IDEAS OF ORDER IN SEVENTEENTH-CENTURY MUSIC WRITING

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ABSTRACT

England in the seventeenth century was in the midst of turmoil: political, religious, and scientific. Civil war and regicide, puritan dissension, and a fundamental shift in the perception of nature all challenged the presumption of unity encoded in the notion of the harmony of the spheres. The very foundation of order and authority was at stake; but because the presumption of unity had prevented the development of a language of diversity, the historian has few sources for the transparent expression of conflict to mine for cultural meaning. The arts though are rich, albeit less than transparent, sources for investigating conflict; and because the harmony of the spheres was more than mere metaphor but perceived to be the very structure of the cosmos, seventeenth-century musical writing especially, both by well-known natural philosophers and by lesser-known musical theorists, encodes shifting notions of authority and order. These writers both created new musical theory and disputed theoretical issues, especially that of temperament tuning: the necessity to modify the heretofore perfect Pythagorean intervals to accommodate modern musical instruments and polyphony. In challenging the perfection of Pythagorean intervals and in claiming musical theory to be the provenance of human creation rather than of nature, musical writers were prognosticators unaware, trumpeting the shift to modernity as humanity wrested control of its destiny from the cosmos.

This abstract accurately represents the content of the candidate's thesis. I recommend its publication.

Carl Pletsch

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CHAPTER 1. INTRODUCTION

In the late sixteenth century, the Rosicrucian scholar Robert Fludd diagrammed a Christianized concept of the Pythagorean monochord, the harmony of the world in pictorial detail, displaying the musical order imposed by God—a speculative, all-encompassing cosmological scheme. Calling it the Divine Monochord, his detailed chart consists of two octaves, with internal intervals designating hierarchical elements of the universe: earth, God, highest heaven. "Totally synthesizing macro- and microcosm was Fludd's sensible and ambitious goal in life."[1] But his intricately constructed scheme amounted to the vain attempt of one man to "put together again the Humpty Dumpty fragments of science, philosophy, and religion," which by then, on the cusp of the seventeenth century, had been "irrevocably sundered."[2] Fludd's was the final great "flowering of speculative music."[3]

It was the Renaissance and it was modernity: divine right of kings and self-governance; natural magic and natural philosophy; harmony of the spheres and the silencing of the harmony; the great chain of being and the taxonomy of nature; Truth and facts; man's place within a holistically organic nature and man's manipulation of nature; music of numbers and music of sound; Pythagorean perfect intervals and

[1] Anthony Aveni, *Behind the Crystal Ball: Magic, Science, and the Occult from Antiquity Through the New Age* (New York: Times Books, 1996), 81.
[2] Jamie James, *The Music of the Spheres: Music, Science, and the Natural Order of the Universe* (New York: Copernicus, 1993), 128.
[3] Joscelyn Godwin, *Music, Mysticism, and Magic: A Science Book* (London, New York: Routledge and Kegan Paul, 1986), 143.

tempered tuning. Whatever one calls the transformation during the long seventeenth century—the Scientific Revolution writ large or small—England at the end of the century was a world fundamentally changed from the England of the later sixteenth century. The transformation, though, far from being linear or cumulative, was marked rather by shifting and shared intellectual spaces, conflict and conflation, recession and ascendance, anomaly and concordance. The philosophical debates that so consumed thinkers and writers early on were left behind by the end of the period, not so much resolved as peripheralized. The century was witness to an epistemological shift none could have foreseen. The intellectual upheaval was defined by changing and diversifying sources of authority in natural philosophy, politics, and religion. By the end of the century, the notion of a harmonious cosmos had lost both its intellectual bite and its cultural meaning as a shared perception of reality.

The first Stuart king of England, James I (James VI of Scotland), ruling after Elizabeth from 1603-1625, continued her priority, formalized in the Elizabethan Settlement, of maintaining harmony and a vision of unity within society, the *via media*,[4] treading a moderate path that rejected extremism in religion and politics and elevated civil peace as the supreme good. The beginnings of a fundamental breakdown in this harmonious perception of reality were evident in religion and politics; and natural philosophers were already experimenting and exploring beyond Renaissance frames of reference, rethinking assumptions about nature and the cosmos. But both Elizabeth and James, through sheer force of powerful personae and

[4] Alister McGrath, *In the Beginning: The Story of the King James Bible and How It Changed a Nation, and Language, and a Culture* (New York, London, Toronto, Sydney, Auckland: Doubleday, 2001), 160.

ability to cajole, persuade, appease, and manipulate, were able to maintain the appearance of unity and harmony, even as its breakdown was increasingly manifest in natural philosophy, religion, and politics.

The rule of Charles I beginning in 1625 was not marked by the political ability or force of personality of Elizabeth and James; he lacked the gifts to contain the increasing fragmentation evident in society. His constant plying Parliament for more funds, taking a Catholic bride, and choosing an archbishop widely perceived to be much too cozy with Rome all served to raise the alarm of the people about the maintenance of order. Where James had been able to placate and sustain the status quo, Charles angered and, fatally, lost the trust of the people to rule for the common good and to maintain order. The fall of the monarchy, regicide, and the interregnum Commonwealth, far from being assaults on order, were attempts to restore order within a society whose fear of chaos ranked almost equally with fear of eternal damnation. Far from a clarion call for democracy, the condemnation of Charles and turn to Parliament represented a desperate pursuit of an alternative source of unity and order as monarchial disorder ran amok.

But unity, real or perceived, was never again to be. The mid-century break of the Civil War and Commonwealth was more than political, more even than religious. A changed society emerged from the grist of that mill, shocked at what had been wrought in the beheading of a king,[5] but never again to wholly trust king or Parliament; agonizingly anxious to restore order and enforce civil conformity, but

[5] McGrath, *In the Beginning*, 289.

forced to recognize fragmentation of authority in religion, politics, and natural philosophy. The Restoration of the monarchy was not a return to former times, but a new tacit agreement between people and king that the latter must accommodate the former in new ways; William and Mary sailing into London in the Glorious Revolution of 1688 made manifest the changed relationship between the people and the monarchy.

That changed relationship was symptomatic of a shift throughout society, not announced or articulated, and certainly not appreciated for the profound social and cultural change it represented—nuanced and subtle—yet utterly transformational. Even as that shift permeated society, it entered into artistic products, representations of shared cultural meanings. Art as ideological statement, that is, addressing notions of order and authority, illuminates the changed epistemology from one of a unitary, harmonious source of cosmological order expressed in the great chain of being and the universal monochord to the recognition of diverse sources of authority; from the notion of absolute Truth to acceptance of good-enough standards of truth; from God as immanent in an organic, holistic nature to God the Creator existing outside His Creation, a nature to be experimented on and manipulated by man.

Just as fundamental changes in natural philosophy were part of the fragmentation of order and authority in politics and religion, so changing ideas about the role of music in the cosmos and about basic assumptions in music theory were embedded in the changing notions about nature and natural philosophy. Music was identified with the harmony and order that structured all of society, an identification

that broke down as the reality of that harmonious unity in society broke apart and music bifurcated into science and art, no longer the metaphysical glue of the cosmos. Monumental as was the shift in music's role, it yet crept in like a thief in the night, neither noticed nor noted, predicted nor understood, like the unheralded entrance of the general epistemological shift of the century. No one willed what happened or directed its occurrence; but by the end of the century, natural philosophy had become merely science, and humanity bore the full weight of responsibility for the creation of order and meaning in a cosmos devoid of both.

The central role of music in the shift to experimental science in the seventeenth century it has been scantily studied in this connection. [6] Historians of music concentrate on the history of method and performance practice, largely irrespective of complex intellectual connections and currents of the century; and historians of science have consigned music to the art category and thus not within their purview. More broadly, music in relation to natural philosophy has not been duly investigated.[7] Historians have largely ignored the centrality of music in "structuring…knowledge and reality,"[8] an omission of the intellectual map of that century.

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[6] Penelope Gouk, *Music, Science, and Natural Magic in Seventeenth-Century England* (New Haven and London: Yale University Press, 1999), 19.

[7] Jamie Kassler, *The Beginning of the Modern Philosophy of Music in England* (Aldershot, Hampshire, England and Burlington, Vermont: Ashgate, 2004), 2; Linda Phyllis Austern, "'Tis Nature's Voice: music, natural philosophy, and the hidden world in seventeenth-century England," in *Music Theory and Natural Order From the Renaissance to the Early Twentieth Century*, eds. Suzanne Clark and Alexander Rehding (Cambridge: Cambridge University Press, 2001), 31.

[8] Paolo Gozza, ed., Preface, *Number to Sound: The Musical Way to the Scientific Revolution* (Dordrecht, Boston, London: Kluwer Academic Publishers, 2000), xii.

Music writing of the seventeenth century is an integral part of cultural history as a rich source of ideological statement in a matrix joining reality, representation, and perception.[9] Culture is implicit in constructing reality; cultural representations "embody and signify political codes and values,"[10] that is, notions of order and the control of disorder. Musical writing is an important piece within the wide range of cultural practices of the seventeenth century in addressing ideas of order; investigating it helps redress its virtual omission in the century's cultural topography.

About 100 treatises were produced in England in the long seventeenth century (1580-1720), more than in any other place.[11] Investigating these and other musical writing is a sort of discourse analysis to reveal ideological meanings within cultural practices, a way to examine questions of authority through these cultural representations. These not only reflect prevailing ideas of order and authority, but also inform and shape attitudes and beliefs: cultural discourse as ideological legitimacy and context for political statement. This "cultural turn" in historical study helps to avoid the pitfalls of imposed meanings, categories, and dichotomies in favor of listening to contemporary sources' own ideas of order and authority as expressed through cultural products, an additional way to read the tumultuous events of the seventeenth century.[12]

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[9] Sharpe, Kevin, *Remapping Early Modern England.* Cambridge: Cambridge University Press, 2000, 15.
[10] Clifford Geertz, quoted in Sharpe, *Remapping*, 17.
[11] Rebecca Herisonne, *Music Theory in Seventeenth-Century England*. Oxford: Oxford University Press, 2000, 6; Austern, "'Tis Nature's Voice," 31.
[12] Sharpe, *Remapping*, 18-19.

Taking this cultural turn in intellectual history by reading musical writing has resonance on another level for the seventeenth century. Musical writing as a cultural expression has to do with order, not only in the general sense as in any historical context; it also directly relates to the commonweal of the seventeenth century because of a continuing and pervasive belief in correspondences and analogies through most of the seventeenth century. These normatively depicted the cosmos as an interconnected hierarchy—a representation, not a metaphor—and writers of the time were clear about the distinction. Truth on one level of meaning translated to truth in another; this system of analogies was widely accepted and virtually unquestioned.[13] Music was identified with order through the harmony of the spheres and the universal monochord. Order was the very fabric of the universe, expressed and organized by music;[14] and the tortuous route of the lost intellectual cache of this pervasive belief is a critical piece of seventeenth-century intellectual history.

As part of its being a cultural representation of ideas of order and authority, music occupies the same intellectual space as natural philosophy in the seventeenth century, the former expressing identical notions of order and disorder, attitudes toward nature and sources of authority as the latter. England was thrown into epistemological ferment after papal authority was dethroned; writing about music is one way to view the ensuing intellectual debates, political, religious, and

[13] Sharpe, *Remapping*, 44.
[14] James, *Music of the Spheres*, 3.

philosophical.[15] The same network of practitioners of natural philosophy also wrote about music in a speculative mode; that is, although they occasionally addressed issues in musical theory, including the vexing one of tuning, they wrote more broadly about the underlying mathematical and physical principles of music, beginning with that iconic advocate of the experimental philosophy, Francis Bacon, and including Hooke and Newton.[16] Still, historians have been slow to appreciate the importance of musical models.

Musical treatise writers in England, who seemed nearly obsessed with order in their construction of a complex edifice of musical theory, incorporated the new thinking about nature and order in their writing. Musical writing, like the New Science in the seventeenth century, acted as a kind of code for imposing order; but the code creators themselves were unaware of their role in the changing epistemology. To this end, then, musical theorists both participated in and perpetuated new ways of thinking of nature and music, even as they unselfconsciously continued alluding to earlier Pythagorean musical notions of order and authority. Those writing about music debated the urgent problem of tuning—division of the scale, consonances, and the proper nature of intervals—as well as more trivial ones: whether or not to attach syllable names, in addition to letter names, to the notes of the scale; the optimal number of lines on a staff; which note to assign to the bottom line of the staff. The musical theory emerged in the context and as a reflection of epistemological change;

[15] Ann Geneva, *Astrology and the Seventeenth Century Mind: William Lilly and the Language of the Stars* (Manchester, New York: Manchester University Press, 1995), 40. She uses astrology as a similar mapping device for the debates of that century.
[16] Gouk, *Music, Science*, 3, 25.

so musical texts were sites of philosophical debate, albeit unconscious and non-transparent.

The distinction between natural philosophers using musical models and musical theorists writing about music, though, is a difference of intent. Both addressed, in varying texts, changing ideas of music and music theory that were an integral part of the more general intellectual ferment in natural philosophy. Intellectual sites, then, for the new musical theory being threshed out were the same ones as for the new experimental philosophy, embedded in changing notions of nature and of sources of authority; and all musical writing of the seventeenth century, experimental to practical, constitutes a single body of musical discourse mapping the intellectual upheaval of the century. That the upheaval resulted in a foundational philosophical shift by the end of the century was entirely an unintended consequence.

CHAPTER 2. CHANGING BELIEFS ABOUT NATURE AND MUSIC

These writers addressed not only the tuning problem but a range of issues relating to music theory, creating most of the musical theory structure in place today. Beliefs about nature inform music, always; and ideas about the natural order, though having the gloss of immutability, are culturally determined. Music writing throughout history attests to both its role as agent of change and its susceptibility to be changed by culture.[17] As ideas about nature change, so do ideas about music. Nature imposes order on music theory, legitimizing it and providing authority for rules that, because seemingly based on nature, appear to transcend culture and history.[18] This illusion is particularly salient for the shift from absolute Truth to scientific truth, "reliable rather than certain knowledge,"[19] in the seventeenth century. Even though truth was no longer certain, the metaphysical search for it just did not matter anymore; reasonable standards of truth about observable nature held sway. Importantly, though, as the new natural philosophy narrowed into experimental science, abandoning any claim to absolute Truth, it still retained its claim to universality, thus establishing its hegemonic claim to knowledge in the modern era, "epistemologically privileged discourse."[20]

Just so, music morphed from a cosmological, mysterious, metaphysical construct to a pursuit accessible and susceptible to scientific inquiry. Music was

[17] Gozza, Introduction, *Number to Sound,* 29.
[18] Clark and Rehding, Introduction, *Music Theory*, 2.
[19] Karl Popper, quoted in Clark and Rehding, *Music Theory*, fn 5, 2.
[20] Clark and Rehding, Introduction, *Music Theory*, 8.

contained and tamed, just as nature was in the seventeenth century—transparent, dissectible: "from music as a divine force to music as a material phenomenon."[21] Music was linked with astronomy in the *quadrivium* and followed it from occult to empirical investigation: from harmony of the spheres to "disenchantment of the world,"[22] a powerful metaphor for the cultural transformation wrought during the seventeenth century and played out in music. The harmony of the spheres was silenced in a world "subjected to analysis and quantification."[23]

Before the new science was legitimized, though, experiments were carried out with some secrecy because of its association with natural magic. Only after the Restoration and with the establishment of the Royal Society did experimental science sufficiently separate itself from natural magic to be in the open. London became its intellectual center, rather than the universities, because of the Royal Society; and inhabiting the same intellectual spaces as experimental science, music became paired with it, leaving behind its cosmological association with the harmony of the spheres.[24]

The Tuning Conundrum

Music's move, with science, from the cosmological to the mundane universal meant that it was now fair game for analysis and theoretical reworking, "amenable to

[21] Clark and Rehding, Introduction, *Music Theory*, 6.
[22] This term was apparently coined by Friedrich Schiller and famously appropriated by Max Weber and the Frankfurt School. In Clark and Rehding, Introduction, *Music Theory*, 6.
[23] Gouk, *Music, Science*, 17.
[24] Gouk, *Music, Science*, 54-55.

interrogation."[25] Scientists and theorists writing about music argued vehemently about a range of issues relating to music theory, none as central as the problem of tuning. If one begins at the tonic or root note ("do" in any key's scale) and ascends or descends in fifths or fourths or any other pre-determined interval, one will never arrive precisely at the octave. Intervals of a fifth plus a fourth, for example, should add up to an octave by Pythagorean reckoning; but they actually overshoot it by a bit. Similarly, the twelfth perfect fifth and the seventh octave from the starting point should culminate at the same point; but they do not. That specific discrepancy, the tonal distance between the twelfth perfect fifth and the seventh octave, is the definition of the Pythagorean comma, the core definition of the tuning problem. Pythagorean perfect intervals are not—perfect, that is. When music-making consisted of a solo instrument or voice or a cappella music, this acoustical gap was not even noted. But the advent of polyphonic music along with fretted and keyboard instruments in the Renaissance inevitably led to the discovery of "cracks in the crystal spheres";[26] accurate tuning was critical for fully exploiting the diatonic system.[27]

Equal temperament tuning simply subtracts a few oscillations from the supposedly perfect intervals, a bit of fudging not discernable to the average listener, to create twelve geometrically-derived equal semitones (each equal to the twelfth root of two) that are, however, irrational numbers, very far in philosophical terms from the supposed perfection of the arithmetic Pythagorean intervals: tuning rationality in

[25] Daniel Chua," Vincenzo Galilei, modernity, and the division of nature," in *Music Theory*, Clark and Rehding, 18.
[26] James, *Music of the Spheres*, 87.
[27] Clark and Rehding, Introduction, *Music Theory*, 6.

irrationality. These twelve tempered, irrational, half-tone intervals within the octave now add up precisely to the octave interval, a seemingly straightforward, uncomplicated solution. But with what cosmological significance that solution is freighted; and this seemingly obvious resolution of the tuning problem became standard practice only at the dawn of the nineteenth century.

Music's Place in Philosophy

Appreciating the seismic epistemological shift that equal temperament tuning represents involves a corresponding appreciation of music's philosophical role through the Renaissance. The ancient foundation of music was number, from the Pythagoreans in the seventh to fifth centuries BCE. Making good music meant choosing the right numbers: that is, creating consonances with perfect intervals. These intervals were defined and illustrated by a monochord (invented by Pythagoras himself, according to tradition), a single stretched string with a moveable bridge. The octave, the most consonant interval, is sounded by placing the bridge at precisely the middle of the monochord, creating a 1:2 ratio of total string length to compressed length. The interval of a fifth, the next most perfect interval, is a ratio of 2:3, and the fourth, the next most perfect after the fifth, is created with a 3:4 ratio. These intervals were the most perfect, not primarily for the sweetness of their sound, but because the

integers used to form the ratios—1, 2, 3, and 4—were philosophically significant for the Pythagoreans.[28]

Pythagoreans conceived a precise universe, ordered by number, against the materialistic universe—earth, air, water, fire—that was the focus of Aristotelian natural philosophy. Aristotle, in the *Metaphysics*, wrote of the Pythagoreans that they believed mathematical principles, including musical ratios, to be the foundation of everything, constituent elements of the whole of nature that were the ultimate reality. For them, nature is of mathematics and music. The noted medieval music theoretician Boethius (480-526) said that the Pythagoreans discovered the mathematical foundation of musical consonances. (Boethius himself surmised that there must be heavenly music because it was impossible to believe that the spheres could be moving silently through the heavens.[29]) So the philosophical connection of music to nature and number has very ancient roots.[30]

Music was identified with order, which was in turn identified with all of nature and philosophy; order inhered in the universe, expressed and organized by music, and was the very fabric and organizing principle of the universe. The universe was seen as a totality, a unity; and all knowledge, morality, and purpose were included in that. Man filled a meaningful and knowable, if lowly, niche in the cosmological unity; his purpose for existence was intimately connected to the

[28] The later medieval rationale for defining the fourth as dissonant was that, compared to the fifth, which was reinforced because of consisting of two thirds, the fourth had no such theoretical reinforcement. In Max Weber, *The Rational and Social Foundations of Music*, Trans. and ed. Don Martindale, Johannes Riedel, and Gertrude Neuwirth (Carbondale: Southern Illinois University Press, 1958), 52.
[29] Murray Schafer, *TheTuning of the World* (New York: Alfred A. Knopf, 1977), 260.
[30] The format for this explanation is from Gozza, *Number to Sound*, Introduction, 1-4.

philosophical whole. The correspondence between earthly and heavenly music was assumed, a manifestation of connected and communicating levels of reality. All attempts at understanding nature were simultaneously attempts at finding man's rightful place in the universe; the harmony of the cosmos and morality were inextricable. Harmony, then, was more of a philosophical term than a musical one, applicable to any level of reality or of nature because of the complex system of correspondences and analogies that inhered in the universe.[31] The universe was perfectly tuned.

To suggest, then, that the perfect Pythagorean intervals were not perfect after all was not merely to point out a mildly vexing issue requiring a technical fix, as the problem might be framed today; it was to assault fundamental assumptions about the universe—the musical cosmos as the source of order, knowledge, and authority, giving moral meaning to man's existence—and to undermine the very foundation of Renaissance epistemology. The Renaissance view of the world, because it was so all-encompassing, did not give way easily, quickly, or by a linear route. And although the relentless onslaught of modernity in the seventeenth century has the certainty of inevitability in hindsight, by no means would it have been viewed as such by the century's contemporaries. Rather, the intellectual habits and ingrained ways of thinking about the cosmos only gradually lost intellectual cache as the new scientific philosophy created new questions, priorities, and criteria to judge truth as it filled the space left by gradually outmoded Renaissance thinking.

[31] James, *Music of the Spheres*, 12.

Four Early Philosophers on Music

Robert Fludd and Johannes Kepler, Vincenzo Galilei and Zarlino, were on the cusp of this change around the change of the seventeenth century but could hardly have comprehended their pivotal place in intellectual history. "Thinkers and writers of a 'transitional' period are disadvantaged by a rather murky sense of what they are part of a transition to."[32] For Fludd, the monochord so central to Pythagorean music-as-number philosophy was more than a scientific instrument for defining and measuring intervals; as we have seen in his Christianized rendering of the Divine Monochord, it was also the "scheme of the cosmos," the identification of the perfect tuning of the universe.[33] His was the "last flowering of speculative music."[34] Squarely within the Renaissance tradition, Fludd was holding fast onto a world that was beginning to cease to matter, obsessed with the kind of symbolic thinking that was antithetical to the new philosophy.[35]

Kepler, his contemporary and also an ardent Pythagorean-Platonist, is by contrast, an intriguing watershed figure, one foot squarely in the Renaissance and one in the new scientific epistemology; he heard the music of the spheres in full polyphony, "as a palpable symphony."[36] Throughout his life, he immersed himself in a range of intellectual passions—astronomy, astrology, theology, mathematics—

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[32] Mary Campbell, *Wonder and Science*: *Imagining Worlds in Early Modern Science* (Ithaca and London: Cornell University Press, 1999), 29.
[33] Gozza, Introduction, *Number to Sound*, 4.
[34] Godwin, *Music, Mysticism,* 105.
[35] Keith Thomas, *Man and the Natural World: Changing Attitudes in England 1500-1800* (Oxford, New York: Oxford University Press, 1983), 67.
[36] James, *Music of the Spheres*, 140.

believing ardently in a fundamental connection among them and making it his life's quest to discover it. Kepler's approach was both speculative—beginning with an assumption of the (polyphonic) harmony of the spheres—and scientific: amassing a wealth of data from his meticulous astronomical observations. Initially theorizing that the planetary orbits could be precisely inscribed within a defined series of geometric solids in a glorious "Eureka" moment, he subsequently found that the astronomical data did not fit the theory. The scientist in him did not allow him to fudge the data, but the speculative Renaissance man refused to abandon his assumption of cosmic harmony. An ardent Christian, he believed that God must have created an alternative scheme that Kepler simply needed to work harder to discover. What eventually resulted, of course, were his laws of planetary motion, still valid today, a grand synthesis of Renaissance and scientific epistemologies.

Vincenzo Galilei, father of Galileo and a generation before Fludd and Kepler, was sufficiently independently minded and audacious to dare to expose the imperfections in the Pythagorean intervals with simple experimental evidence and to suggest a practical solution: tempered tuning. So he was the one to deliver the opening salvo of the assault on Pythagorean perfection. His pronouncement came in the context of a battle of words with fellow scholar and intellectual nemesis, Zarlino, who argued strenuously against tempered tuning, insisting that singers instinctively use just (non-tempered) intonation because it is from nature. Vincenzo scorned this distinction, saying that no scale is intrinsically more natural than another. Although

he admitted that he found the just (untempered) fifth to be sweeter than the tempered one,[37] he personally knew many musicians who preferred the tempered fifth.[38]

Vincenzo's position regarding tuning was highly controversial because it negated the idea of perfection in nature. Once that notion was dispensed with, the entire edifice of the harmony of the spheres was suspect. Zarlino, contemptuous of Vincenzo Galilei, still believed implicitly in heavenly harmony, perfection of nature, order, and the unity of the cosmos. He vehemently rejected the skepticism of Vincenzo, who contended that nature has no cognition, no intrinsic moral compass or exemplary models; the old ideas of consonances and supposedly perfect ratios were restrictive and incompatible with musical practice—not natural at all but a product of human rationality. The aim of music, Vincenzo argued, was not to express perfection but to communicate.

The debate between the two men was extremely heated, including vicious personal attack: not surprising given that, although ostensibly debating the relative merits of just versus tempered intonation, they were in fact striving against one another about the nature of reality. Vincenzo's stance was the first evidence of the leading edge of the dispassionate view of musical philosophy and so of nature that was to dominate the modern world.[39] He did this in two ways: first, by objectifying music as a field for experimentation and, second, by acting on this knowledge to

[37] D. P. Walker, *Studies in Musical Science in the Late Renaissance* (London: the Warburg Institute, University of London; Leiden: E. J. Brill, 1978), 19.
[38] Walker, *Studies*, 113.
[39] Chua, "Vincenzo Galilei," in Clark and Rehding, *Music Theory*, 17.

propose a modern system of equal temperament tuning.[40] In pre-modern music, both the cosmos and the soul are tuned to Pythagorean ratios, and earthly music is a reflection of the celestial spheres. The cosmos is connected to earth by a monochord (one detailed articulation of which was Fludd's) linking the chain of being and imposing unity and harmony. Music was the "rational agent of enchantment." To reject that enchanted role of music in structuring and giving meaning to the cosmos was tantamount to "untuning" the cosmos.[41] It is not an exaggeration, then, to say that the contentious debate between Vincenzo Galilei and Zarlino was the "turning point of the Renaissance."[42]

[40] Chua,"Vincenzo Galilei," in Clark and Rehding, *Music Theory*, 23.
[41] Chua,"Vincenzo Galilei," in Clark and Rehding, *Music Theory*, 22.
[42] Gozza, Introduction, *Number to Sound*, 39-41.

CHAPTER 3. MUSIC AND THE NEW PHILOSOPHY

Through the ensuing century, the new experimental philosophy came into ascendance, and music was central to the story, in two somewhat different senses. First, as noted, music was identified with the structure of the universe in Renaissance thinking; so any challenge to the central role of music in cosmology of was tantamount to challenging epistemological beliefs. Second, with the growing importance of polyphonic and instrumental music by the eve of the seventeenth century, the tuning problem had to be addressed.

Because of its importance in the intellectual conversation of the time, experimental natural philosophers devised experiments and wrote about music, though usually not as an end in itself. These included Francis Bacon, at the beginning of the century, Robert Hooke at mid-century, and Isaac Newton writing *Principia* and his later unpublished *scholia*. The Royal Society, a gathering of gentlemen scholars chartered by Charles II in 1660 and pledged to taking up the gauntlet thrown down by Bacon to construct a new edifice of natural philosophy through experimental investigation and observation, participated in the musical conversation by offering a forum for discussion of musical experiments.

Aside from the well-known experimental philosophers, less noted musical theorists wrote about music as a central concern, not as a way to elucidate other scientific ideas or to explore the nature of sound. These (mostly) men created an edifice of basic music theory that stands almost unchanged to this day, but also engaged in protracted debates with proffered solutions for a range of musical issues,

including the tuning problem. These musical theorists were more narrowly focused than the new natural philosophers who had only incidental interests in music. They did, nonetheless, respond, think, and write within the same epistemologically shifting milieu as the greater philosophers; and their musical writing, as an art product, is also a source of illumination about that tumult.

Each offers hints about the complex, non-linear, even at times retrograde route by which the new philosophy became "epistemologically privileged discourse"[43] and the way music figured in the grand conversation which was ultimately about sources of authority and order. Musical writing illuminates challenges to the Renaissance notions of the harmonic and moral structure of the cosmos and changing attitudes toward nature: from an organic, unitary whole making up the Great Chain of Being with humanity having its place in that continuum, to humans as the objective observers of nature, experimenting and investigating to reveal its secrets.

Three Natural Philosophers on Music

Bacon

The name most firmly linked to the beginning of that is surely Francis Bacon, and as such he warrants particular attention. Bacon's early polemical tracts and the longer, more fully-developed works of his later years set the agenda for early experimental science and served as the methodological foundation of the Royal Society after the Restoration. In a century marked by the coexistence of still-robust

[43] Clark and Rehding, Introduction, *Music Theory*, 8.

Renaissance ideas alongside startlingly new philosophical notions, Bacon's writing stands as a metaphor for the creation of new intellectual spaces. His experimental methodology is often cited as the hallmark of the revolution he helped lead; but his project transcended mere methodology to initiate a repositioning of man in relation to the cosmos and an alteration of the very foundation of order.

Had he foreseen the epistemological shift initiated by the new experimental philosophy as it was to meet the powerfully fragmenting religious and political forces of the century, Bacon may have given serious pause to his strident advocacy of his philosophical agenda. He unquestioningly embraced Renaissance thinking even as he advocated for the new philosophy. Natural magic, an experiment-based enterprise, flourished along with scientific investigation in that century, with no clear distinction made initially.[44] Bacon himself was firmly planted in his own time, holding onto ideas about nature and natural phenomena that would later appear scientifically absurd—ideas which his own proposed methodology would help dismantle.[45] He unabashedly betrays magical Renaissance thinking even as he writes about his new philosophy. In *Sylva Sylvarum* particularly, Bacon reveals the extent of his magical and alchemical thinking, incorporating unselfconsciously an astonishing array of magical beliefs into his explanations.[46] Though heralded as scientific innovator and

[44] Charles Webster, *From Paracelsus to Newton: Magic and the Making of Modern Science* (Cambridge: Cambridge University Press, 1982), 2.
[45] Richard Foster Jones, ed., *Francis Bacon: Essays, Advancement of Learning, New Atlantis and Other Pieces* (New York: The Odyssey Press, 1937), xxviii.
[46] Paolo Rossi, *Francis Bacon: From Magic to Science*, trans. Sacha Rabinovitch (Chicago: University of Chicago Press, 1968), 12.

reformist, Bacon drew heavily on "medieval and Renaissance traditions of natural knowledge."[47]

Nevertheless, clear differences distinguish Renaissance natural magic and the new natural philosophy, consigning the one to historical obscurity and the other to philosophical dominance by the end of the century. The former focuses on the unusual and the occult, promoting a sense of mystery, the latter on the ordinary and revealed book of nature, striving for transparency and the resolution of mystery. Still, because of the persistence of magical beliefs and natural magic's experimental methodology, the new philosophy (and Bacon, grudgingly) found common cause with natural magic, the two coexisting in a shifting intellectual space for most of the seventeenth century as natural magic gradually but inevitably lost intellectual cache even as the new philosophy gained intellectual ascendancy.

While natural magic had its ascendancy in the Renaissance, Aristotelian philosophy dominated the pre-Renaissance centuries; and Scholasticism continued to be taught in the universities through the first part of the seventeenth century. Bacon had only scorn for the failure of Aristotelian natural philosophy to actively investigate nature to discover cause and effect and for relying instead on pointless argumentation to no useful end. Aristotle is the "Prince of Imposture…the Anti-Christ"…who failed to "practice serious study and observation of natural phenomena, which are the only

[47] Richard Serjeantson, "Natural Knowledge in *The New Atlantis*," in *Francis Bacon's* New Atlantis: *New Interdisciplinary Essays* , ed. Bronwen Price (Manchester, New York: Manchester University Press, 2002), 84.

basis of philosophy."[48] Nature must be discovered through the (admittedly limited) senses, aided by experimental method. Aristotelian rationalization is utterly fruitless and "does not produce discoveries, but…crushes and extinguishes them."[49] For the new experimental philosophy, Bacon envisions a marriage of nature and the rational faculties, radically divorced in Aristotle's philosophy. "Let us establish a chaste and lawful marriage between Mind and Nature…[that] from that marriage may issue …wholesome and useful inventions…."[50]

Bacon's contempt for Aristotelian philosophy and its intellectual handmaiden, Scholasticism—words without actions, nature without investigation, talking without doing[51]--made Bacon hypothesis-shy. He insisted that the aim of his new philosophy is the discovery of nature, not the construction of theoretical edifices. His idea of reform for natural philosophy entails the construction of a complete natural history from the active investigation of nature before any theory-construction. Bacon's curt dismissal of scholasticism and alchemy—"the one never faileth to multiply words and the other ever faileth to multiply gold"—epitomizes his contempt.[52] The role of hypothesis in scientific investigation, now virtually unquestioned, was contentious in the seventeenth century because of its connection to Aristotelian speculative natural philosophy.

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[48] Francis Bacon, "The Refutation of Philosophies," in *The Philosophy of Francis Bacon*, ed. Benjamin Farrington (Chicago: University of Chicago Press, 1964), 113, 115.
[49] Bacon, "Refutation," in Farrington, 125.
[50] Bacon, "Refutation," in Farrington, 131.
[51] Serjeantson, "Natural Knowledge," in Price, 85.
[52] Bacon, *Discourse in Praise of Knowledge*, in Farrington, 15.

Scorn for Scholasticism, that complex, rationalist enterprise to reconcile the teachings of the Church and Aristotle, prompted Bacon to insist on a rigid separation of theology and philosophy. It was not a war between the two he fears, but rather an unhealthy entwining of the two, such as had dominated Western philosophy and theology for centuries. He saw this mingling of science and religion as pernicious.[53] Bacon continually emphasized the need to distinguish between Creator and Creation, between God and nature. Failure to do so was a fatal flaw of the ancients in their relationship with nature. Nature is evidence, but not the image, of God and must not be reverenced. It is indifferent to humans; so humans must impose art on nature to harness it for the good of humanity. Nature itself neither "make[s] moral sense" nor "exhibit[s] divine care."[54] Mixing the two conflates and confuses the divine with the natural and blurs the distinction between religion and science.[55]

Early on, Bacon presided over a firm separation of the new natural philosophy from the religious enterprise, a bifurcation within natural philosophy, with all its unresolved tensions, that has persevered to this day. Nonetheless, religion was the primary concern of most people in the seventeenth century. So nature joined Scripture as a new foundation of truth about God and the universe. Theories were reworked in the language of the New Science. These reworkings were normative in the way the old ones had been. New philosophers believed that investigation into nature would confirm Scripture's veracity and thus bolster faith. The reformulations advocated not

[53] Rossi, *Francis Bacon*, 97.
[54] Jerry Weinberger, "On the Miracles in Bacon's *New Atlantis*," in Price, 117-118.
[55] Rossi, *Francis Bacon*, 44.

a break with religion, but adding nature as another field of divine revelation in this religious era.[56] This framing of new science helped legitimize it and armor it against accusations of atheism.

Still, the storm clouds of vague associations with atheism hovered threateningly over the new philosophy; Bacon was prescient about the potentially awesome power of technology born of the manipulation of nature and believed that it must be tempered with and guided by knowledge of God, a moral restraint he would have assumed to be permanent and secure.[57] He himself is "uncertainly suspended" between atomism—materialistic but with the taint of atheism—and Stoical theory of pneuma—uncomfortably close to reintroducing divinity into nature, philosophically untenable. But the cautionary religiosity Bacon saw as a permanent part of this re-alignment was eroded and eventually destroyed by his own methodology; and so too notions of order became severed from morality and religion to become strictly human-fashioned. Regardless of Bacon's own misgivings, the notion of an inert nature with the rejection of God immanent in nature set the agenda for the seventeenth century and is intimately linked to evolving concepts of order and authority. Bacon continually emphasizes the necessity of distinguishing between the Creator and His Creation and nature's moral indifference.[58]

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[56] Roy Porter, "Creation and Credence: The Career of Theories of the Earth in Britain, 1600-1820," in *Natural Order: Historical Studies of Scientific Culture*, eds. Barry Barnes and Steven Shapin (Thousand Oaks: SAGE Publications, 1979), 98.

[57] Weinberger, "Miracles," in Price, 115.

[58] Weinberger, "Miracles," in Price, 117-118. Also, early modern science was almost entirely a male pursuit. The fact that medieval institutions, most notably the hegemonic Church, were the exclusive realm of men meant that the institutions that grew out of that tradition continued to be dominated by males. Because of the clerical origins of early modern science, the "conceptual and ideological

In music this meant a movement away from music as number to music as sound. Bacon stoutly rejects the notion of the harmony of the spheres and Platonic ratios as the foundation of the cosmos. Since physical, not mathematical, investigation of the universe is his aim, music is a sensible acoustic event, not a source of mathematical speculations. This Platonic rejection, ironically, mimics Aristotle, who also rejected philosophical notions of cosmic harmony. Both Aristotle and Bacon, though, adhered to other Platonic ideas including a universe based on order and proportion and a belief in the moral and emotional power of music.[59]

Bacon's approach to music and sound, in fact, incorporates natural magic as well as experimental philosophy. He thinks music can be used for utopian ends through science and technology and is the first to propose a program for the empirical investigation of sound through a mix of "observation, imitation and manipulation of nature,"[60] detailed in Salomon's House in *The New Atlantis*. This work draws heavily on "medieval and Renaissance traditions of natural knowledge."[61] Though its setting is fantastical, Bacon insists this work is not a utopian vision but rather a realizable goal for a society properly employing technology for the good of humanity.[62] The paragraph on sound-houses describes a magical-technological approach to investigation:

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structure" of medieval institutions remained intact regarding gender roles. Bacon strove to break the fetters of traditional Aristotelian philosophy; challenging gender roles too would likely have been beyond his ability to comprehend. In *Revolutionizing the Sciences: European Knowledge and Its Ambitions, 1500-1700,* Peter Dear (Princeton, NJ: Princeton University Press, 2001), 16.

[59] Gouk, "Music in Francis Bacon's Natural Philosophy," in Gozza, 136.

[60] Gouk, "Music," in Gozza, 137.

[61] Richard Serjeantson, "Natural Knowledge" in Price, 84.

[62] James Spedding, Preface to *The New Atlantis*, in *The Works of Francis Bacon*, Vol. V, eds. James Spedding, Robert Leslie Ellis, and Douglas Denon Heath (New York: Houghton Mifflin, 1904), 351.

> We have also sound houses, where we practice and demonstrate all sounds and their generation. We have harmonies….Diverse instruments of music….We represent small sounds as great and deep; likewise great sounds extenuate and sharp; we make divers trembling and warbling of sounds….We represent and imitate all articulate sounds and letters, and the voices and notes of beasts and birds. We have certain helps which set to the ear do further the hearing greatly. We have also divers strange and artificial echos, reflecting the voice many times….We have also means to convey sounds in trunks and pipes, in strange lines.63

Bacon writes more generally about music as part of his plan for the new natural philosophy. In *Sylva Sylvarum*, divided into ten centuries, each containing 100 experiments, Century II focuses on music. The introductory paragraph is the most famous of Bacon's observations on music:

> Music, in the practice, hath been well pursued, and in good variety; but in the theory, and especially in the yielding of the causes of the practique, very weakly; being reduced into certain mystical subtilties, of no use and not much truth. We shall, therefore, after our manner, join the contemplative and active part together.64

Bacon has little use for the elaborate structure of Renaissance music theory, based on Pythagorean intervals and mystical number relationships. As in all of his natural philosophy, he wants to investigate the causes—of musical sound, in this case. He agrees with theorists that the octave is the most consonant interval—"The diapason or eighth in music is the sweetest concord"—but says "the cause is dark, and hath not been rendered by any."[65] Bacon, who ostensibly seems "perverse" in claiming ignorance in his *Sylva Sylvarum* of the octave-unison relationship, for

[63] Bacon, *Works*, Vol. V, 407.
[64] Francis Bacon, *Sylva Sylvarum*, "Century II," in *Works*, Vol. IV, 225.
[65] Bacon, *Sylva Sylvarum*, in *Works*, Vol. IV, 226.

example, since the foundation for Platonic intervals was well-known,[66] is actually merely admitting he does not know about the connection between frequency of vibration and pitch, a discovery just making its appearance on the intellectual horizon.[67] He goes on to suggest it must be that the air is forced into a regular pattern to give the sweet sound of the octave.[68] In the matter of the two half-tones of the major scale, Bacon says "the varying is natural…required" by nature.[69] So much for causes.

Bacon agrees with Renaissance theorists in the order of the sweetness of interval consonances, except about the interval of the fourth. The question of the consonance of this interval was much debated, but composers of polyphonic music needed it and were using it freely. Bacon favors the fourth as consonant, claiming accord with ancient tradition. "The concords in music which are perfect…are the fifth…the third…the sixth…and, as the ancients esteemed, and so do myself and some other yet, the fourth, which they call the diatessaron."[70] This is the pragmatic stance, admitting what was already virtually standard in musical practice.

Study of consonances was of paramount concern to Bacon, as to every writer on music in the seventeenth century. In an intriguing discussion about the causes of sweetness of sound, Bacon makes an analogy with sight. "There be two things pleasing to the sight…*colours* and *order*." The pleasure of color is analogous to the

[66] Walker, *Studies*, 120.
[67] Gouk. *Music, Science,* 167.
[68] Bacon, *Sylva,* in *Works*, Vol. IV, 227.
[69] Bacon, *Sylva,* in *Works*, Vol. IV, 227-228.
[70] Bacon, *Sylva,* in *Works*, Vol. IV, 228.

sweetness of a single tone, but the pleasure of order "doth symbolise with harmony." Garden knots, good proportion, and symmetrical figures please; while irregular shapes are "deformities."[71] Harmony equals beauty equals order. Order is loved, even revered, all the more so as the desperate hope of an early-seventeenth-century society seeming to be losing its unitary way amidst religious and political divisions. "But to find the proportion of that correspondence [harmony], is more abstruse,"[72]—an inquiry for another day, apparently, as Bacon does not investigate causes of harmony in *Sylva Sylvarum*.

He addresses the issue of musical sound though, describing experiments with various materials and instruments to produce a variety of pitches[73] but omitting, interestingly, any reference to the monochord. He is either ignorant of it or thinks, perhaps, the reference touches too closely on mystical Pythagorean number intervals. The intervening and concluding observations describe the creation and transmission of sound and its connection with the percussion of air and vibration. A seemingly glaring omission is any discussion of the tuning problem, becoming acute because of the prevalence of both polyphonic music and fretted and keyboard instruments. Instead, Bacon's century on music, though freely drawing on other sources as does all of *Sylva Sylvarum*, focuses on finding causes for observed phenomena through experimentation.

[71] Bacon, *Sylva*, in *Works*, Vol. IV, 229-230.
[72] Bacon, *Sylva*, in *Works*, Vol. IV, 230.
[73] Bacon, *Sylva*, in *Works*, Vol. IV, 257-261.

In disentangling Aristotelian philosophy from Christianity, Bacon unwittingly aided and abetted the sowing of the seeds of secularization by participating in the fragmentation of authority begun with the Protestant reformation. It is an outcome Bacon himself would have stridently condemned. Others through the century participated in the subordination of mystical Platonic and Pythagorean philosophy in favor of scientific knowledge as the criterion for authority; virtually all of them too would have strenuously decried the materialistic, secularizing consequences of that action. And that is the ironic story of early modernity: the fragmentation of sources of authority and order, borne of an altered relationship to nature and sincere religious sentiment.

Hooke

Later in the century, Robert Hooke was the consummate experimental investigator. As Robert Boyle's assistant in the 1650s (pre-Royal Society), he devised mechanisms for conducting Boyle's own experiments. The most famous was, of course, the air pump, later to become a mainstay of Royal Society discussions and experimentation. His enthusiasm for experimentation was recognized by the Royal Society, which named him the first Curator of Experiments and later Secretary of the Society after Oldenburg's death in 1677. In his experimental mode, Hooke relied on hypothesis-testing, drawing sharp criticism from Newton, who saw this methodology as anti-empirical, muddying the waters by proposing imaginary, contrary explanations for natural phenomena already confirmed by experiment and

observation.[74] Hooke in turn upbraided Newton for his (Newton's) dogmatism in stating with absolute certainty, for example, that he had proved his theory of optics and proposing his own alternate hypothesis for the data.[75]

But far from being a dilettante, Hooke was an ingenious tinkerer, finding creative solutions to practical problems.[76] Even though he advocated a mathematical approach to the development of natural philosophy, his forte was inventing devices to further the cause of useful experimentation.[77] He helped advance the field of microscopy for his magnum opus, *Micrographia* (1665), one of the few books published under the auspices of the Royal Society. Also, Hooke found that he required a better light source than a simple candle or lamp to properly enhance the image from the microscope. His answer—the sotoscope, a liquid-filled glass globe placed between light source and microscope and focused with a convex lens to direct the intensified light on to the specimen.[78] Hooke was not unaware of his creative gifts. On more than one occasion, he claimed to have found a clock-based solution to that Holy Grail of seventeenth-century science, the longitude problem.[79] While acknowledging that the senses were prone to "narrowness and wandering," he had

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[74] Peter B. Anstey, "Experimental Versus Speculative Natural Philosophy," in *The Science of Nature: Patterns of Change in Early Modern Natural Philosophy*, eds. Peter Anstey and John A. Schuster (The Netherlands: Dordrecht, 2005), 229, 232.
[75] Steven Shapin, *The Scientific Revolution* (Chicago: University of Chicago Press, 1998), 115-116.
[76] Marcus Hellyer, *The Scientific Revolution* (Oxford: Blackwell Publishing, Ltd, 2003), 195. Hellyer maintains that twentieth-century historians of the scientific revolution fail to appreciate the extent to which seventeenth-century natural philosophers pursued science to solve practical problems.
[77] Hellyer, *Scientific Revolution*, 180-181.
[78] Lisa Jardin, *Ingenious Pursuits: Building the Scientific Revolution* (New York: Random House, Inc., 1999), 44.
[79] Jardin*, Ingenious*, 51. It was not until the latter part of the eighteenth century that John Harrison found a clock-based solution to that vexing problem of navigation. In *Longitude,* Dava Sobel (Middlesex, England: Penguin Books, Ltd., 1996).

confidence that instruments such as the microscope and telescope would adequately compensate for these shortcomings. [80]

Hooke thought about more than experiments, though. He believed that the ancients possessed great philosophical truth, but that it had become severely compromised over time. "It is said of great Empires, that the best way to preserve them from decay, is to bring them back to the first Principles…on which they did begin. The same is undoubtedly true in Philosophy."[81] Like most other natural philosophers of the time, Hooke professed a personal godliness and religiosity. Under his microscope lens, he saw revealed such perfect adaptation between structure and function that he wondered how anyone could "think all those things the production of chance."[82] Also coincident with most of his peers in natural philosophy, Hooke believed the purpose of natural philosophical knowledge was to "erect a glorious and everlasting structure to nature" and thus nature's Creator.[83]

Musical investigation constituted an important part of Hooke's experimental agenda, mostly relating to the nature of sound, ranging from vibrations and acoustics to the nature of harmonious intervals and the effects of music. He understood sound as vibration and, more importantly, related frequency to pitch in his experiments. Most of Hooke's musical experiments were presented to the Royal Society in 1664. In addition to the experiments presented to the Royal Society, Hooke presented papers focused more on the effects of music to a secret Philosophical Club, formed in

[80] Shapin, *Scientific Revolution*, 93.
[81] Hooke, quoted in Shapin, *Scientific Revolution*, 75.
[82] Hooke, quoted in Shapin, *Scientific Revolution*, 144.
[83] Hooke, quoted in Shapin, *Scientific Revolution*, 153.

the mid-1670s by Hooke and others, including Christopher Wren and William Holder, interested in musical topics. In papers probably prepared for this group, Hooke hypothesized that nature has constructed the ear to receive sound exactly as it is produced, that is, in the same frequency. The consonant intervals (octave, fifth, fourth, etc.) are pleasing and harmonious, not because of mystical Pythagorean numbers, but because these are the frequencies that strike the ear in a "coincidence of the Vibrations."[84] Rhythm "is that which is most active and operative upon the affections & passions of men." Harmony, though, offers the "most ravishing pleasure & delight of all." It is an intellectual pleasure because the mind must sort out the mathematical intricacies of the music to make it pleasurable. This is possible because God has created both the world and humans according to mathematical, geometric principles.[85]

Hooke, along with Newton, saw music as the underlying structure of the universe,[86] an idea that seemed to peacefully co-exist with his cutting-edge experimentation on vibration theory. He constructed musical models, not primarily to explain musical principles, but to elucidate his natural philosophy in the context of this larger notion of the "harmonic structure of the universe," with mathematics as the connecting vector.[87] This notion is, of course, essentially Pythagorean; and Hooke unabashedly subscribed to this Renaissance idea to design experiments and create

[84] Hooke, "Curious Dissertation concerning the Causes of the Powers and Effects of Music," in Gouk, *Music, Science*, 200 and 207-209. Hooke also prepared a series of "Musick Scripts" to discuss his ideas, likely for the Philosophical Club.
[85] Hooke, "Curious," in Gouk, *Music, Science*, 212-213.
[86] Gouk, *Music, Science*, 225.
[87] Gouk, *Music, Science*, 213.

explanations: music as a means to an end rather than an end in itself. Most notably, he compared the minute particles constituting matter to the action of vibrating strings to explain the nature of matter and conducted experiments in acoustics and musical vibration to articulate and fortify his own theory of vibrating matter.[88] Again, he used musical analogies when detailing his theory of color by comparing the spectrum to musical harmonies and his notion of light by comparison to sound waves.[89]

Hooke also weighed in on musical issues in their own right, including musical notation and division of the scale. His approach was, typically, a combination of Pythagorean mysticism and experimental practicality, his ideas on these matters based on widely held ideas of the time, not original but rather his own unique presentation. Whether to give names to the twelve tones of the octave and what those names should be was one much-discussed (though hardly pivotal) musical issue of the time. Hooke suggested a system of musical notation as an attempt to simplify and rationalize both reading and composing music. The division of the scale, an issue closely touching on the tuning conundrum, pre-occupied mathematicians and theorists; and it is clear that Hooke was aware of others' geometrical and irrational-number calculations for the scale divisions. Though acknowledging the necessity of some kind of temperament tuning for practical musical production, Hooke never went so far in musical theorizing as to offer any solution of his own devising; and he

[88] Gouk, *Music, Science*, 214, 218.
[89] Gouk, *Music, Science*, 201, 216.

maintained that the true intervals were of just intonation (Pythagorean plus additional consonant intervals advocated by Zarlino).[90]

Newton

Much greater even than Hooke, Newton wrote that masterwork of Western mathematical logic, *Prinicipia mathematica* (1687), but was loath to publish it. His friend Edmund Halley persuaded him to do so by paying for its publication under the auspices of the Royal Society.[91] Newton was a serious investigator of alchemy and considered his alchemical studies to be the core of his life's work. His volumes of writing mostly concern his astrological and alchemical investigations and speculations; and his personal library included mostly books on these subjects and only a few on the new scientific philosophy.[92]

The initial work on *Prinicipia mathematica* (1687), as well as Newton's discovery of the law of gravity, was a product of his *anno mirabilis*, the year Newton spent at home when Cambridge was closed for fear of the plague. Newton, though, saw both of these scientific-mathematical accomplishments in terms of their value in penetrating the meaning of Pythagoras' celestial harmony; the Pythagorean musical ratios underlay his inverse square law.[93] According to Newton's *scholia*, both the inverse square law and the law of gravity were adumbrated by the *prisci theologi* in

[90] Gouk, *Music, Science*, 201.
[91] The Royal Society, however, lacked the funds to repay Halley, so recompensed him with multiple copies of Francis Willoughby's *Historia piscium*, a lavishly illustrated non-seller published by the Society the year before. In *Ingenious*, Jardine, 36.
[92] James, *Music of the Spheres*, 160.
[93] Gozza, *Number to Sound*, 50.

the mists of antiquity.[94] This consummate man of science and mathematics, the very epitome of seventeenth-century brilliance, viewed his monumental intellectual creations as mere re-interpretations of ancient encoded wisdom.

Not surprisingly, Newton's interest in music was based on mathematics. He developed his own system for the division of the scale, a task exercising theorists mightily because of its intimate connection with the tuning problem. Newton devised a chart of logarithmically calculated tempered semitones that anticipates almost precisely that in use today.[95] He seems more interested in the mathematical complexities and creating symmetry than in aural considerations; and he is anxious to construct a system of intervals, by theorizing tiny building blocks of sound, that is closest to classical just intonation. Newton's musical theorizing is a part of his obsession with mystical number manipulation relating to ancient wisdom rather than a desire to derive some practical solution for the temperament problem facing practicing musicians. He used his acoustical work to inform his optical investigations, drawing an analogy (as others also did) between the musical scale and the color spectrum.[96]

Newton, following Pythagoras, believed the cosmos to be structured by mathematics, evident in *Principia*, and himself as an agent to recover ancient theological wisdom. His investigation into the harmonics of both music and color was part of his lifelong attempt to reveal the true basis of the harmony of the spheres, the

[94] Walker, *Studies*, 25.
[95] Gouk, *Music, Science*, 233.
[96] Gouk, *Music, Science*, 235, 237.

truth of which had been encoded to hide it from the vulgar but symbolically and allegorically decipherable by a true philosopher such as Newton himself. The musical scale and the color spectrum relate to the actual harmony of the heavens, not the literal creation of tones by the motion of crystal spheres, but the entire mathematical edifice underlying the cosmos.[97] Newton saw himself, not as a discoverer of new truths about the working of the universe, but as one revealing its ancient, encoded wisdom. Absolute space was, to Newton, God's "universal sensorium."[98]

[97] Gouk, *Music*, *Science*, 251-254.
[98] Peter Dear, *Revolutionizing the Sciences: European Knowledge and Its Ambitions, 1500—1700* (Princeton, NJ: Princeton University Press, 2001), 169.

CHAPTER 4. HUMANITY CREATING ITS OWN MEANING

Implicit within the century's changing perspectives on nature as they inform altered sources of authority and order is the notion that humans now have chosen to make do for themselves. The cosmos is delineated, humanity is in the ascendant, nature is knowable and controllable—a pyrrhic victory, exacted at the cost of the severing of once-vital connections: between nature and morality, meaning and spirit, science and philosophy. Humanity's pride in its newfound control of nature and authority, wresting power from a spiritually imbued cosmos to bring to earth as its own provenance, wraps the onus in the guise of a gift of increasing scientific hegemony. From now on, humankind itself must operate without reference to the harmony of the spheres. If there is to be harmony, humanity must be both originator and guarantor. On its own in the cosmos, no longer part of a great chain of being ensconced within a unique niche of the natural world, no longer dependent on a shared notion of cosmic harmony, rather relying on its own power to create and sustain, to order and deliver, to provide and satisfy—humanity is the ultimate source for all its own physical, intellectual, and spiritual needs.

One initially compelling metaphor maintains that the traditional religious ideology underlying the new theory of nature in the seventeenth century is the *basso continuo*, supporting the status quo; new lyrics and melody are the changes in

philosophy and religion that play over it.[99] But the *basso continuo* was not left unchanged, even if the moral-religious ethos remained strong. Though not apparent early in the seventeenth century, the moral and the religious were destined to be only vestiges, however sincerely proclaimed, that eventually revealed their uselessness to the new natural philosophy; the new *basso continuo* is the modern scientific enterprise: materialistic, radically divorced from religion, ideologically neutral. The source of morality, religion, and ideology no longer lies with the cosmos; humans now have the freedom, or bear the burden, of fashioning these anew—for each individual and for society. It is a human-made world, in much more than a merely technological sense. This new way of thinking about nature was part of a deep and wide shift within society—political, philosophical, and religious—recognizing that humanity, without recourse to the immutable heavens, must now be in control of its own destiny, including the awful freedom to choose among diverse sources of authority and order.

This new natural philosophy was not just about changing methodology. New ideas about nature and man's relationship to it redefine order and authority, a true epistemological shift. But in no sense was it a linear one. Renaissance-era beliefs in analogies and correspondences continued to be culturally meaningful even as the scientific revolution proceeded apace. This contradictory, complex seismic shift can be viewed through artistic products as they reveal, though opaquely,[100] prevailing

[99] Porter, "Creation and Credence," in Barnes and Shapin, *Natural Order*, 101.
[100] Sharpe, *Remapping,* 40.

beliefs, concerns, and desires, expressing illusions as well as anxieties.[101] Reading cultural texts for ideological meaning is critical for the seventeenth century in particular because political thought and language did not even exist as a distinct, discrete level of discourse until the latter part of the century[102] and because the participants in the profound shift of cultural meanings in the seventeenth century were utterly unaware of the transformational enterprise of which they were a part. So the upheavals of the seventeenth century, far from being transparently expressed in cultural products, often led to a "forceful articulation of organic unity"[103] as writers agonized about their fear of disorder in the face of disintegrating certainties or, later in the century, more easily embraced the new epistemology identified by fragmentation of sources of authority and truth as old meanings and attachments mattered less and less.

Music Central to That Change

Music figures critically in this epic shift in having become, through evolution, hard-wired into the human brain, a source of social cohesion since humanity's pre-history. All known societies have had music; it is intimately connected with the development of language, dating to the beginning of our species.[104] Music is central to what it means to be human; so the musical conversation of the seventeenth century is even more heavily freighted with meaning than just one among any number of

[101] Sharpe, *Remapping*, 29.
[102] Sharpe, *Remapping*, 48.
[103] Sharpe, *Remapping*, 49.
[104] Oliver Sacks*, Musicophilia* (New York: Random House, Inc., 2007), x.

other cultural expressions as political statements. Musical writing, however narrowly focused, is yet accessing a deep human reservoir of meaning of sources of order and authority. As humans assumed increasing autonomy, this epic shift is encoded in music thinking and writing.

Changing Ideas of Nature in Music Writing

That dividing line of seventeenth-century English history, the Civil War, was a cultural break in forcing the polity to confront the *fact* of fragmentation and loss of harmony; but it was not the cause or even the symptom of a sharp break in that belief in a unified and harmonic society. That had been eroding for some time, as evidenced in the temperament controversy in music. The realization that there was a problem with the intervals as pronounced by Pythagoras was known by those who worked in music; and with that realization came inevitable enormous cosmological implications: the harmony of the spheres was not as advertised. As musical theorists and practitioners grappled with the temperament problem, the out-of-sync intervals pointed to more questions, and questioning, about other accepted truths concerning the physical universe—the great chain of being and man's niche within it—along with more mundane but pressing matters of politics and society.

The new realizations and realities in society and philosophy meant that humankind was severing its spiritual ties to nature and cosmos, arrogating to itself the roles previously belonging to a sacralized universe, thus desacralizing those functions as they came within the realm of human-created control and authority. Though

musical treatise writers reveal an increasing sense of mastery as well as continuing anxiety about shifting cosmology through the century, the changes are highly contested and non-linear.

The Royal Society tended to attract men (and only men of course) with a range of interests pertaining to the new experimental philosophy, including music as a means of elucidating other ideas and occasionally musical topics per se. Musical theorists were not stalwarts of the Society (though they occasionally had their papers on music theory topics presented for discussion), but rather focused their attention and writing on musical topics as ends in themselves; and there was much to contend with, during the century when most modern music theory was developed, within the roiling context of what to do about tuning. While the major natural philosophers addressed music in a multi-faceted, global sense for a variety of aims, musical theorists were, by contrast, singularly focused on music in a strictly theoretical sense in which it was central to the story of natural philosophy in the seventeenth century. Where the Royal Society elites articulated a broad range of interest in scientific topics related to the new philosophy and occasionally includied music because of its connection to other kinds of knowledge, the musical theorists pursued defined aims of developing music theory as they grappled with the tuning problem for polyphonic and instrumental music. The groups overlap, of course; but this second were most known as musicians and musical theorists, rather than natural philosophers who occasionally

wrote about music. The musical structures developed by these theorists is nothing less than "ideology…encoded in symbolic systems"[105] and so worthy of investigation.

Though scholasticism was still being taught in the universities into the seventeenth century, neo-Platonism dominated Renaissance thought and launched the seventeenth century, implicit in all institutions. If new-Platonism was concerned with "the realization of perfect forms,"[106] then the purpose of art was to demonstrate the perfection in nature. As the foundation of beliefs about nature began shifting, art became one site of contention about the Platonic ideals, questioning a moral, meaningful, organic cosmos and the authority of the heavens in human affairs. Musical writers advocated a variety of solutions to musical theoretical problems, reflecting and revealing the shifting bases of philosophical beliefs through their writing about music.

Questioning the neo-Platonic notion of the harmony of the spheres as a metaphor for the heavens as source of order and authority for humanity coincided with the changing notions of nature. As beliefs about nature dictate beliefs about music, so music was central to the questioning of old assumptions, though in mostly oblique ways. Musical writers did not set out to debate deep philosophical questions of meaning and authority; but their contentious writing was an active site for that debate, albeit unwittingly, and all the more so because the problem with Platonic intervals, the tuning problem, was of necessity so central to their discussion.

[105] Sharpe, *Remapping*, 94.
[106] Sharpe, *Remapping*, 448.

Harmony of the spheres—rife with correspondences in reflected realities of heaven and earth; an ordered and interconnected universe of hierarchy and beauty; an opaque, sacralized cosmos saturated with meaning and significance—was "metaphysically dependent" on neo-Platonic ideas.[107] This universe was in sharp contrast to that which underlay the new philosophy. The latter demanded "taxonomical" structure in the universe, its meaning transparent to human investigation and experiment.[108] Neo-Platonism was at cross-purposes to the new philosophy and lost its central role; it was not so much attacked as dismissed. With one foot still in the Renaissance, Bacon, at the beginning of the century, had tried to reconcile the new philosophy with neo-Platonism; and Newton, at the end of the century, was still pre-occupied with Platonic-based pursuits. But by the end of the seventeenth century, neo-Platonism simply lost intellectual cache, out of joint with the times. "The [late] seventeenth-century neo-Platonic revival was…a doomed attempt to reinvest an already fatally secular cosmos with the sense of sacred home."[109] The description of the cosmos envisioned by neo-Platonism was no longer seen as useful.

The Platonic ideal in music dictated that the perfect intervals were to be combined into compositions according to strict parameters based on consonances emanating from God and nature, to be discovered by man. The ancient foundation of music was number, as discovered by Pythagoras. Making good music meant choosing

[107] Geneva, *Astrology,* 269.
[108] Geneva, *Astrology*, 271.
[109] Geneva, *Astrology*, 282.

the right numbers, the correct intervals to create perfect consonances.[110] The Pythagoreans conceived of this precise, number-ordered universe against the materialistic universe of Aristotelian natural philosophy. Aristotle himself wrote of the Pythagoreans that they believed mathematical principles, including musical ratios, to be the constituent elements of the whole of nature, the ultimate reality. Boethius (480-526) re-iterated that Pythagoras discovered the mathematical foundation of musical consonances in the perfect intervals. Mathematics is the foundation for harmony, spatial and musical.[111] Because this was such an all-encompassing world view, it did not willingly depart the philosophical stage.

Neo-Platonism's loss of intellectual cache had a specific meaning and consequence for musical theory: from musical sound as number to vibration. Consonances were no longer based on simple numerical ratios but on vibration. The most concordant simultaneous tones were the ones whose vibrations coincided most frequently and regularly. Numbers were no longer the cause but only the representation of what was happening musically.[112] Vincenzo Galilei's exposure of the imperfections in Platonic intervals in the late sixteenth century was the leading edge of this dispassionate view of music informed by a mundane, knowable nature. Music in the modern world now is instrumental (both figuratively and literally), efficient, and harmonically calculated.[113] Equal temperament tuning is the ultimate

[110] Gozza, *Number to Sound*, 1.
[111] Gozza, *Number to Sound*, 2-4.
[112] Jamie Kassler, *Inner Music: Hooke and North on Internal Character* (Madison, Teaneck: Fairleigh Dickinson University Press, 1995), 53.
[113] Chua, "Vincenzo," in Clark and Rehding, *Music Theory*, 20.

rationalization of music; tuning thus rationalized for the purpose of fretted instruments playing in harmony has lost magic and divinity[114] and implies a nature also thus diminished. Pre-modern music is highly rational in a literal sense—based on divine ratios—the "rational agent of enchantment."[115] Disenchantment of music means no less than the untuning of the cosmos, the collapse of cosmic order. Modernity views the disenchantment of musical theory and the rationalization of tuning as obvious and inevitable.

But it was not so for seventeenth-century musical theorists or performers. The latter had been making novel tuning accommodations for instrumental and complex vocal music since the late Renaissance without confronting the philosophical contradiction with Pythagorean intervals. They simply did what they had to do to perform the music. This often meant mean-tone tempering: diminishing a series of consecutive fifth intervals by a bit; but it worked well for only a few keys. These ersatz temperament solutions were not systematized and only more or less satisfactory, usually limiting the keys that a performer could play in. "Just" intonation, Zarlino's system of using more intervals than in the Pythagorean philosophy, still had the inconvenient problem, because of using pure intervals, of music ending on a different pitch than the initial one: the basic problem of non-tempered tuning—the octave is not preserved. Dutch philosopher Huygens contended that good singers (unaccompanied) will compensate for this instability by holding the original pitch in their heads—in effect, creating their own tempered intervals. The

[114] Max Weber, *The Rational and Social Foundations of Music*.
[115] Chua, "Vincenzo Galilei," in Clark and Rehding, *Music Theory*, 22.

trick, apparently, according to Huygens, was to get them to sing a piece *quickly* enough so as not to forget the original pitch.[116]

Seventeenth-century theorists, in engaging more directly with the philosophical issues of music theory, typically accepted the necessity of some kind of temperament adjustment while still holding on to ideals of Pythagorean perfection. The logical and the ideal, then, co-existed through the century, the latter giving way to the former only as neo-Platonism and the idea of cosmological harmony lost intellectual space and became irrelevant, space then taken up by the new experimental philosophy. The co-existence of the pragmatic and the ideal was not always peaceful. Assumptions about nature informed musical treatises, which then became sites for contested notions of nature and the cosmos, though the authors would not have perceived them as such.

Probably the most noted and prolific treatise writer of the early century, Thomas Morley's most important treatise on music theory was an instruction manual for singers and plucked instrument players on the intricacies of improvising two, three, four, five, six, or more parts on a plainsong melody. It is far from being an exact science. Modern music theory developed, haltingly and piecemeal, as a response to the increasing complexity of music beginning in the late Renaissance.

[116] Walker, *Studies,* 112.

Morley consults various sources "for a solution and a clearing of my doubt" for his own treatise and notes the "diursity betwixt them"[117]

Morley is not shy about proclaiming his own theory. He directs the reader to "dispose your musicke according to the nature of the words….if you have a graue matter, applie a graue kinde of musicke to it….when you would expresse any word signifying hardnesse…make the harmonie like vnto it, that is, somewhat harsh and hard but yet so it offend not….sharpe thirds, sharpe sixes and such like."[118] Going out of tune is unnatural because these are given by nature, not human artifice.

Morley claims ancient sources for his musical writing, namely Plato for whom music was "a heauenly thing and profitable for the seeking out of that which is good and honest….and cannot be intreated or taught without the knowledge of all other sciences."[119] Morley also cites Boethius (fifth-century Roman philosopher and mathematician whose five-volume *De Musica* informed music scholarship into the seventeenth century), who "did notwithstanding write more of musick than of al the other mathematical sciences" and "if it had not beene for him the knowledge of musicke had not yet come into our Westerne part of the world."[120] Morley cites these ancient sources to lend credibility to his own writing; but, despite his stridency about other musicians, he does not break any new ground about the philosophy of music,

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[117] Thomas Morley, *A plain and easie introduction to practicall musicke set downe in forme of a dialogue….with many profitable rules to that effect* (London: Peter Short, 1597), "To the Curteous Reader," page unnumbered.
[118] Morley, *A plain and easie*, part III, 177.
[119] Morley, *A plain and easie*, part III, 183-184.
[120] Morley, *A plain and easie*, part III, 184.

content to simply cite ancient sources without challenge even while suggesting pragmatic temperament practices.

Everyone seems to have his (virtually never her) own composition and performance rules, and Morley claims to organize the chaos. He anticipates that many will read his book merely to find something for which to attack him by saying he is undercutting other practitioners with his own methods for making music; he proactively counter-attacks. "[T]his booke will be so farre from the hinderance of anie, that by the contrarie, it will cause those whome they alledge to be thereby damnified, to be more able to giue reason for that which they do."[121]—possibly an allusion to temperament practices, although he does not specify that. Anyone who thinks to have all the answers and condemns others is a fool, "imagining that all the guiftes of God should die in themselves, if they shoulde bee taken out of the worlde."[122]

The tension is almost palpable, even from the distance of 400 years; and the intensity of feeling seems a symptom of the challenging of closely held beliefs that underlay developing musical theory. Over the course of the century, the iron grip of these previously unquestioned beliefs about the nature of the cosmos as they impacted the practice of music loosened, not because anyone proclaimed it should be so but because a dogmatic adherence to Pythagorean perfectionism became inconvenient, an intellectual hanger-on. But early in the century, the intensity of feeling expressed in Morley's treatise suggests a deep unease about the changing foundations of authority.

[121] Morley, "To the Courteous Reader," in *A plain and easie*, page unnumbered.
[122] Morley, *A plain and easie*, Part II, 115.

Thomas Ravenscroft, in 1614, took on changes in practice and philosophy more directly. Music is being mightily abused in this "braine-sick Age wherein we liue,…neither Her selfe, nor her Lawes are regarded euen of her Children but most…runne after their owne rebellious Imaginations;" musicians pursue their own "priuate ends"…pretending to "Musicall Genius, and a religious disposition." These "Golden Sheepe, who are better Clad then Taught,…are willing to prostitute themselues to Dance after euery mans Pipe."[123] He equates the discordant state of music with a commonweal which he sees in disarray. "Let Common Practice and her Complices censure me as they please,…I ayme…to vindicate Her from these Salaecismes, and Barbarismes." He sees an ally in Morley, "who did shine in the Firmament of our Art, and did first giue light to our vnderstanding with his Praecepts" and who saw errors in the "Common Practice" but was "loath to break" with it—a pity, since, if he did, others would surely follow because of his influence.[124]

The upstart musicians of the "Common Practice" must be those who are taking on sacred nature, defying Pythagoras's divinely mandated precepts of music. "But I (says Ravenscroft) have search't the very Originall of our Art, and Etimologis…compar'd the Practise with the Theory, Nature with our Art…and I find it…extracted from the Quintessence of Arithmetick in the Rules and Praecepts.." Those of the Common Practice depart from the "Fundamentall Reasons of the

[123] Thomas Ravenscroft*, A briefe discourse of the true (but neglected) use of charact'ring the degrees* (London: Edward Alide, 1614), opening Apologie.
[124] Ravenscroft, *discourse,* Apologie.

Grounds and Rules of our Art."[125] Following the first section of the Apologie, a series of noted musicians of the day vehemently proclaim the rightness of Ravenscroft's stance. Ravenscroft then concludes the Apologie by saying that concord and discord exist in all the arts, not just music; and he views himself as a messenger of peace to the chaotic state of music, to bring it back into concord and harmony with nature.

Both Ravenscroft and Morley, then, are almost pleading for a return to basics, to the ancients' wisdom about a cosmos based on perfect mathematical intervals and harmony, even though they had to use some kind of tempering to perform music. With their traditional stance, they are eschewing Bacon's roughly contemporaneous call to end speculation in music and just investigate it, as any other facet of nature; but there is no evidence that they either one knew or cared about Bacon's experimental advocacy.

The first major theorist to accord with Bacon and to approach music experimentally rather than mystically was William Brouncker, future Royal Society president and translator, in 1653, of Descartes' 1618 *Compendium musicae*.[126] The introduction to the translation also included Brouncker's own idea for dividing the scale with logarithms, the very anti-Pythagorean notion of dividing intervals into equal parts—the first one to propose this kind of manipulation. He wished to contest Descartes' claim that the consonances are based on arithmetic and show that their true

[125] Ravenscroft, *discourse*, Apologie.
[126] Still, Descartes relates in the *Compendium* that when drum skins of a wolf and a sheep are struck simultaneously, the sheepskin will remain silent for fear of the wolf.

relationship is geometric.[127] Interestingly, though, he did not seem at all interested in solving the tuning problem; in fact, his calculations for various ways of dividing intervals do not preserve the octave, the whole point of tempered tuning.[128] Also in the introduction to the translation, Brouncker notes that the "complete musician" must have competence in the entire range of subjects touching on music, including mathematics and magic—and experimental science, especially acoustics:[129] a Renaissance man and beyond!

Coincidentally, in the same year that Brouncker translated Descartes' *Compendium musicae*, Hugh Platt published *The Jewel House of Art and Music and Nature*. It was an essay in the new philosophy on a mission to subdue, tame, and correct nature, wildness, and exotica,[130] a popular and pragmatic sourcebook of human artifice to enhance nature. It was a distinct departure from Morley and Ravenscroft and heralded increasing intellectual space for the practical over the mystical. That space opened up even more at the end of the century as philosophers focused on mathematical solutions to temperament tuning and investigated consonances in the context of vibration science.

Even in the last quarter of the century, though, Thomas Salmon tenaciously clung to the notion that the true consonances are those perfect ones given by Pythagoras. He unrelentingly campaigned for musicians' using just (untempered) intonation to duplicate the ethical effects of music that the ancients experienced. His

[127] Gouk, *Music, Science*, 142.
[128] Walker, *Studies*, 117.
[129] Gozza, *Number to Sound*, 20-21.
[130] Austern, "'Tis Nature's Voice," in Clark and Rehding, *Music Theory*, 40.

Essay to the Advancement of Musick (1672) first argued his point passionately. In 1688 he published *A Proposal to Perform Musick, in Perfect and Mathematical Proportions,* in which he famously proposed complex mechanical appendages to instruments to compensate for the tuning discrepancy while maintaining just intonation; the system required interchangeable fingerboards and different frets for each string and was wildly impractical. He even gave up trying to explain the details and said that a mechanic would just have to figure it all out.[131]

In Chapter 1 of *A Proposal*, Salmon surveys the history of music. In ancient times, music had great power and flourished, then died during the "Darkness" of the medieval centuries. The present time is witness to a new glorious age of music with the potential of surpassing the ancients because of the advent of polyphony and many kinds of instruments. All are "beholding to the Excellent Genius of our Modern Musicians." Because of these advances, one might conclude, says Salmon, that nothing can be improved upon the present practice of music.[132]

But wait; there is something. The ancients made music with the "Accurate Observation of Proportions, which the Soul is from Heaven inform'd to Judge of, and the Body in Union with it, must Submit to." All the world agrees that the more exact the proportions, the more excellent the music; a singer or instrument out of tune will ruin the best composition. So it is a great error of the present day that the beauty of our music is "rendred Ineffectual, by tolerating so many unproportionate

[131] Walker, *Studies*, 115.
[132] Salmon, *A Proposal To Perform Musick, In Perfect and Mathematical Proportions* (London: John Lawrence, 1688), Chapter 1, 2.

imperfections."[133] Since the octave must be stable, some kind of tempering is in order. Salmon goes on to technically detail the tuning problem on a "Viol," but then insists that the "Perfection" of ancient intervals must be used in the present day also.[134]

In Chapter 3, Salmon launches into the explanation of his solution for the tuning problem. "I have Calculated my Tables" to find the exact tuning discrepancy, and a "Mechanical Workman" then can fashion a "Finger-board" that the player simply adjusts for each key; but of course, each fret must be tuned separately. But he has tested it and found it to be very convenient! Salmon does not presume to tell the fashioner of the fingerboards how to do his job, as that artisan's expertise will suffice to find the best mechanical solution, possibly even better than the one Salmon himself has envisioned.[135]

Salmon admits that in a few instances, his system cannot correct the out-of-tuneness. "But this does not proceed from the defect of this Proposal, Nature it self will have it so." Then he seems to mitigate that statement a bit. "Scholars are not to alter Nature, but to discover her Constitutions, and to give opportunity for the best management of all her Intrigues." Still, he seems somewhat irked at nature for the imperfections in the supposedly perfect Pythagorean intervals but concludes by re-iterating that the proof is in the playing; his system indeed works.[136] Salmon straddles two epistemes: the ancients as the only true basis for music-making and the

[133] Salmon, *Proposal*, Chapter 1, 3-4.
[134] Salmon, *Proposal,* Chapter 2, 13.
[135] Salmon, *Proposal*, Chapter 3, 17-18.
[136] Salmon*, Proposal*, Chapter 3, 23-28.

recognition of ancient imperfection with a modern method to correct it. Like his contemporary Isaac Newton, Salmon identified with neo-Platonism; and Newton owned a copy of Salmon's *A Proposal To Perform Musick, In Perfect and Mathematical Proportions.*

Another major treatise writer at the end of the century, William Holder, manages to cite the ancients, offer pragmatic solutions for tuning, and add a religious devotional.[137] He describes "Sound in General" in Chapter 1 and "Of Sound Harmonick" in Chapter 2, where he defines intervals in slavish detail, using both the monochord[138] and pendulums to illustrate. In Chapter 3, "Of Consonance and Dissonance," consonances are determined by ratios of vibration pleasing to the ear, an aesthetic and natural rather than Pythagorean definition. In explaining the way vibrations work, Holder says that playing two notes that are separated by only a half-tone simultaneously causes "such a Battel in the Air between their disproportioned Motions, sucha Clatter and Thumping, that it will be like the beating of a drum."[139]

Chapter 5, "Of Proportions," explains the complex system of logarithms to divide the scale in equal parts so to keep in tune, always keeping the diapason (octave) constant; the discrepancy between the perfect and tempered intervals, according to Holder, is approximately 1/53 of a diapason, which closely approximates

[137] William Holder, *A Treatise of the Natural Grounds and Principles of Harmony* (London: J. Heptinstall, 1694).
[138] The monochord was used in two ways: to explain perfect Pythagorean intervals and to explain ways of dividing the scale (or other intervals) into equal parts, usually as a solution to the tuning problem.
[139] Holder, *Treatise*, Chapter 3, 34.

the actual irrational number.[140] This logarithmic system for equal-temperament tuning is what Holder calls the "Natural Grounds of Harmony."[141] He notes that Euclid "had a fair Hint…when he measured the Diapason by fix tones and found them to exceed the Interval of Diapason." But the ancients "did not pursue this Way of dividing the Systems."[142] Holder is firm in saying, possibly for intuitive reasons, that only the *approximations* to the irrational numbers that precisely define the tuning discrepancy, not those "Irrational Contrivances[s]" themselves, should be used in creating equal-temperament tuning.[143] In conclusion, he proposes some questions that bear further investigation: why do human voices at the same pitch sound so differently from one another? why do the sounds of the respective instruments differ so from each other? why do some people not love music? (He suggests an answer to this one; there is a "Falseness" in the auditory nerve that distorts the sound.)[144] Holder seems unquestioning about being in that epistemological space between neo-Platonism and experimental philosophy, and includes a heartfelt dedication and thanksgiving to God.

Francis North, in 1677, wrote an extended and innovative essay on acoustics, dedicated to "A Friend" (possibly Hooke), noted in records of the Royal Society, and credited with being the beginning of modern music philosophy by at least one music historian.[145] By this time, acoustics and experimental investigation of sound were

[140] Holder, *Treatise*, Chapter 5, 67-84.
[141] Holder, *Treatise*, Chapter 6, 97.
[142] Holder, *Treatise*, Chapter 6, 116.
[143] Holder, *Treatise*, Chapter 9, 142.
[144] Holder, *Treatise*, Chapter 9, 152-153.
[145] Kassler, Jamie C., *The Beginnings of the Modern Philosophy of Music in England: Francis North's 'A Philosophical Essay of Musick' (1677) with comments of Isaac Newton, Roger North and in the* Philosophical Transactions (Hampshire, England and Burlington, Vermont: Ashgate, 2004).

coming to dominate music discussion, with a continuing pre-occupation with the criteria for concordant and discordant sound. Physical explanations were based on the coincidence theory of vibration. North accepted this, but ranks consonances in a different order than Hobbes and Galileo, for example, whose ranking was based on a Pythagorean arithmetical scheme; he ignores proportions in favor of sensory perception of synchronous pulses.[146] North was the first to investigate sound initiation and perception as well as the way the ear works as intermediary between these two processes, a novel empirical approach.[147] He suggests adding quarter tones to some notes as a way to preserve the octave and was the first to choose, from among the twelve Greek modes, the two scales (major and minor) now in use.[148]

Still, an aura of moral judgment in discussions of tonality and concord lingers in North's essay: concordant sound is good, discordant sound is bad—a vestige of music's central place in the moral framework of the cosmos. Only pleasing harmony is acceptable as a desired musical sound; discord is allowable only on the way to a pleasing concord, when the ear is assured that it will be speedily resolved.[149] Music may also help the listener gain "ethical insights" because of its unique capability to express human affect.[150]

[146] Kassler, *Modern Philosophy*, 52.
[147] Kassler, *Modern Philosophy*, 77.
[148] Kassler, *Modern Philosophy*, 79-81.
[149] Kassler, *Modern Philosophy*, 83.
[150] Kassler, *Modern Philosophy*, 87.

CHAPTER 5. THE NEW PHILOSOPHY: MUSIC AS SOURCE OF ORDER

The waning of neo-Platonism, as well as Aristotelian natural philosophy, was in no way an indication of an increasing freedom from fear of disorder. Order anxiety was pervasive across classes and order widely perceived as fragile, a mere veneer sublimating anarchy.[151] From the first decades after 1500, all of Europe experienced a crisis of authority across all institutions and areas of human endeavor, including the arts, brought on by the Reformation and a range of other social and political changes.[152] Thomas Hobbes' conviction that only the state prevented the war of each against each and that the problem of knowledge was the problem of order, led him to reject the experimental philosophy. Knowledge must not be tentative or contingent: absolute knowledge equaled social order. So for Hobbes, science must be *premised* on secure first causes, not in the business of investigating or debating them; and the failure of the new philosophy to proceed on a foundation of certain knowledge was no less than an invitation to civil war.[153]

Hobbes notwithstanding, the Civil War itself was not about abandoning order but rather overthrowing monarchial anarchy; and afterwards, society seemed collectively appalled at what had been wrought—regicide!—and willing to become acquiescing moderates at the Restoration. As old certainties about cosmological order and authority became increasingly tenuous in the wake of the century's religious and

[151] Kevin Sharpe and Peter Lake, eds., *Culture and Politics in Early Stuart England* (Palo Alto: Stanford University Press, 1993), 11.
[152] H. Floris Cohen, *The Scientific Revolution: A Historiographical Inquiry* (Chicago: University of Chicago Press, 1994), 210.
[153] Cohen, *Scientific Revolution*, 213-214.

political upheaval, an epistemological vacuum opened up; and the new philosophy, all about ruling and taming nature, filled that vacuum as a "hedge against disorder."[154] The order offered by the New Science was correcting, subduing, and classifying nature with human artifice.

It was the right role at a critical time for the new philosophy. The century's chaos "interfere[d] drastically with the sense of mastery that knowledge confers."[155] The sense of order was fundamentally shaken. This provided one impetus to put order into nature by "rationaliz[ing] strangeness and correct[ing] error."[156] Early in the century, Bacon had insisted that all errors in beliefs about nature should be banished. Thomas Browne answered the call to eliminate what he called "vulgar errors" in his *Pseudodoxia Epidemica*, in five re-issues, no less. Its organization is a metaphor for a newly ordered world he was trying to help create.[157] It was a profound shift to this new source of order, one inevitably marked by ambivalence and befuddlement. Even as Browne repeatedly heaps scorn on both fundamentalist religious ideology and magical thinking, he unselfconsciously subscribes to the class prejudices of the time in condemning the lower classes for being unenlightened in the new philosophy; and his false dichotomy of the enlightened upper-class scientist versus the lower-class ignoramus fails to appreciate the fact of elites practicing alchemy, oblivious to its contradiction with the new philosophy, and laborers and artisans well-versed in

[154] Austern, "'Tis Nature's Voice," in Clark and Rehding, *Music Theory*, 40.
[155] Campbell, *Wonder,* 4.
[156] Campbell*, Wonder*, 6.
[157] Campbell, *Wonder,* 86.

understanding and absorbing the new ways of thinking about nature.[158] Browne is just one who is reacting to loss of the old order by embracing the offer of a new one—dogmatically, in his case.

Rising from the ashes of the Civil War at a time, not coincidentally, when England seemed anxious to leave all that disorder far behind, the conservative elites of the Royal Society appropriated the role of director of the new structure of order. At a time of unrest, sources of meaning and authority were eagerly grasped.[159] Science was promoted by the elites as a means of social control since it is everywhere the same, not volatile and complex like politics. One argument for the new philosophy was its "social utility" in maintaining order, a position articulated in Thomas Sprat's 1667 *History of the Royal Society*.[160] This is not an argument for social reform but rather for benefiting elites in promoting the political and social status quo and stability—science for elites, not the wider population. Where Bacon had forcefully articulated science for social utility—for the material benefit of all—the elites repurposed the scientific endeavor, taking ownership of it as a force for social order and control.[161] Identifying the New Science *with* social order, rather than subversive of it, propelled its acceptance; and for this reason, the break in order represented by the Civil War was the single most important event for the integration of the New Science.[162] Moderate reformers morphed into social conservatives, the foundation for

[158] Campbell, *Wonder*, 97.
[159] Jardine, *Ingenious Pursuits,* 39.
[160] Margaret Jacob, *The Cultural Meaning of the Scientific Revolution* (New York: Alfred A. Knopf, 1988), 29-30.
[161] Jacob, *Cultural Meaning*, 38.
[162] Jacob, *Cultural Meaning*, 73.

the Royal Society.[163] Although the Society's strength waned toward the end of the century, the science it had promoted became the foundation of a new epistemology.

The Society's method was to study nature through observation and experimentation; it was vehemently non-partisan, scorning and eschewing anything not purely "philosophical":[164] an ideal value-free space for scholarly pursuits. "A true history of nature, by purifying author's accounts of …partisan zeal"[165] was the goal, toward which results of observation and experiment could be marshaled. Philosophers wishing to join the Royal Society should be "laying aside all idle shadowy notions, [that] they may make a thorough examination of NATURE."[166]

The ideal, if totally unrealistic, principle of an ordered, value-free neutrality in the new philosophy was a powerful draw after the disastrous rivalries of the Civil War. In service of that end, several New Science philosophers wanted a language transparent to all, a new lingua franca of normative scientific discourse, stripped of all the richness, redundancy, and overtones of quotidian speech, signifying only and precisely the signified and reflecting a demystified nature.[167] Wilkins developed the Wilkins Universal Language, used by Hooke to announce his balance spring watch mechanism.[168] The universal language projects were dropped because of the impossible complexities involved.[169] Attempts to create a language somehow devoid

[163] Jacob, *Cultural Meaning*, 77-78.
[164] Dear, *Revolutionizing the Sciences,* 118.
[165] Henry Oldenburg (first secretary of Royal Society) in *The Correspondence of Henry Oldenburg*, eds. A. R. Hall and M. B. Hall (Madison and London: University of Wisconsin Press, 1966), letter 2445.
[166] Oldenburg, *Correspondence*, Letter 2372.
[167] Geneva, *Astrology*, 273.
[168] Jardine, *Ingenious Pursuits*, 317.
[169] Geneva, *Astrology,* 280-81.

of human content inevitably foundered on the same inherent impossibility as that of value-free science; but the belief of its possibility is evidence of the striving for defined order and authority in the wake of political rupture and philosophical dislocation.

Acknowledging Diversity with Loss of Celestial Harmony

As basic and long-held political, religious, and philosophical assumptions became fodder for re-examination, a necessary corollary was the necessity of acknowledging diversity. Although this sea change had been going on since before the dawn of the seventeenth century, the Civil War forced recognition of a new state of affairs. England, at Restoration, did not return to pre-war reality; the model of harmony and organic order could no longer be sustained. The religious and political conflict had come into glaring focus and could not be managed with a hegemonic ideal of unity and homogeneity.[170] Tolerance for differing views, accommodation of diversity was the radically new challenge of the seventeenth century as it emerged into modernity.

The first manifestation of the breakdown of unity, the Protestant Reformation, meant that sources of communal order shifted from public ritual and consensus to individual godliness; protestant spirituality was experienced individually rather than communally, symptomatic of the dismantling of the narrative of unity as a useful way to describe society. The fragmentation of religious belief presaged and hastened

[170] Keith Thomas, "Women and the Civil War Sects," in *Crisis in Europe 1560-1660*, ed. Trevor Aston, (New York: Basic Books, Inc., 1963), 335.

accommodation of political and philosophical fragmentation. In this way, the Protestant Reformation acted as a "midwife for the future,"[171] a future defined by secularism of the modern state in Western society.

The abandonment of unity was centered in the tumult within natural philosophy. Much more than merely the seventeenth-century term for science, natural philosophy was a more comprehensive belief system about cosmological structure and meaning, the character of matter and of cause, and the proper basis for natural knowledge—not conformable to any single modern discipline. Competing claims of Aristotelian-based Scholasticism, neo-Platonism, and the new mechanical philosophy characterize the entire seventeenth century; and interpreting the changes as a simple case of natural philosophy sinking into oblivion as science brilliantly ascends is a profoundly misreading of the cultural significance of all of the voices in the conversation of the seventeenth century.[172] The competing sources of authority, the fragmentation itself, are the story of budding modernity.

In music, the waning of the ideal of unity meant the abandonment of the absolute: intervals are not quite perfect and consonance is not an absolute quality, but one of degree. Rather than based on perfect Pythagorean intervals, consonance came to be recognized as the coincidences of the termination of frequency cycles between two strings. Frequency ratios are not placed into discrete categories of consonance or

[171] Patrick Collinson, *The Birthpangs of Protestant England: Religious and Cultural Change in the Sixteenth and Seventeenth Centuries,* (New York: St. Martin's Press, 1988), 59.
[172] Anstey and Schuster, *Science of Nature,* 1-2.

non-consonance, but rather are on a continuum of consonance.[173] So the idea of concord changed from mystical numbers as the foundation to coincidence of sound vibration. The most concordant simultaneous tones are ones that coincide most regularly and frequently; infrequent or random tones are discordant. Numbers are no longer the cause, but merely the representation of sound. Concord and discord are not contradictory qualities but part of a continuum.[174] This abandonment of the absolute quality of consonance is both manifestation of and metaphor for the changes wrought in seventeenth-century natural philosophy.

Continuing Religiosity With Philosophical Changes

The single characteristic shared among virtually all writers, philosophers, and theorists alike is a profound religiosity. From the religious foundation of Bacon's agenda for the new philosophy to better the lot of humankind to Newton's preoccupation with ancient religious revelation, this century was marked by the primacy of religion. Even as the seeds of fragmentation, diversity, and thus secularism were sown by the Protestant Reformation, individual writers consistently and clearly articulated their religious commitments. This remains true even as ideas of nature and the cosmos, of order and authority, were being renegotiated, as seen in the musical treatises.

[173] Claude V. Palisca, "Scientific Empiricism in Musical Thought," in *Seventeenth-Century Science and the Arts,* ed. Hedley Howell Rhys (Princeton, NJ: Princeton University Press, 1961), 109.
[174] Kassler, *Inner Music,* 53.

Still, this renegotiation in areas touching on religion created a cloud of suspicion of atheism over the new philosophy. The College of Physicians, feeling their status quo threatened by the new philosophy, hired an agitator to attack scientists of the Royal Society as being anti-religious and so undermining the social order and the common understanding of God. Accusations of irreligiosity, albeit by a paid rabble-rouser, could be taken seriously. The crux of the attack was that the mechanical God of the new philosophers is not omnipotent and so can no longer work miracles.[175]

Suspicion about the new philosophy was not limited to the uninformed. After the Restoration, when the conservative elite dominated and busily institutionalized the new science, Leibniz scorned the new philosophers' seemingly contradictory claims for a clockmaker God Who created the cosmos and stepped away to let it run according to physical laws on one hand, while yet being interested in the minutiae of human existence on the other.[176] Some historians since have also read the new philosophers' religious protestations as somehow disingenuous, cynically crafted to appease a doubting public.[177] This reading, though, belies a historicist understanding of this very religious century; and part of the answer for the conundrum of continuing, sincere religious belief among the new philosophers rests on two notions of God uneasily co-existing through Church history and brought into relief in this century of upheaval.

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[175] Francis Oakley, *Omnipotence, Covenant, and Order* (Ithaca: Cornell University Press, 1984).
[176] His scorn was particularly directed at Newton and became intertwined with their bitter rivalry over which of the two was the first inventor of the calculus.
[177] Oakley, *Omnipotence*, 73.

The two notions of God refer to the dual powers of God, absolute and ordinary, vying for primacy through the Middle Ages, Renaissance, and into the seventeenth century. God's absolute powers are philosophically aligned with Platonism, which inhered in early Christian theology, and are associated with the Great Chain of Being; God is not constrained by anything and is able and free to even suspend physical laws, as in the working of miracles. By contrast, God's ordinary powers are philosophically aligned with Aristotle and became the dominant notion of God with the influx of his (Aristotle's, not God's) writings in the twelfth century. God's ordinary powers are those of the God Who created a lawful cosmos and adheres to those laws; as such, He is knowable and transparent to rational investigation.[178] Scholasticism, which enshrined this latter notion of God, dominated Church teaching well into the seventeenth century, notwithstanding an attack by fourteenth-century nominalists who maintained that God is inscrutable and not amenable to rationalist analysis—philosophical adumbration of the seventeenth-century scientific revolution.[179]

The elite, post-Restoration new philosophers of the seventeenth century, then, tapped into both notions of God, the dual powers of God, in claiming both a Creator God of a lawful cosmos as well as a personal, unconstrained God Who *could* transcend these laws if he wished (which He has promised by covenant not to do). This was their stance against charges of atheism, a more embracing, not limiting,

[178] The famous condemnation of Aristotle by the Bishop of Paris in 1277 was an attack on the Aristotelian idea that God could in any way be constrained, including by divinely created physical laws. The Bishop lost that battle.
[179] Oakley, *Omnipotence*, 81.

notion of God. Understanding these religious subtleties undermines the theologically uninformed interpretation of seventeenth-century protestations of religiosity as either naïvete or deliberate obfuscation. One cannot know the minds of individuals, of course; but certainly the prevailing sentiment of the century was one of sincere religiosity.[180]

The religiosity permeated all of society and was not limited to some narrow philosophical—religious agenda of the elites. Musical treatise writers credited religious motivation and inspiration for their efforts or simply alluded to God in incidental ways throughout their treatises. In his 1588 treatise on vocal and instrumental music, John Case declares that music has "God for a father and nature for a mother."[181] The character of these allusions subtly shifted, not surprisingly, through the century. Early on, references to the Divine actually embraced God, the cosmos, and heavenly harmony. Late in the century, religion became disengaged from natural philosophy as the new, morally neutral experimental science moved into philosophy's intellectual space; and Godly references are deliberate rather than incidental, forceful re-articulations of that which seems threatened because no longer philosophically necessary.

Religion, though still vitally important to individuals, necessarily engaged differently with an emerging philosophy that was not dependent on moral meaning in

[180] Earlier in the century, before the conservative, moderate elites dominated the New Science and institutionalized it with the establishment of the Royal Society, radical Protestant reformers and new scientists had formed a pragmatic alliance, united primarily in their opposition to the Roman Church, though for different reasons. Puritan theological rigidity caused the breakdown of this tenuous alliance well before the Restoration.

[181] John Case, quoted in Austern, "'Tis Nature's Voice," in Clark and Rheding, *Music Theory*, 30.

the universe; and this is apparent in music treatises. In his 1694 musical treatise scientifically analyzing the division of the scale, William Holder still proclaims the divine in music. Following a detailed discussion of intervals and tuning, Holden goes on to state that God's wisdom and goodness order the "Nature of Harmony" and are more than we can hope to fully understand, although the search for answers must go on. Music is an essential part of worship and should be used "for our great Creator's Praise, as He is the Founder and Donor of it."[182] Toward the end of the century, St. Cecelia morphed into the patron saint of music, not her original role, as she became identified with nature's female embodiment of music (Musica).[183] As nature lost its cosmological significance, it became increasingly identified with religion. This natural theology was in ascendance, compatible with the new experimental philosophy.

Thomas Mace and Nicholas Brady both wrote, during the last quarter of the seventeenth century, about the importance of music in praising God. Each treatise has an anxiously persuasive tone, as if needing to justify its stance. Mace, a cleric at Cambridge University, created a widely used and respected instructional manual for singing correctly and in tune in church, so as to glorify God. Interestingly, he dedicates it especially to the "Discenting Ministry,"[184] **who** might not be initially friendly to the idea of music in church; Mace is on a mission to convince them

[182] Holder,*Treatise,* 54-55.
[183] Austern, "'Tis Nature's Voice," in Clark and Rheding, *Music Theory*, 59.
[184] Thomas Mace, *Musick's Monument, or A Rembrancer of the best practical musick, both divine and civil, that has ever been known to have been in the world* (London: T. Ratcliffe and N. Thompson, 1676), frontispiece.

otherwise. The first part instructs congregations of parochial churches how to sing psalms well, or do not bother to sing them at all, and suggests how cathedral music may be "much improved."[185]

In rhyming verse, Mace insists that clerics must lead by example, learning music well to set a high musical standard as a model for their congregations. "Example is The Thing:/ Ther's but One Way, which is, Your Selves to Sing." It is better to not sing at all than to sing badly. "Admonishing your selves, (in Sweet Acchord)/ In Singing Psalms, with Grace unto the Lord./ Sed sine Arte, That cannot be done,/ Et sine Arte, Better let alone."[186] Ancient King David, psalm singer and harp player, is the shining example of musical leadership, out in the world rather than cloistered with books, able even to fashion his own musical instruments. "How can He [cleric] be a Judge of Good, or Ill,/ When (in That Thing) Defective's He of Skill?"

Mace acknowledges he is speaking boldly, but knows that advocating for music in church is "True Doctrine." Departing from rhyme now, Mace says he may be taking a position "against the General Swing of the Times," but cares not about offending those who reject his advocacy of excellent church music, the "Sleight and Trivial," people.[187] Music is divinely mysterious, as will be obvious to anyone who earnestly studies it, capable of stirring great religious ecstasy. Mace goes on to vilify, with much name-calling, those who criticize his argument from a stance of ignorance

[185] Mace, *Musick's*, frontispiece.
[186] Mace, *Musick's*, first part, page unnumbered.
[187] Mace, *Musick's*, first part, page unnumbered.

of music. “Let Things Alone, you do not Vnderstand.” He considers it a pity that so few understand the “wonderful-powerful-efficacious Virtues” music “has upon the Souls and Spirits of Men Divinely-bent.”[188]

Music sung in tune is a “simile of God,” while “Jarring Discords are…a simile of the Devil.” Music is to raise souls to God, enhancing the worship experience. Mace feels impelled to provide instruction in good singing to parochial churches to counteract the shocking state of musicianship among non-cathedral congregations.[189] Very interestingly, he claims that singing in tune unaccompanied is a virtual impossibility, even for a singer with a discerning ear; instrumental accompaniment is required to keep both a solo singer and an entire congregation in tune. So nature’s gift of music must be enhanced by human artifice; and the organ is the best choice. Even an indifferent singer would be hard-pressed to sing out of tune with an organ guiding the musical way.[190] And Mace offers proof, real proof, of the efficacy of tuneful singing, a “thing most eminently remarkable.” During a 1644 siege by three armies at York Cathedral, which was filled with people, the cannon shot was unable to penetrate the walls and all inside were kept safe because of the congregation’s angelic, tuneful psalm-singing.[191]

In his discussion of cathedral music, following the parochial music section, Mace attacks more directly the dissenters who eschew music in church. He says that England has attained the highest level of art in church music composition; and to

[188] Mace, *Musick’s,* first part, page unnumbered.
[189] Mace*, Musick’s*, Chap. II, page unnumbered.
[190] Mace, *Musick’s*, Chap. V, 9.
[191] Mace, *Musick’s*, Chap. V, 19-20.

refuse to use this divine resource for worship is to profane it. He then offers a prayer that God will bring into "Concord and Perfect Unity All Dissenting, Jarring, and Discording Christians, so that they may have a Right Discerning of the True Worship and Service of Him." Only then, in imitation of heavenly choirs, will worship be acceptable to God.[192] But Mace has only begun his diatribe against music-eschewing dissenters. Beginning with "Kind Ignoramus," he proceeds with a most vicious-sounding castigation of those who would deny in worship that which "Angels Love, and Devils Abhor…which clearly differ[entiate]s Heav'n from Hell."[193] Apparently, the bitterness of the banning of church music during the interregnum is little abated at this point. The dissension and disunity for which there is not yet a political language are yet capable of being expressed in art.

The bulk of the treatise, nearly 250 pages, instructs singers and instrumentalists in the fine art of making tuneful music for the purpose of right worship. Mace concludes with a general discussion about concord and discord that almost reads as if written in the first part of the century because it emphasizes the mystical character of music, something far more than the sum of the musical parts. He reverts to the old standby of the stretched string to begin an explanation of intervals, but, curiously, confines himself to explanation of the octave, repeatedly created by halving a string's sounding length any number of times. (Perhaps Mace thought that any complicated discussion of the tuning problem would distract from his core message.) Music is characterized by "Contra-Qualities"—love and hate, light and

[192] Mace, *Musick's*, Ch. V, 29.
[193] Mace, *Musick's*, "An EPISTLE To all Ignorant Despisers OF THIS Divine Part of MUSICK," 30.

dark, good and evil—"Perceived by the Conchords, and Dischords: Agreements, and Disagreements, betwixt the 7 Distinct Tones."[194] Music carries moral weight. But Mace also demonstrates a more modern approach in moving beyond intervals to focus on chords as well, especially the 1-3-5 chord, particularly harmonic because reflecting the Holy Trinity. The concordance of three voices singing the tones simultaneously is much more pleasing than hearing them sounded separately, the reason for which is "an occult mystery."[195]

Mace concludes by re-iterating than anyone who tries out his system of learning to make good music will, in the process, discover music's mystical and divine wonders and "shall never after Degenerate into That Gross Sub-Beastical Sin of Atheism."[196] He cannot resist a short adjunct section about the mystical power of music, "there being Nothing of Art, and Science, under Heaven, more Properly Significantly, and Powerfully fit for Divine, and Contemplative Good Christians, than It."[197] Because of its spiritual and emotional power, music should not be used to "stir up, and Excite Lightness, Vainness, Jocundity, and Folly," but used only to serve God. It is "That Eternal, and Coelestial Language."[198] Music retains mystical power; but it is located squarely within the divine religious experience, with no connection to neo-Platonic mysticism or Pythagorean perfect intervals. Even in his discussion of the stretched string to explain the wonder of the octave, Mace avoids any mention of

[194] Mace, *Musick's,* 265.
[195] Mace, *Musick's,* 267.
[196] Mace, *Musick's*, 268.
[197] Mace, *Musick's*, 270.
[198] Mace, *Musick's*, 272.

these ancient sources, focusing exclusively on the religious foundation of music's spiritual power.

Even later in the century, Nicholas Brady—cleric and librettist for Henry Purcell—preached a notable sermon evoking some of Mace's themes.[199] Brady begins by cataloging events in the Bible celebrated by heavenly music, seeming to belabor the point as he cites Bible verses focusing on the centrality of music on numerous spiritually notable occasions.[200] He concludes from this that music, both vocal and instrumental, is used and approved of by God. "[T]he proper Office of Musick in the Service of God, is to praise him, and…we may observe in the last place, how Signal an evidence God has been pleased to give of his avow'd allowance and approbation" of music.[201]

Religion, according to Brady, is the "most entertaining thing in Nature…encouraging the truest chearfulness, and not…condemning any Innocent Delights." Those who would have religion consist of only "Moroseness and Austerity" by banning music from worship have done religion a great disservice; and it would be unnecessary to make that obvious point if it were not for "a party of Men" who unaccountably find music in church "extremely culpable."[202] God Himself enjoins man to make music; and the fact that the "Heavenly Art" is corrupted by some is no reason to eschew it altogether. If that argument for its banning from

[199] Nicholas Brady, *Church-musick vindicated: a sermon preach'd at St. Bride's church, on Monday, November 22, 1697, being St. Caecilia's day, the anniversary feast of the Lovers of music* (London: Printed for Joseph Wilde, 1697).
[200] Brady, *Church-musick*, 2-5.
[201] Brady, *Church-musick*, 5-6.
[202] Brady, *Church-musick*. 8.

religious use were reasonable, it would follow that poetry should also be banned from religious use because of the debauchery of some verses. Music naturally directs us to "Mansions of Joy" having in it "something of Divinity…which acts upon the Soul with such a sweet Violence."[203] Alluding to recent political discord, a shattering of the peace now mended, Brady offers a prayer that all the "several parties in the kingdom, however formerly divided by interest or design, would…resemble the Trumpeters and Singers in the Text [Bible]…and [be] as one…in Praising and Thanking the Lord!"[204] Brady concludes by saying he is sorry for those "whose unhappy Aversion to Divine Harmony, renders them unlike to the Saints and Blessed Spirits" who join with God in making heavenly music.[205]

Like Mace, Brady makes mention of neither Plato nor Pythagoras in his urgent advocacy of instrumental and vocal music in church. He speaks lovingly and passionately about the mystical and divine properties of music, capable of moving men to heights of joy and wonder, eliciting from them the best that God has put into humanity. None of this has to do with ancient wisdom, though; it is all about the Christian religious experience. The divinity of music is not to be found in number mysticism but in its power to connect humans to the divine presence through this divinely ordained art.

[203] Brady, *Church-musick*, 10-12.
[204] Brady, *Church-musick*, 17.
[205] Brady, *Church-musick*, 23.

CHAPTER 6. CONCLUSION

Music writing offers a window to illuminate the changes wrought over the course of the tumultuous seventeenth century concerning sources of order and authority. The fragmentation across political and religious institutions was mirrored in profound changes in natural philosophy. As the narrative of the harmony of the spheres lost intellectual space to New Science, treatises and other music writing became sites for contested ideas about shifting intellectual spaces.

Religion seems to be a constant; writers throughout the century express deep and sincere religious sentiments which are not apparently diminished by the new natural philosophy or the fragmentation in religion itself. The constancy is an illusion, though. Even if individual sentiment did not wane, the way in which religion engaged with philosophy changed fundamentally. When the harmony of the spheres was dominant, a unified vision of the cosmos with a place for everything (and everyone) and everything in its place, religion was part of that unified scheme; it shared cosmological space with natural philosophy. But as ideas of nature drastically changed and the new experimental philosophy came into ascendance, there was no longer any intellectual space for religion. Religion became extraneous: a personal choice rather than a philosophical necessity. The urgent-sounding re-articulation of the importance of church music after the Restoration attests to a growing, if still unconscious, nervousness about the cultural role for religion when it no longer mattered to the new philosophy.

When the cosmos was tuned to the music of the spheres, order inhered throughout the universe, a given of human existence. But when the cosmic music was silenced, order was no longer to be found in the cosmos. Humankind was now unencumbered, free from cosmic control and the certainly that accompanied it. Order must now be imposed by a newly autonomous humankind. Music treatises illuminate that highly contested process, fraught as it was with such great cosmological significance, revealing a deep level of discomfort as previously unquestioned certainties are now fodder for debate. The level of vitriol is astounding as debates were fought bitterly over issues ranging from the inconsequential—whether or not to label notes with syllable names—to the central problem of the Platonic foundation of intervals. The bitterness and deep animosity among treatise writers seems to encode the fear of the new reality of a desacralized cosmos.

The tuning problem, that the Platonic intervals were not perfect at all for performing polyphonic and instrumental music—along with the corollary issues of the nature of consonance and the proper division of the scale—was the most critical issue for the music world in the seventeenth century and was met by a variety of responses that shed light on the way epistemological change occurred over the course of the seventeenth century.

The tuning problem could not reasonably be ignored; musical performance demanded some kind of resolution. For some, it was the elephant in the room. They worked around it—limiting the music they played or the range of music, limiting the keys they used to perform music, making on-the-spot adjustments to instruments or

individual tuning of instruments for specific pieces—but not confronting, metaphysically or technologically, the core issue of the imperfection of the Platonic intervals.

Of the other perhaps more philosophically-inclined thinkers and writers on music, some may have been excited about the new experimental philosophy and not sorry to give up cosmological certainty for the prize of new knowledge of nature and a tuning "cure" for the inconveniently inadequate Platonic intervals. Bacon, though not offering comment about tuning specifically, forcefully eschewed musical mysticism. Hooke seemed unabashed by the metaphysical consequences of tempered tuning, eagerly joining in the search for the most useful solution. Newton's entire sense of reality was founded on Platonic mysticism, but he also joined in the musical discussion of new kinds of tuning, commenting on Francis North's essay on acoustics, consonance, and the scale.

Most of the both philosophically- and musically-inclined were more mixed in their confrontations with the tuning issue. They developed or subscribed to new tuning paradigms while convincing themselves that, somehow, Platonic certainty still inhered in the cosmos. This was Thomas Salmon, who invented ludicrously unwieldy mechanical contraptions to fit on instruments so that musicians could still use just intonation. Others saw various methods of dividing the scale into equal pieces to develop a system of tempered tuning not as abandoning but rather redefining cosmic harmony. The range of responses is witness to the shifting and re-alignment of intellectual space in the seventeenth century.

Because of this metaphysical and intellectual jostling, neo-Platonism and the harmony of the spheres, cosmological certainty and a unified narrative of religious, political, and cultural reality all were eventually squeezed out of meaningful existence. But it was not because anyone made it so; and it was not deliberate, systematic, or linear. Certainly there was never a conference called to discuss the tuning problem and come up with a workable solution or fashion a compromise. Even the kind of profound epistemological change such as occurred in the seventeenth century is piecemeal, unconscious, at times retrograde. There is no zero-sum game of experimental philosophy or tempered tuning advancing and taking over the old cosmological thinking. Music lost cosmological significance, not through willful advocacy, but because it ceased to be an important way to view the cosmos.

No one in the seventeenth century, even the brightest and most prescient, could have surveyed the sweep of the century and announced the epistemological shift. There is no announcer, neither declarer nor decider. The paradox of historical change is that it occurs only through sentient, willful actors; yet what is wrought is unforeseen, little understood, and largely unintended, always prey to some level of historical contingency, and written in the passive voice. People through the century placed a host of meanings on the political, religious, and philosophical upheaval; and change happened, fundamentally and permanently.

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