

# Cardano and Scaliger in Debate on the Revival of Ancient Music

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**I**n the sixteenth century new ideas about the world, humanity, and music went hand in hand, strongly affecting each other and shaping the practices of musical composition and performance.<sup>1</sup> Notwithstanding the fact that almost no ancient music was handed down to scholars of the time, music theorists and musicians used the methods of humanist philology to reconstruct ancient music theories and practices, which changed contemporary conceptions of music, sometimes drastically.<sup>2</sup> They also drew on classical theories of the power of music to explain how music in their own time affected, or should affect, the listener. Through the work of medieval and early Renaissance music theorists a large body of ancient Greek musical thought was made available to music scholars and musicians in the sixteenth century. But because certain aspects of Greek music practice and theory remained difficult to understand, these music scholars attempted to clarify the matter by distinguishing fact from fiction.

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<sup>1</sup> For an introduction to the subject, see Ann E. Moyer, *Musica Scientia: Musical Scholarship in the Italian Renaissance* (Ithaca, NY: Cornell University Press, 1992); and Claude V. Palisca, *Music and Ideas in the Sixteenth and Seventeenth Centuries* (Urbana: University of Illinois Press, 2006).

<sup>2</sup> Anthony Grafton, "The Humanist and the Commonplace Book: Education in Practice," in *Music Education in the Middle Ages and the Renaissance*, ed. Russell E. Murray, Jr., Susan Forscher Weiss, and Cynthia J. Cyrus (Bloomington: Indiana University Press, 2010), 141–60, at 142.

Controversies and rivalries, however, broke out between Platonists and Aristotelians, rationalists and sensualists, and occultists and scientists on this very point: *how* to distinguish fact from fiction, since both originated from authoritative traditions. One of the hot topics in this debate was musical “subtlety,” that is, acoustic and musical phenomena that were difficult to perceive, or not perceivable at all, such as sympathetic vibration in strings, which was regarded as observable but occurred through seemingly occult means. To satisfy their curiosity about these wonders of nature, sixteenth-century musical scholars tried to come up with new explanations of the hidden causes of these occult or subtle phenomena. But sometimes their attempts consisted of merely relabeling old wine in new bottles.

To get a better grasp of the structure of one of these controversies, in this article I will revisit the famous debate between the Italian polymath Girolamo Cardano (1501–76) and Julius Caesar Scaliger (1484–1558), a French classical scholar of Italian descent. Cardano’s *De subtilitate* (On subtlety, 1550–54),<sup>3</sup> which included substantial discussions of music theory, prompted Scaliger’s critical reply, the *Exotericarum exercitationum liber quintus decimus de subtilitate ad Hieronymum Cardanum* (The fifteenth book of exoteric exercises on subtlety in reply to Girolamo Cardano, 1557).<sup>4</sup> In addition to being one of the most original and talented physicians, mathematicians, and astrologers of his time, Cardano occupies an

<sup>3</sup> Girolamo Cardano, *De subtilitate*, in Girolamo Cardano, *Opera omnia*, (Lyon: Jean Antoine Huguetan and Marc Antoine Ravaud, 1663), 3:353–672, available online at <http://www.cardano.unimi.it/testi/opera.html>, hereafter cited as *OO*. For a translation of Cardano’s *De subtilitate*, see John M. Forrester, ed., *The De subtilitate of Girolamo Cardano*, 2 vols. (Tempe: Arizona Center for Medieval and Renaissance Studies, 2013). See also the translation of Cardano’s two (different) books entitled *De musica* and excerpts from the *De subtilitate*, in Clement A. Miller, ed., *Writings on Music: Hieronymus Cardanus* (Rome: American Institute of Musicology, 1973). On Cardano, see Giuliano Gliozzi’s entries “Girolamo Cardano,” in *Deutscher biographischer Index*, ed. Willy Gorzny et al. (Munich: Saur, 1986), 19:758–63, and in *Dictionary of Scientific Biography*, ed. Charles C. Gillispie (New York: Charles Scribner’s Sons, 1971), 3:64–67; and Guido Giglioni, “Girolamo [Geronimo] Cardano,” in *Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta (Stanford University, 1997–), first published April 23, 2013, last modified April 3, 2019, <https://plato.stanford.edu/archives/sum2019/entries/cardano/>. On Cardano’s music theory, see Guido Giglioni, “Bolognan Boys Are Beautiful, Tasteful and Mostly Fine Musicians: Cardano on Same-Sex Love and Music,” in *The Sciences of Homosexuality in Early Modern Europe*, ed. Kenneth Borris and George Rousseau (London: Routledge, 2008), 201–20; Moyer, *Musica Scientia*, 158–68; and Ingo Schütze, “Cardano und die Affektenlehre der Musik,” *Bruniana & Campanelliana* 7 (2001): 453–67.

<sup>4</sup> Julius Caesar Scaliger, *Exotericarum exercitationum liber quintus decimus de subtilitate, ad Hieronymum Cardanum* (Paris: Michael Vascosanus, 1557). On Scaliger, see “Julius Caesar Scaliger,” in *Encyclopaedia Britannica*, last updated October 17, 2021, <https://www.britannica.com/biography/Julius-Caesar-Scaliger>. On Scaliger’s *Exotericae exercitationes*, see Kuni Sakamoto, *Julius Caesar Scaliger, Renaissance Reformer of Aristotelianism: A Study of His Exotericae Exercitationes* (Boston: Brill, 2016).

important place in the history of Renaissance music theory and practice. In his musical thought he was inspired above all by the Platonic tradition. Scaliger, a fervent Aristotelian, worked in botany, zoology, grammar, and literary criticism. Even though he had no musical expertise himself, as a polymath he felt confident enough to attack his colleague. But their famous controversy is more than a variation on the Plato-Aristotle controversy. I argue that behind their fierce debate on the interpretation of ancient musical sources there is a remarkable similarity in their scholarly approach.<sup>5</sup> Even though Cardano presents himself in *De subtilitate* as a mathematician, sensualist, and experimentalist and Scaliger in his *Exercitationes* as an Aristotelian, philologist, and sensualist, they use the very same mixture of arguments from authority and from subjective observation and experience to underpin their views about music. Scaliger laid claim to objective scholarly discourse and a methodical exposition in his attack on Cardano, accusing his opponent of confusing fact and fiction. In so doing, however, he seems to be guilty of the very same “bad” scholarly practices for which he faults Cardano.<sup>6</sup> In this regard, their debate testifies to an early stage in the emergence of early modern musical science, in which scholars started to theorize in different ways about acoustical facts and musical experience but had no established research agenda upon which to rely when doing so.

To ground the transdisciplinary conceptual problems encountered by almost all scholars in the Renaissance, I will discuss issues related to the Renaissance revival of ancient music that were perceived as important by Cardano and Scaliger, even if they are less significant in the context of our modern views of the history of musical thought. Gary Tomlinson has emphasized that Renaissance humanism and scholarship

<sup>5</sup> A similar point has been made by Gary Tomlinson, who argues that behind the worldviews of the Platonist Ficino and the Aristotelian Pomponazzi lie comparable occult mentalities; Tomlinson, *Music in Renaissance Magic: Toward a Historiography of Others* (Chicago: University of Chicago Press, 1993), 199. On the debate between Cardano and Scaliger, see Ian Maclean, “The Interpretation of Natural Signs: Cardano’s *De subtilitate* versus Scaliger’s *Exercitationes*,” in *Occult and Scientific Mentalities in the Renaissance*, ed. Brian Vickers (Cambridge: Cambridge University Press, 1984), 231–52; Maclean, “Cardano’s Eclectic Psychology and Its Critique by Julius Caesar Scaliger,” *Vivarium* 46 (2008): 392–417; Luc Deitz, “*Magnus animi tui candor*, or: How Julius Caesar Scaliger Told Geronimo Cardano That He Was a Fool,” in *Die Kunst des Streitens: Inszenierung, Formen und Funktionen öffentlichen Streits in historischer Perspektive*, ed. Marc Laureys and Roswitha Simons (Göttingen: V&R unipress, 2010), 127–44; and Guido Giglioni, “Scaliger versus Cardano versus Scaliger,” in *Forms of Conflict and Rivalries in Renaissance Europe*, ed. David A. Lines, Marc Laureys, and Jill Kraye (Göttingen: V&R unipress, 2015), 109–30. On Cardano’s reception, see Kristian Jensen, “Cardanus and His Readers in the Sixteenth Century,” and Ian Maclean, “Cardano and His Publishers, 1534–1663,” in *Girolamo Cardano: Philosoph, Naturforscher, Arzt*, ed. Eckhard Kessler (Wiesbaden: Harrassowitz, 1994), 265–308 and 309–38, respectively.

<sup>6</sup> The analysis of Cardano’s and Scaliger’s methodology presented here is inspired by Maclean’s analysis of the debate in “The Interpretation of Natural Signs.”

on ancient texts were guiding forces in the emergence of new musical thought.<sup>7</sup> This emergence, however, met with methodological obstacles, which are the focus of this article. First, I will explore Cardano's and Scaliger's views on the role of Pythagorean-Platonic mathematics as the foundation of a tuning system. Moreover, I will investigate why Cardano and Scaliger deemed it important to repeat the well-rehearsed debate over reason and perception in Italian music theory. Then I will analyze their views on the connection between music and the human soul, and the acuity and superiority of the sense of hearing. Lastly, I will examine how both scholars used knowledge of ancient musical instruments in the construction of their musical views. Taken together, the debates on these musical issues illustrate that Cardano and Scaliger, in their ambition to share the subtle wonders of nature with a wider audience, often paraded old ideas as new ones, sometimes because they lacked the conceptual tools to frame the new but often because they were also convinced that the eternal truth of their Platonic or Aristotelian views only needed a new guise.

*The Foundations of a Tuning System: Pythagorean-Platonic Mathematics versus Aristotelian Methodology of Observation*

During the Renaissance, establishing a tuning system was important for both the theory and practice of music. Fully in line with music-theoretical treatises of the period, Cardano began his discussion of the science of music in *De subtilitate* by formulating a system of related sounds.<sup>8</sup> He classified sounds into three categories: consonant, intermediate, and dissonant. This system of sounds related by numerical ratios is grounded in the Pythagorean mathematical tradition, in which numbers precede both logically and ontologically physical phenomena such as sounding bodies.<sup>9</sup> In a discussion of the numerical structure of sensible objects, Cardano defines the basic consonances as follows:

<sup>7</sup> Gary Tomlinson, "Renaissance Humanism and Music," in *European Music 1520–1640*, ed. James Haar (Woodbridge, Suffolk: Boydell Press, 2006), 1–19, at 2–6.

<sup>8</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:572. The translations of Cardano in this article are taken from Miller's *Writings on Music*, Forrester's *De subtilitate of Girolamo Cardano*, and Moyer's *Musica Scientia*, or based on their translations. In the latter case, "translation modified" is added to the reference. All other translations are my own.

<sup>9</sup> Moyer, *Musica Scientia*, 160. For an introduction to sixteenth-century music-theoretical debates on sense and reason in Italy, for example Ramos and Spataro against Gaffurio, Galilei against Zarlino, and Artusi against Monteverdi, see Palisca, *Music and Ideas in the Sixteenth and Seventeenth Centuries*, 29–47; and Michael Fend, "The Changing Functions of *Senso* and *Ragione* in Italian Music Theory of the Late Sixteenth Century," in *The Second Sense: Studies in Hearing and Musical Judgement from Antiquity to the Seventeenth Century*, ed.

First, as I said, they arise in a proportion, for as such they are known and thus are pleasing. So it happens that because an octave consists in the 2:1 ratio it is highly pleasant to the ears; then follow a double octave in 4:1, and octave and a fifth in 3:1, a fifth in 3:2, and a fourth in 4:3. A ditone [major third] becomes equal to 5:4, and a trihemitone [minor third] to 6:5 by removing an eightieth part [a syntonic comma], as I taught in [my] books on arithmetic [*Practica arithmeticae* (1539)]. Sixths also are almost integral ratios, the one 8:5 [minor sixth] and the other 5:3 [major sixth].<sup>10</sup>

First, pleasant consonances are seen by Cardano as analogous to simple ratios. Yet, even though his point of departure is the still dominant Pythagorean tuning system and its concomitant mathematical approach, his definition of the consonances shows an awareness of the flaws and limitations of this system and an emerging interest in the Aristotelian methodology of observation.<sup>11</sup> Pythagorean tuning, or temperament, consisted of three consonant intervals—the octave (2:1), the fifth (3:2), and the fourth (4:3)—filled with whole tones (9:8) and semitones (256:243). Beginning in the twelfth century, a gradual development in musical composition toward harmonious polyphony, making use of the vertical, or harmonic, intervals of thirds (5:4 and 6:5) and sixths (5:3 and 8:5), led to the expansion of accepted consonant intervals.<sup>12</sup> As a result, this development forced changes in the calculation of the entire tuning system as well as in the definition of consonance.

In this passage, Cardano explained how the subtle phenomenon of a syntonic comma, which had already been discussed by Ptolemy in his *Harmonics*, drastically changed the traditional Pythagorean tuning system. A new system of interval proportion that made use of the syntonic comma became known as “just intonation” and was first described by Bartolomeo Ramos de Pareia in his *Musica practica* (1482). Just intonation is inspired by the tense diatonic tetrachord of Ptolemy, in which a fourth (4:3) is divided in two whole tones of different sizes (10:9, 9:8) and a semitone (16:15). The individual intervals in this temperament can be combined to form certain consonant thirds, for example, the major

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Charles Burnett, Michael Fend, and Penelope Gouk (London: Warburg Institute, University of London, 1991), 199–221.

<sup>10</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:572–73; Miller, *Writings on Music*, 211–12 (translation modified). Cardano’s citation of his “books on arithmetic” refers to his *Practica Arithmeticae* (*OO* 4:42). The syntonic comma is expressed by the ratio 81:80.

<sup>11</sup> Temperaments are tunings of the scale in which some or all of the concords are made slightly impure in order that few or none will be left distastefully so. On Pythagorean and quasi-Pythagorean (just intonation) temperaments, see Mark Lindley, “Temperaments,” *Grove Music Online*, accessed September 1, 2020, <https://doi.org/10.1093/gmo/9781561592630.article.27643>.

<sup>12</sup> Fend, “The Changing Functions of *Senso* and *Ragione*,” 202–3.

third at 5:4—created by subtracting the syntonic comma (81:80) from the Pythagorean major third (81:64), a calculation that Cardano discussed in his *Practica arithmeticae*, as cited in the quotation above. Similar calculations yield the minor third at 6:5, the major sixth at 5:3, and the minor sixth at 8:5, while maintaining pure fourths and fifths.<sup>13</sup> Cardano defined these new consonances as an intermediate category between consonances and dissonances.

Taking Ptolemy's update of the Pythagorean tuning system as his point of departure, Cardano loosened the connection between sound and number even more by shifting the cause of musical pleasure away from the proportions in musical consonances (object) and toward how those proportions are perceived by a listener (subject). Already in Greek antiquity the question of whether the science of music should be considered as part of mathematics was answered negatively by Aristoxenus. He believed that the science of music should not be focused on the calculation of intervals expressed by the ratio of two whole numbers, for its object was not mathematical structures but the orderly arrangement of musical sounds, which could not be defined by numbers. Consequently, auditory perception of aspects of sounds that go beyond mathematical definitions became an important topic in his music theory.<sup>14</sup> In sharp contrast with Pythagorean theory, Cardano argued that, ultimately, consonances are constituted in the subjective experience of the listener. Just as "better things are always pleasing after worse ones, the opposite is displeasing. So light pleases after darkness, sweetness after bitterness, oil of roses after dill, and consonances after dissonances."<sup>15</sup>

Cardano's definition of a tuning system is based on a mixture of traditional Pythagorean mathematics supplemented with subjective auditory experience as a convincing and trustworthy authority. But even though the reported musical experience in *De subtilitate* seems to be

<sup>13</sup> Cardano's division of the 9:8 Pythagorean whole tone relates to contemporary practice. Moreover, Cardano was strongly influenced by Ptolemy's *Harmonics* and reproduced his turnings in the different genera in his *De subtilitate* bk.16, *OO* 3:603; Miller, *Writings on Music*, 23.

<sup>14</sup> Andrew Barker, *The Science of Harmonics in Classical Greece* (Cambridge: Cambridge University Press), 136–96. Probably the most important event for sixteenth-century Italian scholars interested in Aristoxenus's views on sound was the publication in 1562 of a Latin translation by Antonio Gogava, who had been encouraged in this project by Gioseffo Zarlino (this translation was published after the first edition of Cardano's *De subtilitate*).

<sup>15</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 212. Zarlino expressed a similar view: "A dissonance causes the consonance which follows it to sound more agreeable . . . just as light is more delightful to the sight after darkness, and the taste of sweets more delicious after something bitter. We daily have the experience that after the ear is offended by dissonance for a short time, the consonance following it becomes more sweet and pleasant." Gioseffo Zarlino, *The Art of Counterpoint: Part Three of Le istituzioni harmoniche, 1558*, trans. Guy A. Marco and Claude V. Palisca (New Haven, CT: Yale University Press, 1968), 53–54. I owe this reference to Isaac Louth.

repeatable and measurable, it includes also aspects of his reading, that is, of common-sense knowledge and what others have observed and recorded in their own writings. Moreover, in authorizing and verifying his own claims, Cardano gives his own auditory experience an indisputable truth value. Ultimately, however, Cardano's approach is essentially philological. Scaliger's objections, moreover, evince a similar mixture of argument from authority—largely Aristotelian—and subjective experience that is remarkably similar to his opponent's argumentative strategies.

Right from the start of his attack on Cardano's view of the principles of musical science, Scaliger sets a hostile and sarcastic tone in deference to the Aristotelian view of the subject:

Even though as always you adduced certain trifles, even swept up the trash, in order to give an opinion about music, with a little bit of subtlety you could have raised the their low level, even if you were too lazy to separate the wheat from the chaff. You divide sounds into consonant, dissonant, and intermediate sounds. Given that this view is commonly accepted and promulgated, you should have asked whether it seemed contrary to reason. Surely there is no one who would not admit that between the high and the low there is an intermediate. One or more sounds necessarily fall between a low sound and a high sound. Even though these [i.e., high and low] are said relatively, nevertheless each sound in itself is an absolute thing; on the contrary, consonance and dissonance are relations. But the first philosopher [i.e., the metaphysician] argues that relatives do not have an intermediary. Thus, whatever note is not consonant to another note will necessarily be dissonant.<sup>16</sup>

Scaliger does not deny that gradations in dissonance exist (as he admits in the continuation of this argument); however, he refuses to change the Pythagorean system such that certain slightly consonant dissonances will be accepted as a third category of sounds. We may derive from this point of view that he is of the opinion that accepting intermediary sounds such as thirds and sixths as consonances in a tuning system is clearly a case of blurring Aristotelian principles. Cardano's defense of "just intonation" on the basis of auditory experience is presented by Scaliger as a fallacy. It is interesting to observe how eclectic their views on tuning principles are: Cardano is freely combining Pythagorean-Platonic mathematics with Aristotelian methodology of observation, while Scaliger underpins Pythagorean principles with reference to Aristotle, who did not count

<sup>16</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 381r. Scaliger's reference to the argument of the "first philosopher" would seem to target Aristotle, *Metaphysics* X.7, 1057a38–39.

as a primary authority in music theory, even though his pupil Aristoxenus was ascribed this role at the end of the sixteenth century.<sup>17</sup>

Scaliger argued that Cardano wrongly listed tuning as one of the things the ancients did not deal with properly. He is right that the arithmetical calculations proposed by Pythagorean and Aristotelian writers alike gave a precise set of intervals that could not be obtained with the same degree of certainty by the judgment of hearing. Scaliger buttressed the binary division of sound into consonances and dissonances with an implicit appeal to Aristotle (albeit with a convoluted and confused, if not fallacious, argument). But this division was also defended in the sixteenth century by adherents of the Pythagorean-Platonic worldview, who argued that the universe is ordered by the same numerical proportions that produce consonances in earthly music. Both Cardano and Scaliger seem to defend a similar numerical foundation of a tuning system, but they disagree on how a music theory should reflect gradations in consonance and dissonance that can be perceived by the ear. Ultimately, both Cardano and Scaliger, in dividing nature from man's perception of it and in locating reality in human reason, used a similar methodology. Even for an Aristotelian like Scaliger, the empirical method employed by Aristotle's pupil Aristoxenus to determine musical intervals by relying on a methodology of observation and aural judgment would have been inconceivable.<sup>18</sup>

It was only with Vincenzo Galilei's new orientation toward tuning and temperament that judgments based on hearing real music were accepted in sixteenth-century music theory. In the first section of his *Dialogo della musica antica et della moderna* (*Dialogue on Ancient and Modern Music*, 1581), Galilei set out to prove that the tuning then used in vocal music could not be the tense diatonic of Ptolemy, as Cardano and Zarlino maintained, but had to be a compromise consisting of Pythagorean pure fifths and Ptolemaic consonant thirds.<sup>19</sup> The debate about whether sense or reason must be taken as basis for a tuning system continued to be a contentious issue in music theory long after Cardano and Scaliger; ultimately the idea that tuning is a matter of convention rather than of natural law came to dominate Western music theory. Even though neither scholar made a significant contribution to this development, their arguments demonstrate that different ways of dealing with musical experience in the sixteenth century were still highly determined by learned traditions.

<sup>17</sup> Warren Anderson and Thomas J. Mathiesen, "Aristotle, 2: Symbolism, Number, Harmonic Theory," *New Grove Online*, accessed September 1, 2020, <https://doi.org/10.1093/gmo/9781561592630.article.01247>.

<sup>18</sup> For the Renaissance revival of Aristoxenus, see Claude V. Palisca, *Studies in the History of Italian Music and Music Theory* (Oxford: Clarendon Press, 1994), 189–99.

<sup>19</sup> Daniel P. Walker, "Vincenzo Galilei and Zarlino," in *Studies in Musical Science in the Late Renaissance* (London: Warburg Institute, 1978), 14–26, at 19–23.



*The Utility of Music: Platonic Belief in the Power of Music versus Music as Merely a Temporary Distraction*

Renaissance scholars inherited another problem from their ancient predecessors: while Platonists believed in an intrinsic connection between music and the soul, which entailed a concomitant belief in the power of music over the souls of its listeners, Aristotelians denied such a connection; skeptics even maintained that music does not possess an intrinsic nature but depends entirely upon our interpretation. Cardano and Scaliger recapitulated this debate but rephrased it in the terms of the learned traditions to which they belonged.

Having briefly discussed the ancient modes and the harmonic genera in the eighth book, Cardano turned to their alleged effects in the thirteenth book of his *De subtilitate*.<sup>20</sup> To substantiate his claim that musical sound can influence the soul more directly than any other sensory object, Cardano retold a famous ancient story about a military victory caused by the power of music:

Of all the stimuli that can move the senses, sound is alone in moving the passions maximally, because it is the only [sensory object] with obvious movement. A loud, harsh, energetic and dissonant [sound] arouses people eminently to fury and battles, which is sufficient to make a man forget himself. So soldiers in battle, especially at the outset, do right to make a din with trumpets and drums, and to shout; it is indeed no small thing to risk one's death, and important people (or people whose judgement is disrupted by especially dissonant sounds and shouts) would only do this willingly for glory. Hence, Caesar was right to criticize Pompey for holding his troops back at the start of a battle, as if they were off to a wrestling match or to debate the hair splitting of philosophers.<sup>21</sup>

According to Cardano, Caesar's unexpected victory in the battle of Pharsalus, which was an important episode in Caesar's war against Pompey the Great, could only be explained by the power of stirring music, which aroused frenzy and great courage in the soldiers. Influencing the passions of the soul of soldiers with inflaming music that benumbed their rational fear of death was seen by Caesar as an efficient military strategy. Cardano fully endorsed Caesar's criticism of Pompey's cool and purely rational attack strategy. Even though Scaliger agreed that music can

<sup>20</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:571.

<sup>21</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:572; Forrester, *The De subtilitate of Girolamo Cardano*, 2:708 (translation modified). Cf. Caesar, *De bello civili* 3.82–99. On sound (the proper object of hearing) as a movement, see the pseudo-Aristotelian *Problems* XIX, 27, 29; ed. and trans. Robert Mayhew (Cambridge, MA: Harvard University Press, 2011), 552–55.

induce a fighting spirit and reduce fear in a soldier, he thought it dangerous to assume that this would always guarantee a successful outcome of a battle. According to Scaliger, Caesar's victory at Pharsalus can only be seen as the exception that proves the rule that a military strategy should be fully rational. He argued that Pompey

hoped with good reason that, while his own troops remained at their location and were still fresh, the hostile troops would become exhausted because they had to undertake an assault which was twice as long. In my view, [Pompey's] hope, which was based on his military strategy and insight, was not unfounded, but thanks to the fiery bellicosity of the enemy it turned out to be vain. In the same way Homer makes the barbarians scream, and the Greeks march silently and full of fighting spirit. He must have remembered the warlike deeds of his ancestors better than you!<sup>22</sup>

Scaliger is right, of course, that the power of music to stir the passions of the soul cannot be taken as a reliable point of departure in a military strategy. To modern eyes at least, the debate on the utility of music for military purposes seems irrelevant, but Scaliger used it to repeat the point that Cardano is confusing facts and authority and has a selective memory. In his view, music, at best, affects our behavior merely by providing a temporary distraction; whereas a text may benefit us, music can only provide pleasure or other temporary emotions such as rage and recklessness.

To demonstrate his point that ancient Greek music was powerful and thereby deserved to be revived, Cardano continued to retell some of the most famous stories about the ancient power of music:

Among many ancient examples I find two that are outstanding concerning the power of sound to stir the passions. One concerns Timotheus, who by changing the mode filled Alexander with ardour and compelled him to spring up from the banquet table. In the other Agamemnon was about to leave his country and go to Troy. Being doubtful of the fidelity of his wife, Clytemnestra, as she was called, he left behind a citharist who so moved her to constancy and virtue with the sound of his cithara that Aegisthus could not have her without killing the citharist.<sup>23</sup>

Cardano used both stories to substantiate his Platonic claim that music has the power to influence the hearer's passions of the soul (emotions)

<sup>22</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 381v.

<sup>23</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 214. The Timotheus anecdote is related in the tenth-century Byzantine lexicon *Suda*, s.v. "Timotheus" (τ 620); the tale of Agamemnon is recounted at *Odyssey* 3.265–72; cf. Athenaeus, *Deipnosophistæ* 1.14b–c, on which see Krystyna Bartol, "The Voice of Tradition: Representations of Homeric Singers in Athenaeus 1.14a–d," *Classical Quarterly* 57 (2007): 231–43

and behavior in a more profound way than any other sensory object.<sup>24</sup> Music's enormous influence on the listener, in his view, is the result of an innate "subtle" harmony and likeness between movement in the human soul and musical movement. In ancient times composers and musicians were more knowledgeable about this harmony as a result of which they could perform musical miracles, but in his own time this knowledge had faded into oblivion, rendering music empty and powerless.

In his attack on this view, Scaliger argued that classical stories of the miraculous powers of music should be banned from the science of music altogether because they are merely based on authority rather than on facts. He accused his opponent of underpinning his musical thought with myth and legend, and he began his attack with ironic praise:

Quite rightly you share the opinion of learned men about sounds, who report that by the power of sounds souls are sharpened. The story about the citharist and Clytemnestra from the first book of Athenaeus [*Deipnosophistae* 1.14b–c] is generally known. The story about Alexander and the flute player is also told by many. However, telling these stories does not offer anything whatsoever that is useful in itself. Come on, Cardano, explain yourself and do not make a mockery of our expectations. Why does sound stir a human more than any other sensory stimulus? (It is known that this happens to be also the case with the bear, the horse, and the dog, and we read it also about the deer.) But in this question, too, lies subtlety. Every sensory stimulus stirs the latent powers of a sense to act accordingly, and this happens most powerfully in the case of taste. But [the arousal is] more intense in case of sexual desire.<sup>25</sup>

Scaliger first claims that with respect to auditory perception humans are equal to many other animals. In contrast with Cardano, Scaliger argued (in line with Aristotle) that there is nothing unique or more "subtle" about auditory perception: like the other senses, the sense of hearing is given to humans for the purpose of survival. He contended that if one classifies the senses according to the extent to which a sensory object stirs a sense, the traditional hierarchy of the senses with its primacy of sight and hearing must be reversed: taste has the most powerful impact on the affections. Lastly, he asserts that since sexual stimuli more intensely stir the passions than musical sounds it makes no sense to argue that sounds have a unique quality to shape and condition the soul.

Scaliger then tried to demythologize Cardano's view by explaining music's alleged powerful effects on the human soul in purely

<sup>24</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573. On Plato's theory that music has the power to shape and condition the soul, see Andrew Barker, *Greek Musical Writings I: The Musician and His Art* (Cambridge: Cambridge University Press, 1984), 124–68.

<sup>25</sup> Scaliger, *Exercitationes exotericae de subtilitate*, fol. 381r.

physiological terms. His explanation of the power of musical sound on the passions of the soul is given in terms of the actions of different kind of spirits inside the human body. To the question, “Why did these alleged musical miracles happen?” Scaliger formulates an answer in terms of Aristotelian physiology:

The spirits which are active in the heart receive the vibrating and upwards swirling air in the chest and unite with that with which they are akin. In such a way the remaining spirits which are situated in other bodily parts also follow: they either set muscles into motion or they slow them down. Depending on the frequency [of a sound] the stimuli increase, or they induce tranquility by way of an orderly movement, or they imitate tranquility by their slow movement. Just as when on a string instrument a certain string is plucked, another string tuned the same (*aeque tensa*) starts to co-vibrate, in the same way the spirits in the heart are stimulated by an external sound.<sup>26</sup>

The capacity for sounds to stir the passions of the soul can be explained simply in terms of spirits that vibrate sympathetically with the vibrations of sounds: faster sounds will arouse strong passions, and slower sounds will induce tranquility. But Cardano also conceptualized his explanation of music’s wonderful effect in terms of spirits. On the question of how sound affects the passions of the soul, he answered: “This cannot be because it moves the soul, which is immortal and immaterial, but because it moves either that part of the body that is the instrument of the soul, that is, the spirit, or the main bond by which the soul is connected to the body.”<sup>27</sup>

Cardano’s and Scaliger’s explanations of the power of music in terms of spirits exemplify a controversy between Galenists and Aristotelians about the concept of principal members of the body.<sup>28</sup> Aristotle generally taught that the heart, the source of heat and life, ruled the entirely body and is dominated by the vital spirit. The Galenists, inspired by Plato’s *Timaeus* 69d–72d, taught that three principal members—heart, brain, and liver—each governed a separate group of organs and bodily functions. Each of the three fundamental members of the body is dominated by a particular spirit (the liver by the natural, the heart by the vital, and the brain by the animal spirit).<sup>29</sup> Moreover, in Galen’s system, spirits and humors are linked with certain temperaments and affections.

<sup>26</sup> Scaliger, *Exercitationes exotericae de subtilitate*, fol. 381r–v.

<sup>27</sup> Cardano, *De proportionibus*, OO 4:551.

<sup>28</sup> Nancy G. Siraisi, *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice* (Chicago: University of Chicago Press, 1990), 107–9.

<sup>29</sup> For an introduction to the place of this theory in the musical thought of the Renaissance, see Palisca, *Music and Ideas in the Sixteenth and Seventeenth Centuries*, 183–87.

As a Galenist, Cardano conceptualized the power of music in terms of a sensory experience that affects the soul through the animal spirit in the brain.<sup>30</sup> This Platonic-Galenic view was popularized in the fifteenth century by Marsilio Ficino, who argued that because the ear contained animal spirit, which was in immediate contact with the exterior air, sounds were capable of influencing the animal spirit and the soul more directly than the objects of sight, taste, smell, and touch.<sup>31</sup> Thus by way of spiritual transference music has a privileged entry into the soul. Even though no direct quotations from Ficino are found in Cardano's work, from the way he connects music and spirit and privileges the sense of hearing it can be inferred that he endorsed a Galenic music-spirit theory with its natural magical implications. As an Aristotelian, Scaliger theorized about music's experience as a sensory experience that physically affects the heart, that is, the vital spirit. Just as sexual stimuli result from temporary alterations of the natural spirit, musical stimuli result from temporary alterations of the vital spirit. In Scaliger's discussion of music's effect on soldiers in battle, for example, the music works not by being heard and understood but by directly affecting the body, in the same way that ephemeral, tactile, sexual stimuli work.

Cardano's account of the power of music is more psychological, Scaliger's more physiological.<sup>32</sup> Their underlying views of the principal members of the body greatly influenced their ideas about what music does, could, or should do: in a Platonic-Galenic model music could shape and condition the human soul in a profound and lasting way, but in an Aristotelian model a special relationship between music and the soul was absent, which entailed that music could only have a temporary effect on lower members of the body and their ruling spirit.

Scaliger argued that Cardano's account of the power of music was not a neutral scientific discourse, but he failed to acknowledge that his own view on the subject was similarly colored by his adherence to the Aristotelian tradition. Likewise, in his ambition to expound clearly that which is hidden or obscure in nature, Cardano claimed to distinguish

<sup>30</sup> For Cardano's reception of Galen, see Markus Fierz, *Girolamo Cardano, 1501–1576: Physician, Natural Philosopher, Mathematician, Astrologer, and Interpreter of Dreams*, trans. Helga Niman (Boston: Birkhäuser, 1983), 37–55; and Nancy G. Siraisi, *The Clock and the Mirror: Girolamo Cardano and Renaissance Medicine* (Princeton, NJ: Princeton University Press, 1997).

<sup>31</sup> Ficino creatively revived ancient theories of the connection of music and spirit at the end of the fifteenth century. His restatement of these theories became very influential in the sixteenth century. For Ficino's music-spirit theory, see Daniel P. Walker, *Spiritual and Demonic Magic from Ficino to Campanella* (University Park: Pennsylvania State University Press, 2000), 3–11.

<sup>32</sup> On Cardano's view on psychology in his *De subtilitate* and Scaliger's critique of it, see Maclean, "Cardano's Eclectic Psychology and Its Critique by Julius Caesar Scaliger," 403–11.

himself from the Renaissance tradition of natural magic in his explanation of music's subtle effect on the soul. But he was in fact explaining musical subtlety in similar terms of natural magic and occult powers.

To substantiate his belief in the power of music Cardano also borrowed the theory of the acuity and superiority of the sense of hearing from Ficino, which was refuted and replaced by an account of the structural equality of all the senses by Scaliger. When comparing hearing and sight earlier in his *De subtilitate*, Cardano had argued that the experience of beauty and pleasure results from both the intrinsic orderliness of a sensory object and the soul's ability to recognize that order.<sup>33</sup> In this, he concluded, hearing and sight were equal. In his discussion of the science of music, however, he argued for the greater acuity and superiority of hearing in comparison to sight.

Ficino borrowed from the pseudo-Aristotelian *Problemata* the theory that there is a fundamental distinction between hearing and the other senses, because sound, alone of all sensory objects, has movements.<sup>34</sup> Moreover, given that those movements in sound are of the same nature as the movements inside the human soul, they possess a moral character (*ethos*) or are symptomatic of it. Building on and further developing the theory of his predecessor, Cardano argued that the pleasure of hearing a consonant sound is based on rational calculation combined with aural perception: "Remember, we said a consonance or harmony is the ratio of many tones recognized *aurally*. If, therefore, they are divided so minutely that they are not perceived by the sense of hearing they not only will not please but will even offend."<sup>35</sup> Subsequently, Cardano argues that the sensory threshold—the weakest stimulus that the ear can detect—is lower for hearing than for seeing. He provides evidence for this view by referring to the experience of an expert listener who is capable of distinguishing differences in the tuning and temperament of musical sounds that are far smaller than differences discernible in visual objects:

But the sense of hearing recognizes even smaller differences than the visual sense or any other sense. It is so acute that it very beautifully distinguishes the removal of one part from thirty-three or even from eighty[-one], for a ditone [major third] without this decrease [81:64] sounds harsh, but with it [80:64] the interval sounds smooth. In temporal proportions a beat (*ictus*) is divisible into sixteen parts.<sup>36</sup>

<sup>33</sup> Cardano, *De subtilitate* bk. 8, *OO* 3:494.

<sup>34</sup> Marsilio Ficino, *Compendium in Timaeum* (Florence: Laurentius de Alopa, 1496), fol. 69, on which see Walker, *Spiritual and Demonic Magic*, 8–11. For Cardano's restatement of problems related to sound and auditory perception, see Cardano, *Problemata*, *OO* 2:652 and *OO* 2:661.

<sup>35</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 213 (italics mine).

<sup>36</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 213.

Not only can the microtonal intervals of a (syntonic) comma and an enharmonic quartertone be perceived aurally in a melody or a harmony, but also minute subdivisions in a rhythm, for example, the subdivision of a note into sixteen smaller notes, can be perceived. For Cardano, the acuity with which the ear discerns these very small differences within a moving musical structure renders hearing superior to seeing:

Thus the sense of hearing is subtler than the sense of sight, either because (as I said) it alone is concerned with motion, or because the objects of sight, namely colors, on account of their intensity, mutually nullify each other by their contiguity, or because sight relates to many objects and hearing to one very simple object.<sup>37</sup>

Given that musical and psychological movements are identical, Cardano argued that music has the greatest impact on the soul. He continued his argument by claiming that hearing is the best sense because it relates to one simple object, while sight relates to many objects. Lastly, he praised the sense of hearing for its power of discerning subtle temporal differences in rhythm, for example a *hemiola*, a rhythmical figure in which, typically, two groups of three beats are replaced by three groups of two beats, giving the effect of a shift between triple and duple meter.<sup>38</sup>

In contrast with Cardano, Scaliger argued that it makes no sense to take the ear of a trained musician or listener as a point of departure in a discussion about the physiology of the senses. In his Aristotelian counterargument, he took the role of the senses as instruments in human survival as his point of departure. Like Cardano, he bolstered his argument by giving experience an indisputable truth value:

As regards its function, its matter, and its power the sense of seeing is superior. We do not only perceive more by it, but also in a better way and at a greater distance. And the spirits of the sense of seeing are thinner [than those of the sense of hearing]. And because [the sense of seeing] is related to light it is also more acute. Someone from Sicily could see ships leave from Africa but could not hear their sound.<sup>39</sup>

Like Cardano, Scaliger claimed that experience in these matters is the only trustworthy authority, especially when it confirms commonsense knowledge. But in framing this kind of knowledge, he used Aristotelian sources. Scaliger rejected Cardano's view that there are sounds that cannot be heard but nonetheless can offend the ear. Moreover, the idea that

<sup>37</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 213–14.

<sup>38</sup> For the concept of hemiola in sixteenth-century music theory, see Michael B. Collins, "The Performance of Sesquialtera and Hemiolia in the 16th Century," *Journal of the American Musicological Society* 17 (1964): 5–28.

<sup>39</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 382v.

this would have something to do with small differences in tuning and temperament he condemned as being “ridiculous and completely irrelevant.”<sup>40</sup> He was clearly of the opinion that Cardano’s transformation of the traditional definition of the quantity (*quantitas*) of a musical sound in terms of its numerical proportion into an aural magnitude was wrong. To clarify the concept of the quantity of musical sound, Scaliger referred again to Aristotle, who defined the *diesis* (quartertone) in the tenth book of his *Metaphysics* as being the smallest part of a tone in rational numerical terms, while Alexander of Aphrodisias (active in the late second and early third century CE) defined it as the smallest unit of sound that can be aurally perceived.<sup>41</sup> Scaliger warned his readers that historical discussions of different *dieses* have led to considerable confusion in his own time: “When there is discussion about music many kinds of *dieses* are in use. However, in nature we do not encounter any *diesis* at all.”<sup>42</sup>

For Scaliger, Cardano’s discussion of the auditory perception of microtonal intervals is a kind of theoretical hair-splitting that jeopardizes traditional music theory. As a way out of the impasse that dominated sixteenth-century discussions of the principles of a music theory, Scaliger suggested abandoning any new and, to his eyes, complicating *artificial* (that is, conventional) terms. As an alternative for innovative tuning systems in which the pureness and naturalness of certain intervals is compromised for the sake of musical practice, he offered a return to Aristotelian methodology. His argument is based on the belief that the first and absolute *natural* elements of sound, as discussed in the tenth book of Aristotle’s *Metaphysics*, must be taken as the point of departure for a tuning system. But he does not demonstrate awareness that any concept of nature in a music theory has a normative role.

Cardano believed that the reintroduction of ancient Greek genera could be used to restore the power of ancient music. The genera are

<sup>40</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 382r.

<sup>41</sup> “In all these, then, the measure and starting-point is something one and indivisible . . . , in music the quarter-tone (because it is the smallest interval).” Aristotle, *Metaphysics* X.1, 1052b32–1053a12 (cf. XIV.1, 1087b33–1088a4 and V.5, 1016b17–24), here following the translation by W. D. Ross in *Complete Works of Aristotle*, ed. Jonathan Barnes (Princeton, NJ: Princeton University Press, 1984), 2:1663. For this passage, see also Andrew Barker, ed., *Greek Musical Writings II: Harmonic and Acoustic Theory* (Cambridge: Cambridge University Press, 1989), 72–73. For Alexander’s commentary, see Alexander of Aphrodisias, *On Aristotle Metaphysics I*, trans. William E. Dooley (Ithaca, NY: Cornell University Press, 1989), 54–67; and Alan Towey, “Aristotle and Alexander on Hearing and Instantaneous Change: A Dilemma in Aristotle’s Account of Hearing,” in *The Second Sense: Studies in Hearing and Musical Judgement from Antiquity to the Seventeenth Century*, ed. Charles Burnett, Michael Fend, and Penelope Gouk (London: Warburg Institute, University of London, 1991), 7–18.

<sup>42</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 382r.



defined in *De subtilitate* as three possible ways of dividing the tetrachord (bound by the interval of a fourth), establishing a pitch system in which the highest and lowest strings maintain their fixed proportion and pitch, while the middle two are moved to achieve a variable series of intervals (listed here as fractions or multiples of the whole tone): *diatonic*  $\frac{1}{2}$ –1–1; *chromatic*  $\frac{1}{2}$ – $\frac{1}{2}$ – $1\frac{1}{2}$ ; and *enharmonic*  $\frac{1}{4}$ – $\frac{1}{4}$ –2.<sup>43</sup>

The debate between Cardano and Scaliger on the intrinsic orderliness of sound and the soul's and ear's ability to recognize that order testifies to an early stage in emergent attempts to quantify the qualitative aspects of natural objects such as sounds, but without an established, comprehensive theoretical framework. The deeper problem for those concerned with the study of music as object and the human mind as subject in the sixteenth century was that acoustics and aesthetics were not yet separate realms of study; the descriptive and normative were intertwined in Cardano's and Scaliger's methodological exposition of the musical experience. Both confused fact and authority, and both firmly believed that choosing the correct authority would lead to a neutral scientific discourse. That there was no real method yet to distinguish between acoustics and aesthetics, or between facts and authority, becomes clear when we analyze Scaliger's solution to the problems of tuning and temperament. He proposed to discuss other parameters of sound, such as volume, in order to refute Cardano's thesis of the acuity and superiority of hearing and sight:

But there is another aspect [of sound] that is even subtler. *Diesis* pertains to pitch, but *concisio* [Greek *syncope*] pertains to time. The latter concerns length (*longitudinem*) of a voice, the former its depth or altitude (*profunditatem et altitudinem*). However, do we also speak about a voice in terms of its latitude (*latitudo*)? Why not? Yet, to this [latitude] musicians have dedicated less time. So too these aspects have hitherto gone unnoticed by grammarians; consequently, they have confused duration (*tempora*) with intonation (*tenoribus*) in their understanding, treatment, and use of accents. Yet in my very subtle book *De causis linguae latinae libri tredecim* [On the causes of the Latin language] they have been reprimanded [for this confusion] by me. But they cannot digest my book because of the frigidity of their stomach.<sup>44</sup>

Scaliger's criticism suggests that Cardano was lost in pointless casuistry about the use of microtonal intervals, but Scaliger himself is guilty of the

<sup>43</sup> Cardano addresses the Greek genera of harmony in *De subtilitate* bk. 16, *OO* 3:603.

<sup>44</sup> Scaliger, *Exercitationes exotericae de subtilitate*, fol. 382v. Scaliger's term *latitudo* refers to an aspect of a tone that should be perpendicular to its length and pitch. Such a third dimension of a tone is its volume (*afflatio* and *attenuatio*). See Julius Caesar Scaliger, *De causis linguae latinae libri tredecim* (Lyon: Seb. Gryphium, 1540), 94–98.

offense of which he accuses Cardano. With this pedantic remark about the introduction of the concept of latitude in a discussion of music theory, Scaliger reveals that he completely misses the point of the sixteenth-century debate about the problems the Pythagorean tuning was causing for the musical performance practice of his time, especially for playing consort music.<sup>45</sup> Moreover, a closer look at Greek microtones in the formulation of tuning systems could offer a way out of these problems, as is proven by Vincenzo Galilei who formulated an early version of equal temperament in his *Dialogo della musica antica et della moderna*, itself inspired by the Greek genera.<sup>46</sup>

*Musical Instruments as a Source of Knowledge for the Revival of Ancient Music*

In addition to theoretical sources on music, Cardano explored descriptions of ancient musical instruments to help revive ancient music. Figures such as Pythagoras and his alleged empirical research (attested by Boethius) into the nature of sounding objects, such as hammers and strings, inspired Cardano to explore the theory-bearing dimensions of instruments.<sup>47</sup> In his *De subtilitate* we find descriptions of scientific experimentation—that is, descriptions of how instruments helped him to come to confront scientific phenomena under scrutiny that carry specific (but as yet “occult”) sources of knowledge within them. Aspects of this “experimental practice” were transferred to his music theory. But, again, the role of experience still encompasses his (philological) study of Greek theoretical sources about music.

Cardano sang and played several instruments, including the recorder and the lyre, and studied ancient instruments to discover their “miraculous” properties, sharing this knowledge with a broad audience.<sup>48</sup> In his search for the subtle effects of specific musical instruments on the listener he took accounts from the learned tradition as his point of departure: “Musical instruments were highly pleasing not only to this Roman emperor [Nero] but also to King David, severe and strongest of men, who was attached to the sweet sound of the psaltery, which also calmed the rage of Saul.”<sup>49</sup> Cardano refers here to the curative effect of

<sup>45</sup> Fend, “The Changing Functions of *Senso* and *Ragione*,” 210–13.

<sup>46</sup> Vincenzo Galilei, *Dialogue on Ancient and Modern Music*, trans. Claude V. Palisca (New Haven, CT: Yale University Press, 2003), 105–15.

<sup>47</sup> Anicius Manlius Severinus Boethius, *De institutione musica*, ed. Gottfried Friedlein (Leipzig: B. G. Teubner, 1867), 196–98; and Boethius, *Fundamentals of Music*, trans. Calvin M. Bower (New Haven, CT: Yale University Press, 1989), 17–19.

<sup>48</sup> Miller, *Writings on Music*, 17, 24–29.

<sup>49</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:573; Miller, *Writings on Music*, 214. Cf. 1 Samuel 16:23.

David's lyre. The story of David, who lifted Saul's spirits by playing his lyre, was a commonplace in early music treatises and histories for instantiating the power of music over the listener.<sup>50</sup> Usually no more was said of it than what was written in the biblical verse. But in his ambition to reveal music's subtle effects, Cardano went further by investigating the source of the power. He identified three possibilities: the music, the instrument and its tuning, or the soul and ear of the listener. In his research, a new sixteenth-century critical approach toward legendary stories manifests itself.

Cardano was interested in the tuning and properties of the strings of lyres and psalteries and believed that a revival of ancient tuning principles would help revive the powerful music of the ancients.<sup>51</sup> In contrast with earlier Renaissance theories, in which the magical properties of string instruments were conceptualized through the supernatural terms of their likeness with the tuning of the world lyre, Cardano looked for an explanation of the manifest natural properties of the sensible matter from which strings are made. But he lacked the methodological tools to frame the subtle and occult power of sympathetic vibration in terms of an inference between manifest properties of sensible matter and their effects.

The *De subtilitate* seemingly documents an experiment to establish the natural phenomenon of sympathetic vibration, whereby a string responds, at a distance, to external vibrations to which it has a harmonic likeness. This phenomenon was often used in music theory and natural philosophy to explain how bodies in the cosmos act on each other at a distance through the occult powers of sympathy.<sup>52</sup> Cardano tried to explain this wonder of nature as follows:

Take two lyres or lutes and lay one of the two on its back, its strings having first been tuned by tightening or loosening them. Then, over the second and first strings of the supine lyre place a piece of straw and pluck the first string of the instrument that you are holding in your

<sup>50</sup> For ancient and medieval sources on the topic, see Don Harrán, "David's Lyre, Kabbalah, and the Power of Music," in *Psalms in the Early Modern World*, ed. Linda P. Austern, Kari B. McBride, and David L. Orvis (Burlington, VT: Ashgate, 2011), 257–95, at 257n4. For Ficino's Renaissance reception of the story of David's lyre, see Walker, *Spiritual and Demonic Magic*, 6, 23–24.

<sup>51</sup> For Cardano's discussion of tuning and temperament, the lyre (*lira*, *lyra maior*, *lira da braccio*) and the psaltery, see Miller, *Writings on Music*, 73–97, 172–92.

<sup>52</sup> For early modern conceptions of "sympathy" see Jacomien Prins, "Sympathy in Early Modern Thought," in *Encyclopedia of Early Modern Philosophy and the Sciences*, ed. Dana Jalobeanu and Charles T. Wolfe (Berlin: Springer, 2020–), [https://doi.org/10.1007/978-3-319-20791-9\\_312-1](https://doi.org/10.1007/978-3-319-20791-9_312-1). For Renaissance theories of action at a distance, the category to which "sympathetic vibration" belongs, see Steven Shapin, *The Scientific Revolution* (Chicago: University of Chicago Press, 1996), 42.

hands; when it sends out the same sound to that which is in the supine instrument, immediately the straw will spring up and dance about as though it were struck by something. And once the piece of straw has been moved in this manner from one string to the next, you will, with wondrous skill, have transferred an equal or in fact the same tone on one instrument to the other.<sup>53</sup>

According to Cardano, sympathetic vibration in this experiment can be explained in terms of motions in the air. At first sight it seems that Cardano was presenting an early modern scientific experiment, but he borrowed this experiment from the learned tradition on the subject.<sup>54</sup> Likewise, in an attempt to explain (in book 13) music's effects on the listener (another example of an action at a distance), the concept of sympathetic vibration again appears. And the argument again relied on a complex experiment with a lyre, through which acoustic vibrations are made visible and tangible:

It is surely a remarkable thing—though anyone can test it—that if a spear is placed so that it touches [on one end] a lyre or a person's mouth, [then] if [another] person holds the other end of the spear's head with his teeth, the sound is as if it were heard in the teeth; [in so doing] a person will hear sounds and words from far away, which he could not have heard otherwise. Subsequently, look at what kind of movements in the spirits create affective states and chose the appropriate kind of sounds to arouse these same states.<sup>55</sup>

In this experiment Cardano described the phenomenon of the propagation and amplification of a sound made on a lyre (or by a human voice), whose tangible and perceptible vibrations travel through the material of a spear to the teeth of a listener on the other end of the spear. In this way, the listener is capable of hearing amplified sounds at a distance, which he would not have heard at the same volume otherwise. But by translating sympathetic vibration through a spear—an explanation in which the distance between the emitter and receiver is bridged by

<sup>53</sup> Cardano, *De subtilitate* bk. 18, *OO* 3:646; Forrester, *The De subtilitate of Girolamo Cardano*, 2:928–929 (translation modified). Many thanks to Remi Chiu for sharing his thoughts on this passage.

<sup>54</sup> The same experiment had been described by Porphyry (*Letters to Gaurus*) and Aristides Quintilianus. See Charles Burnett, "Harmonic and Acoustic Theory: Latin and Arabic Ideas of Sympathetic Vibration as the Causes of Effects between Heaven and Earth," in *Sing Aloud Harmonious Spheres: Renaissance Conceptions of Cosmic Harmony*, ed. Jacmien Prins and Maude Vanhaelen (New York: Routledge, 2017), 31–43, at 39.

<sup>55</sup> Cardano, *De subtilitate* bk. 13, *OO* 3:572; Forrester, *The De subtilitate of Girolamo Cardano*, 2:709 (translation modified). The concept of hearing through the teeth was later taken up by Thomas Edison. See Steven Connor, "Edison's Teeth: Touching Hearing," in *Hearing Cultures: Essays on Sound, Listening and Modernity*, ed. Veit Erlmann (Oxford: Berg, 2004), 153–72.

a material object—he lost the full explanatory power of sympathetic vibration to account for other kinds of phenomena of action at a distance. The analogy presented in this quotation, that vibrations in musical sound can alter the vibrations in the soul of the listener at a distance, is complicated by the fact that it is impossible to find an equivalent to the spear in auditory perception. Cardano had no other solution than to adopt the theory of auditory perception in terms of spiritual transfer, but in doing so he reintroduced the occult concept of an invisible spirit rather than a manifest property of the brain.<sup>56</sup>

Scaliger detected the flaw in Cardano's argument. He ridiculed his opponent's attempt to explain the effect of a distant sound on a listener in terms of subtle "manifest" properties of a lyre and a spear:

How crass this subtlety is could be explained by those who guard an army camp, because if they press their ears against the ground, they pick up even the softest sounds at night. Hence, the subtlety [of your experiment] is situated in this: that it has nothing to do with subtlety at all.<sup>57</sup>

Scaliger accused Cardano of confusing subtle musical phenomena and common-sense knowledge about sound transmission. The debate testifies to an interest in a methodical explanation of occult natural phenomena, such as sympathetic vibration, in terms of manifest properties of sensible matter, but also to a lack of conceptual tools to explain acoustic phenomena in terms distinct from learned traditions and common-sense knowledge. Scaliger was right that Cardano's experiment is not a repeatable way of making new experimental facts. At the same time the debate marked the emergence of an interest in artificially contrived experiments to establish acoustic facts.

In his refutation of Cardano's musical thought, Scaliger accused his opponent of believing that the benefit of reviving ancient music was an indisputable truth. His counterargument against Cardano's discussion of ancient musical instruments aimed at demonstrating that this type of discourse is far from neutral or factual. But in his refutation, Scaliger himself also confused facts and philological authority in offering his own discussion

<sup>56</sup> This problem was still present in seventeenth-century discussion of music's effect on the listener. On the reception of the Cardano–Scaliger debate, see Penelope Gouk, "English Theories of Hearing in the Seventeenth Century," in *Hearing History: A Reader*, ed. Mark M. Smith (Athens: University of Georgia Press, 2004), 136–50, at 139–40. For the development of topics of this debate in seventeenth-century sources, see Penelope Gouk, "Raising Spirits and Restoring Souls: Early Modern Medical Explanations for Music's Effects," in *Hearing Cultures: Essays on Sound, Listening and Modernity*, ed. Veit Erlmann (Oxford: Berg, 2004), 87–105, at 104; and Katherine Butler, "Changing Attitudes toward Classical Mythology and Their Impact on Notions of the Powers of Music in Early Modern England," *Music & Letters* 97 (2016): 42–60, at 51–52.

<sup>57</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 382r.

of ancient Greek music in his *Poetices libri septem* (Commentary on the *Poetics* [of Aristotle], 1561) as a scientific alternative to Cardano's account:<sup>58</sup>

These things, which are not known by authorities such as you, are dealt with in detail in my *Poetices libri septem*. . . . I do not wish to be guilty of vanity. However, in order to divert the soul, I would like to add that the Ethiopian Troglodytes also nowadays define what we name as a "harp" as the harp of David (*Mozanc David*). This [instrument] was similar to the zither (*Psalterium*), with which you musicians are familiar.<sup>59</sup>

Extrapolating from this passage, Scaliger seems to suggest that it is impossible to reveal the secret of David's healing music if one does not even know what instrument he played. In doing so, he demonstrated that Cardano uncritically adopted stories of the wonderful power of music from earlier treatises: he was filling old skins with new wine by assuming that David's harp is similar to the modern Italian lyre, while it is in fact similar to the zither or psaltery. In Scaliger's view, Cardano simply assumed the fabled power of ancient musical instruments, while in the sixteenth century there was much more knowledge of ancient musical practices and instruments that should be studied with discernment, even if this would lead to the demythologization of these stories.<sup>60</sup> He was right, of course, that robust philological analysis would be a necessary prerequisite to the revival of an ancient performance practice and, moreover, that the study of ancient instruments would never lead to the reconstruction of an ancient performance practice. We find Scaliger's opinion also in Zarlino's *Le istituzioni harmonice* (*Harmonic Institutions*, 1558), which argued that modern scholars, when they try to revive the powers of ancient music, have failed to understand that they have exclusively focused on a few themes, such as tuning and temperament, and should have examined a range of other aspects determining ancient Greek musical practice.<sup>61</sup> In this regard, the debate between Cardano and Scaliger on ancient musical instruments also reflects the changing attitude toward the belief that ancient music could be revived in sixteenth-century Italy.

<sup>58</sup> Scaliger, *Poetices libri septem* ([Geneva]: Jean Crespin, 1561; [Geneva]: Pierre de Saint André, 1581). For a modern edition, see Scaliger, *Poetices libri septem: Sieben Bücher über die Dichtkunst*, ed. Luc Deitz, Gregor Vogt-Spira, and Manfred Fuhrmann, 6 vols. (Stuttgart-Bad Cannstatt: Frommann-Holzboog, 1994–2011).

<sup>59</sup> Scaliger, *Exercitationes exotericæ de subtilitate*, fol. 382v–383r.

<sup>60</sup> In Scaliger's *Poetices libri septem* there is no mention of David's harp. There is, however, a discussion of musical instruments (mainly flutes) in bk. 1, chs. 19–20, and a few more passing references can be found in bk. 1, chs. 4 and 9. Moreover, the harpsichord is mentioned in bk. 1, ch. 48. I owe this reference to Luc Deitz.

<sup>61</sup> Gioseffo Zarlino, *Le istituzioni harmoniche*, in *De tutte l'opere*, vol. 1 (Venice: Senese, 1589), 76–77.

*Conclusion*

The debate between Girolamo Cardano and Julius Caesar Scaliger exemplifies broader transformations in sixteenth-century theories of music and science. Why is it interesting to look at these transformations again from the perspective of a debate with so many dead ends, when we know the outcome of the process? First, the debate offers a better understanding of how the status and underpinning of musical facts became a subject for discussion in the scholarly discourse of the time. Second, it illustrates how problems of epistemology and interpretation associated with the learned traditions of Pythagoreanism, Platonism, and Aristotelianism resurfaced in sixteenth-century musical thought. Based on the analysis presented in this article, it can be tentatively concluded that Cardano failed in his ambition to offer an alternative to well-established musical thought. His attempt to explain subtle musical phenomena in a new scientific way fell short because his observations were structured by expectations based on his reading of authoritative sources and common knowledge. Moreover, Scaliger failed in his ambition to attack Cardano for the very same reason.

Cardano's defense of ancient music's wonderful power and the superiority of the sense of hearing and Scaliger's critique of these beliefs changed expectations about the revival of ancient music in the middle of the sixteenth century. On the one hand, the debate between Cardano and Scaliger is evidence of the emergence of a new demarcation in music theory—an approach in which musical sound was conceptualized in terms of acoustics, the sense of hearing in physiological terms, and music's effects on the human soul and its passions in aesthetic and psychological terms. This development came to dominate the research agenda in the seventeenth century. On the other hand, the debate illustrates that humanism was not always a prominent driving force in the assumed emergence of modern forms of scientific research during the sixteenth century but often an impediment. In this regard, the analysis presented above nuances the view of a straightforward musical way to the Scientific Revolution: the flaws and weaknesses in the discussion of sound, hearing, and the power of music of both scholars give us a better sense of “science in action”; they bear witness to a process of trial and error by which a new methodical exposition of musical facts and new concepts of musical science and thought were made.

In sum, despite Cardano's claim that he had successfully revealed the subtle nature of the most intriguing musical phenomena and Scaliger's rejection of this claim, both thinkers conducted their debate on the basis of the same inherited learned traditions, in which the discipline of acoustics was highly intertwined with the discipline of aesthetics. In their

attempt to separate musical fact from fiction, the split between acoustics and aesthetics is laid bare: musical subtleties were reconceptualized and increasingly explained in the natural-philosophical, physiological, and affective terms belonging to different subdisciplines of music theory. The reevaluation of sound and hearing and the modified perspective on the powers of music that resulted from this debate were an initial step toward new ways of thinking about music's place in a philosophy of nature and an aesthetic theory.

ABSTRACT

The rediscovery of ancient ideas about the power of music inspired Renaissance scholars to formulate a tantalizing view of the restoration of the wonderful music of the ancient Greeks. But from the start of this revival, skeptical voices questioned the feasibility of any attempt to establish a historically informed music practice. This article explores the changing status and authority of classical music-theoretical sources in sixteenth-century Italy by analyzing the famous debate between Girolamo Cardano and Julius Caesar Scaliger on ancient ideas about sound, hearing, and the power of music. Both voices mark a pivotal early stage in the emergence of early modern musical science, in which scholars began to study musical phenomena in accordance with a new philosophy of nature but had no established research agenda upon which to rely when doing so. Their attempts to theorize, in terms of natural phenomena, the seemingly inexplicable musical wonders recounted in traditional sources demonstrate that the tradition of Pythagorean and Platonic mathematics could not be easily discarded in the mid-sixteenth century. Cardano and Scaliger inspired later generations of scholars to formulate new theories in which music was valued less for its numerical perfection and supernatural power than for its sensory qualities and natural effect on the passions of the soul—ideas that would come to underpin the development of acoustics and music aesthetics in later centuries.

Keywords: Girolamo Cardano, Julius Caesar Scaliger, world harmony, musical ethos, musical subtlety