that the "point of difference which had proved imperceptible to ordinary mortals" lacks substance. The difference between truth and error is infinitesimal:

> Truth, we know, is so delicate, that if we make the slightest deviation from it, we fall into error; but this alleged error is so extremely fine-spun, that, if we diverge from it in the slightest degree, we fall back upon the truth. There is positively nothing between this obnoxious proposition and the truth but an imperceptible point.[37]

Pascal argues in his early *Provincial Letters* that the truth, for the Jansenists' opponents, is not discovered through hard work or the clarity of expression that characterize the narrator and others in "the world".[38] Rather, their "truth" or "falsity" is attached to one's person, depending upon whether one is associated with a particular group or not. Furthermore, in these little theological clubs, unlike the mathematical group of Mersenne, legitimate entrance is based not upon a person's productions, but upon a mere acceptance of an incoherent doctrinal vocabulary. Pascal argues that what the Jansenists' opponents have produced is not theology, which for him should be inextricably linked to virtuous action. Instead, it is religious nonsense.

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[36] See above, pp. 124-127.

[37] Pascal, *PL*, 172. This passage provides an example of how mathematical language informs the work of the *Provincial Letters*. The notion of the hypothetical infinitesimal point for use in mathematics was up for debate in the seventeenth century, especially with the growing importance of atomism, which assumed some smallest units that could not be divided.

[38] E.g., "Have you forgotten, since you retired to the cloister, the meaning attached, in the world you have quitted, to the word *sufficient*?–don't you remember that it includes all that is necessary for acting?", ibid., 158. Subsequently, the narrator specifies all types of people, from artisans to women, who understand the word "sufficient" in the same general way as the narrator, ibid., 159.

The narrator's efforts to grasp the truth about these questions are masterfully contrasted in the *Provincial Letters* with the efforts of the Jesuit fathers to provide solutions for cases of conscience.[39] With his ironic appeal, Pascal portrays his antagonists as those who, under the pretense of laboring to bring sinners to the confessional and the altar, actually manage to excuse their abominable acts.

The examination of specific cases of moral action begins in the fifth letter, which introduces a morality having no need for recourse to spiritual discipline or industry. When the narrator strategically plays the role of an individual who has "difficulty supporting the fast," he is only cursorily instructed to "do violence to my inclinations." After more insistence, he is offered a number of possible means by which he may be excused from fasting. The Jesuit multiplies situations and possibilities, making every effort to be accommodating to the struggling sinner.[40] This type of interaction goes on for several letters. The Jesuit father cites quotations that serve as "probable" opinions on which one may act, thereby excusing a number of offenses, including participation in a duel, immodesty, and even murder. Just as Saint-Ange tried to win Monflaines, Auzout, and Pascal by proclaiming the astonishing nature of his philosophical viewpoints, the Jesuit seeks to excite amazement in the narrator concerning the accomplishments of a moral system that is able to excuse almost any offense. For example, the Jesuit enlarges on a case of theft in the following way:

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[39] The narrator also offers a praise of his Jansenist friend in the realm of his studied knowledge on a particular theological point, as compared with the Jesuit: "My friend, however, who was so ready on the whole question, that I am inclined to think that he had studied it all that very morning, replied," ibid., 187.

[40] This idea of stating the many possibilities is parallel to Matthew L. Jones's emphasis on the importance of Pascal's "enunciation" of mathematical propositions; see above, pp. 221-224.

> But only attend to this notable decision of Father Bauny, on a case which will still more astound you, and in which you would suppose there was a much stronger obligation to make restitution.[41]

In an even more obvious attempt to impress the narrator with the wit with which his colleagues have worked, the fictional Jesuit outlines the approach to solving the difficult question of duels:

> Anxious to keep on good terms both with the Gospel, by doing their duty to God, and with the men of the world, by showing charity to their neighbor, they needed all the wisdom they possessed to devise expedients for so nicely adjusting matters as to permit these gentlemen to adopt the methods usually resorted to for vindicating their honor, without wounding their consciences, and thus reconcile two things apparently so opposite to each other as piety and the point of honor. But, sir, in proportion to the utility of the design, was the difficulty of execution. You cannot fail, I should think, to realize the magnitude and arduousness of such an enterprize.[42]

Pascal, who had made his own appeals to the difficulty of such tasks as the creation of the arithmetic machine and the demonstrations of the void, has here crafted a finely probing and laughably sad example of industry badly placed.

The Jesuit's attempts to demonstrate the cleverness of moral probabilism fail. They are the source of ironic laughter with a tinge of horror and result in the undermining of the priest's goals of legitimation. Indeed, rather than being struck by the success of the Jesuits in drawing "penitents" to their confessionals, the narrator elicits a different kind of surprise. He reacts with "pure astonishment at finding the books of men in holy orders stuffed with sentiments at once so horrible, so iniquitous, and so silly."[43] And when confronted with more justifications and excuses, he writes that "[t]his preposterous decision fairly dumbfounded me" with its "pernicious tendencies."[44]

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[41] Pascal, *PL,* 255-256.

[42] Ibid., 230.

[43] Ibid., 259-260.

[44] Ibid., 261.

The Jesuits, placing much emphasis on the effort required to soothe consciences, eliminate the need for self-discipline and taming of nature, Pascal suggests. According to the narrator, "Their morality being entirely Pagan, nature is quite competent to its observance."[45] In fact, the sin of immodest dress is excused if it is by reason of the natural inclination to vanity. This view of human nature is distinctly un-Augustinian and the narrator observes that while some "prescribe painful austerities for healing the soul . . . you show that souls which may be thought desperately distempered are in quite good health."[46]

According to the portrayal of the *Provincial Letters*, the Jesuits were concerned with making Christian life easier, in order to attract people to their religious camp. But the theologians had misunderstood the purpose of their work. They were not accomplished as theologians because of their ability to handle words carefully and to create their own definitions of sin: "These are disputes of theologians, not of theology."[47] The hallmark of true theology, Pascal claims, should be right living and he will therefore leave the theologians to the Sorbonne and make no claims against their type of learning. In response to another excuse, this time allowing the rich to avoid giving alms, the narrator proclaims: "Why truly . . . if that be the case I give up all pretension to skill in the science of sins."[48]

Étienne Pascal had argued in his letter to Father Noël that his son, although young, had demonstrated virtue superior to that of the Jesuit priest. Thus Blaise had maintained in his natural philosophical work a quality that the theologians, those whose lives should be most in

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[45] Ibid., 199.

[46] Ibid., 183. The use of the language of distemper may be related not only to health but also metaphorically to music. The "well-tempered" instrument is one which keeps the proper mathematical ratios between the musical intervals. Pascal suggests that the human "instrument" is one that must be submitted to the professional tuner to be corrected. In this case, that tuner is the grace of God through Jesus Christ.

[47] Ibid., 177.

[48] Ibid., 273.

keeping with the teaching of the Gospel, had abandoned. In fact, the quip at the end of the previous paragraph suggests that at the heart of Jesuit morality is a contrast between two types of skill. The Jesuit's hard work to make the penitent more comfortable is not an innocent or even ignorant childishness that masquerades as learning. Instead, it is the founding of a "science of sin," in which the pupils who are instructed in it become learned in how to transgress God's laws with impunity.

It is clear that Pascal believes that the morality endorsed by the Jesuit fathers who are cited in the *Provincial Letters* ultimately leaves human beings in a state of childish ignorance. They are at the whim of their natural inclinations. The gentleness of Jesuit morality is in accordance with their belief that humans have a natural capacity to perform the commands of God. No instruction or transformation seems to be required. But for Pascal, orthodox Christian doctrine, as stated by Augustine, maintains that our natural state must be transformed to enable such obedience through charity. And indeed, it is in the famous chapter on love in Paul's first letter to the Corinthians that the apostle writes: "When I was a child, I spoke like a child, I thought like a child, I reasoned like a child; when I became a man, I gave up childish ways."[49]

The critique of the Jesuits as "childish" in the *Provincial Letters* is parallel to the indictment against Pascal's other adversaries in questions of mathematics and natural philosophy, and is related to his own history as a promising boy genius. Pascal, who had been encouraged in his own inclinations for geometry and mathematics by his father's friends, had to exercise those talents and give significant effort in order to prove the legitimacy of those claims to natural talent. In his attempts to legitimate himself as a savant worthy of full acceptance in that community, he contrasted his own work with those who represented uncultivated inclination.

[49] 1 Corinthians 13.11, RSV.

Pascal was born into an intellectual culture that, in rediscovering the great ancient writers, came to seek the reestablishment of a "golden age" of the mind. They sought the new embodiment of those intellectual virtues that they saw as central to classical Greek culture.[50] But Pascal was also born into a world of skepticism, rooted in that same classical tradition.[51] He lived at the cusp of Paul Hazard's brilliantly overstated "Crisis of European Consciousness."[52] The intellectual trend was toward questioning the claim that someone might be born, one may say "elected," to a position of intellectual superiority, whether through bodily constitution or the influence of the stars. Pascal was thus poised to fill the role of a "new Archimedes." But he was also compelled to justify his position as such through a great deal of effort, and to show that his status as promising young savant did not remain in those terms but showed maturity and development.

With the convergence of Pascal's background as child prodigy and his exposure to Augustinian theology, it is hardly surprising that Pascal should be so particularly interested in the necessity of hard work for Christian living.[53] The contrast between this rigorous view of Christianity and that of the Jesuits presented in the *Provincial Letters* is pronounced. For Pascal, the Jesuits' attempts to make Christianity more palatable for its adherents are in direct opposition to historical Christianity. One of Pascal's Jesuit interlocutors admits this very point in a discussion of penance:

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[50] Indeed, Pascal's lifetime overlaps with French Classicism, an approach to literature and art.

[51] Richard H.Popkin traces these Greek sources of early modern skepticism in Popkin, *The History of Scepticism: From Savonarola to Bayle* (Oxford, 2003,) Chapter 2, "The Revival of Greek Scepticism in the Sixteenth Century," 17-43.

[52] Paul Hazard, *The European Mind, the Critical Years: 1680-1715* (New Haven: Yale UP, 1953).

[53] The Jansenist Augustinianism, and Pascal's ascetic tendencies, place him in significant continuity with some of the prominent values of the so-called "Protestant work-ethic" described in Max Weber, *The Protestant Ethic and the Spirit of Capitalism* (London: J. Murray, 1927).

> [Narrator:]"But, sir, what then becomes of what Father Petau himself is obliged to own . . . 'that the holy fathers, doctors, and councils of the church agree in holding it as a settled point, that the penance preparatory to the eucharist must be genuine, constant, resolute, and not languid and sluggish, or subject to after-thoughts and relapses?"
>
> "Don't you observe, replied the monk, "that Father Petau is speaking of the *ancient church*? But all that is now *so little in season*, to use a common saying of our doctors, that, according to Father Bauny, the reverse is the only true view of the matter."[54]

The Jesuits thus represented for Pascal a corruption of the true church, controlled by the undulations of culture rather than by tradition and divine revelation.

Merits and Demerits of Children: Pascal's *Comparaison des chrétiens*

Two Childhoods of Christianity and the Necessity of Christian Instruction

It is in this vein of contrasting the contemporary church with the ancient church that Pascal penned a much-neglected piece that draws together the duality of childhood innocence and vulnerability to emphasize the importance of education for child and adult. Given the title *Comparaison des chrétiens des premiers temps avec ceux d'aujourd'hui* ("Comparison of Christians of the First Times with Those of Today") by later editors, Pascal demonstrates Jansenism's "primitivist attraction for the first Christian centuries" in this short work.[55] The fascination for the Greek writings of mathematics during the sixteenth and seventeenth centuries was matched, in some circles, by enthusiasm for the early Christian church. *Comparaison des chrétiens*, which considers the status and purpose of infant baptism, emphasizes themes of interest to this study (the importance of effort and the significance of education for Christians). Furthermore, it suggests a distinction between two contrasting aspects of childhood, which will inform both Pascal's own understanding of the human condition and the interpretation of Pascal given by his later biographers.

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[54] Pascal, *PL*, 290-291.

[55] Philippe Sellier, *Port-Royal et littérature* (Paris, 1999-2000), 2: 46.

The first contrast that Pascal offers between the church of the first Christian centuries and the Catholic Church of his time is the relative necessity of concerted efforts to enter into communion with the church. While Pascal recognizes the benefit of infant baptism (discussed below), he claims that the church of his time had, because of this practice, abandoned the kinds of rigors that were required of those who were converted to Christianity and baptized during the early centuries of Christianity. He states this contrast in several ways at the beginning of the piece:

> One then entered into the church only after great works and long desires.
>
> One is found there now without any pain, without care, and without work.
>
> One was received into it then only after having denied his past life, only after having renounced the world, flesh, and the devil.
>
> One enters in it now before one is in a state that one may do these things.[56]

Pascal suggests that the most significant way that hard work is manifested for the believer is through catechetical instruction subsequent to baptism as a newborn. The practice of infant baptism is beneficial, he argues. The purpose of it is that "those that it withdraws at such a tender age from the contagion of the world take sentiments entirely opposed to the world."[57] Here Pascal makes use of the positive connotation of childhood. The assumption of the argument is that a child is, with respect to certain aspects of worldliness, unsullied. However, its benefit, Pascal continues, is limited, and is particularly dependent upon the faithfulness of the godfather to his duties with respect to the child. The godfather is given, among others "an indispensible commandment . . . to instruct the children" in the commands of God and the

[56] "On n'entrait alors dans l'Église qu'après de grands travaux et de longs désirs. / On s'y trouve maintenant sans aucune peine, sans soin et sans travail. / On n'y était reçu alors qu'après avoir abjuré sa vie passée, qu'après avoir renoncé au monde, et à la chair, et au diable. / On y entre maintenant avant qu'on soit en état de faire aucune de ces choses, "Comparaison des chrestiens," Mesnard OC, 4:54.

[57] "Son véritable esprit est que ceux qu'elle retire dans un âge si tendre de la contagion du monde prennent des sentiments toutes opposés à ceux du monde," ibid., 4:56.

church.[58] In order to encourage such learning, it is necessary that godchildren be instructed in the history of the church and "the difference in the customs which have been practiced in the church in the diversity of times."[59] They must be taught, in particular, about how in earlier times individuals were required to be catechumens before entering the church and that they were thoroughly instructed and examined before being accepted.

Thus, Pascal states, contemporary Christians are not exempt from laboring in their faith. Although they enter the church as children, through their baptism as infants, they do not avoid their responsibility as its members because of their safeguarding from "the vices into which corrupt reason leads them."[60] Instead, it is necessary, as they grow older, that they receive the same education as the adult believers of the first centuries after Christ. They are obliged to be learned in questions of the faith, rather than relying upon their status as born into the community of the church. The benefits of such a birth are not to be gainsaid, as has already been stated. Furthermore, it is clear that the message of Christ included the charge that the true believer is to be like a little child, that the Kingdom of Heaven belongs to little children.

The danger in the baptism of infants in the Catholic Church, says Pascal, is that the two states of childhood will be confused rather than held distinct. In the ancient church, he writes, there was a chronological distinction between the two births taught by Christ and thus also the same distinction between one's physical and one's spiritual childhood. Growing up in the first childhood in the world, the individual became learned in the ways of the world and progressively corrupted, while remaining as ignorant as a newborn in the ways of the truth. In the early

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[58] [E]lle leur commande expressément de les garder inviolablement, et ordonne par un commandement indispensible aux parrains d'instruire les enfants de toutes ces choses," ibid., 4:57.

[59] "[I]l faut leur faire entendre la différence des coutumes qui ont été pratiquées dans l'Église suivant la diversité des temps," ibid., 4:58.

[60] "Elle prévient l'usage de raison, pour prévenir les vices où la raison corrompue les entrainerait," ibid., 4:56.

Christian church, individuals had to take pains in order to demonstrate that they were serious about renouncing the world before being admitted to the second birth through the rite of baptism.[61] As scholars of the Christian life, they had to *first* submit to "a very exacting examination."[62]

In the church of Pascal's time, however, the two births could be confounded due to their chronological proximity:

> One finds oneself now be in both [the world and the church] at nearly the same time, and the same moment in which we are born into the world has us reborn into the church. Thus, reason arising no long makes a distinction between these two worlds that are so contrary to one another. It is raised in both together. One attends the sacraments, and one enjoys the pleasures of the world.[63]

The danger of being born into the community of the church is that instruction seems optional. To be baptized as an infant could carry with it a sense of "chosenness" that could encourage one to remain in the state of the spiritually immature child.[64] The true believer must be a scholar of the commandments of God and of the ways of the renunciation of the world. But instead of following in the way of the *très instruites* converts of the early Christian church, most of the individuals born into the church in Pascal's day, he says, "are now in an ignorance that provokes horror."[65] Thus, for the present church, Pascal continues, one's birthright of election seemingly

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[61] "[O]n quittait, on renonçait, on abjurait le monde où l'on avait reçu sa première naissancce pour se vouer totalement à l'Église où l'on prenait comme sa seconde naissance: et ainsi on concevait un différence épouvantable entre l'un et l'autre," ibid., 4:55.

[62] "On n'y était admis qu'après un examen très exact," ibid., 4:54.

[63] "[O]n se trouve maintenant presque au même temps dans l'un et dans l'autre; et le même moment qui nous fait naître au monde nous fait renaître dans l'Église. De sorte que la raison survenant ne fait plus de distinction de ces deux mondes si contraires. Elle s'élève dans l'un et dans l'autre tout ensemble. On fréquente les sacrements, et on jouit des plaisirs de ce monde," "Comparaison," ibid., 4:55.

[64] Chosenness does not, of course, always prompt such laxity. Most famously, Weber argues that for Calvinists, hard work was a way of proving that a person was, in fact, one of the elect, Max Weber, *The Protestant Ethic and the Spirit of Capitalism*, trans. Stephen Kalberg (New York, 2009), chapters 4 and 5, 101-159.

[65] "[E]lles sont maintenant dans une ignorance qui fait horreur," ibid., 4:55.

preempts any need for in-depth instruction: "one is persuaded of the necessity of baptism, and not of the necessity of instruction."[66]

Pascal's *Comparaison* and His "Baptism" as a Savant

Pascal's treatment of the question of infant baptism and catechetical instruction suggests certain parallels with the process by which he became a legitimate part of the learned community and the writings (such as the preface to the treatise on the void and the writings on the arithmetic machine) that articulate his status as savant. Pascal's description of the presumption of those baptized into the Catholic Church is not unlike that which is possessed by individuals who would eschew instruction of any sort in the sciences while still hoping to be considered savants. To leave intellectual inclinations unrefined through lack of instruction was, for Pascal, to promote remaining in a childish state of ignorance. Pascal and Huygens endured an examination, even if informal, to merit the endorsement of Mersenne and others. Pascal's playroom discovery of geometry led to his "baptism" into the company of the learned cohort gathered together in Paris. His writing of the *Essai pour les coniques* was his confirmation as a mathematical catechumen. In his attempts to legitimate himself as a mathematician, the contrasts of child/adult and beast/human demonstrated his consciousness that his own natural talent would not suffice to qualify him as full-fledged mathematical savant. His mathematical training was a model for his understanding of Christian instruction.

Positive and Negative Views of Childhood in the Intellectual Realm

In the realms of the mind and faith in the seventeenth century, there were two distinctive dimensions of childhood; one was admirable, the other was to be left behind. There was the conception during that period of a type of pristination of the mind prior to any type of education.

[66] "[O]n est persuadé de la nécessité du baptême, et on ne l'est pas de la nécessité de l'instruction," ibid., 4:59.

Although Locke had not yet presented the modern articulation of *tabula rasa*, the idea had been expressed by Aristotle, Avicenna (ibn Sina), and Aquinas.[67] And many who had experienced the typical educational system in the seventeenth century, most notably Descartes, considered that this system had done more harm than good.[68] Similar to Pascal's expression of the sullying influence of the world on a child, the influence of schools was often seen as corrupting young minds. Hence, the method of self-instruction was intended to bypass the influence of the "world" on the genius of the child.[69] Indeed, Descartes' method of doubt was a chronological retrogradation of the intellect when he, sitting in front of his fire, sought to undo the various assumptions and conclusions he had previously made about the world.

In spite of Descartes' return to an innocent state, not yet spoiled by false opinions, his purposeful return to childhood was not complete. According to Descartes, the childlike void of the mind had to be coupled with a mature judgment of the senses. The child's interpretation of the world and his use of intellect were unreliable. Most of the errors in philosophy, argued Descartes, began in childhood.[70]

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[67] A brief summary of the historical background to the early modern *tabula rasa* idea is in Neal Wood, "Tabula Rasa, Social Environmentalism, and the 'English Paradigm,'" *Journal of the History of Ideas* 53 (1992), 650-665. Avicenna's theory of knowledge is in his *De anima*.

[68] In his *Principles of Philosophy*, Descartes writes: "most of those who have attempted to be Philosophers in recent centuries have blindly followed Aristotle in such a way as to often corrupt the sense of his writings by attributing to him diverse opinions which he would not recognize as his own if he returned to this world. And those who have not followed him (among whom were many of the best minds) were nevertheless immersed in his opinions in their youth (because these are the only ones taught in the schools), which prejudiced them to such an extent that they were unable to attain knowledge of the true Principles, Descartes, *Principles of Philosophy*, xx.

[69] Descartes' *Discourse on Method* has as one of its major concerns the rejection of instruction of the schools in favor of self-education, with Descartes presenting his own biography as an example, René Descartes, *Discourse on Method* and *Meditations on First Philosophy*, trans. Donald A. Cress (Indianapolis, 1993), 3-6.

[70] Paragraph 71 of Descartes's *Principles of Philosophy* is headed "That the principal cause of errors proceeds from the prejudices of our childhood." Descartes argues that the reason for these errors is the inability of the child to separate thought from bodily experience. As an example of childhood error, he cites the belief that the stars are no larger than the candles, since they appear only so large to the eye, Descartes, *Principles of Philosophy*, 33.

Pascal agreed with Descartes on the basic weakness of the child's intellect. A child's thoughts, they both maintained, were formed primarily through habit and not through ratiocination. The child is hampered, they suggested, by a quantitative lack of experiences. Pascal's preface to the treatise on the void indicted the institutions of his day for revering the ancients too much, thus exalting the data-deprived "childhood" of humanity.[71] Contemporaries, he added, had the benefit of the accumulation of experiences that leads to more perfect knowledge.

Pascal's view of the ancients was not uncontested. For many during the sixteenth and seventeenth centuries the ancients typified old age because they possessed wisdom and knowledge that had survived the passage of time and had proven superior to the knowledge passed on from the Middle Ages.[72] In addition, the language of *renaissance* as a label for the complex of intellectual developments that drew inspiration from the rediscovery of ancient writings suggests a return to a childhood, innocent of the corrupting influences that covered the true wisdom of earlier days of humanity.

Thus, in the realm of knowledge, childhood had metaphorical connotations of both ignorance and innocence during the seventeenth century. Both dimensions were based on lacking something. Childhood was ignorance because it had not had the opportunity to accumulate the experiences that can only occur in time. It is on this state of ignorance and

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[71] "Le respect que l'on porte à l'antiquite étant aujourd'hui à tel point, dans les matières où il doit avoir moins de force, que l'on se fait des oracles de toutes ses pensées, et des mystères même de ses obscurités," "Préface sur le traité du vide, Mesnard *OC*, 2: 777. "Cependant il est étrange de quelle sorte on révère leurs [ancient authorities'] sentiments. On fait un crime de les contredire et un attantat d'y ajouter, comme s'ils n'avaient plus laissé de vérités à connaître," ibid., 781.

[72] The problem is theologically complex, considering questions of the status of the first man's knowledge before and after the Fall. Peter Harrison draws attention to how the emergent natural philosophy of the sixteenth and seventeenth centuries was indebted in its motivations and methods to ideas about the effects of the Fall, Harrison, *The Fall of Man and the Foundations of Science* (New York, 2007). As one example of an appeal to biblical antiquity, hermeticism drew on the notion of the perfection of Adam's knowledge, emphasizing an unbroken tradition with his pristine understanding, ibid., 117-119.

immaturity that Pascal focused in his preface to the treatise on the void and which is closely related to his characterization of the artisans of Rouen as like beasts trained only through habit. As a young and talented savant, he desired to make a clear claim that his successful inventions and experiments were not the result of chance. They were the result of hard work, determination, and training in specific types of knowledge. The efforts that he put forth and his training in mathematics demonstrated that though he had inclinations for such work, he became validated through his strivings toward perfection.

On the other hand, the seventeenth century vision of childhood included its innocence. It lacked the pollution of false teachings by authority. In the realm of natural philosophy, many disbelieved in the void because their education had taught them that it was impossible. In order to explore the question, however, it was necessary to retreat to the untaught position of the child in order to evaluate the experiences presented.

This connotation of innocence was important for self-education through both books and experiences. It was the type of innocence that Desargues attempted to maintain by claiming that he had taught himself geometry through books, that he never had a master. It was also a key aspect of Pascal's own education by his father, who apparently believed that mathematics had the potential to cripple the rest of his son's education.

Pascal's *Comparaison* and the Spiritual Duality of Childhood

In spiritual matters the two aspects of childhood were even more clearly delineated. Whereas Jesus proclaimed little children as the heirs to the Kingdom of Heaven and commended childlike faith, Paul the Apostle taught that Christians were supposed to grow up and be mature, no longer sustaining themselves on spiritual milk, but on the "meat" of important doctrinal issues. Pascal's *Comparaison des chrétiens*, as has been shown, includes elements of both of these aspects of childhood. In one sense, infant baptism is considered by Pascal to be a

preservation of the innocence of childhood. Pascal's emphasis in his *Comparaison* is the way that the child's reason is safeguarded from its corrupt use. Innocence, for Pascal, was also ignorance: "an ignorance of the world."[73] But Pascal did not stop there, for the godfather of the child was also obligated to remove that child's ignorance of spiritual things, a task that, if he failed to do it, would leave the child in "an ignorance that provokes horror."[74] As the child's reason began to be put to use, it was to be given a "full instruction in the mysteries of religion," which is a key aspect of protecting the child from falling away from the faith.[75] Childlikeness was a positive characteristic when it signified the uncorrupted use of reason (and distance from the vices of the world) but childishness in a baptized believer who is bereft of understanding of the "grandeur of our religion" is a tragic flaw.[76]

Childhood Innocence and the Correction of Inclinations: Jacqueline's *Règlement pour les enfants*

Dual Nature of Childhood in the *Reglement*

The contrast between these two types of childhood is also evident in Jacqueline Pascal's account of her instruction of young girls at the Port-Royal convent.[77] Though technically not a part of the educational experiment of the *petites écoles*, the education of novices drew from the same sources of inspiration as the schools established for the sons of the associates of Port-Royal. Jacqueline's close relationship with her brother through the end of her life and the depth of her involvement in Port-Royal suggest that her views on the education of the young likely

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[73] "Comparaison," Mesnard *OC*, 4:57.

[74] Ibid., 4:55.

[75] "[O]n ne les y admettait qu'après une pleine instruction des mystères de la religion," ibid., 4:58.

[76] "[I]l arrive que la négligence des parents laisse vieillir les chréstiens sans aucune connaissance de la grandeur de notre religion," ibid., 4:59.

[77] The full text of what Jean Mesnard calls the "Règlement pour les enfants" is in Mesnard *OC*, 3:1135-1198.

informed those of her brother and reflected those of the religious community of which she was a part and with which he was closely associated. The *Règlement pour les enfants*, written in 1657, is focused particularly on the shaping of these young girls through a correction of inclinations. This emphasis is understandable, since the little piece is about the active role that the older nuns play in the girls' spiritual development.

However, Jacqueline's rule also gives indications of understanding childhood as synonymous with innocence. In her instruction to others who are in the position of overseeing these girls, she calls their charges "these innocent souls" and "sacred deposits that he [God] has entrusted to us, and for which he will make us render an account."[78] This reminder of the accountability of teachers for youngsters resonates with Jesus' warning that it would be better to be thrown into the sea millstone-laden than "cause one of these little ones to sin."[79] Furthermore, Jacqueline explains that during the past year she had given particular attention to teaching the girls "how much Christians are obligated to preserve the innocence of their baptism."[80] Thus, she recognizes and places importance on the association of childhood with preservation from sin. For Jacqueline, oversight and discipline were keys to overcoming natural fallenness.

The dual nature of childhood is most clearly summed up in a piece appended to Jacqueline's "rule for children." Published in 1665 under the title *Image d'une religieuse parfaite et d'une imparfaite*, this piece, made up of various prayers, was probably not written by Jacqueline. It reflects, however, the spirit of Port-Royal and, as Mesnard writes, has "some

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[78] "[N]ous devons toujours regarder ces petites âmes comme de sacrés dépôts qu'il nous a confiés, et dont il nous fera rendre compte," "Règlement," Mesnard *OC*, 3:1164.

[79] Luke 17.2, RSV.

[80] "[J]e l'ai toute employée à la pénitence, . . . insistant particulièrement sur les endroits qui font voir combien les chrétiens sont obligés de conserver l'innocence de leur baptême," "Règlement," Mesnard *OC*, 3:1155.

likelihood of respecting the ideas and practices of Jacqueline, even of being based on other writings that she had left behind."[81] This prayer offers the contrast between childhood innocence and childhood ignorance succinctly:

> Make us, Lord, to always be children through simplicity and innocence, as people in the world are so through ignorance and weakness. Give us a holy childhood, which the course of the years cannot remove from us, and from which we will never pass into the old age of the ancient Adam, or into the death of sin.[82]

In this prayer, childhood is characterized by simplicity, innocence, ignorance, and weakness. The former two are associated with the faithful believer's willingness to trust and with inexperience in vice.[83] The latter two refer to the lack of knowledge of the Creator and an inability to perform the works that God requires. This piece suggests that Jacqueline and (by extension) Port-Royal, were concerned that those within the earliest years of their physical life should cultivate a "holy childhood." Adulthood and old age were tied to Adam. In this case, as opposed to Pascal's use of the ancients in his preface, the earliest of men was linked with old age, probably because of the introduction of death through his sin. This association is in line with Paul's denotation of Adam as representing the "old man," and sinful nature, while Jesus Christ is the "new man," the means by which believers experience the "new birth" and enter a second childhood of innocence.

Natural Inclinations and Discipline in the *Reglement*

With respect to childhood and natural inclinations, as has already been suggested, Jacqueline was decidedly in favor of a basic suspicion of inclinations and their correction:

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[81] "Les addition ont cependant quelques chances de respecter les idées et la pratique de Jacqueline, voire de reposer sur d'autres écrits qu'elle aurait laissés," Mesnard *OC*, 3:1136.

[82] "Faites, Seigneur, que nous soyons tousjours enfants par la simplicité et l'innocence, comme les personnes du monde le sont toujours par l'ignorance et par la faiblesse. Donnez-nous une enfance sainte, que le cours des années ne nous puisse ôter, et de laquelle nous ne passions jamais dans la vieillesse de l'ancien Adam ni dans la mort du péché," "Règlement," Mesnard *OC*, 3:1197.

[83] "Brethren, do not be children in your thinking; be babes in evil, but in thinking be mature," 1 Cor. 14.20, RSV.

> One tries to accustom the children to mortify themselves, and not at all to follow their inclinations, by attaching themselves to one work rather than another.[84]

For Jacqueline, the tendency of children to follow their inclinations without question is particularly pervasive and pernicious, and one of several specific faults of childhood that Jacqueline mentions throughout her writing. The principle of putting away one's natural bent toward a specific subject, which Jacqueline articulates, was one of the keys to Étienne Pascal's original strategy for Blaise's education. The elder Pascal sought to "mortify" his son's interest in geometry by leaving him ignorant of its content. He knew, according to Gilberte, the consuming nature of such studies and so did not want him pursuing it at the expense of linguistic pursuits. Jacqueline's emphasis on the mortification of natural inclination was more spiritual than intellectual, however. Because of original sin, without vigilant attention, she says, that to which one is naturally drawn inevitably leads to sinful behavior. Such vigilance requires the knowledge of the natural inclinations of the children.

In Campanella's *City of the Sun*, children's talents were judged by their teachers to determine how they should spend their lives. Jacqueline's *Règlement pour les enfants* likewise places a burden on the preceptor to be observant of their pupils:

> A continuous vigilance to consider them and recognize their humor and their inclination are necessary, in order to learn by considering them what they do not have the power to reveal to us themselves. It is good to anticipate them when one sees that they are ashamed to speak of their unruliness [*dérèglements*] and, in order to give to them more liberty to reveal them, it is good to hide from them in the beginning very many truths that we believe are too strong for their imperfect state.[85]

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[84] "On tâche d'accoutumer les enfants à se mortifier, et à ne point suivre leurs inclinations, en s'attachant plutôt à une ouvrage qu'àun autre," "Règlement," Mesnard *OC*, 3:1143.

[85] "Il faut une continuelle vigilance pour les considérer, et reconnaître leur humeur et leur inclination, afin d'apprendre en les considérant ce qu'elles n'auraient pas la force de nous découvrir. Il est bon de les prévenir, quand on voit qu'elles sont honteuses de dire leurs dérèglements, et, pour leur donner plus de liberté de les découvrir, il est bon de leur cacher à elles-mêmes dans le commencement beaucoup de vérités que nous croirions être trop fortes pour leur état imparfait," ibid., 3: 1172.

This sensitivity to individual readiness is a hallmark of a newly developing understanding of childhood during the early modern period. The emerging consciousness of development has been explored by Philippe Ariès, who gives particular credit to Port-Royal educationalists for promoting it.[86] It is this realization of stages of readiness that was also probably an aspect of Étienne's pedagogical strategies.[87] For Jacqueline, however, only recognition of a child's weakness and an awareness of his inclinations would lead to proper spiritual oversight. For this reason, the insights of teachers into the nature of the child were communicated to others who watched over that child:

> We take some sort of confidence in these sisters who help us, in order to tell them of the inclinations of the children, especially those of the small, and those also of the great who could cause some unruliness, in order that they can better watch over them.[88]

Knowledge of the child was not confined to those in authority. One aspect of the educational strategy communicated by Jacqueline is that the pupils themselves should be instructed to understand their natural leanings, so that those may be turned, through discipline, to their proper use:

> One ought to strongly exhort the children to know themselves, their inclinations, their vices, and their passions, and to dig to the root of their defects. It is good also that they know what their natural [self] carries them towards, in order uproot in themselves what could displease God, and change their natural inclinations into spiritual. To tell them, for example, that if they are of an affective humor they ought to change the love that they have

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[86] Ariès explores this new differentiation between ages and its eventual result, the association of particular ages with particular levels of schooling; see especially Ariès, *Centuries of Childhood*, Part 2, Chapter 4, "The Pupil's Age," 189-240.

[87] Pier Paolo Vergerio the Elder advised parents and teachers to consider the individual differences between children that necessitated individualized curriculum. He especially advocated for teaching subjects one at a time, Benjamin G. Kohl, "Humanism and Education," in *Renaissance Humanism: Foundations, Forms, and Legacy*, ed. Albert Rabil , vol. 3, *Humanism and the Disciplines* (Philadelphia, 1988), 12-13.

[88] "Nous prenons quelque sorte de confianceaux sœurs qui nous aident, pour leur dire les inclinations des enfants, surtout celles des petites, et celles ausi des grandes qui pourraient causer quelque dérèglement, afin qu'elles puissent mieux les veiller," "Règlement," Mesnard *OC*, 3:1162.

> for themselves and for creatures into loving God with all their heart, and likewise for other inclinations.[89]

Once they were aware of what they were, children were enjoined not to rely upon their natural inclinations to lead them in the right path. Such self-centeredness was seen as the path to sin. Rather, Jacqueline contends, they must turn to God. An unquestioning and undisciplined following of inclinations, she states, is antithetical to the freedom from attachment to self which was so prized in Port-Royal spirituality. Thus knowledge of the self and hard work was the means by which the natural inclinations could be controlled and put to proper use. Jacqueline's emphasis of this point is clear from a letter written about six months before the *Règlement*, to a young girl considering becoming a nun:

> This, my dear Maiden, is a type of goods that the fathers of the earth do not give, but we must hope for them from our Father who is in heaven, . . . and we invoke him in truth in order to obtain them, not only by praying but by sincerely working to destroy little by little all the inclinations or bad habits which could be opposed to these virtues in us.[90]

The spiritual novice, like the apprentice mathematician had to work to gain maturity and spiritual learning.

Jacqueline's instruction on the education of her charges agrees with the positions of Bardin and Cureau de la Chambre, since the inclinations were seen as correctable. To simply lean on the natural inclinations was portrayed as improper. As Mersenne argues that *exercice* is necessary to complete what is lacking in natural talent, so in the moral realm (as emphasized by Jacqueline, Bardin, and Cureau de la Chambre) a reliance on one's natural inclinations is the

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[89] "On doit fort exhorter les enfants à se connaître elles-mêmes, leurs inclinations, leurs vices et leurs passions, et sonder jusques à la racine de leurs défauts. Il est bon ausi qu'elles connaissent à quoi leur naturel les porte, afin de retrancher en elles ce qui peut déplaire à Dieu, et changer les inclinations naturelles en spirituelles. Leur dire, par exemple, que si elles sont d'une humeur affective, elles doivent changer l'amour qu'elles ont pour elles-mêmes et pour les créatures, à aimer Dieu de tout leur cœur, et ainsi des autres inclinations," ibid., 3:1168.

[90] "Voilà, ma chère Demoiselle, une espèce de bien[s] que les pères de la terre ne donnent point; mais il faut les espérer de notre Père qui est au ciel, . . . et que nous l'invoquons en vérité pour les obtenir, non seulement en priant mais en travaillant sincèrement à détruire peu à peu toutes les inclinations ou les mauvaises habitudes qui pourraient s'opposer à ces vertus en nous," Jacqueline Pascal to ***, 3 October 1656, Mesnard *OC*, 3:960.

pathway of vice, which can only be overcome through effort. Therefore, Pascal's insistence that he had moved past mere habit, instinct, and natural inclination, was not simply an establishment of personal qualifications. It was a principle of intellectual and moral integrity.

The ultimate goal of all of the instruction advocated in Jacqueline's handbook was spiritual, but it reflects a trend in pedagogical innovation. She and her fellow nuns did not treat children as mere passive vessels, identical and waiting to be filled, but accounted for individual differences.[91] While rejecting a path following the slope of natural inclinations, it did not ignore them completely; it sought to reshape them to what was judged to be their proper ends.

From Pupil to Pedagogue: Pascal's Educational Contributions and the *Petites Écoles* of Port-Royal

Jacqueline was directly involved in the education of girls at the convent, while her brother participated informally in educational endeavors. His participation demonstrates a clear shift in the understanding of his vocation. In the first place, he was the godfather of a boy named Blaise Bardout, for whom he provided a sum of money in his will for apprenticeship in a trade, and with whom he may have put into practice his pleas for proper education of godchildren.[92] Both Jacqueline's *Règlement* and Blaise's endorsement of proper catechetical training in his *Comparaison des chrétiens* are in harmony with the concern for the spiritual nurturance that was the final goal of Port-Royal's *petites écoles*.[93]

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[91] Ariès, *Centuries of Childhood*, 27-28.

[92] For the mention in the will, see "Testament de Pascal," Mesnard *OC*, 4:1509. Some scholars have mistakenly believed that he was also the godfather of his nephew, Blaise Périer. However, the baptismal record clearly indicates, as Jean Mesnard shows, that the Blaise Pascal who was Périer's godfather was "secrétaire du roi," and thus the first cousin of Étienne Pascal, Mesnard *OC*, 2:999. No documents have, to date, been discovered indicating the place of birth, parents, or subsequent life of Blaise Bardout.

[93] Delforge reinforces the importance of the entire community of like-minded individuals would have contributed to the project of the schools: "At Port-Royal education is which the masters participate, but also the Solitaires, the religious, the servants, and the friends of Port-Royal. Understandably, it is not appropriate to place these educators on the same plane; but all are united by a common vision of education and through the same desire to do what was

Spiritual Work at the *Petites Écoles*

Port-Royal began the project of the *petites écoles* in 1637 with the combined intellectual and spiritual training of a handful of upper-class boys at the group's convent in the country. [94] Soon after, the pupils moved to a second convent in Paris; there were eventually groups of teachers and students in both locations. The boys, taught by the male *solitaires* associated with and living at Port-Royal, were sent to these schools in order to avoid the defects of other types of education, including education by parents and in the Jesuit colleges.[95] The "little schools" of Port-Royal have been credited with an influence on educational theory and practice far beyond what their short duration and small number of pupils might suggest. Port-Royal is credited, among other achievements, with inspiring education in the vernacular and with providing a number of textbooks (e.g., the *Grammaire* and the *Logique*) that would be used for many years to come.[96] Ariès credited Port-Royal's schools as one of the key moments in the emergence of a view of children as different, distinct as an age-group and as individuals.[97]

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in their power to educate correctly the children for which they feel responsible in one way or another," Delforge, *Les petites écoles*, 173.

[94] A primary source concerning the Port-Royal *petite écoles*, which I have been unable to consult, is Pierre Coustel, *Les regles de l'éducation des enfans*, 2 vols. (Paris, 1687), a very rare published work that gives a retrospective view of the philosophy and operation of the schools during Pascal's lifetime. Another primary source that mentions a number of informal conversations and episodes dealing with key players, including Arnauld, Nicole, and Pascal is *Receuil de Choses Diverses*, a manuscript of which is at the Bibliothèque Nationale, Paris, nouvelles acquisitions française, 4333. It has recently been published in a critical edition, Lesaulnier, ed., *Port Royal Insolite: Édition Critique de Receuil Choses Diverses*. The definitive secondary source on the history and the significance of the *petites écoles* is Delforge, *Les petites écoles*. See also Barnard, *Little Schools of Port-Royal*; Nicholas Hammond, *Fragmentary Voices: Memory and Education at Port-Royal* (Tübingen: Narr, 2004).

[95] Pierre Coustel mentions the possible dangers associated with educating children at home in Coustel, *Règles de l'éducation des enfans*, quoted in Delforge, *Les petites écoles*, 162. Nicholas Hammond argues that the *petite écoles* were consciously opposed to Jesuit colleges, Hammond, *Fragmentary Voices*, 54-55; cf., Delforge, *Les petites écoles*, 163.

[96] "Through Rollin, the Port-Royalists inspired the University; their use of the vernacular was adopted by S. Jean-Baptiste De La Salle and has since become universal; their treatises were 'devoured' by Rousseau; their cultivation of their mother-tongue laid the foundations of modern French prose; their school-books have been in use down to our own days, not only in France, but in several other European countries," Barnard, *Little Schools of Port-Royal*, 4.

[97] Ariès, *Centuries of Childhood*, 27-28.

Jacqueline's female charges would not have been a part of the *petites écoles,* but the education of the young girls also took place under the influence of the abbé of Saint-Cyran, whose writings had so affected the lives of the Pascal family in Rouen. Port-Royal's schools were envisioned by Saint-Cyran and inspired by his "general inclination for all children," and the recognition that "they are very pure through the innocence and the grace of baptism."[98] However, innocence was accompanied by weakness and the possibility of being led astray by natural inclinations or bad habits.[99] As such, the boys and girls of Port-Royal were treated with respect for their purity before God, understanding for their weakness, and the strong discipline that would save their souls. Ultimately, Port-Royal's educational endeavors were "a matter of education 'in Christ.'"[100] The goal of the work was the salvation of souls and the cultivation of lives lived entirely for God.[101]

Intellectual Training at the *Petite Écoles*

The *petites écoles* were to be places that primarily promoted spiritual maturity, but the formation of the intellect played a role in this process. The organizers and educators of the schools consciously "ride on a current of pedagogical innovation" propelled by the likes of

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[98]Jean Duvergier de Hauranne to Princesse de Guéméné, n.d. [January 1642], in Duvergier de Hauranne, *Lettres inédites*, 265.

[99] Jean Duvergier de Hauranne to Monsieur David, n.d. [1640], in Duvergier de Hauranne, *Lettres inédites*, 56.

[100] "For it is indeed a matter of education 'in Christ'. It is in Jesus Christ that the educators of Port-Royal find the source, the path, and the finality of education. They think and they live the educational work in reference to Jesus Christ. They affirm unceasingly this fundamentally Christian character of their pedagogy. For the coherent educational system that they build, they find (or aim to find, for all is not always so simple) solid biblical and patristic foundations. They want education (and moreover all that concerns human life) to be connected directly and exclusively to Jesus Christ. It is from this perspective alone that they judge the value of the masters, educational means, of the whole science of education," Delforge, *Les petites écoles*, 351-352.

[101] H. C. Barnard describes Port-Royal's education work as "a desparate attempt to save souls," Barnard, *French Tradition in Education*, 182. Delforge writes: "If the students of the Petites Écoles lives in a closed world, in a closely supervised universe, it is in order to better root them in the faith; this will permit them then to face, spiritually and intellectually, the most serious realities of the world in which it is necessary to testify [of] the Living God, incarnate in Jesus Christ," Delforge, *Les petites écoles*, 351.

Erasmus, Ramus, and Montaigne.[102] Their goal for the intellectual development of their pupils was to enable them to read and understand a variety of texts, including mathematics and physics.[103] All that was needed of the technical subjects was a "rough understanding."[104] To delve too deeply into them would be to keep from engaging with more diverse texts from non-mathematical or scientific authors. In this way, the training of the *petites écoles* involved helping the child to develop beyond the limited scope that would ostensibly result if left to their own devices.

The relationship between attitudes about natural talent, pedagogical methods, and generality of education also impinged upon the growing importance of the sociability of knowledge. The *petites écoles* were highly influenced by the *conférence*, as were the proceedings at Mersenne's "academy."[105] This key development within the seventeenth century helped to reinforce the idea that following one's own whims in a particular subject was not as profitable as engaging in the give and take of discussion.

There was a growing concern during the seventeenth century for the simplicity of expression in the conference, the ability to communicate with others, and a concern for the limits of technical jargon. Pascal's interlocutor in the *Provincial Letters* makes this argument with the theologians who, he claims, have resorted to a use of language that contradicts the way that

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[102] Delforge, *Les petites écoles*, 352.

[103] Ibid., 314.

[104] Mathematics is one of "these particular sciences which it is necessary that the children have at least a slight tinge and a rough understanding," Pierre Coustel, *Regles de l'education des enfans,* quoted in Delforge, 315.

[105] Delforge, *Les petites écoles*, 322. William Ritchey Newton's notion of a "Société de Port-Royal" is dependent on the sociable interactions that would have taken place during spiritual and intellectual conferences. This model of social interaction is particularly important for the mingling of those who are official *solitaires* and those who are only friends of the convent, W. R. Newton, *Sociologie de la communauté de Port-Royal: histoire, économie* (Paris, 1999), 140-141. The conference was important as an emerging form of sociability during the seventeenth century, Simone Mazauric, "Structures et formes de la sociabilité académique parisienne dans la première moitié du XVIIe siècle," *Cahiers d'histoire de l'Institut de recherches marxistes* 59 (1995): 27-45.

words are understood by all people in "le monde." Furthermore, the efficacy of the conference for the advancement of knowledge eroded the privileged position of one who had a special disposition or *génie* for a particular subject. It is not that such talent was thought not to exist or be efficacious, but it was considered to be subject to the necessity for improvement based on interactions with others. Thus, Pascal exhibited his genius for geometry through his independent discovery of one of Euclid's theorems. But his position as an Archimedes was cemented while in the company of his father's friends in Mersenne's cell.

Pascal's Work with the *Petites Écoles*

A pedagogical turning point

Pascal was indirectly involved in the project of these "little schools," as the opening anecdote of this chapter illustrates. His expression of interest in pedagogical materials and methods demonstrates that a shift was occurring in his life at this time. With his ties to Port-Royal strengthening during the mid-1650s, Pascal no longer played the part of the child prodigy seeking to legitimate himself and his work by appealing to his studies and efforts. Having redefined himself according to a desire for devout living in the manner of the Jansenists, he was reconsidering the various aspects of inclination and effort, ignorance and innocence. He shifted his attention, in part, to the goal of cultivating another generation by deploying methods that he had practiced in his career.

The previous sections of this chapter suggest this pedagogical shift and Pascal's reflections on childlikeness and maturity in the context of what may be referred to broadly as teaching. In his *Provincial Letters* and the little work on baptism Pascal stressed the importance of living a life of childlike innocence, but also of escaping the ignorance of childhood through instruction. In the *Provincial Letters*, he mocked the Jesuits for the so-called learning that would allow them to transgress against common sense, the rules of geometrical definition, and morality in their

teaching of others. These Jesuits, who presented themselves as masters, were inferior to their pupils. According to Pascal's reflections, the naïve, child*like* investigator who was willing to ask intelligent questions could trump the child*ish* "experts" who babbled their equivocal words. Common-sense thinking was a means by which abstruse religious difficulties could become clear. In his *Comparaison des chrétiens*, Pascal also reflected on the importance of education for the Christian, now seeking to reemphasize the differentiation between a child*like* baptismal innocence and a child*ish* ignorance of the mysteries of the Christian religion. In both cases intellectual maturity and childlike purity were paired together.

Whereas the *Comparaison des chrétiens* focused on Pascal's interest in specifically Christian instruction, his involvement in the work of Port-Royal's *petites écoles* demonstrates a more wide-ranging pedagogical engagement. The *petites écoles* were at their high point during the time of Pascal's most intimate connection to Port-Royal. Frédéric Delforge, historian of these schools, has divided their development into three stages: "La Création" (1636-1647); "L'Affermissement" (1646-1655); and "L'Achèvement" (1656-1660). According to Delforge, the period of "maturity and dynamism" of the middle years was interrupted by the short dispersion in March 1656 and then proceeded to expand and be fruitful for several years more until the 1660 dispersion.[106] Pascal became a participant in certain aspects of the operations and vision of the *petite écoles*. His contributions to the project demonstrate his desire to improve upon natural ignorance through the instrument of geometry. Alongside his *Comparaison des chrétiens*, they also reiterate the ultimate goal of these schools: the preservation of baptismal innocence.

[106] See above, p. 243.

Pascal, contributor to textbooks

The first evidence of Pascal's pedagogical efforts is in a letter written from Jacqueline to her brother in October 1655, less than a year after his "Night of Fire" and just months prior to the writing of the first of the *Provincial Letters*. In her letter, Jacqueline refers to a method that her brother had apparently shared with her of teaching children how to read.[107] The method advocated introducing the letters to children according to the way they are pronounced rather than the formal names of those letters. Jacqueline's correspondence simply suggests the basics of the method of putting the pronunciation of letters together to form words and asks several questions regarding difficulties raised by this method. But it does make clear that the authorities of Port-Royal were aware of Pascal's ideas in this area, for she writes:

> Our Mothers have commanded to write to you in order that you tell me all the circumstances of your method to read by *be, ce, de,* etc., in which the children do not have to know the names of the letters.[108]

The method that Jacqueline describes as originating with her brother is given in further detail in the 1660 *Grammaire de Port-Royal*, written by Antoine Arnauld and Claude Lancelot, two of the most important masters of the *petites écoles*.[109] According to Jean Mesnard, Jacqueline's letter and the excerpt from the grammar are "[f]ormal proof of the attention given by Pascal, soon after his conversion, to questions of pedagogy raised to him by the masters of the *petites écoles*."[110]

In a similar manner, Pascal's discussions with Arnauld about the best way to teach geometry led Blaise to produce an *Éléments de géométrie* for this purpose. Pascal's work never

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[107] Jacqueline Pascal to Blaise Pascal, 26 October 1655, Mesnard *OC*, 3:439-440.

[108] "Nos Mères ont commandé de vous écrire afin que vous me mandiez toutes les circonstances de votre méthode pour apprendre à lire par *be*, *ce*, *de*, etc. où il ne faut point que les enfants sachent le nom des lettres," ibid., 3:439.

[109] Anon, *Grammaire générale et raisonnée* (Paris, 1660). The method of reading is given in Part One, Chapter VI, "D'une nouvelle maniere pour apprendre à lire facilement en toutes sortes des Langues."

[110] J. Pascal to B. Pascal, 26 October 1655, Mesnard *OC*, 3:438.

saw the light of day, since Arnauld wrote his own *Nouveaux éléments de géométrie* and Pascal, considering his own inferior, burned it.[111] Its introduction, however, remained, and Leibniz has preserved a fragment in his notes.[112] The fact that this work was not officially used by Arnauld or the *petites écoles* does not lessen its significance as a sign that Pascal was in the process, thanks to his friends at Port-Royal, of reflecting on the means by which particular fields of knowledge were best acquired and how they were to be used in a full-fledged program of training for children. Pascal made intellectual contributions to another textbook, *La logique de Port-Royal*, which acknowledges Pascal's "De l'esprit géométrique" as the source of some of its material. Arnaud sought, says one of the key twentieth-century Pascal scholars, to "make of geometry the effective instrument of a rational pedagogy."[113] Pascal's attempts to lay down rules, according to which proper and convincing arguments may be constructed, assisted in this goal of Arnauld and Port-Royal's schools. Published just weeks before Pascal's death, the first edition of *La logique de Port-Royal* briefly mentions the contributions of "vn excellent esprit," while later editions, beginning in 1664, name him explicitly.[114]

Pascal's involvement with the project of the *petites écoles* was, finally, in the service of a goal of developing people who would be well-rounded and trained for holy living. Pascal's previous experience as a mathematician resonated with Nicole's and Arnauld's beliefs in the

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[111] The story, its dubious origins, and the relationship between Pascal's and Arnauld's treatises are recounted in Delforge, *Les petites écoles*, 346.

[112] The fragment preserved by Leibniz is in Mesnard *OC*, 3: 435-437. The original or copy from which Leibniz copied the fragment has not been found.

[113] Brunschvicg, *Blaise Pascal*, 156.

[114] "On en a aussi tiré quelques autres d'vn petit Escrit non imprime, qui avoit esté fait par vn excellent esprit, & qu'il avoit intitulé, *De l'esprit Geometrique*," Antoine Arnauld and Pierre Nicole., *La logique ou l'art de penser* (Paris, 1662), 18. Arnauld points to the specific portions of the text that are drawn from Pascal, ibid., 105-110; 378. Editions following Pascal's death include the following wording: "un petit écrit, qui avait été fait par feu M. Pascal," Antoine Arnauld and Pierre Nicole, *La logique ou l'art de penser*, ed. Charles Jourdain (Paris, 1992), 15.

possibility of mathematics to exercise and perfect the mind, leading to the "good life," as Matthew L. Jones has argued.[115] And yet, as Pascal makes clear in his "De l'esprit géométrique," there are axioms and truths that transcend mathematical proof. Pascal's years of practicing geometry as his *métier* were over. His attention now turned to the problems of the human situation, not the least of which was the training up of young minds. His own experience as one burdened by natural talent prepared him to teach those whose temporal greatness required a special diligence in instruction.

Final Contribution to Pedagogy: Pascal's "Discourses on the Condition of the Great"

At about the same time as Pascal's watchful care of the dispersed students of the *petites écoles*, he expressed his pedagogical interest through several discourses delivered to "a child of great condition."[116] The content of these discourses, aided by memory and written sources, was recorded by Pierre Nicole in part of his *De l'éducation d'un Prince* (1670).[117] Nicole's personal interactions with Pascal allowed him to recount Blaise's passion for such a project of education:

> One of the things on which the late M. Pascal had more views was the instruction of a prince that one would try to raise in the way most proportionate to the state to which God called him, and the most appropriate to render him capable of fulfilling all the duties of it and of avoiding all the dangers. He was often heard to say that there was nothing to which he desired more to contribute if he was engaged in it, and that he would willingly sacrifice his life for such an important thing.[118]

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[115] Jones, *Good Life in the Scientific Revolution*, 50.

[116] "[I]l est venu dans l'esprit d'une personne qui a assisté à trois discours assez court qu'il fit à un enfant de grande condition," Pierre Nicole, *De l'education d'un Prince, divisee en trois Parties, dont la derniere contient divers Traittez utiles à tout le monde* (Paris: Charles Savreux, 1670), 270. The discourses are recorded under the title "Discours de feu M. Paschal sur la condition des grands," ibid., 269-285.

[117] Nicole assures the reader that although it may not be true "that these are the words that Pascal himself used then . . . these are at least his thoughts and his sentiments," ibid., 271. Nicole does not place his own name on the title page and the privilege for the book is issued to "sieur de Chanteresne." Mesnard believes it possible that the *Discourses* are based on the expansion of some *Pensées* dealing with those of high position, Mesnard *OC*, 4: 1013-1026.

[118] "Vne des choses sur laquelle feu M. Paschal avoit plus de veuës, estoit l'instruction d'un Prince que l'on tâcheroit d'élever de la maniere le plus proportionée à l'estat où Dieu l'appelle, & la plus propre pour le rendre capable d'en remplir tous les devoirs & d'en éviter tous les dangers. On luy a souvent ouy dire qu'il n'y avoit rien à

Probably intended for the marquis d'Albert, future duke de Chevreuse and son of the duke de Luynes, Pascal's discourses are reminiscent of his letter written to Queen Christina some eight years earlier.[119] As with the letter to Christina, Pascal is concerned in this piece with the contrast between greatness conferred by the circumstances of birth, and greatness that is merited through developed qualities that are worthy of esteem. Pascal praised Christina because she not only possessed the favor of a high birth, but also had exerted the requisite effort to be recognized as a person with a great mind. In the *Discours*, Pascal emphasizes that those who, like the marquis, have been favored with a privileged birth, must not rely upon this as a justification for respect. It is a grave error, Pascal argues, to believe being born into a particular family gives one a legitimate claim to superiority. The path by which one comes to be born at a specific time and place is littered with chance meetings and marriages. The greatness that comes from birth, he insists, is instead that of a "greatness of establishment" [*Grandeurs de l'establissement*].[120] It is only because there has been a decision for temporal goods and power to pass to the son that a chance birth yields wealth and influence. This decision is one that is utterly free and entirely based upon the contingencies of human government.

Pascal contrasts "greatnesses of establishment" with what he terms "natural greatnesses." These "consist in true and effective qualities of the soul or of the body, which make one or the other more estimable."[121] In this case, unlike the references to natural inclinations mentioned previously in this study, Pascal uses the term "natural" to describe particular qualities, not

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quoy il desirât plus de contribuer, s'il y estoit engagé; & qu'il sacrifieroit volontiers sa vie pour une chose si importante," Nicole, *Education d'un prince*, 269-270.

[119] This is the opinion of Léon Brunschvicg, who follows that of Havet, Brunschvicg *OC*, 9:363-364.

[120] Nicole, *Education d'un prince*, 278-279.

[121] "Les Grandeurs naturelles, sont celles qui sont indépendantes de la fantaisie des hommes, parce qu'elles consistent dans des qualitez reelles & effectives de l'ame ou du corps, qui rendent l'un ou l'autre plus estimables, comme les sciences, la lumiere de l'esprit, la vertu, la santé la force," ibid., 279.

considering the means by which these are acquired, but the means by which they are judged great. He argues that virtue, skill, and learnedness have a God-ordained connection with the granting of respect to those who possess them. God's sovereign plan is that those who have these qualities should be esteemed. The most important of these "natural" qualities, according to Pascal, is that of being an *honnête homme*, a man of well-rounded skills, virtue, and the ability to communicate. But also among those characteristics that merit natural recognition is the skill of being a geometer.[122] In neither of the two particular qualities that Pascal mentions, *honnêteté* and geometry, does he make clear whether such traits are naturally acquired. Nevertheless, it is necessary, in order to demand the esteem that is required for these "natural greatnesses," that one demonstrate those qualities, whether through fine conversation or through the solution of a geometrical problem.[123] Some sort of exercise is necessary. The type of "natural" respect that is associated with these qualities may not, Pascal states, be accorded merely on the basis of a high birth.

In this moral lesson to the young marquis, then, Pascal attempts to make clear the limitations of what were, he believed, sometimes erroneously considered the natural possession of the highly born. Indeed, the very "gift" of such a birth has, according to Pascal's analysis, specific "defects to which greatness tends toward."[124] A belief in an overarching superiority based only upon chance events of nativity encourages the individual to ignore the more estimable

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[122] "La geometrie est une grandeur naturelle, elle demande une preference d'estime, mais les hommes n'y ont attaché aucune preference exterieure," ibid., 281.

[123] "[J]e vous prierois de me monstrer les qualitez qui meritent mon estime, si vous le faisiez elle vous est acquise, & je ne vous la pourrois refuser avec justice; mais si vous ne le faisiez pas, vous seriez injuste de me la demander," ibid., 282.

[124] "Ces trois petits discours avoient pour but de remedier à trois defauts ausquels la grandeur porte d'elle-même," ibid., 271. This phrase is from Nicole's summary of the three discourses.

qualities of virtue and intellect, so that "they do not try to acquire them."[125] Pascal instructs the future duke that, if he wants to be respected, he should "show me the qualities which merit my esteem. If you do so, it will be secured by you."[126]

Pascal the young savant had been faced with the similar necessity to legitimate himself as truly learned, and not a mere boy genius. While the Mersenne group could praise him to the savant world as one whose precocious talents promised much, his test as a true geometer came through the toil, effort, and expense of his subsequent work. Respect was not acquired through a fortuitous conjunction of stars or the makeup of one's temperament. To rely on them would be to remain as a child or as a beast. Likewise, despite the testimony that the marquis d'Albert's mind was "extremely advanced," "already capable of the most powerful truths," and "completely extraordinary in all things which depend on intelligence," it was necessary for him to take heed lest he fall prey to the temptation to rule according to a mistaken belief in his superiority by birth.[127] Having been so instructed, the future duke was, in Pascal's terms, saved from the "brutal lives" of those who are not cognizant of this difference.[128]

Pascal proceeds deeper in his instruction of the marquis, moving from the intellectual to the spiritual. Whereas his letter to Queen Christina in 1652 stopped at considering high birth and intellectual virtue, Pascal now takes the marquis into the realm of Christian training. He instructs the marquis to move beyond the *honnête homme* to be one who truly knows the difference between "greatnesses of establishment" and "natural greatnesses." In harmony with

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[125] The phrase is from Nicole's summary: "ils ne taschent point les acquerir," ibid., 271-272.

[126] "[J]e vous prierois de me monstrer les qualitez qui meritent mon estime," ibid., 282.

[127] "[I]l fit à un enfant de grande condition; & dont l'esprit qui estoit extremement avancé, estoit déja capable des veritez les plus fortes, ibid., 270. The last compliment is in Arnauld and Nicole, *La logique*, 4.

[128] "[I]l me suffit de vous avoir détourné de ces vies brutales où je voy que plusieurs personnes de vostre condition se laisser emporter, faute de bien connoistre l'état veritable de cette condition," Nicole, *Education d'un prince*, 285.

his sentiments in the 1648 letter (co-written with Jacqueline) and in the *Comparaison des chrétiens*, Blaise urges that this temporal leader "aspire to this realm of charity where all the subjects breathe only charity, and desire only the goods of charity."[129] The marquis should no longer claim the benefits of his fortunate birth when he so aspires. As Mesnard observes, he must take his place within God's kingdom, "as the humblest of his subjects."[130] Pascal shies away from taking a position of spiritual director in this realm, stating that "others than me will tell you the path of it," probably referring to those of Port-Royal.[131] Yet Pascal's transformation to the place of instructor, both in questions of *honnêteté* and in religion, is unmistakable.

Having recognized the limitations of his own natural bent, Pascal attempted in his three discourses and in the *Pensées*, to exercise a new role as one human teaching another about the human condition. But Pascal's original talents and natural inclinations were not abandoned. The complex relationship between the mathematical work of his youth and the recognition of limitations of his late twenties and early thirties were reflected in his final savant project dealing with the curve called the roulette. Through his involvement in the roulette problem, and through numerous mathematical analogies and strategies in the *Pensées*, Pascal improved upon the gifts of his birth, moving from the *métier* of geometry to a true Christian vocation. Likewise, the original tension between childhood and maturity that was evident in his early savant work was transformed by his considerations of Christian spirituality and education. This new perspective on scholarly endeavors created an atmosphere of ambivalence toward him within the learned community in Paris and beyond.

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[129] "Il faut méspriser la concupiscence & son royaume & aspirer a ce royaume de charité, où tous les sujets ne respirent que la charité & ne desirent que les biens de la charité," ibid., 285.

[130] "Il lui faut se situer dans l'ordre de la charité, comme le plus humble de ses sujets," Mesnard *OC*, 4:1025.

[131] "D'autres que moy vous en diront le chemin," ibid., 285.

CHAPTER 6
PASCAL AS AMOS DETTONVILLE: A RETURN TO CHILDHOOD

Having sought as a young adult to distance himself from childhood genius, and then from the restrictions of his mathematical career, Pascal tackled a mathematical problem in his last years that again situated him as a major figure in savant Europe. Pascal's approach to the roulette problem, however, had motivations that evoke religious issues. These motivations and Pascal's approach to publicizing his solutions meant that his work, though considered praiseworthy, was no longer part of the mainstream of the Parisian community of natural philosophers. Pascal, it would seem, was not the one to fulfill Mersenne's hopes for a "new Archimedes."

Pascal's last work represents a return to a problem that exercised the geometrical group in which he was raised. The problem involved the curve alternately known as the roulette, the cycloid, or the trochoid.[1] Put simply, the roulette is the curve described by a fixed point on the circumference of a circle that is rolling along a line at a uniform velocity. The curve is the sum of two motions: on the one hand, a circular motion; on the other, a directional motion following the trajectory of the line. In the tradition of pure geometry, Pascal discovered a means for measuring this curve.[2] As Pascal demonstrated, the measurement of the curve is a multi-faceted problem, for it includes such calculations as the length of the curve, the area between the curve and the line along which the circle is rolling, and the volume of the solids created by the rotation

[1] *Roulette* is the specifically French name which Mersenne attributed to the curve. *Trochoid*, originally used by Roberval, is from the Greek *trochoïdes*. See Pascal, "Histoire de la Roulette," Mesnard *OC*, 4:214-215. The term *cycloid* or *Cycloïde* is attributed by Pascal to Jean Beaugrand,ibid., 4:216. Pascal's preference for the term "roulette" reflects his preference for writing in French. As such, I refer to the curve by this French name.

[2] The Greek γεωμετρία literally refers to "measuring the earth," and the measurement of distances, areas, and volumes are at the heart of ancient geometry, *Oxford English Dictionary,* http://dictionary.oed.com/cgi/entry/50093912?single=1&query_type=word&queryword=geometry&first=1&max_to_show=10 (accessed 8 October 2008).

of those curves around a vertical or horizontal axis. In addition, Pascal was particularly concerned in his work to find a method for calculating the centers of gravity of solids associated with the curve.[3] His method for finding these dimensions was especially indebted to an application of the principle of a physical balance, which may be traced back to Archimedes. In order to use this technique, Pascal had to employ a controversial idea: geometrical indivisibles. The problem, the method, and Pascal's means of publicizing it would evoke both praise and criticism from the learned.

Pascal anonymously proposed a contest to "the most eminent geometers of all the earth" in 1658, challenging them to find a number of the dimensions of the roulette and its solids.[4] The contest was to take place during a specified time frame and would reward its winner with a monetary prize. While the response to the contest was limited, there were a handful of mathematicians from France, Holland, and England who answered the challenge. Of these, Pascal recognized the contributions of a select few, including Christopher Wren of England, René-François de Sluse of Liège, and Christiaan Huygens in Holland. In the end, however, Pascal and the panel of judges selected by Pierre de Carcavy judged that none of the solutions had truly answered the challenge of finding a general method for the solution of the problems.

Pascal presented his own solutions under the pseudonym Amos Dettonville, an anagram of Louis de Montalte, the name he used as author of the *Provincial Letters*.[5] The response to the contest, and the subsequent publication of the *Lettres de A. Dettonville*, was mixed. If there was

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[3] This includes both the solids of rotation and another solid which he calls *double onglet*. This solid was described by Grégoire de Saint-Vincent, Mesnard *OC*, 4:399.

[4] "praestantissimis tot orbe geometris," Pascal, First letter circulated to the learned geometers of Europe (June 1658) (hencefort, "First circular letter"), Mesnard *OC*, 4:189.

[5] In the orthography of the time, the "u" in the middle of words was written as a "v". Hence Lovis de Montalte is a true anagram of Amos Dettonville.

admiration for the "subtle" and ingenious methods used to attain to the results, there was also sharp criticism. The Englishman John Wallis, for example, strongly objected to the secretive and partial methods that, in his estimation, had characterized the contest.

This chapter aims to analyze the logistics of the contest, Pascal's attitude toward it, and the responses that it received. In particular, it seeks to show how the virtues of childhood and the virtues of maturity are a part of Pascal's portrayal of his role in the project. Along these lines, this chapter argues that Pascal asserted the difficulty of the roulette problems in order to emphasize his mathematical maturity, but he emphasized ease in order to maintain the childlike immediacy and diversionary character of the project. This chapter will also make some suggestions about how the Parisian learned community in the middle of the seventeenth century defined itself and the virtues it considered important. It will make the claim that some of the behaviors exhibited by Pascal during this late part of his life and some of the relationships he maintained, cultivated associations with childlike behavior that alienated him from that community. Huygens, not Pascal, would assume the role of Mersenne's new Archimedes.

A Mathematical Remedy

As with most events of Pascal's life, Gilberte Périer's biography provides an explanation for Pascal's last efforts in mathematics that manages to highlight his admirable qualities. She describes it as an aberration from his turn toward religious questions after the dramatic Night of Fire, but also as a further demonstration of the power of his mind. According to her story, expanded by her daughter in a later memoir, Pascal's reflections on the roulette curve were prompted by the pain of a midnight toothache. In an attempt to disconnect his mind from the ravaging pain, Pascal applied himself to a familiar problem. By focusing on the problem, he was able to relieve his physical discomfort and arrive at a long-sought solution.

Playful Problem-Solving

Discovery in isolation

The narrative of Blaise's "discovery" of a method of measuring curves suggests aspects of his continuing identification with childhood. Several elements of the story recall a similar event from Pascal's childhood. Like the account of Blaise's discovery of geometry as a teenager, his solution to the problem of the roulette took place in isolation; he discovered it in a single night in his room. Both his Euclidean doodling and his work on the roulette are portrayed by Gilberte as diversionary activities, not primary concerns. In the one case, Blaise's father's restriction of his interaction with geometrical texts and ideas had relegated the exploration of mathematical ideas to "his hours of recreation, being alone in a room where he was accustomed to divert himself."[6] It was a playful discovery that involved a full-blown pursuit of the building blocks of geometrical reflection: lines, circles, and angles. In the case of the roulette, Pascal's religious preoccupations, commitments, and pursuits were an internal barrier to a renewed pursuit of mathematical interests. This is because he had understood, at the time of his Night of Fire, that "the Christian religion obliges us to live only for God" and that, as such, "he renounced all other [fields of] knowledge."[7] Blaise remained within his father's orders by pursuing his interests in geometry only during his playtime. Likewise, Blaise's sister insists that he worked on the roulette problem "without design," only to divert himself from unbearable pain.[8]

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[6] "[I]l se mit lui-même à rêver; et, à ses heures de récréation, étant seul dans une salle où il avait accoutumé de se divertir, il prenait du charbon et faisait des figures sur les carreaux," "La vie de Pascal," Mesnard *OC*, 1:574.

[7] "[I]l comprit parfaitement que la religion chrétienne nous oblige à ne vivre que pour Dieu . . . . [I]l renonça à toutes les autres connaissances pour s'appliquer uniquement à l'unique chose que Jésus-Christ appelle nécessaire," "La vie de Pascal," ibid., 1:577-578.

[8] "Ce renouvellement de ses maux commença par un mal de dents qui lui ôtait absolument le sommeil. Dans ses grandes veilles il lui vint une nuit dans l'esprit, sans dessein, quelque pensée sur la proposition de la roulette," "La vie de Pascal," Mesnard *OC*, 1:585.. Bouwsma, "Christian Adulthood," identifies an "appreciation for play" as a central aspect of the joining of adulthood and childhood in Christian thought: "the Christian can relax, even (paradoxically) when he is most profoundly and actively confronting the sinfulness of the world. He can enjoy

Effortlessness of solution

The childlike aspect of Pascal's geometrical explorations of the roulette, and their connection to his earlier discovery of Euclidean geometry as a teenager, is further emphasized through the supposed lack of effort necessary in order for him to solve the problem. Gilberte states that Pascal's initial, unpremeditated consideration of the roulette was followed by a cascade of thoughts, apparently regarding the consequences of a particular proposition on the roulette.[9] These thoughts "uncovered to him, as if despite himself, the demonstration of all these things, by which he was himself surprised."[10] This immediacy of his mathematical solutions suggests the type of talent that would make great effort unnecessary for such mathematical results. It is the kind of talent that Blaise himself sought to downplay during his legitimacy-seeking period. His sister's emphasis on it in this later case only makes clear her desire to highlight the virtues of childlikeness in her brother. As a child, Pascal needed no adult help to attain the proof of a Euclidean proposition. He simply learned by "playing." Likewise, Blaise required no assistance in Gilberte's account of the roulette problem.

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playfully (which also means to delight in, for itself, not to exploit instrumentally, for himself) the goodness of the creation. His culture can be an unbounded playground for free and joyous activity. He can risk the little adventures on which play depends . . . . Play is a natural expression of the joy of faith, which makes it possible to engage in life, even the hard work of life, as a game that has its own seriousness . . . and that yet can be enjoyed precisely because the ultimate seriousness of existence lies elsewhere, with God," 92.

[9] This unimpeded flow of thoughts also suggests an element of the earlier geometrical discovery story. When Pascal's father questions him about his discovery of Euclid's proposition on triangles, Pascal signals the type of reasoning suggested in this account of the later event: "My father asked him what had made him think to seek that: he said that it was that he had found such and such a thing; and on that having made the same question to him, he said still some other demonstration that he had made; and finally, by regressing . . . he came from there to his definitions and his axioms," "La vie de Pascal," Mesnard *OC*, 1:574-575.

[10] "[E]nfin une multitude de pensées qui se succédèrent les unes aux autres lui découvrirent comme malgré lui la démonstration de toutes ces choses, dont il fut lui-même surpris," ibid., 1:586. His surprise likewise mirrors his father's shock at finding him drawing geometrical figures on the floor.

Overcoming restrictions

The parallel between his teenage diversion and his epiphany with the roulette continues even after the isolation of the roulette discovery. His follow-up interaction with a close friend (probably the duke de Roannez) mirrors Étienne's response to Blaise's boyhood demonstration. After discovering him drawing on the playroom floor, Blaise's father questioned him, ultimately giving his seal of approval to his son's study of geometry only after consulting his long-time friend Le Pailleur about how to deal with the natural talents of his son. Following Blaise's surprising discovery of a number of the properties and calculations of the roulette curve many years later, his friend the duke also questioned him about his findings. Both Pascal's father and the duke were surprised at Blaise's discoveries in their respective cases. In the case of the teenager, Étienne sought and received Le Pailleur's affirmation that it was appropriate to cultivate this talent for geometry. Henceforth, Blaise was given permission to pursue geometrical study, with the caveat that it was done only during "his hours of recreation."[11]

In the later case of the roulette, Blaise's own "renunciation" of mathematical work was the restriction that had to be overcome. When he heard of the solutions that Pascal had generated regarding the roulette, the duke de Roannez, like Étienne before him, envisioned the possibilities of Pascal's application to mathematics. In order to overcome the restrictions that Pascal believed had come from a heavenly father, the duke appealed to that same authority as the reason to pursue the problem further:

> M[onsieur]. de Roannez . . . asked him what he had in mind to do with that. My uncle told him that it had served as a remedy, and that he did not ask any other thing from it. M[onsieur]. de Roannez told him that there was indeed another use to make of it; that, in the design in which he was engaged of combating atheists, it was necessary to show them

[11] "Cependant il n'employait à cet étude de la géométrie que ses heures de récréation," ibid., 1:575-576.

> that he knew more than all in what regards geometry and what is subject to demonstration.[12]

Based on such arguments, at least according to the early familial biographies, Pascal became convinced that an exception to the renunciation of mathematics might be made. But the exception could only occur under certain conditions. His teenage geometrical studies were to be pursued only in his leisure time and his pursuit of the roulette question was only allowable if it had a religious motivation and goal.

The similarities between the two stories of Pascal's geometrical discoveries suggest that early biographers saw the roulette problem as a reiteration of the virtues of Pascal's childhood. The links between the two stories, and the ease with which the problem seems to have been solved, serve to strengthen the theme of childlikeness. Moreover, the involvement of Pascal's friend the duke de Roannez highlights another recurring biographical element that suggests Blaise's characterization as a child. The duke had little problem, so it seems, convincing his friend that there was a good religious reason to make an exception to renunciation, and that the mathematical question could be pursued for religious ends. Once again, Pascal's motivations were assimilated to others' goals and purposes. His talent was deployed by others; he became a tool in their hands. Pascal's compliance with such possessiveness provides further evidence of a pattern of submissiveness to others. Pascal assumed the position of the child, willing to be led where he was told.

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[12] "M. de Roannez . . . lui demanda ce qu'il avait dessein de faire de cela. Mon oncle lui dit qu'il lui avait servi de remède, et qu'il ne lui demandait pas autre chose. M. de Roannez lui dit qu'il y avait bien un meilleur usage à en faire; que, dans le dessein où il était de combattre les athées, il fallait leur montrer qu'il en savait plus qu'eux tous en ce qui regarde la géométrie et ce qui est sujet à démonstration, "Mémoire sur Pascal et sa famille," "Mémoire sur Pascal et sa famille," Mesnard *OC*, 1:1104. This account is from the memoir of Marguerite Périer, Gilberte's daughter and Blaise's niece.

Lingering Childhood Influences

The source of the roulette problem shows that, even in the material choice of such problems, Pascal's childhood reasserted itself. If Gilberte's biography emphasizes that his consideration of the curve was by chance, she is also clear that his original exposure to the problem was through Mersenne. Pascal wrote two separate pieces during his period of engagement with the roulette problem that dealt with the history of the curve.[13] The *Histoire de la Roulette* clearly shows that Pascal was not merely concerned with the accumulation of mathematical knowledge; he also sought to ensure that the mathematical community in which he had been trained received the proper credit for their strides in examining the curve and uncovering a number of its properties and dimensions.

In the *Histoire de la Roulette*, Pascal carefully credits Mersenne with defining the curve.[14] Mersenne initiated the study of the curve by proposing the problem of its measurement to Roberval, Galileo, and others.[15] The result was Roberval's discovery that the area under the curve was three times that of its generating circle, which triggered responses and contributions by Pierre de Fermat and René Descartes, those pillars of the French mathematical community. And while Italian mathematicians claimed originality for the results of Torricelli in this area,

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[13] The first is entitled *Histoire de la Roulette appelée autrement La Trochoïde, ou La Cycloïde, où l'on rapporte par quels degrés on est arrivé à la connaissance de la nature de cette ligne*, and is dated 10 October 1658, Mesnard *OC*, 4:214-224; this piece is duplicated in Latin, as *Historia Trochoidis, Sive cycloidis, Gallice, La Roulette; in qua narratur quibus ad intimam illius lineau naturam cognoscendam perventum sit*, Mesnard *OC*, 4:225-233. The second "historical" writing, especially emphasizing Roberval's priority, is *Suite de l'Histoire de la Roulette, où l'on voit le procédé d'une personne qui s'était voulu attribuer l'invention des problèmes proposés sur ce sujet*, dated 12 December 1658, Mesnard *OC*, 4:238-245; it is duplicated in *Historiae Trochoidis sive Cycloidis continuato, in qua videre est cujusdam vidi machinamenta qui se autorem problematum super hac re propositorum erat professus*, Mesnard *OC*, 4:246-252.

[14] "Le feu P. Mersenne, Minime, fut le premier qui la remarqua environ l'an 1615, en considérant le roulement des roues: ce fut pourquoi il l'appela *La Roulette*," "Histoire de la roulette," Mesnard *OC*, 4:214.

[15] "Il proposa donc la recherche de la nature de cette ligne à tous ceux de l'Europe qu'il en crut capables, et entre autres à Galilee," "Histoire de la roulette," Mesnard *OC*, 4:214. Mersenne proposed the problem to Roberval in 1634, according to this account, ibid., 4:215.

Pascal assured his readers that both he and this specifically-defined curve originated with the Parisian mathematical community. The fact that Pascal returned to the roulette in this his last mathematical work suggests the attraction that the values and content of his early experiences continued to have for him. Living in Paris, Pascal maintained close personal connections with members of that learned circle, as noted in previous chapters. It is almost as if, even though dead, Mersenne continued to exercise a powerful force on Pascal's work.

Pascal's historical account of the curve is in some ways a reflection on his own origins. In it, he evidences a dual understanding of his past that reflects the careers of Mersenne and Roberval, two of his mentors.[16] Pascal portrays Mersenne as the quintessential proposer of problems and questions. Through his prodigious ability to communicate and to maintain correspondence with others, he "provided the occasion for several fine discoveries, which would never perhaps have been made if he had not excited the *savants* to them."[17] In Pascal's life, Mersenne's well-defined questions continue to exert their power and to determine the selection of his work. On the other hand, Roberval remained Pascal's master and possessor in matters of the theoretical and methodological values of mathematics. It is probably owing to Roberval that Pascal remained so opposed to algebra during his lifetime, an issue that will be considered further in the next section of this chapter.[18]

Pascal's linguistic choices also reflect the double influence of Mersenne and Roberval. Mersenne had labeled the curve with the French word *roulette*. His use of the vernacular

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[16] Pascal, "Histoire de la roulette," Mesnard *OC*, 4:214-224; and Pascal, "Suite de l'histoire de la roulette," Mesnard *OC*, 4:238-245.

[17] "[I]l a donné l'occasion de plusieurs belles découvertes, qui peut-être n'auraient jamais été faites s'il n'y eût excité les savants," ibid., 4:214. Pascal's opinion of Mersenne is not unmixed praise. Pascal evidences some reserve: "Mais encore qu'il n'eût pas un pareil bonheur à les resoudre, et que ce soit proprement en ceci que consiste tout l'honneur, il est vrai néantmoins qu'on lui a obligation, et qu'il a donné l'occasion de moins qu'on lui a obligation," ibid.

highlights his role as mediator of questions and his ability to communicate those questions simply and effectively.[19] Roberval alone, however, called it a *trochoid*, which is based on the Greek term for wheel.[20] This choice communicates the priority that Roberval placed on his ancient Greek predecessors, including Archimedes, whose construction-based geometrical method became the ruling standard for Pascal's own work. Pascal's double exposure to Mersenne and Roberval is suggested in his choice to compose both French and Latin versions of some of the works on the arithmetic triangle and the roulette. On the one hand, Pascal's aim was in part to make the works convenient for those whose native language was not French. On the other, this choice reflects the influences of both Mersenne the communicator and Roberval the traditional scholar.

So far, this chapter's account of the circumstances surrounding Pascal's work on the roulette has relied mainly on biographies written by his sister and his niece. The observations above are as much about his family's interpretation of his work as they are about his own perceptions and those of the savant community. These biographers were part of the same religious community with which Blaise shared many attitudes about the devout life. Moreover, they write with the full knowledge of the fragmentary religious musings that Pascal had penned during his last few years. It is therefore important to recognize that the narrative may be shaped in a way that presents a Pascal entirely focused on religious devotion. Such a portrayal highlights the power of Pascal's mind and his lack of desire for the usual recognition associated with mathematical discovery. This virtue is in contrast with the ambiguity that would be apparent if Pascal were presented as sincerely interested in the solution of the problem itself.

[19] This is not to say, of course, that Mersenne could not communicate effectively in Latin. He had a number of correspondents (e.g., Pierre Gassendi, Galileo, Athanasius Kircher) to whom he wrote in the traditional language of learning. He also wrote several works in Latin.

[20] The Greek word is τροχός, Mesnard *OC*, 4:152.

The diversionary character of this work, as presented by Gilberte, signals Pascal's innocent way of pursuing it and communicates to her readers his lack of intellectual hubris.

Backdrop to Diversion: The Sluse-Pascal Correspondence

While many accounts of the genesis of Pascal's work on the roulette still take this essential narrative at face value, Pascal scholars recognize that there are significant difficulties involved with it. The clearest difficulty with viewing the work on the roulette as a single, diversionary aberration from a normal renunciation of mathematics is the indirect and direct correspondence between Pascal and a Liégeois canon and amateur mathematician, René-François de Sluse.[21] Beginning in late 1657, Sluse began a correspondence with Cosimo Brunetti, an Italian who had a lively interest in mathematics and was friendly with the Port-Royalists.[22] In response to a problem sent by Sluse to Brunetti, the latter sought out Pascal, who apparently solved this problem before providing two others of his own.[23] Brunetti presented to Sluse these two problems of geometrical construction proposed, as Sluse states in a letter to Huygens, by "a man. . . most ingenious, M. Pascal, whom perhaps you know."[24] These problems, which seek

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[21] Sluse was born 2 July 1622 and died 19 March 1685. He was a canon in Liège and a mathematician of some significant European connections, including Henry Oldenburrg of the Royal Society, A. R. Hall and M. Boas Hall, "Sluse, Oldenburg and the Royal Society," in *'René-François de Sluse' (1622-1685): Actes du Colloque International, Amay-Liège-Visé, 20-22 mars 1985* (Liège, 1986): 49-58. He also wrote a mathematical work of note, entitled *Mesolabum seu duae mediae proportionales inter extremas datas per circulum et par infinitas hyperbolas* (Liège, 1668). For biographical information, see M. C. Le Paige, *Correspondance de René-François de Sluse* (Rome, 1885).

[22] Brunetti had represented the interests of Port-Royal in Rome during the mid-1650s and was later to take a voyage to Martinique in order to scout the possibility of the settling of the religious group in the New World; see Susan Heller Anderson, "Cosimo Brunetti: Three Relations of the West Indies in 1659-1660," *Transactions of the American Philosophical Society* 59 (1969): 1-49.

[23] The documents written by Sluse were published in 1885 in Le Paige, *Correspondance*. Kokiti Hara has pinpointed the problem that was probably proposed to Brunetti, and was subsequently addressed by Pascal, as identical with a problem that Sluse sent to Huygens 11 July 1657, Mesnard *OC*, 4:91-92; Kokiti Hara, "Genèse présumée des Lettres de A. Dettonville," in *Méthodes chez Pascal: actes du colloque tenu à Clermont-Ferrand, 10-13 juin 1976*, ed. Jean Mesnard (Paris, 1979): 101-108.

[24] "proponente viro . . . ingeniosissimo, Domino Pascal, quem fortasse noveris," Sluse to Christiaan Huygens (23 October 1657), Mesnard *OC*, 4:96. Sluse's correspondents also included Constantin and Christiaan Huygens; Samuel Sorbière; and Henry Oldenburg, Sluse, *Correspondance de Sluse*, esp. 21

constructions meeting certain conditions, are more closely related to Pascal's early works on conic sections than to his subsequent work on the roulette.[25] In fact, they had already been proposed by Pascal in 1654, in the piece addressed to the "Academiae parisiensis," and prior to Pascal's Night of Fire. It seems that Pascal was not averse to passing along his previous geometrical thoughts, though his family suggests otherwise. He did not stop with a cursory interaction with Sluse. At Sluse's urging, he and Pascal began an extended correspondence.

The contrast between the lives and careers of Sluse and Pascal is stark, particularly in their exposure to learned circles. Pascal had been identified with his past and the savant community that represented it. The expectations of his father, of Mersenne, and of Roberval, largely determined the course of his mathematical work and even resulted in periodically controlling behavior, as the Roberval-Descartes verbal duel demonstrates.[26] As he got older and achieved some level of renown, he also began to be pursued by those, such as Sluse, for whom mathematics held a special place of interest.

For Sluse, on the other hand, the tables were turned. Pascal had been surrounded by the culture of the learned; Sluse was deprived of it. Indeed, M. C. Le Paige observes Sluse's nostalgia for the years of his youth and the time during which he had been able to devote himself to his studies without interruption.[27] Sluse yearned for intellectual stimulation and, in particular, an outlet for his interest in mathematics. He had such a concern to nurture an atmosphere of

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[25] Specifically, the problem is stated thus: "Being given two circles, A, C, and a line EF, to find a circle EBDF which, being tangent to the given circles, allows on the line given an arc capable of a given angle." The second problem is: "Being given five lines, AG, BF, CK, DL, EH, to find a conic section which is tangent to the five given lines," addendum to René-François de Sluse to Christiaan Huygens, 23 October 1657, Mesnard *OC*, 4:97-98.

[26] See above, pp. 163-164.

[27] See Sluse, *Correspondance de Sluse*, 18-19.

intellectual learning that his house was called by one "a very famous university where all the divine and human arts flourished."[28]

Sluse had never experienced the kind of engagement and excitement that came with being involved in a renowned mathematical group. He sought connection with such an atmosphere by establishing a correspondence network.[29] Given the opportunity to exchange letters with someone like Pascal, whose name was now well-known, Sluse made every effort to present ideas to him. His letters to Pascal indicate that he did so in the hope of receiving feedback, in the form of acknowledgement, correction, and the reciprocal, compensatory offering of discoveries. Pascal willingly corresponded with Sluse, albeit not without attempting to engage the canon in discussions regarding Jansenism and the interpretation of biblical texts.[30] His responsiveness to Sluse's desire for correspondence is not uncharacteristic of Pascal, given the way he yielded to the requests and nudging of friends and family. The intermediacy of Brunetti, a faithful friend to Port-Royal, may have added to the compulsion that Pascal felt to communicate with the canon of Liège.[31]

The indirect correspondence between Pascal and Sluse through Brunetti consisted in an extended consideration of the first two of Pascal's problems, discussion of related questions, and

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[28] "Pouvait-on voir autrefois un esprit plus illuminé que celui de Monseigneur votre autre frère, chanoine de Liège et prévot d'Hama, la maison duquel estoit comme une université très fameuse où tous les arts divins et humains fleurissaient," E. Mulkeman, *Nouvelle pratique d'arithmétique* (Liège, 1698), dedication, quoted in S. Bormans, "Lettres inédites de René Sluse," *Bulletin de l'archéologique liégeois* 6 (1863), 91. 4.

[29] On the important role of correspondence for those living in provincial areas and for natural philosophers and mathematicians generally during the early modern period, see J. L. Pearl, "The Role of Personal Correspondence," 106-113.

[30] Sluse's letters indicate, for example, that Pascal asked for the canon's interpretation of a particular Hebrew word in a passage of Isaiah, René-François de Sluse to Blaise Pascal, 6 April 1658, Mesnard *OC*, 4: 124. Furthermore, he offered to send Sluse "des pièces du temps", which Mesnard identifies as those concerning the Jesuits and Jansenists, René-François de Sluse, 29 June 1658, Mesnard *OC*, 4: 129.

[31] Mesnard argues, for his part, that correspondence with Sluse was attractive to Pascal because "in him [i.e., Sluse] distinction and elegance, modesty and simplicity were allied to an exceptionally brilliant intelligence, to a mind with which Pascal could feel himself *de plain-pied*," Mesnard *OC*, 4:118.

the appropriate methods to use in solving them. By early 1658, Sluse and Pascal were writing directly to one another. Furthermore, the mathematical problems in the ensuing letters increasingly approached the issues with which Pascal's work on the roulette would grapple. In particular, the correspondence with Sluse considered questions of the volume of the solids created by rotations of curves about axes and identification of centers of gravity of these curves and solids. The exchange of letters continued for the several months prior to Pascal's initial proposal of the roulette problem.

Pascal's extended correspondence with Sluse suggests that his "discovery" of the measurement of the roulette curve involved a longer, more involved process than Gilberte describes in her narrative of mathematical diversion.[32] Gilberte's and Marguérite's accounts of Pascal emphasize the diverting nature of the work and the lack of significant mental exercise required for the solution of the problem. His correspondence and the *Histoire de la roulette* demonstrate that this work was also the result of a long process of development beginning in Pascal's earliest years. But the issue is not solved simply by accepting the latter narrative of Pascal's work on the roulette and rejecting the former. The Sluse-Pascal correspondence, as well as other subsequent writings and letters from this period in Pascal's life, continue to represent an uncertain relationship between immediate discovery and gradual solution, ease and difficulty. The virtues of childhood intersect with the virtues of maturity in the story of Blaise's work on the roulette.

The balance of this chapter will aim to analyze the events and texts relating to Pascal's work on the roulette by focusing on the issues raised that relate to childlikeness and maturity. The key theme in what follows will be the relationship between the language of ease and the

[32] Mesnard's position is that the "unforeseen occasion . . . [which] made me think about geometry" was probably the correspondence with Sluse, "Histoire de la Roulette," *OC*, 4: 219; Mesnard *OC*, 4: 169.

language of difficulty in Pascal's writings, those of the participants in the contest, and other contemporary works. This chapter argues that geometry was considered both very difficult in some ways (requiring effort to solve problems) and quite easy in others (immediacy of perception and of following the rules of calculation). This chapter will also explore the reactions of the learned community to Pascal's contest, especially the way those reactions compare with their reaction to Huygens (both in his works and as a person). The concluding part of the chapter will attempt to show that Pascal's tendency to secrecy, his continued rejection of an algebraic approach, his association with an uncouth individual such as Roberval, and his isolation all contributed to his being marginalized as a serious contributor to the savant community.

Paradox of Mathematical Ease and Difficulty

Contemporary Background

Anyone who has spent time studying mathematics probably knows the frustration of having someone claim that a result "follows clearly" from a set of statements, or that "one may easily see" the result, when the inference seems quite problematic or opaque. The description of geometrical practice in the seventeenth century likewise indicates a seemingly contradictory relationship between the ease of mathematics and its difficulty.

In the first place, ease and difficulty are related to the different mathematical domains. Geometry, for example, was often considered to be extremely simple and able to be learned by young people. Bardin, whose book considers the characteristics of an *honnête homme*, follows the opinion of Aristotle when he notes the appropriateness, for "young men" [*jeunes gens*] of studying geometry as opposed to physics. This attitude stems in part, Bardin states, from this subject's status as stable and static, a representative of that which is unchanging in the universe,

whereas physics is, by definition, concerned with what is dynamic. The entities of geometry, and thus the principles of its study, are more evident than those of physics:

> Physics being attached to a material that is subject to several changes has need of experience of several singular things in order to establish its truth. Thus its Principles are not well known except after having made a great progress.[33]

Pascal highlights the simplicity of geometry's principles in his little work "De l'esprit géométrique." Pascal makes clear that these principles are accessible and comprehensible by everyone. Instead of needing a long explanation, they are built on concepts such as space and time that are intuitively natural to human beings. All people, he argues, agree on what the terms "space" and "time" refer to, even if they cannot articulate definitions in unequivocal language.[34] The very inability to communicate these truths closely links them, in a way that Pascal does not articulate, to early childhood and its pre-linguistic character.

Pascal participates in a long tradition of valuing the simplicity and clarity of geometry. These notions are at the heart of the discussion of ease and difficulty in the correspondence between Sluse and Pascal and in the roulette contest. Besides the simplicity of geometry's principles and its unchanging immateriality, geometry was also considered accessible because of its use of figures (i.e., its visuality). This connection with sensory perception remained in spite of the supposed alienation that philosophers often suggested between the physical world of perception and the conceptual world of geometry. Antoine Arnauld, a key figure of Port-Royal during the middle of the seventeenth century, viewed geometry as a possible remedy to

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[33] "[L]a Physique estant attaché à vne matiere sujette à plusieurs changemens,a besoin de l'experience de plusieurs singulieres pour establir sa verité. De sorte que ses Principes mesmes ne sont pas bien connus qu'aprés y auoir fait vn grand progrés," Bardin, *Le lycee,* 1, 384. Aristotle's statement of this opinion is in *Metaphysics* 6.

[34] "Elle [geometry] ne définit aucune de ces choses, espace, temps, mouvement, nombre, égalité, ni les semblables qui sont en grand nombre, parce que ces termes-là désignent si naturellement les choses qu'ils signifient à ceux qui entendent la langue que l'éclaircissement qu'on en voudrait faire apporterait plus d'obscurité que d'instruction," "De l'esprit géométrique," Mesnard *OC*, 3:396. He goes on to say, specifically of time, "Qui le pourra définir? Et pourquoi l'entreprendre, puisque tous les hommes conçoivent ce qu'on veut dire en parlant de temps, sans qu'on le désigne davantage?," ibid., 3:397.

childhood's attachment to sensible objects, which is in harmony with the distinction between the material and immaterial mentioned above.[35] For Arnauld and others, visuality and sensory disconnection are bridged by the intellectual faculty known as "imagination."

The status of the imagination in the seventeenth century was ambiguous, with Descartes and even Mersenne assigning it little value.[36] But Jean-Robert Armogathe has also shown that imagination was, in the seventeenth century as it often is today, associated with childhood.[37] The visuality of geometry, and thus imagination, were extremely important for Pascal, who began his studies in projective geometry, which through techniques of perspective is closely related to the visual arts.[38] Scholars such as Thomas More Harrington and Pierre Humbert have concurred on the importance of visuality for Pascal.[39] Specifically, this aspect of geometrical work is contrasted with the methods of algebra that were increasingly being espoused during the seventeenth century.

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[35] Of childhood attachment to the senses, Arnauld writes: "il faut considerer que dans les premieres années de l'enfance l'ame de l'homme est comme toute plongée & toute ensevelie dans les sens, & qu'elle n'a que des perceptions obscures & confuses des objets qui font impression sur son corps," Arnauld, preface to *Nouveaux elemens*, n.p. And of the role of geometry in removing these attachments, he writes: "entre les exercices humains qui peuvent le plus servir à la diminüer, & à disposer même l'esprit à recevoir les veritez chrestiennes avec moins d'opposition & de dégoust, il semble qu'il n'y en ait gueres de plus propre que l'étude de la Geometrie. Car rien n'est plus capable de détacher l'ame de cette application aux sens, qu'une autre application à un objet qui n'a rien d'agreable selon les sens; & c'est ce qui se rencontre parfaitement dans cette science," *Nouveaux Elements de Géométrie*," ibid.

[36] Armogathe, "L'*imagination* de Mersenne à Pascal," in *Phantasia-imaginatio; V Colloquio internazionale, Roma 9-11 gennaio 1986* (Rome, 1988): 259-272.

[37] In particular, he offers an example of Mersenne's negative assocation of the imagination with children and women, Armogathe, "L'*imagination*," 267.

[38] Daniel C. Fouke argues that Pascal's projective geometry, with its emphasis on the visual imagination, as structuring the rest of his thought, including his physics and his religious writings, Fouke, "Pascal's physics," in *Cambridge Companion to Pascal*, 99; Fouke gives a fully developed exploration of the development of Pascal's method by way of projective geometry in his dissertation.

[39] Humbert writes: "Pascal is above all visual," *Cet effrayant génie*, 166. Another exploration of Pascal's visuality is in Harrington, *Pascal philosophe*.

The turn toward algebra in the practice of European mathematics is often said to take decisive form in Descartes. But it was the culmination of a long-standing search by Renaissance and early modern mathematicians for the ancient method of "analysis." Analysis was the method that was used to originally solve the problem and was contrasted with synthesis, which is the way that the final proof is communicated to readers. In geometry, the synthetic proof was often linked to a geometrical construction. The recovery of ancient mathematical texts during the late Middle Ages and Renaissance reiterated the talent that Greek geometers had for uncovering new mathematical results. The question for the later mathematicians was how the ancients attained their results, for their presentation was in the form of deductive proofs which gave no hint to how they had been invented. Thus, early modern mathematicians searched for the ancient method of analysis.

During the sixteenth century, one type of analysis that proceeded by establishing and manipulating equations containing unknown quantities began to be explored. This method drew on earlier discoveries of Arabic algebraic texts and was also known as "specious analysis."[40] One of the pioneers of the use of symbols in the method of analysis was François de Viète, whose admiration by Mersenne was discussed in Chapter 2.[41] Algebraic methods were quite well-developed by the time of Pascal, but Descartes is often noted as one of the key links between geometry and algebra in the seventeenth century. It is Descartes, of course, who is credited with the articulation of a coordinate system that would be used to analyze curves and

[40] François de Viète uses the term "specious" to describe the use of "species or forms . . . such as for example are the letters of the alphabet," thus the use of *x* in modern algebra, Viète, *La algèbre nouuelle de M*^{r}*. de Viète*, trans. A. Vasset (Paris, 1630), 9. This work of Viète's is a French translation of Viète's Latin work.

[41] The historical background of Viète's work and some of the key points of his accomplishment are described in a prefatory letter to Vasset's translation, Viète, *La algèbre nouuelle*, n.p. [7ff].

create equations from them.[42] Pascal's unwillingness to adopt Descartes' algebraic approach is one important aspect of the traditional contrast that has been made between him and Descartes.[43] It is also one of the reasons that some mathematicians have seen Pascal as out of the main stream of mathematical influence.[44]

One of the key drawbacks to the use of algebraic analysis was the difficulty in maintaining clarity despite the use of symbols for quantities. This is especially evident when contrasted with the clarity of a classical, construction-based geometry. Jean Boulenger admitted in his *La géométrie pratique*, for example, that the first part of his work was "a little difficult, because the demonstrations of Algebra are used there, to which there is some pain at first to accustom oneself."[45] The reason for this difficulty, especially for the artisans to whom Boulenger addressed it, is that in algebra, which may treat magnitude in general, "one cannot use figures in

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[42] A recent historical work on Descartes's seminal contribution to a transformed understanding of the place of geometrical construction in mathematics, especially as it relates to algebraic analysis, is Henk J. M. Bos, *Redefining Geometrical Exactness: Descartes' Transformation of the Early Modern Concept of Construction* (New York, 2001). Bos's work stops its chronological consideration with Descartes's death in 1650 and therefore does not mention the roulette contest. Étienne Pascal has two listings in the index, one of which should rather be a reference to Blaise, as it deals with the latter's work on the arithmetic triangle, ibid., 209.

[43] Pierre Humbert states it as a contrast between the "analytical tendency of Descartes and the geometrical tendency of Desargues," of which Pascal will choose the latter, Humbert, *Cet effrayant génie*, 19, adding in another place that Pascal "est un géomètre, non un algébriste," ibid., 166. In offering his critique of the accepted view of Pascal's genius, Koyré cites the "anti-algebraism" of Pascal and accepts the contrast between Descartes's "geometrical" mind and Descartes's "algebraic" one, Koyré, "Pascal Savant," 264, 261. For her part, Dominique Descotes believes that this contrast of Koyré's is overstated. Pascal, she argues "n'ignore pas l'utilité du symbolisme mathématique." Thus, the relationship between Pascal and algebra is more complex than previously admitted, but Descotes admits that Pascal "admet les expressions abstraites, à condition qu'elles ne versent pas dans le symbolism pur," *Blaise Pascal, littérature et géométrie*, 67, 71.

[44] C. B. Boyer, for example, believes that it was Pascal's inability to accept Descartes's new approaches to mathematics that kept Pascal from fully developing the calculus prior to Leibniz and Newton, Boyer, "Pascal: The Man and the Mathematician," *Scripta Mathematica* 26 (1963), 284, 304.

[45] Jean Boulenger, preface to *La geometrie pratique des lignes des superficies et des corps, ou nouuelle methode de toiser & arpenter auec la mesure ordinaire, sans que toutesfois il soit besoin de vser de fractions, ny de reductions en petites parties* (Paris, 1630), n.p. One of Boulenger's subtitles labels it a "Work useful to all architects, engineers, masons, surveyors, and other geometers,"

order to aid the imagination."[46] Newton also acknowledged that algebraic resolution of problems "is ill-suited to be taught to the masses."[47] "[I]ts operations are complicated and excessively susceptible to errors, and can be understood by those learned in algebra alone."[48] The method of resolution was suitable for those with mathematical maturity and legitimacy, the learned not the ignorant.

Synthesis, by contrast, was for Boulenger the appropriate means of presentation, in order to make the results "as transparent, clear, and manifest to all as possible."[49] Mersenne's Christian Philosopher, in *La vérité des sciences contre les septiques*, suggests a similar relationship between the two mathematical approaches when he writes: "let us pass on to Geometry, in which you will have more contentment than in this algebra, which is too thorny and too difficult for familiar discourses."[50]

By articulating a standard of "familiar discourses," Mersenne is arguing that those not yet trained in mathematics would find the geometry based in constructions more accessible than algebra, the "analytic approach," which involves the reduction of geometrical figures to symbolic equations.[51] Mathematical pedagogy nearly always began with a text that took a synthetic

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[46] Ibid.

[47] Isaac Newton, "First Essays at a Multi-Partite Treatise on 'Geometry'," in *The Mathematical Papers of Isaac Newton,* ed. D. T. Whiteside (Cambridge, 1967-1981), 7: 307.

[48] Newton, "Analysis and Synthesis: Newton's Declaration of their Application in the *Principia*," in *Mathematical Papers*, 8: 450.

[49] Ibid.

[50] "[P]assons à la Geometrie, dans laquelle vous aurez plus de contentement qu'en cette algebre, qui est trop épineuse, & trop difficile pour les discours familiers," Mersenne, *La vérité des sciences*, 716. The language of the "thorny" path is also used in Pascal's description of his hard work in the creation of the arithmetic machine, see above, pp. 130, 179, 227.

[51] It is ironic, of course, that Mersenne's invocation for "new Archimedeses" is articulated in the context of a discussion of the contributions of the work of Anderson and Viète. Pascal's rejection of the algebraic techniques of these two mathematicians means that he could not truly continue or perfect their work. For many a historian of

approach, in the belief that a brief, logical presentation of geometry would create the best foundation.[52] Despite apparent "clarity," however, such a method also involves "obscurity" when it comes to dealing with particular problems.[53]

Sluse's Language of Ease and Difficulty

Pascal's correspondence with Sluse highlights a paradoxical relationship between method and relative difficulty in mathematics. From one side, the method of construction was portrayed as offering a relatively easy presentation of a geometrical result. From the other, algebra was represented as an easier, less taxing mental process of discovery. It required less effort to produce more results.

There are then two types of ease: an ease of representation and an ease of procedure. Pascal and Sluse disagreed on whether ease of procedure trumped simplicity of presentation. Pascal insisted on the necessity of a synthetic proof by construction, and in the ensuing contest concerning the roulette, would be careful to insist on using only methods of "pure geometry."[54] Sluse, on the other hand, preferred an analytic method that, in his eyes, sufficiently produced the

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mathematics, this also places Pascal outside the main current of mathematical thought in the second half of the seventeenth century.

[52] F. W. Kokomoor surveyed a large number of seventeenth-century geometrical textbooks and found that they were generally synthetic in approach, though he believes that much of the teaching that was done may have been synthetic, Kokomoor, "The Teaching of Elementary Geometry in the Seventeenth Century," *Isis* 11 (1928), 92-93. More generally, Comenius, the great educational theorist, writes: "in dealing with any subject the analytical method should never be used exclusively; in fact, preponderance should rather be given to the synthetic method," John Amos Comenius, "Great Didactic," in *Comenius*, ed. and trans. M. W. Keatinge (New York, 1931), 105.

[53] Kokomoor remarks this irony after having discussed the usefulness of synthesis for reasons of format and concision: "On the other hand, there is very often an obscurity of explanation in connection with the brief and beautiful synthetic proof which leaves with the learner a sense of helplessness. The method of attack is missing," Kokomoor, "Teaching of Elementary Geometry," 93.

[54] "Lettre de A. Dettonville a Monsieur de Carcavy," in *Lettres de A. Dettonville*, 12; Mesnard *OC*, 4:426.

results sought without the great expenditure of time that was required to create a visually compelling general proof.[55]

Sluse himself recognized the deep divide that existed between himself and Pascal in his letter to Brunetti of December 1657:

> It is quite true that it displeases me first that I am not of the sentiment of M. Pascal regarding *Analyse speciose*, of which I make a greater case than he.[56]

It is unfortunate that Brunetti's letter to Sluse regarding Pascal's views on the analytic method has not survived, since Pascal never gives a clear statement of his objections to it in his extant writings.[57] On the other hand, Sluse's justification of its usefulness and ease in solving problems is made clear in his letter to Brunetti. He continues:

> I daresay that the proofs that I have through it [analysis] are so great that not only do they persuade me, but they oblige me to make a very great estimation of it. I avow that the return from it is very often difficult; but, because, when I have made exactly the analysis, I am as sure of the solution of the problem as if I had demonstrated it by synthesis, I do not care sometime to seek the easiest [*le plus aisée*] construction, being persuaded of what M. Pascal said on another occasion: *non esse par labori præmium*.[58]

Sluse was prepared to concede that a proof by construction was *le plus aisée*; it was the easiest, the most convenient, or the most accessible to the reader. It was the ease of presentation,

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[55] Mesnard emphasizes this difference between Pascal and Sluse, claiming that Sluse's use of the methods of pure geometry were in deference to his correspondent. In commenting on one letter from Sluse to Pascal, he writes: "This piece shows that Sluse spontaneously retreats to analysis. If he makes discreet use of it in his letters destined for Pascal, it is in order to submit himself to the preferences of his correspondent," Mesnard *OC*, 4:114, n. 1.

[56] "Il est bien vrai qu'il me déplaît que d'abord je ne suis pas du sentiment de M. Pascal touchant l'*Analyse speciose*, de laquelle je fais plus grand cas que lui," René-François de Sluse to Cosimo Brunetti, December 1657, Mesnard *OC*, 4:103.

[57] Pascal mentions the method of analysis in his "De l'esprit géométrique": "La géométrie, qui excelle en ces trois genres, a expliqué l'art de découvrir les vérités inconnus; et c'est ce qu'elle appelle analyse, et dont il serait inutile de discourir après tant d'excellents ouvrages qui ont été faits," "De l'esprit géométrique," Mesnard *OC*, 3:390.

[58] "[J]'ose dire que les preuves que j'en ai sont si grandes que non seulement elles me persuadent, mais elles m'obligent d'en faire une estime bien grande. J'avoue que le retour en est bien souvent difficile; mais, parce que, quand j'ai fait exactement l'analyse, je suis aussi sûr de la solution du problème comme si je l'eusse démontré par synthèse, je ne me soucie pas quelquefois d'en chercher la construction la plus aisée, me persuadant ce qu'en une autre occasion M. Pascal dit: *non esse par labori præmium*," Sluse to Brunetti, December 1657, Mesnard *OC*,4:103.

not of procedure. In contrast to this ease was the great difficulty of producing such a proof. Sluse used Pascal's Latin phrase ("it is not the result of a first attempt") to emphasize that he did not have the time for a proof by construction. The proofs of analysis, Sluse argued, have a persuasive power that would be sufficient for the dismissal of the need for the geometrical proofs that pure geometricians like Pascal would require. Furthermore, he was convinced that a creation of a construction from his analytical solution ('le retour') would be possible because of his belief in the efficacy of analytic method. Translating his solutions into synthetic constructions was but a matter of time and effort.

In his correspondence with Brunetti and Huygens, Sluse also made use of the language of difficulty and ease. In a letter to Huygens, upon the reception of Pascal's problems, he writes of the first that "its solution posed no difficulty, although it presents a construction a little complicated,"[59] an opinion echoed in a letter to Brunetti, where Sluse writes:

> Having made a little rough sketch of analysis, I recognized that the problem was plane, and that the resolution of it was not difficult, but that the construction of it would be a little long and muddled.[60]

In the first place, then, Sluse attempts to legitimate himself as a mathematician by professing the simplicity of the solution of the problem. The implication of his letters is that this kind of solution is the most interesting and important and that his ease in perceiving it adequately demonstrated his mathematical accomplishment. Secondly, and concomitantly, Sluse implied that the difficulty of "le retour" after the "little rough sketch of analysis" was basically a matter

[59] "nec difficilis solutionis, licet κατασκευην ostendat paulo intricatiorem," René-François de Sluse to Christiaan Huygens, 23 October 1657, Mesnard *OC*, 4:96. Sluse also puns on the Latin word *planum*: thus when he describes the solution as *planum* ("reperi planum esse"), he is stating that the locus of the points is a plane and that it is clear or obvious, ibid.

[60] "[A]yant fait un petit griffonnement d'analyse, je reconnus que le problème était plan, et que la resolution n'en était pas difficile, mais que la construction en serait un peu longue et embrouillée," René-François de Sluse to Cosimo Brunetti, October 1657, Mesnard, *OC* 4:100

of overcoming technical complications. The time and effort would result in a proof that was "easiest" [*le plus aisée*] but not one that was substantially more convincing. Sluse suggested that it was not geometrical inferiority that has prevented him from giving these synthetic proofs, but because "I do not at this time have the leisure" due to "the multitude of affairs which overwhelm me."[61]

Sluse blamed not his lack of skill, but Brunetti's lack of timeliness in supplying the problems, for his lack of thoroughness. He writes scoldingly to Brunetti: "If they had been sent to me when I had asked for them, I would have tried to give satisfaction to him [Pascal]."[62] As it is, he claims, he only had time to consider "one case", and to give "a brief construction" based upon this one example.[63] Nevertheless, he claims that based on this simplification "all intelligent persons will easily see that I have the universal construction."[64] The matter of generalizing from this single case to the universal, Sluse suggests, is not the essence of the problem. It is permissible, on this view, to minimize its importance, especially in light of his many duties as a canon, which "do not permit me to apply my mind to such niceties [*gentillesses*]."[65]

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[61] Sluse to Brunetti, December 1657, Mesnard *OC*, 4:106; Sluse to Brunetti, October 1657, Mesnard *OC*, 1: 100. This is reiterated later in the same letter: "l'embarras continuel des affaires qui se sont présentées et multipliées au triple depuis que vous n'avez été ici ne me donne pas le temps d'y penser pour le présent," Sluse to Brunetti, October 1657, Mesnard *OC*, 4:100. For another example of Sluse's decrying of the lack of leisure time, see Sluse to Brunetti, December 1657, Mesnard *OC*, 4:108: "Le porisme des anciens à la description des sections coniques me semble très joli, mais je n'ai pas le loisir de les examiner pour à cette heure."

[62] "[S]'ils m'eussent été envoyés quand je les ai demandés, j'aurais tâché de lui donner satisfaction," Sluse to Brunetti, October 1657, Mesnard *OC*, 4:100.

[63] "[J]'ai choisi un cas seulement entre plusieurs qui sont dans le problème; et pour trouver une construction plus brève, je l'ai appliqué aux nombres," ibid.

[64] "[T]outes les personnes intelligentes verront aisément que j'ai la construction universelle," ibid.

[65] "ne me permettent pas d'appliquer mon esprit à semblables gentillesses," ibid.

The characterization of particular geometrical efforts as mere *gentillesses* would have probably been quite amenable to Pascal. It is in agreement with his general evaluation of application to non-religious matters during the post-Night of Fire period as diversionary. Within the context of a deliberate application to geometry, even if it were primarily a leisure pursuit, Pascal insisted in his articulation of problems that the synthetic solution was not simply an appendix to an algebraic solution; it constituted the solution's substance. Sluse acknowledged this insistence of the Parisian mathematician when he wrote that Pascal "does not simply want the analytic solution, but . . . also a nice [*gentille*] and easy [*facile*] construction."[66]

Sluse's portrayal of Pascal's attitude toward synthesis and specious analysis makes clear the dual nature of synthesis as both difficult (*difficile*, *embrouillée*) and easy (*facile*, *aisée*). But this duality also points to the more general and widespread double-portrayal of savant work, particularly in mathematics. On the one hand, Sluse, Pascal, and others wanted to highlight, just as did Pascal's earliest biographers, the immediacy, simplicity, and ease of his solution to problems. Based on such portrayals, the problems could be associated with a leisurely, recreational, and hence childlike activity. On the other hand, just as Pascal claims that his arithmetic machine "is not the first effect of the imagination that I have had on this subject," [67] and that his experiments in physics cost him much "expense, pain, and time," it was important that the problems be recognized as sufficiently demanding in order to highlight the accomplishment that their solution represented.[68]

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[66] "[L]e susdit Monsieur ne veut pas la solution simplement analytique, mais qu'il veut aussi une construction gentille et facile, laquelle je n'ai pas pour à cette heure le loisir de la chercher," Sluse to Brunetti, December 1657, Mesnard *OC*, 4:106.

[67] "[L]a forme de l'instrument, en l'état où il est à present, n'est pas le premier effet de l'imagination que j'ai eue sur ce sujet," "Avis," Mesnard *OC*, 2:340.

[68] Pascal, *Experiences nouvelles*, "Au lecteur," n.p. [5].

It is already clear that, in his correspondence with Brunetti and Huygens, Sluse desired to communicate the immediacy of his own comprehension, especially of Pascal's first problem. This is true, Sluse claims, even if he does not have the time to find the full, geometrical demonstration. Likewise, regarding a second problem, he writes: "The resolution of it is long, but I do not believe it so difficult."[69] In this he is echoed by Huygens, who says that "it is not difficult to show how to reveal the equation; but the calculation is entirely too much work."[70] Sometimes, both Sluse and Huygens suggest, the work is not worth the reward.

As a provincial amateur, Sluse stressed how easily he had perceived the crux of the geometrical matter, probably because of his desire to legitimate himself in the eyes of the mathematicians whose correspondence he craves. It was his way of expressing the kind of mathematical aptitude that Étienne Pascal discovered through his young son's playful acquisition of a Euclidean geometrical theorem. If he were able to show, despite the limitations on his time, that he had been able to penetrate deeply into the problems supplied him, he might gain the respect of savant geometers such as Pascal and Huygens.[71]

To be sure, Sluse was also not overly bold. Despite his previous statement to Brunetti that the solution of Pascal's problem of the five lines is "not so difficult," Sluse writes just two months later:

> For that which concerns the other problem of the five given lines, I do not know who has told him that I judge it easy. I do not believe to have written you any such thing, since I

[69] "La résolution en est longue, mais pourtant je ne la crois pas si difficile," Sluse to Brunetti, October 1657, Mesnard *OC*, 4:100.

[70] "At neque in altero illo de coni sectione quinque datas positione lineas contingente, difficile est ostendere quomodo ad aequationem perveniatur, sed calculus nimii profecto laboris," Christiaan Huygens toRené-François de Sluse, 2 November 1657, Mesnard *OC* 4:99.

[71] He seems to have found a place of respect with Huygens, who corresponded with him until 1668, Sluse, *Correspondance de René-François de Sluse*, 455. He also communicated with Samuel Sorbière, Henry Oldenburg, and John Wallis.

> perceived then that one could come with difficulty to the equation and that after one will have found it, the construction of it would be very involved.[72]

Sluse's about-face in his perspective on the ease of the problem was likely prompted by a response from Pascal, who had read or heard about Sluse's words. Not wanting to alienate the renowned Pascal, Sluse backpedaled and took a conciliatory tone.

The canon's cautious approach to statements of ease continued with the initiation of the direct correspondence between Pascal and Sluse. But he was encouraged and emboldened by a number of observations and methods that he was achieving, including a means by which to draw tangents to a number of different types of curves. Sluse was thus ready, in a letter of June 1658, to question Pascal's evaluation of the difficulty of a particular problem. He writes with a combination of confidence and deference:

> The other [problem], that you perhaps believe more difficult, has seemed to me very easy in the manner in which it is proposed, if however I have indeed understood it, for which I ask you to enlighten me through yours.[73]

As the correspondence continued, and with the proposal of the contest of the roulette anonymously drawn up by Pascal, Sluse asserted the effortlessness of solution of one of the problems proposed. Likely unaware that he addressed the problem's author, Sluse confidently asserted to Pascal in a letter written 6 July 1658, that "the thing is very easy." Considered in the way that he proposed, Sluse continues, "one will not meet more difficulties in their measures and their parts than in that of a triangle."[74]

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[72] "Pour ce qui est de l'autre problème de cinq lignes données, je ne sais pas qui lui a dit que je l'estime facile. Je ne crois pas de vous avoir écrit une telle chose, puisque je m'aperçus alors qu'on pouvait venir difficilement à l'équationet qu'après qu'on l'aurait trouvée, la construction en serait beaucoup embrouillée," Sluse to Brunetti, December 1657, Mesnard *OC*, 4:106.

[73] "L'autre, que vous croyez peut-être plus difficile, m'a semblé très facile en la manière qu'il est proposé, si toutefois je l'ai bien compris, de quoi je vous prie m'éclaircir par les vôtres," Sluse to B. Pascal, 29 June 1658, Mesnard *OC* 4:128.

[74] "Et la chose est très facile; il faut seulement considérer l'origine des cycloïdes d'autre façon que l'on ne fait, car alors on ne rencontrera pas plus de difficultés à leurs mesures et de leurs parties qu'à celle d'un triangle," René-

Sluse's use of the language of ease and difficulty in his correspondence with Pascal suggests that it was a rhetorical attempt to highlight the clarity and penetration of his mind that would class him among the learned. Because he considered himself limited with respect to the time and effort he was able to give to these mathematical problems, he tried to emphasize his "childlike virtues" and natural talents associated with mathematics, such as immediacy of perception. He repeatedly states the ease with which problems may be solved, particularly as they relate to other questions that he had previously considered. But he also continually considered himself as under the control of his official activities as canon. In this way, Sluse may be seen as a foil for Pascal, whose own notions of relative and absolute difficulty in his writings on the roulette are in significant conflict with the opinions of the Liégeois mathematician. The following section shows that the dialogue between the virtues of childlike simplicity and the virtues of maturity, wisdom, and hard work continued in the work of the roulette. It will argue that by expressing the language of simplicity and complexity, Pascal's language in the contest of the roulette drew on ideas that were linked with early modern notions of childlikeness and maturity. In particular, the sensory immediacy of construction-based geometry that Pascal preferred and Pascal's portrayal of the diversionary status of his discoveries were set alongside his insistence on ultimate difficulty of the problems that could only be solved by the truly learned.

Pascal's Language of Ease and Difficulty and the Roulette

Pascal's anonymous announcement of the roulette contest opened by affirming the difficulty of problems whose solution would merit reward: "we come upon propositions

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François de Sluse to Blaise Pascal, 6 July 1658, Mesnard *OC*, 4:267. Sluse seeks to justify this assertion in a later letter to Pascal: "Ce n'est pas sans raison que vous avez été surpris de ce queje vous ai écrit d'avoir trouvé la mesure des cycloïdeset de leurs parties avec la même facilité que celle d'un triangle, car m'étant peut-être fort mal expliqué, je vous ai donné sujet de croire qu'il y eût du mystère où il n'y en a point, comme vous allez voir par cette figure," René François de Sluse to Blaise Pascal, 2 August 1658, Mesnard *OC*, 4:269.

sufficiently strenuous and difficult, as it seems to us."[75] That he would even think of proposing a contest would already suggest the challenge of skill, since it is supposed that not all those who dabbled in geometry could solve them. The early biography by Pascal's niece, Marguérite Périer, suggests that the duke de Roannez encouraged the contest to demonstrate that a devout mind could successfully deal with complex and difficult problems as well as any other savant. It was important that it required significant aptitude and effort to accomplish this goal.

Other evidence also suggests that the very difficulty of the problem prompted Pascal's decision to initiate the contest. In his *Histoire de la Roulette*, Pascal writes that he had devised a method for finding centers of gravities of curves, surfaces, and solids, from which "few things could escape."[76] He firmly believed that he had developed a powerful, generalized tool; but it remained to test this tool in order to know whether it delivered as promised.

From the memories of his own experiences and his knowledge of the Parisian mathematical community, Pascal's mind lit on a curve that had exercised the mind and skill of Roberval and others. It was precisely "in order to make the test of it [his new method] on a subject more difficult" that Pascal began to consider the unsolved measurements of the roulette.[77] Using his method on this curve, he obtained the results for which he had hoped, results which "appeared to me so difficult by any other way."[78] But was this problem of the roulette of such difficulty that it would prove the power of his method? Pascal's contest was

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[75] "in propositiones satis arduas ac difficiles, ut nobis visum est, incidimus," Pascal, First circular letter, Mesnard *OC*, 4:189.

[76] "[J]e me formai des méthodes pour la dimension et les centres de gravité des solides, des surfaces planes et courbes, et des lignes courbes, auxquelles il me sembla que peu de choses pourraient échapper," "Histoire de la roulette," Mesnard *OC*, 4:219.

[77] "[P]our en faire l'essai sur un sujet des plus difficiles, je me proposai ce qui restait à connaître de la nature de cette ligne," ibid.

[78] Ibid.

specifically designed to determine "if they [the roulette problems] were in fact as [difficult] as I had imagined," and therefore to test the extent of his methodological accomplishment.[79]

Pascal ostensibly chose the roulette curve as the basis for the contest because he remembered the difficulty that it had posed for those with whom he had his first mathematical apprenticeship. In his *Histoire de la roulette*, Pascal traces the attempts by a number of mathematical savants to discover the measurements of the curve. In so doing, he implicitly and explicitly asserts its challenges. Implicitly, the long years of research that Europe's greatest mathematical minds had expended on its exploration show its full arduousness. It had become a classic geometrical puzzler of the seventeenth century and had been pursued by Roberval, Galileo, Fermat, Desargues, and Beaugrand, all renowned mathematicians. Even for these, the work was not easy. When, for example, Mersenne initially described the curve and proposed its research to the savants of Europe, including Galileo, "none could succeed in it, and [they] despaired of it."[80] Only Roberval, that great professor of mathematics, succeeded in finding the measurement of the area under the curve. Further on in the history, Pascal again clearly states the quality of the problems associated with this curve when he describes Torricelli's failed attempt to find the volume of the solid engendered by the roulette rotated around its base: "it is there that he found well the difficulty; for it is a problem of a high, long, and painful research."[81]

Pascal's description of the difficulty of the roulette problems was another way of saying that its solution required "penetrating vision" and "force" that comes from a "natural talent," as

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[79] "Je commençai par les centres des gravité des solides et des demi-solides, que je trouvai par ma méthode, et qui me parurent si difficiles par toute autre voie que, pour savoir s'ils l'étaient en effet autant que je me l'étais imaginé, je me résolus d'en proposer la recherche à tous les géomètres, et même avec des prix," ibid.

[80] "Mais aucun n'y put réussir, et tous en désespérèrent," ibid., 4:214.

[81] "Mais ce fut là qu'il trouva bien la difficulté; car c'est un problèmd'une haute, longue et pénible recherche," ibid., 4:218. Cf. Pascal's language regarding the experiments on the void, above, pp. 179, 211-212.

well as "masterful expertise."[82] Pascal made the claim, in his *Numeri figurati seu ordines numerici*, that the key skill of the geometer was the multiplication of propositions and putting them to different uses. For those who cannot do this, he continues, "the cultivation of geometry will be thankless."[83] What is more, whereas natural talents may seem to be the key to the qualities of mind, Pascal reiterates in *Numeri figurati* that the skill of geometry "is not given, but is assisted."[84] In other words, Pascal suggested that his own ability to uncover new methods of finding the measurements of curves was due to the hard work of the mature mathematician, not the immediate perceptions of the child.

In the roulette problem, Pascal made a clear distinction between the kind of arduousness involved in finding a method, like his, and difficulties that are merely time-consuming. Lesser minds, those trained in the habits of calculation, could tackle the latter challenge; only the truly learned could achieve the former. Pascal's correspondence with Sluse provided him with a good example of one whose self-proclaimed main obstacle was his duty-laden position as canon.[85] The design of Pascal's roulette contest, however, sought to clearly distinguish successful results

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[82] Pascal suggests in his second circulated letter that it was his desire to reward a particular application of mind: that he characterizes as "perspicacitate ingenii" and "viribus ingenii," Second letter circulated by Pascal to the learned geometers of Europe (July 1658) (henceforth "Second circular letter"), Mesnard *OC*, 4: 196. The date for this letter is inferred by Mesnard from Boulliau's transmittal of it to Huygens on 19 July 1658, Mesnard *OC*, 4: 255. In Pascal's first circular letter, he had suggested a similar characterization by highlighting that neither "vis ingenii" nor "peritia artificis" were necessary for performing the technical calculations, as opposed to the difficult work of setting forth a method," First circular letter, Mesnard *OC*, 4:191.

[83] "Cui versatile hoc deest ingenium ingratus erit geometriae cultus," "Numeri figurati seu ordines numerici," Mesnard *OC*, 2:1203. M. L. Jones uses the notion of multiplying enunciation as the key to viewing Pascal's thought on geometry as a "spiritual exercise." See above, pp. 221-224, and Jones, *The Good Life in the Scientific Revolution*. For the importance of geometry as a way of teaching one to think in the work of the Abbé Fleury, see Frederick B. Artz, *The Development of Technical Education in France, 1500-1800* (Cambridge, MA, 1966), 16.

[84] "non datur sed juvatur," "Numeri figurati seu ordines numerici," Mesnard *OC*, 2:1203.

[85] By contrast, some have suggested that Copernicus had plenty of time for mathematical and astronomical work precisely because of his position as a canon. A brief description of the duties of a canon in Copernicus's situation is in Hermann Kesten, *Copernicus and His World* (New York, 1945), 72. Kesten suggests that, as a canon, Copernicus would not even have been expected to be in residence for more than half of the year.

of method from the finishing work of calculation. He did not want to discriminate against those who, like Sluse, did not have a great deal of leisure time.

Pascal's first circular letter for the contest thus allows for an abbreviated solution to the problem. As the anonymous proposer of the contest, Pascal requests: 1) a demonstration, "in the manner of the ancients [i.e., synthesis/construction] or through the theory of indivisibles," that the given pieces of data that the problems suppose are sufficient for the calculation; or, 2) a full calculation of two specified cases.[86] These options were slightly modified in the second circular letter, with Pascal specifying one particular case whose proper calculation was necessary to lay claim to the prize.[87]

What does not change from one circular letter to the other is that Pascal expects that, whatever abbreviations of demonstration or reduction to a single calculation are made, they would be followed, in time, by a full demonstration. The contestant must make a claim to Carcavy, the administrator of the contest, "that he possesses the demonstration of the questions posed" and, if only a calculation is given, that the person must be "ready to demonstrate in their entirety all these things at the signal of M. de Carcavy."[88] Pascal explains that the sending of a calculation simply signals a person's eligibility for the prize within the time set for the contest, as Pascal further clarifies in the third circular letter. He no doubt believed that such a calculation could only be accomplished by someone who was in possession of a "perfect and geometrical

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[86] "vel more antiquorum, vel certe per doctrinam indivisibilium," First circular letter, Mesnard *OC*, 4:190.

[87] Pascal, Second circular letter, Mesnard *OC*, 4:197.

[88] The Latin full text reads: "Qui publico instrumento, intra praestitutum tempus, illustrissimo domino de Carcavi significaverit eorum quae quaesita sunt demonstrationem penes se habere; et aut ipsammet demonstrationem quantumvis compendiosam ad ipsum miserit; aut si cartae mandare nondum per otium licuerit, saltem ad confirmandam suae assertionis veritatem, casus quem mox designabimus calculum dederit; seque paratum esse professus fuerit omnia omnino demonstrare ad ipsius D. de Carcavi nutum, hunc nobis satisfecisse declaramus," First circular letter, Mesnard *OC*, 4:196. Mesnard writes: "Dès l'origine, Pascal entendait certainement réserver les prix à ceux qui apporteraient une solution complète, ou, comme il le précisait très clairement, les principes de cette solution. Répondre aux seules premières questions ne pouvait ouvrir droit à la récompense," Mesnard *OC*, 4:174.

demonstration."[89] The Jesuit Father Lalouvère, however, sent a faulty calculation for the contest but still expected to claim the prize, saying that he had simply made a mistake. But for Pascal, the difficulty of the calculation was not the central problem to be solved. There was no backing down from the truly difficult work, which was a generalized construction that would make accurate calculations possible.

The importance of the difficulty of the problem to the purpose and effectiveness of the contest became even more transparent with the pseudonymous publication of Pascal's results in his *Lettres de A. Dettonville*.[90] The very first article in the book is a letter from Carcavy to "Monsieur Dettonville," requesting the mathematical results that are then articulated in the remainder of the book.[91] In the letter, which sets the significance of the work, Carcavy specifically pinpoints a particular set of problems (i.e., the determination of the centers of gravity of the surfaces of the solids produced by rotation around the axis and the base) as most important, precisely because they are difficult rather than easy. For Carcavy, "they appear so difficult by their mere enunciation."[92] But he goes further:

> [W]hen I had in fact considered them a little, it seemed to me, according to the little light that I had concerning it, that the least that one could say of it was that there is nothing more

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[89] "une démonstration parfaite et géométrique," Pascal, Third letter circulated to the learned geometers of Europe (7 October 1658), Mesnard *OC*, 4:202.

[90] *Lettres de A. Dettonville contenant Quelques-vnes de ses Inuentions de Geometrie* (Paris: Guillaume Desprez, 1659; reprint London, 1966). This publication is included in Mesnard *OC*, 4:407-565.

[91] The letter prefaces Pascal's *Lettres de A. Dettonville*, which is a set of four letters with accompanying treatises. The parts of the work include *Lettre de A. Dettonville a Monsieur de Carcavy* (Paris, 1658); *Lettre de A. Dettonville a Monsieur de Sluze Chanoine de la Cathedrale du Liege* (Paris, 1658); *Lettre de A. Dettonville a Monsieur A. D. D. S.* (Paris, 1658); and *Lettre de A. Dettonville a Monsieur Hugguens de Zulichem* (Paris, 1659).

[92] "ils paraissent si difficiles par la seule énonciation," "Lettre de Monsieur de Carcavy a *Monsieur* Dettonville," in *Lettres de A. Dettonville*, n.p. [1]; Mesnard *OC*, 4:410.

> hidden that has been solved in all of geometry, either by the ancients, or by the moderns, and I was not alone in this sentiment.[93]

The declaration is extreme! According to Carcavy, Dettonville is considering something that is so geometrically obscure that even the discoveries of the ancients could not match it. It is an astonishing statement for one of the missionaries of Mersenne's group of geometers, which so valued what was received from Greek mathematics.

When Carcavy expands on these thoughts, he vaguely suggests Dettonville's kinship to Archimedes, and even the way in which he surpasses the great ancient geometer:

> For even though, for greatness of genius, none of the ancients has perhaps surpassed Archimedes, it is certain nonetheless that, for the difficulty of the problems, those of today surpass his by a great deal, as is seen by the comparison of the entirely uniform figures that he has considered to those that one considers now, and especially the roulette and its solids, the *escalier*, the cylindrical triangles, and other surfaces and solids of which you have discovered the properties.[94]

The above passage, with its suggestion of the way in which moderns surpass the ancients, hearkens back to Pascal's statements regarding the status of moderns as adults in comparison with the childhood associated with the ancients. It suggests that although it may be difficult to claim that anyone has as much penetration of mind as the ancient mathematicians and natural philosophers, contemporary mathematicians could build upon their accomplishments. The child (i.e., the ancients) naturally had first to tackle the less complex, more obvious, and more regular problems. This is the case even if the talent of the child is extremely evident (and seventeenth-century geometers certainly believed in the brilliance of the ancients). The modern geometer,

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[93] "[Q]uand je les eus un peu considérés en effet, il me sembla, selon le peu de lumière que j'en ai, que le moins qu'on en pouvait dire était qu'il n'avait été resolu rien de plus caché dans toute la géométrie, soit par les anciens, soit par les modernes, et je ne fus pas seul dans ce sentiment," ibid.

[94] "Car, encore que, pour la grandeur du génie, aucun des anciens n'ait peut-être surpassé Archimède, il est certain néanmoins que,pour la difficulté des problèmes, ceux d'aujourd'hui surpassent de beaucoup les siens, comme il se voit par la comparaison des figures toutes uniformes qu'il a considerées à celles que l'on considère maintenant, et surtout à la roulette et à ses solides, à l'escalier, aux triangles cylindriques, et aux autres surfaces et solides dont vous avez découvert les propriétés," ibid., 4:411.

having benefited from the maturation begun by the ancients, explores (as a full-fledged adult) problems that are even more hidden and have complex irregular characteristics. These are produced by multiple motions: e.g., the roulette, which is defined by two simultaneous movements; and the *escalier*, which is a type of spiral that includes both a circular and a vertical component. Insofar as Dettonville solved a more difficult (or at least more "hidden") problem than any of those considered by the great Archimedes, he had proven himself to have achieved greater things than the mathematician from Syracuse.

For Carcavy, the difficulty of the roulette problem was further attested by the ultimate failure of others to find the solutions. Dettonville had implied that he was more mature in learning than other mathematicians of his time, exploring the obscure reaches of the geometrical unknown. Carcavy, as the previous passage showed, believed that Dettonville bore characteristics as impressive as the ancients. Perhaps he would have concurred in giving Pascal the label of a "new Archimedes . . . who will bring mathematics to its last perfection."[95]

Pascal's reasons for proposing the contest, then, are closely related to the perceived difficulty of the problems, as recognized by Pascal, Carcavy, and others. Frans van Schooten (1615-1660), Huygens's teacher and mentor, wrote to his pupil that in order to find the solutions sought by the anonymous author of the contest one would have to be "a man thoroughly at leisure, as well as unrestrained, in order to solve them within the determined time."[96] Moreover,

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[95] Mersenne, *La verité des sciences*, 750. See above, p. 67.

[96] "homini penitus ocioso atque libero competat, ut illa intra praestitutum tempus solvat," Frans van Schooten to Christiaan Huygens, 22 July 1658, Mesnard *OC*, 4:257. Van Schooten was himself the son of an illustrious father, taking over his father's chair in mathematics at Leiden. He is perhaps most well-known for his popularization of the work of Descartes. It was in his capacity as professor of mathematics that van Schooten met Christiaan and his brother. Van Schooten was to remain one of Huygens's key correspondents, Edwin van Meerkerk, "The Correspondence Network of Christiaan Huygens (1629-1695)," in *Les grands intermédiaires culturels de la République des Lettres: études de réseaux de correspondances du XVIe au XVIIIe siècles*, ed. Christiane Berkvens-Stevelinck, Hans Bots, and Jens Häseler (Paris, 2005), 214, 216, 220, 223. On the relationship between Schooten and Huygens, see Frankfourt and Frenk, *Christiaan Huygens*, 35-36.

he argues that the slight chance of winning the prize is not worth the effort that is necessary, an echo of Sluse's earlier comments to Brunetti about the difficulty of the constructions Pascal sought.[97] Huygens communicates similar thoughts to Boulliau, who had ostensibly avoided considering the roulette because of time constraints. This "young Archimedes" questions the very *possibility* of the solutions that are sought by the anonymous mathematician:

> They seem to me so difficult for the most part that I strongly doubt if even he who has proposed them could solve them all, and we would like to know that he has assured us of it in this publication.[98]

A month and a half later, Huygens wrote letters to Sluse and to Wallis, in which he once again communicated questions concerning the possibility of solution of solving all of the problems.[99] The reply from Wallis suggests that both he and Christopher Wren agreed: "in any case, we have solved most of them. . . . [W]e doubt, however, that all of these things are able to be solved in a way other than through geometrical approximation."[100] It was precisely the sort of reaction, as Mesnard points out, for which Pascal was hoping.[101]

Pascal had portrayed the process of discovery of the means of solution to the problems as especially difficult. He believed, however, that the proper presentation of the solutions would

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[97] "[L]'auteur se glorifiant même de produire de plus grandes choses encore, il n'y a pas de raison, mis à part un léger et douteux espoir de récompense, de se charger à la légère (du moins à mon jugement) du travail que cela requiert," Schooten to Christ. Huygens, 22 July 1658, Mesnard *OC*, 4:257.

[98] "Ils me semblent si difficiles pour la pluspart que je doubte fort si celuy mesme qui les a proposez les pourroit tous resoudre, et voudrois bien qu'il nous en eust assurè dans ce mesme imprimé," Draft of letter from Christiaan Huygens to Ismaël Boulliau, 25 July 1658, Huygens *OC*, 2:200. Huygens goes on to ask of Boulliau "si vous me pouuez que assurer de sa part que ce qu'il nous propose est chose qui soit desia trouuée, ou du moins trouuable," ibid., 201. Mesnard states that Huygens's doubt about the solvability of the problems is a measure of "le science du temps" and suggests that, because of his little enthusiasm for the use of indivisibles in mathematics, Huygens "se trouvait mal armé devant de tels problèmes," Mesnard *OC*, 4:255.

[99] Draft, Christiaan Huygens to René-François de Sluse, 6 September 1658, Mesnard *OC*, 4:282; draft, Christiaan Huygens to John Wallis, 6 September 1658, Mesnard *OC*, 4:316.

[100] "pleraque saltem solvimus . . . ; an omnia tamen possint aliter quam per approximationem geometrice solvi dubitavimus," Wallis to Christ. Huygens, 1 January 1659, Mesnard, *OC*, 4:316.

[101] Mesnard *OC*, 4:255.

involve an ease of procedure. Dettonville claims this for his own work in the final sentence of a section of the *Lettres de A. Dettonville* written to Carcavy: "It will be easy based on that for everyone to find the calculations of all these cases, by means of these methods."[102] By thoroughly detailing his method he was able to avoid the difficulty that readers often had with the ancient Greek mathematicians, who have "left only their solutions without instructing us in the ways by which they had arrived there."[103] Through explanation, he believed, he had created a way that others could calculate the dimensions sought without the same expenditure of effort.[104]

Through his concerted application to the problem of the arithmetic machine Pascal had reduced the inconveniences and difficulties of arithmetic to a simple movement of the hand. Similarly, he had now uncovered the "hidden" aspects of the roulette, allowing unfettered access to its dimensions. Thus, Pascal's work on the roulette suggests a dual status of geometry. It is both difficult and easy and involves both maturity and childlikeness. The problems posed an incredible challenge even to the learned. Through his efforts and the disciplined application of method, however, Pascal/Dettonville fathomed its deepest mysteries. However, his insistence on

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[102] "Il sera sur cela facile à tout le monde de trouver les calculs de tous ces cas, par le moyen de ces méthodes," "Traitté General de la Roulette," in *Lettres de A. Dettonville*, 10.

[103] "[J]e vous ai souvent ouï plaindre de ce que les anciens n'en ont pas usé de même, ne nous ayant laissé que leurs seules solutions sans nous instruire des voies par lesquelles ils y étaient arrivés, comme s'ils nous eussent envié cette connaissance," "Lettre de A. Dettonville a Monsieur de Carcavy," in *Lettres de A. Dettonville*, 1.

[104] Dettonville recognizes, in fact, that this method might present problems to some, because of its use of indivisibles. He asserts, however, that their use provides no difficulty: "*I have wanted to write this notice in order to show that all that is demonstrated by the true rules of indivisibles is demonstrated also in the rigor and manner of the ancients; and that thus one of the these methods does not differ from the other except in the manner of speaking; which cannot wound reasonable people when one has once warned them of what one understands by that. / And this is why I will have no difficulty in what follows of using this language of indivisibles*: the sum of lines, *or* the sum of planes; *and thus when I will consider . . . the diameter of a semicircle divided into an indefinite number of equal parts . . . . I will not have any difficulty using this expression*: the sum of the ordinates, *which seems not geometrical to those who do not understand the doctrine of indivisibles, and who imagine that it is to sin against geometry to express a plan by an indefinite number of lines; which comes only from their failure of intelligence*," ibid., 10.

the use of construction and the numerous diagrams highlight the visual immediacy of Pascal's solutions to the roulette problems.

A Game for the Learned

The previous section has sought to show that Pascal's procedure of sharing his new method of calculating areas and volumes in the form of a contest was based primarily upon the desire to emphasize the difficulty of the problems of the roulette. The idea of a mathematical contest did not originate with Pascal. University chairs of mathematics were often awarded based on the solving of significant problems.[105] The contest was an established way for mathematicians to legitimate their abilities. By proposing a contest, Pascal likely hoped that many of the geometers of Europe would be drawn to attempt the solution, in order to gain, as Sluse expressed it, "the glory that will accompany you if . . . you accomplish it."[106] When Pascal anonymously proposed the contest, he did so to "the most eminent geometers of all the earth."[107] In addition, he offered the legitimation that the one who solved the problem within the time allotted "will be our great Apollo."[108] Through such a challenge, Pascal appealed to individuals who would like to prove their prowess in geometry.

Pascal's rhetoric in the first circular letter was clearly an attempt to engage the curiosity and the desire for achievement of the savant geometers of Europe. The anonymity of the challenge created further intrigue that would draw attention and conversation to the question of

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[105] In fact, this is one of the reasons for Roberval's notorious tendency to keep his mathematical results secret. Probably the most famous of the early modern mathematical contests was devised by Tartaglia (1500-1557) regarding cubic equations. Tartaglia's challenge is described in Martin A. Nordegaard, "Sidelights on the Cardan-Tartaglia Controversy," *National Mathematics Magazine* 12 (1938): 327-346.

[106] "Non illud intelligo χρύσεον quod infra te esse scio; sed gloriam quae te sequetur si rem, uti spero confeceris," René-François de Sluse to Christiaan Huygens, 5 July 1658, Mesnard *OC*, 4:279.

[107] Pascal, First circular letter, Mesnard *OC*, 4:189.

[108] "Quisquis superius proposita, intra primum diem mensis octobris anni 1658, solverit et demonstraverit, magnus erit nobis Apollo," ibid., 4:192.

their origin. The problems of the roulette did indeed become fodder for conversation within the learned correspondence networks, and the identity of the anonymous author of the problems excited interest.[109]

The consideration of the roulette by way of a contest suggests childhood connotations of gaming. Pascal had done a good deal of reflection on the diversions of gambling, both in the circles of the Chevalier de Méré and in his correspondence with Fermat regarding "the geometry of chance."[110] The connection with these considerations of games of chance is even stronger given the monetary award associated with the roulette contest, which was one of its unique features. Pascal recognized that the offer of money could seem a particularly vulgar motivation for solving the problems. Sluse affirmed this when he wrote to Huygens of this material prize: "I know that it is below you."[111] Pascal justified the reward by its symbolism:

> not for the lure of reward (far be it from us!), but as a public proof of our consideration, or rather of the merit of those who would have solved it.[112]

The monetary prize was a tangible wreath of victory in the contest, a token that the winner had emerged as superior to other contestants. Pascal's observations about diversion and

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[109] The question of the authorship of the contest arises in correspondence between Huygens and Boulliau: "je vous priai de me faire savoir le nom de l'auteur des problèmes de la cycloïde," draft, Christiaan Huygens to Ismaël Boulliau, 19 September 1658, Mesnard *OC*, 4:260; Huygens and Sluse: "De Pascalio autem, in suspicionem incidi eum esse qui problemata proposuerit," René-François de Sluse to Christiaan Huygens, 10 January, 1659, Mesnard *OC*, 4:284; Huygens and Wallis: "Si autem (quod suspicor) Pascalius sit qui haec proposuit," Wallis to Christ. Huygens, 1 January 1659, Mesnard *OC*, 4:317; Sluse and Pascal: "Il me semble aussi de pouvoir tirer de la même histoire par conséquence assurée que cet excellent anonyme qui nous a proposé les problèmes, c'est M. Pascal, et que ce sera aussi lui seul qui les résoudra," René-François de Sluse to Blaise Pascal, 16 November 1658, Mesnard *OC*, 4:274.

[110] Pascal's initial interest in probability theory is said to have come from his interactions with the Chevalier de Méré, which contributes to interpretations of Pascal that stress the importance of friendships and their influence on his work, Humbert, *Cet effrayant génie*, 11; Le Guern *OC*, 1:xiii. The terminology of "geometry of chance" (original Latin: *aleae geometria*) originates in Pascal's address to the Parisian Academy, "Celeberrimae matheseos academiae parisiensi," Mesnard *OC*, 2:1035.

[111] "infra te esse scio," Sluse to Christ. Huygens, 5 July 1658, Mesnard *OC*, 4:279.

[112] "quarem solutionem a praestantissimis toto orbe geometris supplices postulamus, proposito ipsis praemio, non mercedis gratia (quod absit!) sed in obsequii nostri, aut potius meriti eorum qui haec invenerint, publicum argumentum," First circular letter, Mesnard *OC*, 4:189.

gambling, which appear in the *Pensées*, highlight that the material gain is not the primary goal that most have in doing it. The player of a game may have no need of the monetary prize, but the game offers the diversion of risk as well as "so that he can boast tomorrow to his friends that he played better than someone else."[113]

Pascal directly implicated mathematics in this same attitude of competition: "Likewise others sweat away in their studies to prove to scholars that they have solved some hitherto insoluble problem in algebra."[114] In the passages above, the fierce competition and pride involved in the "games" is seen for the absurdity that it is, and the supposedly important "adult" activities such as hunting, gambling, and algebra become associated instead with childishness. To take such significant pains, simply in order to be the first to solve a problem, is to mistake a diversionary activity for a serious occupation. It is to be "just like children taking fright at a face they have daubed themselves."[115]

In his *Lettres de A. Dettonville*, Pascal describes an individual who seems to represent a mature view of mathematics. He addresses the last of Dettonville's letters to "A. D. D. S.," who embodies the "ease" of geometrical thought, for "that which is a study for others is only a diversion for you."[116] The initials, following Mesnard, are almost certainly those of Antoine Arnauld ("Arnauld Docteur de Sorbonne") and this identification hearkens back to what Pascal's earliest biographers claim was the purpose of the roulette contest: "a design which regarded only

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[113] Pascal, *Pensées*, trans. Krailsheimere, no. 136, 40. In the roulette contest, there was both risk and the possibility of award, as in a gaming situation. The risk was one of time lost and pride shattered. With respect to the first, Sluse writes: "One of those who have wasted their effort is, I think, Wallis, or another English geometer," Sluse to Christ. Huygens, 27 December 1658, Mesnard *OC*, 4:283-284. For pride lost, one may consider the negative reception given to Lalouvère's entry.

[114] Pascal, *Pensées*, trans. Krailsheimer, no. 136, 40.

[115] Ibid., no. 136, 41.

[116] "ce qui est un étude pour les autres n'est qu'un divertissement pour vous," "Lettre de A. Dettonville a Monsieur A. D. D. S.," in *Lettres de A. Dettonville*, 1.

the glory of God."[117] Convinced by the duke de Roannez, Pascal tackled the project to combat the belief of certain skeptics and unbelievers that those who are devout have weak minds.[118]

The roulette contest represents a serious and concerted intellectual effort by Pascal, with the attempt to earn a favorable place among posterity by providing the means of progressing still further.[119] Paradoxically, this mature effort was expended in an activity that could be characterized as a game, as childlike. Furthermore, within the game that was the roulette contest, there was another "game," the puzzle of Pascal's pseudonymous identity. The use of the pseudonym Amos Dettonville forged a link between the ironic religious writer (under the pseudonym Louis de Montalte) and the ingenious geometer. Both characters demonstrated how the virtues of childhood and superior learning could go hand in hand. Dettonville combined a playful, diversionary approach to geometry with the intellectual probity respected by geometrical savants. Louis de Montalte, the author of the *Provincial Letters*, represented the innocence and "ignorance" that was able to disarm critics of the Jansenists.[120]

Limitations of a Mathematical Métier

The link between the pursuit of mathematics as a game/diversion/childlike activity, and the intellectual maturity Pascal pursued during the final period of his life, became even more explicit after the roulette contest. In 1660, Pascal articulated his view that the meaningfulness of mathematics as a personal pursuit was limited. The letter to Fermat that expresses this was a

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[117] "un dessein qui ne regardait que la gloire de Dieu," "La vie de Pascal," Mesnard *OC*, 1:586. For an explanation of Mesnard's identification of Arnauld as the addressee, see Mesnard *OC*, 4:391-392. Other possibilities that have been suggested are Augustin (i.e. Antoine) de Singlin and Alphonse-Antoine de Sarasa, Brunschvicg *OC*, 8:249.

[118] "argument puissant contre l'identité souvent posée entre croyance et faiblesse d'esprit," Mesnard *OC*, 4:168.

[119] Mesnard *OC*, 4:193.

[120] To these we may add that Pascal's planned apology for the Christian religion was to be written under the pseudonym of Salomon de Tvltie, another anagram of these two names; Pascal, *Pensées*, trans. Krailsheimer, no. 745, 229 and note 1.

response to a request by the provincial mathematician to meet somewhere between Toulouse and Clermont-Ferrand, the location to which Pascal had retired when he had once again lapsed into ill-health:

> For, to speak to you frankly of geometry, I find it the highest exercise of the mind, but at the same time I understand it to be so useless that I draw no distinction between a man who is only a geometer and an able artisan. I also call it the finest craft [*métier*] in the world, but in the end it is only a craft [*métier*], and I have often said that it is good for the testing, but not the employment of our forces: in such a way that I would not take two steps for geometry, and I am very much assured that you are of the same disposition.[121]

In this passage, the limitations of the geometer are portrayed as similar to those of any manual laborer, an idea that conjures Pascal's belittling spirit toward artisanal knowledge that was manifest during his early career. But the artisan that he now considered was the geometer, and the *métier* was the one to which he himself had been "apprenticed" in the Mersenne group.

When Pascal began his mathematical and scientific career, as Chapter 3 has argued, he differentiated himself from the limited place of the child genius, from talent due to inclination, and from the habitual training of artisans. During the roulette contest, he maintained the importance of the hard work that he believed would earn him "the recognition of posterity."[122] At the same time he stressed the ease and immediacy that his method contributed to the solution of the problem and, based on his letter to Fermat and Gilberte's story of the toothache, he considered this last work in mathematics as little more than a diversion.

The labeling of mathematics as a *métier* and the link between childlike diversion and the roulette contest suggests a particular way of understanding Pascal's childhood. Pascal's

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[121] " Car pour vous parler franchement de la géométrie, je la trouve le plus haut exercice de l'esprit; mais en même temps je la connais pour si inutile que je fais peu de différence entre un homme qui n'est que géomètre et un habile artisan. Aussi je l'appelle le plus beau métier du monde; mais enfin ce n'est qu'un métier; et j'ai dit souvent qu'elle est bonne pour faire l'essai, mais non pas l'emploi de notre force: de sorte que je ne ferais pas deux pas pour la géométrie, et je m'assure fort que vous êtes fort de mon humeur," B. Pascal to Fermat, 10 August 1660, Mesnard *OC* 4:923.

[122] Pascal, First circular letter, Mesnard *OC*, 4:193.

discovery of geometry was made in the context of diversion. It was shaped into a *métier* through the influence of his father's friends. In the *Pensées*, Pascal describes the process by which people choose careers:

> The most important thing in all of life is the choice of a craft [*métier*], chance disposes us to it.
>
> Custom makes masons, soldiers, roofers. 'That is an excellent roofer,' says one, and in speaking of soldiers, 'They are indeed fools,' says one, and others on the contrary: 'There is nothing greater than war, the rest of men are rascals.' Through the force of hearing praised in childhood these crafts [*métiers*] and scorning all the others, one makes one's choice. For naturally one loves virtue and hates folly, these words then end up deciding it, and one sins only in the application.[123]

It is for this reason, Pascal goes on, that some countries produce more people of one *métier* and others contain more of another. It is not a question of temperament, the matrix of the hot/cold and wet/dry of the body that had often been used to explain differences in custom based upon climate.[124] For Pascal, being raised by a father whose friends often gathered at their home to discuss geometry and had particular philosophical and religious reasons for praising it may have served as an important accustomization to the *métier* of mathematics. For Pascal, early in his life, geometry became the model for virtue.

With time, according to Pascal's own autobiographical musings, he had begun to see limitations in the study of mathematics:

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[123] "Custom makes masons, soldiers, roofers. 'He is an excellent roofer,' they say, and speaking of soldiers: 'They are quite mad,' while others on the contrary say: 'There is nothing as great as war, while everyone else is worthless.' From hearing people praise these trades in our childhood and running down all the others we make our choice. For we naturally love virtue and hate folly; the very words will decide, we only go wrong in applying them." Pascal, *Pensées*, trans. Krailsheimer, no. 634, 209.

[124] Huarte's use of the four qualities as determinate for different "*esprits*" is in agreement with this perspective: "Whence it clearly appears that from Cold proceeds the greatest difference of Wit in Man, *viz*. the Understanding. *Aristotle* therefore enquiring, why the Men inhabiting hotter countries (as *Ægypt* is) are more Subtile and Ingenious than those who live in colder Climates, makes Answer, That the Ambient Heat being excessive, draws forth and consumes the Natural Heat of the Brain, leaving it cold, which makes Men more sharp," Huarte, *Tryal of Wits* (1698), 135-136.

> I had passed a long time in the study of the abstract sciences and the little communication that one could have with others about them disgusted me. When I began the study of man, I saw that these abstract sciences are not proper to man.[125]

Pascal explains in this excerpt from the *Pensées* that he was repulsed from geometrical study because of the limited ability to effectively talk about those discoveries with others.[126] It was a limitation of scope, made clear through the failure of interpersonal communication. When he was working with the artisans of Rouen on the construction of the arithmetic machine, Pascal's inventiveness collided with the incommunicability of the mathematical theory of the device. In that case, the habituated learning that a clockmaker received during his apprenticeship was considered incompatible with a full understanding of the details of the mechanism of the machine.

In the above passage, there is a transformation of the significance of incommunicability. The difficulty is not on the side of those, such as artisans, untrained in mathematical thinking. Instead, it is a characteristic of geometry itself. Pascal had earlier suggested that artisans, who learn through habit, are not at the highest level of human enterprise. In this passage, on the other hand, geometry is also considered to be "not proper to man."[127] Pascal insists that by giving himself to the study of geometry he was "straying further from my true condition."[128] The limitation of scope was so severe that it was not just a minor liability of mathematics, but a justification for abandonment.

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[125] "I had spent a long time studying abstract sciences, and I was put off them by seeing how little one could communicate about them. When I began the study of man I saw that these abstract sciences are not proper to man," Pascal, *Pensées*, trans. Krailsheimer, no. 687, 217.

[126] That Pascal is referring to geometry when he speaks of these "abstract sciences" [*sciences abstraites*] is made explicit later in the fragment, ibid.

[127] Ibid.

[128] Ibid.

In the roulette problem, Pascal tried to avoid the problems associated with taking geometry too seriously by keeping the conclusions strictly differentiated from practical application. The most basic reason for pursuing the answer to a difficult problem was to find out whether his mind was as strong as was believed. Pascal expresses this approach when he writes to Fermat that geometry "is good to make a test, but not the use of our force."[129]

In addition, Pascal's solution to the problem of the roulette uses a process whereby figures are divided into an indefinitely small size in order to calculate their area. Pascal then had to deal with the question of the existence of indivisibles that was then current. Although this "does not seem to be geometrical to those do not understand the doctrine of indivisibles," Pascal shows that it is equivalent to accepted ancient practices.[130] These troublesome aspects of mathematical method, he states in his "De l'esprit géométrique," are what make it worthwhile: they are able to produce "reflections which are of better worth than all the rest of geometry."[131]

The insights to which such mathematical concepts lead the mathematician deal with the nature of humanity, as situated between infinite greatness and infinite smallness.[132] And these are fundamentally linked to Christian teachings about childlikeness and maturity. On the one hand, humanity's smallness suggests the position of the child, thrown into an immense universe

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[129] B. Pascal to Fermat, 10 August 1660, Mesnard *OC*, 4:923.

[130] "Et c'est pourquoi je ne ferai aucune difficulté dans la suite d'user de ce langage des indivisibles . . . qui semble n'être pas géométrique à ceux qui n'entendent pas la doctrine des indivisibles," "Lettres de A. Dettonville," Mesnard *OC*, 4:424

[131] "Sur quoi on peut apprendre à s'estimer son juste prix, et former des réflexions qui valent mieux que tout le reste de la géométrie," "De l'esprit géométrique," Mesnard OC, 3:411.

[132] "For, after all, what is man in nature? A nothing compared to the infinite, a whole compared to the nothing, a middle point between all and nothing, infinitely remote from an understanding of the extremes; the end of things and their principles are unattainably hidden from him in impenetrable secrecy," Pascal, *Pensées*, trans. Krailsheimer, no. 199, 61.

and humbly dependent upon the Creator.[133] On the other hand, the greatness of human beings is the capacity for what might be achieved and understood through thought.[134] The practice of geometry is the exercise of that adult-like capacity for reason. But because of the shortness of its grasp, limited in that it "considers only very simple lines," it is also related to childhood; it is extremely clear but also extremely limited.

For Pascal, then, the roulette contest was proof that the geometrical strength of a Dettonville and the spiritual devotion of a Montalte or a Salomon de Tultie (an authorial pseudonym used in the *Pensées*) may legitimately coexist and, in fact, mutually support one another. The "glory" of significant contributions to the *métier* of mathematics should be balanced by the recognition that "these abstract sciences are not proper to man."[135]

This section has shown that Pascal's last major mathematical endeavor was indeed a return to childhood. It was a return to the type of geometrical work he had done in Mersenne's group and to a problem that had been of special concern for the members of that group. In the exercise of the contest, he was dependent upon the individuals associated with that group: Roberval, for his prior knowledge of the curve; Carcavy, for the administration of the contest. In content and mathematical approach, Pascal's return to childhood involved the search for an "easy" method that would reduce the difficulty of the mathematical problem and make it possible to solve other types of curves. The childlike immediacy of geometry and its status as diversion was matched by a deep sense of accomplishment in the face of a difficult problem.

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[133] "I see the terrifying spaces of the universe hemming me in, and I find myself attached to one corner of this vast expanse without knowing why the brief span of life allotted to me should be assigned to one moment rather than another," ibid., no. 427, 130. This helplessness is reflected in Pascal's famous statement: "The eternal silences of these infiinite spaces fills me with dread," ibid., no. 201, 66.

[134] "Through space the universe grasps me and swallows me up like a speck; through thought I grasp it," ibid., no. 113, 29.

[135] Pascal, *Pensées*, trans. Krailsheimer, no. 687, 217.

For many of the members of the European savant community at large, however, the roulette contest hardly represented the heights of virtue. A brief exploration of some of the negative reactions to the contest will provide insight into the deep gulf that separated Pascal from those who would become the key players in the late-seventeenth-century scientific community. His "gaming" approach to mathematics did not respect the "adult" virtues of civility so important to that community. Moreover, while Pascal expressed the limited scope of geometry by referring to it as merely a *métier*, the childlike, synthetic approach to geometry was in the process of being rejected as obscure and without utility.

Criticisms of the Contest: Between Childhood and Sociability

Pascal's efforts in the roulette contest were criticized by members of the savant community in ways that directly undermined his attempts to combine childlike and adult virtues in his pursuit of mathematics. The mathematicians involved in the contest did not always agree with Pascal's evaluations concerning the ease or difficulty of the problems or with the clarity of the solutions offered. Furthermore, they called the administration of the contest into question, reacting negatively to Pascal's game of identity and the peculiarity of the contest rules. This section will explore some of these criticisms and their contrast with Pascal's claims for the contest. It will conclude with a comparison of Pascal with Huygens regarding the two mathematicians' involvement with the roulette problem. This comparison will suggest reasons why Pascal was marginalized by the Parisian savant community near the end of his life.

This chapter has stressed the importance that Pascal accords to the difficulty of solving the set of roulette problems. Significant references to the question of the problems' difficulty by those who became involved in trying to solve them suggest this as a central theme of the roulette contest. The *Lettres de A. Dettonville* opens dramatically with a letter written to the author by Carcavy, in which he asks Dettonville to reveal his solutions. In it, Carcavy distinguishes

between "the problems that you have proposed as easy" and "those that you have proposed as difficult."[136] When he first received word of the proposed problems, Christiaan Huygens questioned the possibility of a solution.[137] Expanding upon this question, he inverts the issue, contrasting the effort required for resolution of arduous mathematical problems with the simplicity of proposing them.

Objections to the Characterization of the Problems as Easy

The response to the contest by Antoine Lalouvère, himself a Jesuit from Toulouse, further demonstrates the centrality of questions of relative ease to the contest. Lalouvère sent solutions to the problem, but these were minimized by Pascal in documents circulated later.[138] Lalouvère had sent the calculation of a specific instance of the problems, but the calculation contained an error. Having been taken to task in writing, Lalouvère continued to justify his responses and criticized the contest. A key aspect of his argument against the contest was his rejection of Carcavy's claim, mentioned above, that the problems of the roulette surpassed the problems of the ancients, including Archimedes. Though the problems of the roulette were "astonishingly difficult," Lalouvère admits, their solution was proportionally less significant in comparison to the progress made by the ancients. The difference between the roulette problems and "the common diligence of the Geometers" of the seventeenth century was not, Lalouvère argues, as

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[136] "Et il s'offre encore un soulagement à votre travail, en ce qu'il ne sera pas nécessaire de vous étendre sur les problèmes que vous avez proposés comme faciles . . . ; de sorte que vous n'aurez presque qu'à donner ceux que vous avez proposés comme difficiles," "Lettre de Monsieur de Carcavy a *Monsieur Dettonville*," in *Lettres de A. Dettonville*, n.p. [1].

[137] See above, note 98.

[138] The third circular letter about thecontest (7 October 1658), appears, as Mesnard suggests, to refer to Lalouvère, when it states: "je ne puis assez admirer la vaine imagination de quelques autres, qui ont cru qu'il leur suffirait d'envoyer un calcul faux et fabriqué au hasard pour prendre date du jour qu'ils l'auraient donné, sans avoir produit autre marque qui fasse connaître s'ils ont résolu les problèmes," Third circular letter, Mesnard *OC*, 4:201. A similar judgment is given in Pascal's announcement of the results of the contest (25 November 1658), "Récit de l'examen et du jugement," Mesnard *OC*, 4:234.

great as the difference in difficulty between the work of Archimedes and the state of "accepted geometry" during the time that he lived.[139] In a gesture of self-deprecation, Lalouvère argues that the fact that he, an amateur geometer, a "man of so little mind," was quickly able to find some of the calculations provides evidence that the problems are less difficult than the anonymous had suggested.[140] The original proposal labeled the problems in their entirety as being an arduous challenge and was addressed to "the most outstanding geometers in all the world." The contest did not "make distinction between what was required of apprentices and of these masters, of these consummate men of science."[141] This inability clearly to state the requirements for demonstrating learnedness in geometry proved to Lalouvère that the author of the contest determined which problems he would consider easy and which he would consider difficult based on what the contestants were able to solve successfully.[142] The Jesuit father calls into question the "adult" mathematical virtue and exercise necessary in order to solve such problems, arguing that their difficulty was merely relative and not absolute.

Conversely, Lalouvère questions Pascal's claim that the calculations that would result from his method of using indivisibles would be easy. He does not believe that Pascal's work simplifies the issue to the extent that its author claims. Pascal had written of the ease of finding

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[139] "Thirdly, I do not deny that the thought of the cycloid entirely pertains to our present age, and that the problems proposed regarding it are remarkable in their difficulty, even if they are attempted by he who is well-instructed in the uncommon principles of the balance; but in bringing forth their solution, could you surpass the common diligence of the Geometers by as great distance as Archimedes surpassed the accepted geometry of his time? There is rightly reason to doubt it," Antoine Lalouvère, *Veterum geometria promota in septem de cycloide libris et in duabus adjectis Appendicibus* (Toulouse, 1660), excerpted in Mesnard *OC*, 4:903.

[140] "However, what a man of meager mind has so quickly discovered, who could say that this is impenetrable and hidden as much as possible, in such a great light of the geometers of ours age," ibid.

[141] "[T]he Anonymous , once he had without distinction proposed all the problems to the most outstanding geometers in all the world, and had made no distinction between what he required of novices and what of Masters (those consummately learned men), whispered to us through his friends that what we had been the first to give was without difficulty," ibid.

[142] Ibid.

the calculations using his methods.[143] But Lalouvère states that "For my part, I have never found it easy since this book came into my hands."[144] Pascal suggested that the work of calculation was child's play, a matter for an apprentice of the mathematical *métier*. Lalouvère disagreed:

> Do not suppose, Learned Reader, that this calculation is of the number of commonplace ones and, as the Anonymous says, is of those that do not depend on the power of innate genius, and which is able to be committed to whatever novice comes along; clearly it is most intricate, and it requires a complete geometer, and often the Father of the very demonstration.[145]

Lalouvère counters both of Pascal's suggestions regarding childlikeness and maturity. He dismisses Pascal's claims to being geometrically mature in a way that rivals the ancients; and he rejects the assertions of the ease and simplicity of the resultant calculations.

While Lalouvère questioned Pascal's evaluation of the various aspects of the roulette problem, Huygens, for the most part, agreed with Pascal regarding the difficulty of the problems, to the point that he believed them impossible. However, he did not share the anonymous writer's belief that what was most important about the contest was how challenging it was:

> Not indeed that I value geometrical discoveries only for their difficulty (which nevertheless in this case was actually quite great), but also if around them would turn things that may be pleasing to learn.[146]

One of the results that impressed Huygens the most was discovered by Christopher Wren. Wren made the discovery of the length of the roulette curve, which Huygens says "is admirable and has pleased me marvelously." Indeed, "[t]his is the best of what has been found concerning this

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[143] See above, note 102.

[144] "Ego certe id facile non reperi unquam ex quo ille liber venit in manus meas," Lalouvère, *Veterum geometria*, excerpted in Mesnard *OC*, 4:905.

[145] "Neque existimes, Erudite Lector, istum calculum esse de numero vulgarium et a viribus ingenii, ut dixit Anonymus, non pendentium, qui Tyroni cuilibet demandari queunt; intricatissimus quippe est, et totum Geometram, atque saepe ipsius demonstrationis Parentem desiderat," ibid., 4:888.

[146] "Non enim sola difficultate (quae tamen in his etiam satis magna erat) reperta goemetrica estimo, sed ex eo quoque si circa ea versentur, quae cognoscere jucundum sit," Draft, Christiaan Huygens to René-François de Sluse, 1659, Mesnard *OC*, 4:639-640.

line."[147] Wren's result prompted Huygens to write, in opposition to Pascal's stress on difficulty, that "[i]t would please me to distinguish difficulty from elegance."[148] Without doubt, the problems concerning the centers of gravity of solids associated with the curve were very arduous, Huygens makes clear, but Wren's solution was more pleasing and thus more important.[149]

Huygens thus questioned Pascal's privileging of difficulty as of the utmost importance, but he also stressed how the work of Dettonville failed the test for the childlike virtue of clarity. Pascal, Huygens maintained, forfeited his claim through his unwillingness to engage in calculation or examples, instead sustaining a general discussion of his method using purely geometrical terms. Dettonville's solution, Huygens argues, was neither as easy nor as rigorous as he claimed: "This method is indeed, in my opinion, sometimes obscure, sometimes a little too bold and too distant from geometrical exactness."[150] He did not perceive restriction to pure geometrical demonstration as an advantage, as Pascal did, but argued instead that it prevented complete clarity:

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[147] "[J]'ai compris l'inventin de Wren, qui est admirable et qui m'a plu merveilleusement. C'est le meilleur de ce qui a été trouvé sur cette ligne," Draft, Christiaan Huygens to John Wallis, 31 January 1659, excerpted and translated into French from Dutch in Mesnard *OC*, 4:318. On Christopher Wren's contribution to the roulette contest and his other mathematical work, see D. T. Whiteside, "Wren the Mathematician," *Notes and Records of the Royal Society of London* 15 (1960): 107-111; James Arthur Bennett, *The Mathematical Science of Christopher Wren* (Cambridge, 1982).

[148] "Il me plaît de distinguer la difficulté de l'élégance," Draft, Christ. Huygens to Wallis, 31 January 1659, excerpted and translated into French from Dutch in Mesnard *OC*, 4:318.

[149] In a letter to Wallis, Huygens writes: "As to this which regards me, the writings addressed to Carcavy fill me with admiration and wonder for their extreme subtlety. The difficulty was extreme; but there are other questions on which we can exercise our subtlety and our intelligence, holding on matters that there is more pleasure to know. On the comparison of cycloid lines with ellipses, one remarks for their elegance of reasonings to which however the illustrrious Wren has given occasion through his invention," Christiaan Huygens to John Wallis, 6 June 1659, excerpted and translated into French from Dutch in Mesnard *OC*, 4:658-659.

[150] "Est enim methodus kista, ut mihi quidem videtur, tum obscura, tum audacior paulo atque a geometrica ἀκριβεία," Draft, Christ. Huygens to Sluse, 1659, Mesnard *OC*, 4:639. In his response to Huygens, Sluse generously writes: "It seems that he deviated in places in his demonstration from precision and from clarity, but he has wanted, in my opinion, to follow the highest summits of matters, content to have indicated his method," René-François de Sluse to Christiaan Huygens, 13 June 1659, Mesnard *OC*, 4:642.

> I admire more and more the subtlety of the writings of Monsieur Dettonville, but it is necessary to avow that it is a labyrinth when one wants to make the construction of some problem, and for that I would like that he had everywhere taken only the easiest case in order to give the calculation of it at length . . . or indeed an example for each theorem.[151]

Huygens believed that Dettonville's approach to his problems would alienate readers. Pascal himself recognized that the approach of pure geometry was difficult for some individuals because its principles are distant from everyday life.[152] A perfected geometrical procedure in matters outside of geometry, Pascal claimed, is not only difficult but totally impossible. Nevertheless, within the *métier* of geometry, Pascal insisted that such purity of demonstration was a model for perfect reasoning and should not be forfeited. The perfect geometer, he believed, was absolutely clear because supremely rigorous.

The procedural aspects of the contest, like the issues of content considered above, drew questions and criticism from savants. John Wallis, an English mathematician who submitted solutions to some of the problems, upbraided Pascal for unfair treatment of all but the French participants, since the time given to solve the problems was, in his opinion, absolutely prohibitive.[153] Moreover, when Wallis began to suspect that Pascal was not only the author of the problems but had taken Carcavy's place as the recipient of the solutions while Carcavy was out of town, he wrote to Huygens:

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[151] "J'admire de plus en plus la subtilté des escrits de Monsieur Dettonuille, mais il faut auouer que c'est un labyrinthe lors que l'on veut faire la construction de quelque problème, et pour cela je voudrois qu'il eust partout pris seulement un cas le plus facile pour en donner le calcul tout du long, . . . ou bien un exemple a chaque Theoreme," draft, Christiaan Huygens to Pierre de Carcavy, 22 May 1659, Huygens *OC*, 2:411.

[152] The principles of geometry, Pascal states in the *Pensées*, are ones that *esprits de finesse* "have never seen in practice and are quite outside ordinary experience," Pascal, *Pensées*, trans. Krailsheimer, no. 512, 183.

[153] John Wallis preface to *Tractatus duo, prior de cycloide et corporibus inde genitis* (Oxford, 1659), n.p., exerpted in Mesnard *OC*, 4:727-728.

> I am unaware of how candidly it may be asserted to be done, seeing that it may by no means be free from every suspicion of being able to pick out from there [i.e., other's submissions] either solutions or at least opportunities for solutions.[154]

Some commentators have joined Wallis's critique of Pascal's contest, claiming that the winner had been predetermined and that Pascal's critical remarks of contestants were unfair.[155] This was not necessarily an uncommon strategy in the seventeenth century. Mersenne, for example, had concocted a contest for musical composition that seems to have been merely a demonstration of the superiority of French composition.[156]

Rejection of Detonville's Anti-Social Behavior with Roberval's "Rusticity"

In England and France, savants were becoming ever more concerned with sociability. Pascal's use of a pseudonym undermined community values. It exposed him to accusations of plagiarism and conflict of interest, diminishing the sense of fair play. Parisian geometers already had a reputation for being inwardly focused and boastful about great accomplishments and this contest only served to reinforce those beliefs.[157] Its pseudonymous presentation also implicated the contest in the anti-social behavior of secrecy. The delay in publication of the contest's results was, for Wallis, a symptom of the French geometers' tendency to hoard their results, thus denying the importance of sociability.[158] Wallis's objections show that the roulette contest, with its lack of clarity and openness, chafed against the desire for the transparent, forthright development of knowledge within the learned community.

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[154] "nescio quam id candide fieri dicatur, cum non omni suspicione vacet se vel inde solutiones aliquas vel solutionum saltem ansas desumpsisse posse," Wallis to Christ. Huygens, 1 January 1659, Mesnard *OC*, 4:317.

[155] Condorcet, *Pascal* (Paris, n.d.), 21-22.

[156] D. P. Walker, "Joan Albert Ban and Mersenne's Musical Competition of 1640," *Music and Letters* 57 (1976), 234, 244-245.

[157] This tendency of the Parisians to forget others contributions is suggested in Wallis's criticism of the *Histoire de la roulette* for minimizing the contributions that the Italians had made with respect to the curve.

[158] Wallis especially objects to Roberval's choice to maintain secrecy of the solutions: "he and his friends keep them private, [and] have not publicly divulged them," Wallis to Christ. Huygens, 1 January 1659, Mesnard *OC*, 4:317.

Pascal's close association with Roberval and his defense of Roberval's originality in the *Histoire de la roulette* further undermined the acceptability of the community represented by the contest. Roberval was notorious for keeping his results secret and for being suspicious of others' discoveries. For those who valued sociability, he represented the epitome of what they wanted to avoid in their learned conversations. He also symbolized the inability of geometry to communicate with those who were non-mathematical. Though Pascal recognized these limitations, he remained willing to associate himself with the work of Roberval, who was the clearest example of the artisan-geometer to which the 1660 letter to Fermat refers. Roberval's reputation and actions, however, helped to undermine Pascal's attempts to portray the mathematical community as at the nexus of simplicity and maturity.

During the middle of the contest, Roberval's reputation suffered even further from a famous outburst that occurred at the Montmor Academy, the center of Parisian savant sociability in the late 1650s and early 1660s:

> Monsieur de Roberval has done a stupid thing at the home of Monsieur de Montmor, who is as you know a man of honor and of quality; he has been so uncivil as to say to him in his house, being piqued about one of the opinions of Monsieur Descartes that Monsieur de Montmor approved, that he had more wit [*esprit*] than him and that he had nothing less than him except the goods and the charge of Master of Requests, and that if he was Master of Requests, that he would be worth one hundred times more than him. Monsieur de Montmor who is very wise told him that he could and ought to behave more civilly, than to quarrel with him and to treat him with contempt in his house. All the company found very strange the rusticity and the pedantry of Monsieur de Roberval.[159]

[159] "Pour Monsieur de Roberual il a faict un sottise chez Monsieur de Montmor, qui est comme vous scauez homme d'honneur & de qualité, il a esté si inciuil que de luy dire dans sa maison, s'estant picquez sur vne des opinions de Monsieur desCartes que Monsieur de Montmor approuuoient, qu'il auoit plus d'esprit que luy & qu'il n'auoit rien de moins que luy que le bien & la charge de Maitre des requestes, & que sil estoit Maitre des Requestes, qu'il vaudroit cent fois plus que luy. Monsieur de Montmor qui est tressage luy dist, qu'il en pourroit & deuoit vser plus ciuillement, que de le quereler & le traicter de mespris dans sa maison. Toute la compagnie trouua fort estrange la rusticité & pedanterie de Monsieur de Roberual," Ismaël Boulliau to Christiaan Huygens, 6 December 1658, Huygens *OC*, 2: 287. This episode has taken on a particular importance for scholars who have focused on the importance of etiquette and sociability and especially to emerging state-sponsored academies of science in London and Paris. Mario Biagioli argues that Roberval's outburst against Montmor exemplifies the tensions between different types of social norms and points to a connection between Roberval the rustic (practitioner of the "craft" [*métier*] of mathematics) and Robert Hooke, who had an artisan's social style, Biagioli, "Etiquette Interdependence,

Roberval's behavior at Montmor's home provided the savant community with evidence that the geometers represented not childlike simplicity and clarity, but childish argumentativeness. Furthermore, it reinforced the restricted nature of mathematics as a *métier*. The account above shows that Roberval's similarity to unsophisticated artisans did not begin and end with a tendency to focus upon mere mathematics. In his outburst against Montmor, he behaved, writes Boulliau, like one of the lower social classes of rural areas (a "rustic") who, like artisans, were not a part of the cultured society of the truly learned.[160] The restrictedness of the artisan was matched by the immaturity and the outburst of a child.

The learned community at large admired the results that Pascal published, but the virtues of the community of geometers and the ultimate value of the published results were compromised by the social drawbacks of the contest and the obscurity of the subject. Pascal had emphasized the fine balance between the virtues of maturity (e.g., concerted application to difficult problems) and those of childhood (e.g., clarity and ease of application); instead, the contest was shrouded in complexity and polluted by the perception of childish behavior.

Two Archimedeses: Pascal and Huygens in the Roulette Contest

Pascal's failure to acquire untarnished praise from the evolving savant community coincided with the rise of Christiaan Huygens, Mersenne's other Archimedes. It is with the roulette contest that their lives converged (and diverged) most decisively. Through the mid-1650s, contact between the young mathematicians was sporadic and indirect. In 1656, Huygens corresponded with Mylon and Carcavy about the work of Pascal and Fermat in probability

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and Sociability in Seventeenth-Century Science," *Critical Inquiry* 22:2 (Winter 1996), 198, 200 n. 23. For Steven Shapin, the disruptive nature of the Roberval episode was what the Royal Society wanted to avoid with its standards of sociability, Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 79 (1988), 397-398. On this episode, also see Harcourt Brown, *Scientific Organizations in Seventeenth Century France,* 82-89.

[160] Boulliau's description of Roberval's "rusticity" may be a reference to Roberval's origins *inter multos*, see above, p. 88.

theory.[161] And when on his voyage to Paris in 1655, Huygens did not meet Pascal and did not make significant attempts to do so, having been told that his counterpart "had entirely abandoned the study of mathematics."[162] Huygens later regretted not making more of an effort at an acquaintance, and it was probably only during the roulette contest that the two first directly corresponded. Their interaction provoked a growing mutual admiration. Pascal, as Dettonville, addressed one of the parts of his publication to Huygens, praising his "incomparable clock" and his geometrical reflections, "which are a subject of admiration to all our geometers."[163] Reflecting a similar pairing of practical and theoretical accomplishments, in 1659 Huygens expressed his admiration of Pascal to Chapelain: "I esteem Pascal infinitely both for [the arithmetic machine] and for his knowledge in geometry, of which he has given the proof."[164] Huygens and Pascal mutually praised the two elements that qualified them to bear the name Archimedes: technical mathematical skill and the practical application of that skill.

The involvement of Pascal and Huygens in the roulette contest and their respective approaches to the curve show their comparable talents and accomplishments. However, the

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[161] Huygens had learned about this work during his 1655 visit to Paris and had undertaken some solutions of his own. The series of letters includes especially, Pierre de Carcavy to Christiaan Huygens, 20 May 1656, Huygens *OC*, 1:418-419; draft, Christiaan Huygens to Claude Mylon, 1 June 1656, Huygens *OC*, 1:426-427; Pierre de Carcavy to Christiaan Huygens, 20 May 1656, Huygens *OC*, 1:431-433; Christiaan Huygens to Pierre de Carcavy, 6 July 1656, Huygens *OC*, 1:442-446; Christiaan Huygens toClaude Mylon, 6 July 1656, Huygens *OC*, 1:448-449; Pierre de Carcavy to Christiaan Huygens, 28 September 1656, Huygens *OC*, 1:492-494; draf, Christiaan Huygens to Pierre de Carcavy, 12 October 1656, Huygens *OC*, 1:505-506; draft, Christiaan Huygens to Claude Mylon, 8 December 1656, Huygens *OC*, 1:524-525; Claude Mylon to Christiaan Huygens, 2 March 1657, Huygens *OC*, 2:8-9.

[162] "Si l'on ne m'eust asseurè lors que j'estois à Paris que ce dernier avoit entierement abandonnè l'estude de mathematiques j'aurois taschè par touts moyens de faire connoissance avec luy," Christiaan Huygens to Claude Mylon, 1 Feb 1657, Huygens *OC*, 2:7.

[163] "cet horloge incomparable"; "ces merveilleuses dimensions des surfaces courbes des conoïdes, que vous venez de produire, et qui sont un sujet d'admiration à tous nos géomètres," "Lettre de A. Dettonville a Monsieur Hugguens de Zulichem," in *Lettres de A. Dettonville*, 1.

[164] "J'estime Pascal infiniment et pour ceci et pour son savoir dans la géométrie, dont il a donné la preuve, et qu'il m'a dédiée," Christiaan Huygens to Jean Chapelain, 11 September 1659, translated into French from Dutch in Mesnard *OC*, 4:691.

contest also represents an occasion during which the Archimedeses are sifted by circumstances and by the savant community, with Huygens emerging as the mathematician who embodied the ideals of the learned community that would become the Académie Royale des Sciences. Pascal, despite his efforts to play the broad-minded "honnête homme géomètre," was alienated from the Montmor Academy, which defines the French learned scene of that time.[165] By contrast, the learned group of Paris increasingly recognized and admired Huygens as a rising star. There are two reasons why Huygens became the central young celebrity of the Parisian learned community while Pascal was marginalized. Both of these reasons highlight the Parisian community's preference for "adult" virtues to the childlikeness that plays such an important role in Pascal's work.

First, Huygens was preferred to Pascal because of his loyalty and commitment to the community of learning. He was sociable and communicative, corresponding regularly with individuals from the Low Countries (e.g., Sluse), England (e.g., Wallis), and Paris (e.g., Boulliau). Through these individuals, he maintained a steady contact with the work of others.[166] Correspondence was an important element of early modern scientific endeavor, as recent research makes abundantly clear.[167] Although living at a geographical distance from the Parisian savant community, by writing and receiving letters he maintained close personal and scientific contact. He also established face-to-face relationships with Parisian savants during his visit to the capital of France during 1655. His interpersonal aptitude is further attested by his busy

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[165] Dominique Descotes uses this label and the term "mathematical *honnêteté*" to describe Pascal's work as Dettonville in the roulette contest. "It is necessary to the *honnête* savant to unite competence, universality, and utility to others," Descotes, *Blaise Pascal: littérature et géométrie*, 34-35.

[166] Van Meerkerk, "Correspondence Network of Christian Huygens," 211-228.

[167] See, for example, Robert A. Hatch, "Peiresc as Correspondent: The Republic of Letters and the Geography of Ideas," *Science Unbound: Geography, Space, Discipline* (Stockholm, 1998); also, L. T. Sarasohn, " Peiresc and the Patronage of the New Science"; and *Les grands intermédiaires culturels*, ed. Christiane Berkvens-Stevelinck et al.

schedule and interaction within the social and learned circles of Paris during his visit there in 1660-1661.[168] During this visit, he cemented his place within the learned community through the polite and polished communication of his work on the pendulum clock and his observation of the rings of Saturn. Aided by the reputation and social standing of his father, Christiaan's favorable interactions with the Montmor group in Paris generally increased the respect its members had for him.[169]

By contrast, Pascal did not display the same sensitivity to sociability during the roulette contest. Besides the issues of secrecy discussed above, the limitation of access to the contest's key figures promoted isolation, not conversation. Both Pascal and Carcavy were at times entirely cut off from the savants of Europe, and even from those in Paris. Despite having issued a challenge to submit solutions by 1 October 1658, the administrator of the contest, Carcavy, was absent from Paris during the month of September.[170] What is more, Pascal withdrew from Paris, for health and religious reasons, being, as Boulliau writes "confined I know not where in a Jansenist phrontistery."[171] He was effectively detached from the learned community at a time when the work that he had produced suggested the most possibility for the type of conversation so valued by this community.

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[168] Huygens maintained a detailed journal of his "Voyage en France de 1655." Huygens *OC*, 22:473-492; The journal for the 1660-1661 journal is in Huygens *OC*, 22:525-576;

[169] On technical aspects of Huygens, especially the centrality of mathematics to his work, see Joella Yoder, *Unrolling Time: Christiaan Huygens and the Mathematization of Time* (Cambridge, 1988).

[170] This is attested by Boulliau to Christ. Huygens, 27 September 1658, Mesnard *OC*, 4:261 Boulliau excuses himself for not responding the questions made by Huygens concerning the contest because of this absence, ibid.

[171] "Monsieur Paschal s'est confiné je ne scay ou dans vn phrontistere de Jansenistes, que j'ignore encores, ainsi je ne pus la faire voir," Ismaël Boulliau to Christiaan Huygens, 7 March 1659, Huygens *OC*, 2:366.

As Huygens's correspondence with him shows, Wallis believed that the Dutch mathematician possessed the quality of fair-mindedness that the author of the contest did not.[172] Wallis questioned Pascal's civility in having extravagantly offered a prize for the solution, for not giving adequate time to non-French mathematicians to solve the problem, and for the deception of the hidden identity of the initiator of the contest. Huygens demonstrated great tact in these letters, repeatedly praising the subtlety of Pascal's work on the roulette, while recognizing the possible negative aspects of the contest.[173] Huygens's ability to build bridges marked him as a skilled social diplomat.

Huygens's sociability was more conducive to his ongoing acceptance by the savant community than was Pascal's secrecy and isolation, but the practical applications of his work were also in harmony with the Montmor group's goals. In a letter from Sorbière to Hobbes outlining the "constitution" of Montmor's group, the first rule of the gathering emphasizes the importance of "practical benefits, in those arts and sciences which are best suited to achieve them."[174] The same rule contrasts the importance of such utility in contrast with "useless subtleties."[175] It is not insignificant that the word "subtle" is used by some contemporaries to describe Pascal and his on the roulette.[176]

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[172] "Judicium vero quod de me meisque feceris, quanto candidius sit quam quod tulerint Galli, posteriores quas misisti litterae notum faciunt," John Wallis to Christiaan Huygens, 10 September 1660, Huygens *OC*, 3:126.

[173] For example, Huygens himself questions the motivations for the offering of a prize, Draft, Christ. Huygens to Wallis, 6 September 1658, Mesnard *OC*, 4:316.

[174] Samuel Sorbière to Thomas Hobbes, 1 February 1658, in Hobbes, *Correspondence*, *Vol. 1*, 495.

[175] Ibid.

[176] Answering Huygens's inquiries about the roulette contest, Boulliau states his belief that Pascal was its originator. He then gives a brief descripion of Pascal: "Il est vrai qu'il a l'esprit tresprofond & tres-subtil," Ismaël Boulliau to Christiaan Huygens, 3 January 1659, Huygens *OC*, 2:309. Huygens writes in a letter to Carcavy, 16 January 1659: "Je crois les choses de Pascal encore plus subtiles [than those that he and Wren had done]," Christiaan Huygens to Pierre de Carcavy, 16 January 1659, translated into French from Dutch in Mesnard *OC*, 4:349. In describing his own work, Huygens writes of the *Horologium* that "Il y a beaucoup d'hasard a rencontrer des inventions semblables

The preference of Sorbière and the Montmor group's for utility over subtlety does not suggest a complete dismissal of mathematics. In another letter, Sorbière characterizes mathematics as godlike, showing the greatness of the human soul. However, its usefulness is limited: "I do not discover there . . . the great advantage which has resulted from it, for the perfection of our reasoning on other matters."[177] The contest was, for Pascal, a purely geometrical one; little thought was given to application. The goal, suggested above, was to demonstrate the overpowering intelligence of the one who solved these difficult problems.

Huygens, on the other hand, contributed to the geometrical conversation on the roulette, but he also made practical use of the roulette curve in the design of his pendulum clock. The curve used for a piece of metal to regulate the movement of the pendulum clock was the roulette (or the cycloid, as he refers to it).[178] Huygens's other major discovery of this period, the rings of Saturn, though not practical in itself, was closely linked to the technology of telescopes and lenses and was associated with observation rather than subtle reasoning. Huygens thus had the impressive ability to communicate mathematically with the likes of Pascal while maintaining a fruitful discussion with others whose interests were less abstract. Huygens's fruitful work with the pendulum clock, much more successful than Pascal's arithmetic machine, also suggests a more comfortable relationship with the artisanal epistemology that informed the continued hands-on element of early modern natural philosophy.

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et fort peu de science ou de subtilitè," Christiaan Huygens to Amos Dettonville [Blaise Pascal], 5 February 1659, Huygens *OC*, 2:340.

[177] "Je ne descouure pas . . . le grand aduantage qui a en reussi, pour la perfection de Nostre raisonnement sur les autres matières,"Samuel Sorbière to Abbé Tallemant (1 June 1659), BN, Paris, f. fr. 20612, folio 220 recto.

[178] *Horologium Oscilatorium* (1673), Huygens *OC*, 18:102-104.

Huygens was convinced of the importance of geometrical study and believed that Pascal's talents in mathematics would have proven of great worth to the learned community. After hearing of Pascal's death, Huygens wrote to his brother Louis:

> I had always hoped that he would be given remittance from his weakness and that he would take up again some day this study in which he has so greatly excelled.[179]

Perhaps, had Pascal lived longer, Huygens might have urged him to publish more of his findings in mathematics; Chapelain had suggested the possibility that Pascal's friends could convince him to do so:

> Retired from the world as he is, I do not believe that any similar material could be drawn from him. He has a great number of other Treatises ready to give some curious Problems, but he keeps them most cruelly suppressed. Little by little one will win over him as he allows them to appear.[180]

Pascal and Huygens both believed in the power of mathematics, but in his final analysis the power was, for Pascal, only indirect. Scientific inquiry could not offer spiritual consolation, the most important of goals.[181] By bringing together childlike and adult virtues, mathematical practice mirrored the Christian life. Having known a career of mathematics from an early age, Pascal drew on the resources of that experience, and the virtues and vices of childhood as displayed in geometry, to encourage him to a life of Christian submission that pressed on toward spiritual perfection.

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[179] "J'avois tousjours esperè qu'il se remettroit de sa foiblesse, et qu'il reprendroit quelque jour cette estude ou il a si fort excellè," Christiaan Huygens to Louis Huygens, 31 August 1662, Huygens *OC*, 4:213.

[180] "Retiré du monde comme il est je ne croyois pas qu'on pust rien tirer de luy de semblable matiere. Il a vne grande quantité dautres Traittés prests a donner de Problemes curieux, mais qu'il tient supprimé auec assés de cruauté. Peu a peu lon gaignera sur luy qu'il les souffre paroistre," Jean Chapelain to Christiaan Huygens, 15 October 1659, Huygens *OC*, 2:496.

[181] Pascal writes in the *Pensées*: "Knowledge of physical science will not console me for ignorance of morality in time of affliction, but knowledge of morality will always console me for ignorance of physical science," Pascal, *Pensées*, trans. Krailsheimer, no. 23, 6.

CHAPTER 7
CONCLUSION

Pascal's life has been described as a struggle between his religious devotion and his work in mathematics and science. This conflict has been a legitimate and central concern of scholarly accounts of Pascal's life and work, though in diverse ways. Some scholars have been content to lament Pascal's waste of intellectual talent on superstitions and mysticism.[1] But arguably, Pascal has proven attractive as a cultural icon precisely because of his complexity, that diverse mix of motivations and ideas so characteristic of the perennial pursuit of knowledge, transcendence, and salvation. For nearly four centuries, scholars have sought to analyze Pascal's writings and behaviors to understand how he navigated between reason, faith, science, and religion.

The primary goal of this study has been to show that the relationship between Pascal's religious devotion and his scientific pursuits is closer and less adversarial than is often assumed. A guiding concern has been to show that these two types of pursuits represent a common tension between childlikeness and adult maturity. This study has shown that religious and scientific communities in seventeenth-century France shared many of the same concerns: the necessity of proper training and the mature exercise of discipline, as well as the continued innocence and receptivity of childhood.

This study of Pascal is not a biography. It has not recounted all of the events of Pascal's life (or even all of the important ones, some may argue) and all of his writings. It has instead sought to highlight the role of childlike and mature virtue in Pascal's life and work. More

[1] Carl Boyer expressed the sentiments of many when wrote: "As mathematicians, . . . many of us undoubtedly would prefer that he had continued as a creator of mathematics rather than as the tormentor of the Jesuits," Carl B. Boyer, "Pascal: The Man and the Mathematician," *Scripta Mathematica* 26 (1963), 296.

broadly, it has suggested what this tension might mean for the relationship between a devout life and a learned life in seventeenth century Paris.

Pascal's navigation of these waters is unique and this study has attempted to make these peculiarities clear, suggesting how they relate to the broader seventeenth-century milieu. Pascal's childhood talent, it has been shown, was appropriated by the Mersenne Circle, as he was pinpointed early as a possible candidate to contribute to the "completion" or "perfection" of mathematics. This study has linked Mersenne's mathematical goals with Pascal's early talent to an extent that previous studies have not. It has done so, in part, by highlighting the close parallel that Mersenne draws between Pascal and Huygens. This parallel, which is reiterated and analyzed further in Chapter 6, has also extended beyond the contributions of previous scholars. In addition, this study has emphasized the educational role of the Mersenne Circle in Pascal's life and has attempted a consolidation of the pedagogical associations of the term "académie."

This study's investigation of the tension between childlikeness and maturity in Pascal has uncovered instances of his appeal to the contrast between his own work and childish, instinctual behaviors. When taken together, these examples suggest Pascal's attempt to distance himself from the associations that his early mentors had made between his young age and his mathematical accomplishments. Along these lines, this study has located a previously unidentified connective thread between Pascal's work on the arithmetic machine and his work on the void. It has shown the significant childlike/mature parallels between Pascal's self-defense against the counterfeit work of the artisans of Rouen and the justification of novelty in his preface to the treatise on the void. It has thus suggested how the artisan/theorist distinction (and its relationship to a burgeoning scientific method) is given further nuance and complexity through emphasizing its connection with both childlike receptivity and mature mastery.

Underscoring the geometrical origins of Pascal's religious pursuits and the role that mathematics plays in his broader views of knowledge, this study has reflected key epistemological shifts during the early modern period. It has argued that the Jansenist questioning of the sufficiency of mathematical reasoning combined with the chevalier de Méré's suggestions that mathematics was of dubious value disturbed Pascal's confidence in geometrical supremacy. This study has linked Pascal's uncertainty about the role of rhetorically useful but restricted mathematics with his religious reflections concerning the need of believers to submit to the limitations of their createdness while also seeking the self-transcendence of perfection. The present study has maintained that the combination of these ideological concerns and the circumstances of Pascal's position between devout and learned communities created an atmosphere in which religion and science mutually informed one another.

This study's examination of the period of Pascal's life following his 1654 "Night of Fire" has reiterated what other scholars have also recognized: Pascal's life did not follow a linear trajectory away from mathematics and toward a more devout religious commitment. Focusing on the duality of childlikeness and maturity has demonstrated that Pascal's expression of these traits in his religious works has underlying connections with the language of his mathematical and natural philosophical writings. Pascal's back-and-forth movement between mathematical and religious work shows that he continued to explore this troublesome relationship throughout his life. This study has attempted to show how reflections on childhood virtue and the necessity for mature application of talent appear as strong and consistent elements in Pascal's life and work.

Reflecting these ongoing concerns, Pascal's roulette contest, this study has argued, was a quasi-return to the mathematics that he had practiced as a child and as a young man. While he

attempted to prove through his discovery of new results that his mathematical talent had been put to good use and that such work had a kind of utility, he also reverted to an attitude of mathematics as a diversion. In the end, Pascal's ambivalence about mathematics and the contingencies of his ill health helped to frame his separation from the community of savants during the late 1650s and early 1660s.

Pascal's life was not tidy and neat, it did not march toward a clear and simple conclusion. When Pascal died at the age of 39, he left many questions unanswered. Biographers and historians are left to conjecture about what might have happened, and what legacy Pascal might have left had he lived longer. If he had returned to full health, it seems likely that Pascal would have made another attempt to establish the quality of his mind and his legitimacy in the learned community of Paris. Given the opportunity, the evidence suggests that Huygens would have been keen to develop a deeper relationship with Pascal.[2] The interaction between the Catholic Archimedes and the Protestant Archimedes would certainly have benefited both. As this study has suggested, a detailed comparison of Pascal and Huygens would be fruitful and telling, it would shed light on their status as childhood mathematicians, the role and influence of Mersenne, and respective experiences and relationships with artisans.

Pascal's legacy is unique. Because of his variegated identity translated through more than three hundred years of works about him, he is a rich source of insight regarding the cultural values of the seventeenth century and the assumptions of those that have written about him. Pascal's complexity, refracted through so many lenses, may sometimes appear aberrant. But when viewed from the intersection of childlikeness and maturity, many faces of Pascal come to focus, sometimes with a fresh shock of recognition.

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[2] See above, p. 347.

APPENDIX
CHRONOLOGY[1]

19 June 1623	Birth of Blaise Pascal in Clermont
1625	Publication of Mersenne's *La vérité des sciences contre les septiques*, in which Mersenne invokes "some new Archimedeses"
1626	Death of Antoinette Bégon, Pascal's mother
14 April 1629	Birth of Christiaan Huygens at The Hague
November 1631	The Pascal family relocates from Clermont to Paris
6 February 1635	Richelieu appoints a commission of five individuals to investigate Jean-Baptiste Morin's supposed invention of a method for determining longitude. The commission includes Étienne Pascal, the abbé Chambon, Claude Mydorge, Jean Boulenger, and Pierre Hérigone
23 May 1635	In a letter to Nicolas-Claude Fabri de Peiresc, Marin Mersenne announces the existence of the Parisian "mathematical academy"
September 1635	Mersenne lists by name the members of the group he had previously announced: Étienne Pascal, Mydorge, Claude Hardy, Gilles-Personne de Roberval, Girard Desargues, abbé Chambon, "and some others."
1635-1636	According to the familial legend, Blaise "discovers" geometry during his leisure time. Shortly thereafter Blaise is introduced to Mersenne's circle of friends
24 March 1638	Étienne Pascal goes into hiding after an uprising of those who received Hotêl de Ville rents, which went unpaid due to French war debts
February 1639	Publication of Desargues' *Brouillon Projet*
November 1639	After having returned to favor in late spring, Étienne Pascal is appointed as Deputy Commissary of Normandy. The Pascal children remain in Paris under the care of Louise Delfault
1640	Pascal's *Essai pour les coniques* is printed in Paris. The *Essai* is distributed to a number of Mersenne's correspondents, including René Descartes

[1] Much of this appendix is indebted to the detailed chronological work of Jean Mesnard in Blaise Pascal, *Oeuvres complètes*, vols. 2-4.

Spring 1640	The Pascal children return to the care of their father, living in Rouen
1642-1643	According to his sister's biography, Blaise begins work on his arithmetic machine
14 May 1643	Death of Louis XIII
26 February 1643	Letter from Pierre Bourdelot to Pascal indicates that Pascal had an arithmetic machine ready to demonstrate
1645	Pascal writes his two major accounts of his invention of the arithmetic machine: his "Lettre dédicatoire a Monseigneur le Chancelier" and his "Avis nécessaire à ceux qui auront curiosité de voir la machine arithmétique, et de s'en servir"
January 1646	Étienne Pascal falls on some ice and breaks his leg, bringing him into contact with the Jansenist brothers Adrian and Jean Deschamps. The brothers introduce the family to the writings of Saint-Cyran
September 1646	Pierre Petit describes the experiment of mercury in tubes of glass to Étienne and Blaise Pascal
12 September 1646	Constantin Huygens introduces Christiaan's work to Mersenne in a letter. This begins a correspondence between Mersenne and Christiaan
October 1646	Pierre Petit and Étienne and Blaise Pascal perform the mercury experiments together in Rouen
January 1647	In letters to Constantin and Christiaan Huygens, Mersenne favorably compares Christiaan to Archimedes
1, 5 February 1647	Interview between Pascal, Hallé de Monflaines, Adrien Auzout, and the priest Jacques Forton, sieur de Saint-Ange, recorded in the *Récit de deux conférences*
Summer 1647	Pascal and Jacqueline return to Paris
20 August 1647	Death of Claude Mydorge
23-24 September 1647	Meetings between Descartes and Pascal. The September 23 meeting is in the presence of Roberval, and ends in a heated argument between the two older mathematicians. The September 25 meeting is attended by Dalibray
October 1647	Publication of Pascal's *Expériences nouvelles touchant le vide*

October-November 1647	Exchange of letters between Pascal and Father Étienne Noël, concerning the question of the void
26 January 1648	Letter from Blaise to Gilberte in which he recounts the meeting between him and Monsieur de Rebours of Port-Royal. Rebours, suspicious of Pascal's background in mathematical studies, reproves Pascal for his claim to be able to defeat Port-Royal's enemies through reason
January 1648	Étienne Noël publishes his work *Le plein du vide*
Winter 1648	Letter from Pascal to Jacques Le Pailleur, explaining his non-response to Noël's claims regarding the void
April 1648	Letter from Étienne Pascal to Father Noël
1 April 1648	Letter to Gilberte Périer from Blaise and Jacqueline Pascal, in which they articulate the need for recognition of limitations and a striving toward Christian perfection
Summer 1648	Jacqueline desires entry to the convent of Port-Royal, but is opposed by her father
1 September 1648	Death of Mersenne
19 September 1648	Under the advice of Pascal, Florin Périer performs the mercury experiment on Puy-de-Dôme in Auvergne
May 1649	Étienne, Blaise, and Jacqueline Pascal escape difficult conditions in Paris due to the Fronde. They live in Clermont until November 1650
22 May 1649	Privilege issued for Pascal's arithmetic machine
11 February 1650	Death of Descartes in Stockholm
November 1650	Étienne, Blaise, and Jacqueline Pascal return to Paris
7 September 1651	Louis XIV assumes his throne
24 September 1651	Death of Étienne Pascal
1654	Date of Pascal's address to Paris's mathematical circle, "Celleberrimæ matheseos academiæ parisiensi." In it, Pascal gives an outline of his completed works and his works-in-progress
5 June 1653	Despite Blaise's opposition to the plan following Étienne's death, Jacqueline becomes a nun at the convent of Port-Royal de Paris.

1653 or 1654	Journey with the Duke de Roannez and the Chevalier de Méré, described in Méré's *De l'esprit*
July-October 1654	Correspondence between Pierre de Fermat and Pascal, marking the beginning of modern probability theory
September 1654	Pascal visits Jacqueline and confides in her his movements toward spiritual renewal
4 November 1654	Death of Jacques Le Pailleur
23 November 1654	Pascal's "Night of Fire."
Summer/Fall 1655	Christiaan Huygens's first visits to Paris
26 October 1655	Letter from Jacqueline to Blaise in which she mentions Blaise's method for teaching children to read
23 January 1656	Date of first of the *Provincial Letters.* The letters would continue to be written and published quickly, with the eighteenth letter dated 24 March 1657
30 March 1656	Temporary dispersion of Port-Royal's *petites écoles*. Children would return to the schools a year later
15 or 17 April 1657	Jacqueline Pascal writes her "Règlement pour les enfants" in a letter to Antoine Singlin, regarding her procedures for teaching and overseeing the young girls in her care
Fall 1657	René-François de Sluse begins indirect correspondence with Pascal through Cosimo Brunetti
Spring 1658	Beginning of the direct correspondence between Sluse and Pascal
June–July 1658	Pascal's anonymous first circular letter concerning the contest of the roulette is distributed to savant mathematicians across Europe
July 1658	Second letter on the roulette contest is printed and circulated
September 1658	Carcavy, responsible for receiving solutions to the roulette problems, is absent from Paris
1 October 1658	Date at which the first circular letter requires solutions to the problems of anonymous to be attested as complete

7 October 1658	Date of third circular letter on the roulette contest
10 October 1658	Date of the *Histoire de la Roulette*, written anonymously in both French and Latin
December 1658	Printing of the first of Pascal's *Lettres de A. Dettonville*
6 December 1658	Letter from Boulliau to Huygens describing Roberval's disruptive outburst at Montmor's home
12 December 1658	Date of *Suite de l'histoire de la roulette*
February 1659	First publication of the full form of Pascal's *Lettres de A. Dettonville*
12 March 1660	Final closing of Port-Royal's *petites écoles*
28 October 1660	Christiaan Huygens returns to Paris. He remains there until 19 March 1661
6 November 1660	Letter from Jacqueline to Blaise, which refers to Pascal's temporary care of students displaced by the closing of Port-Royal's *petite écoles*
4 October 1661	Death of Jacqueline Pascal
June 1662	Pascal's last illness begins
3 August 1662	Date of Pascal's Last Will and Testament
19 August 1662	Death of Blaise Pascal

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BIOGRAPHICAL SKETCH

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