

## Galileo, glassware, and the peacock

Eileen A. Reeves

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Résumé de l'article

This essay examines Galileo's peculiar comparison of small lunar craters in 1610 in his first treatise of telescopic observations, the *Sidereus Nuncius*, to the eyes in a peacock's feathers and to a particular sort of glassware, and it argues that these allusions reveal more about a certain kind of sound than about the visual appearance of the moon. Galileo's odd analogies find subsequent development in a thought experiment relating sight, sound, and sensation in his *Two New Sciences* of 1638.

## GALILEO, GLASSWARE, AND THE PEACOCK

EILEEN A. REEVES

*Abstract:* This essay examines Galileo's peculiar comparison of small lunar craters in 1610 in his first treatise of telescopic observations, the *Sidereus Nuncius*, to the eyes in a peacock's feathers and to a particular sort of glassware, and it argues that these allusions reveal more about a certain kind of sound than about the visual appearance of the moon. Galileo's odd analogies find subsequent development in a thought experiment relating sight, sound, and sensation in his *Two New Sciences* of 1638.

What is it about glassware and peacocks? Why do they so often travel together? From the glitzy baubles most favoured late in the first century BCE by some Roman floozy—or so that unreliable witness Propertius maintained in one of his elegies (Propertius 2.24.11–12; Goold 170)—to the scandal of James Whistler's Peacock Room, a Gilded Age dining area repurposed as an “aesthetic laboratory” (Glazer 17), we find such pairings. Unsurprisingly, variants on the combination of the avian and the artificial emerge unbidden in baroque literature; the duo was so familiar that Gabriello Chiabrera needed only an indolent gesture to it in his *Scherzi* of 1603:

In quel terso cristal profondo, e largo,  
Trovo io per ogni mal Lete, e letargo.  
Se de l'aureo trebbiano  
I toschi fiaschi ò Gelozea son voti,  
Versa del grande Ispano;  
Mà fà, che d'Appenin gielo vi noti;  
E mentre il core allatterone, scuoti  
Le piume ò Filli, che fur occhi d'Argo. (Chiabrera 14)

In that deep, dark, and wide glass,  
For every evil I find the lotus and oblivion.  
And if, oh Gelozea, the glinting Trebbiano

Lingers no longer in those Tuscan flasks,  
Serve me something from the big Spanish one.  
But do let in a little Apennine chill,  
Such that while I suckle here,  
You wave those feathers, Phyllis:  
For they once were Argus' eyes.<sup>1</sup>

This essay has as its focus a pairing of peacocks and glassware in a celebrated example of early modern scientific prose. I will argue that the emphasis that baroque literature, art, music, and cabinets of curiosity placed on the perspective of judicious audiences extends in this particular instance to the reader of natural philosophy (Dell'Antonio 106–21; Gal and Chen-Morris 1–11). More specifically, what we might call the measured excess and controlled breakage of the avian and vitreous combination are designed to simulate an uncanny aural experience, the relevant visual phenomena being barely perceptible to most observers and readers. We might go further still and see in the Galilean instances under scrutiny in this essay—an image and two texts—a sibling similarity with what Michael Gaudio in an extraordinary new study has called “soundings,” or a series of images that make insistent, disruptive claims on the viewer's *hearing* (Gaudio xii–xviii). That those claims necessarily go unfulfilled is, in Gaudio's reading, their strength: it is in the tension between the governing faculty of sight and the uncanny gesture to hearing that we register sounds that can neither be smoothly assimilated nor entirely erased. While Gaudio's study attends in chronological and cumulative fashion to visual images concerning the Americas—a sixteenth-century engraving of a Tupinambá dance, two seventeenth-century landscapes of Brazil, an eighteenth-century mezzotint portrait of Benjamin Franklin, an early nineteenth-century landscape of the Catskills, and Thomas Edison's 1894 kinoscope of a Lakota dance—my emphasis will be on the much narrower domain of a few Galilean objects. What Gaudio's *Sound, Image, Silence: Art and the Aural Imagination in the Atlantic World* and this essay share is an interest in what one does when the wrong, or dormant, sense seems to be summoned, and why these productive ruptures in the aesthetic process occur in the first place. I will return to other common denominators in the conclusion.

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<sup>1</sup> This and all subsequent translations are my own unless otherwise indicated. For a celebrated early modern pairing of peacocks and glassware in a humorous anecdote, see de Santa Cruz, fols. 60v–61. This story also appeared in Italian in 1590, in a parallel Spanish and French version in 1614, in Latin in 1630, and in German in 1640.

### The avian and the vitreous

Let me begin with Galileo Galilei's description of the telescopic appearance of shadowed craters in the crescent moon in the *Starry Messenger* of 1610. This passage follows his suggestive presentation of isolated peaks in the unlit region of the lunar globe: "Hinc inde quasi pullulantes, intra tenebrosam partem accenduntur, augentur, ac demum eidem luminosae superficiei, magis adhuc extensae, copulantur" ("hatching like chicks in the dark, they are inflamed, grow, and finally are coupled with that brilliant surface, now much extended in length"; Galilei, *Sidereus Nuncius* 64); more decorously, these summits also erupt like bright islands in a murky gulf (see Figure 1). The astronomer had set out by stating that he preferred not to cloak his observations in silence, and indeed the text, despite its expected visual objectives, tends towards a crescendo of sound. Galileo's point is that the craters on the bright horns of the crescent moon generally have within them a spot—the shadow cast by the wall closest to the sun—and that this spectacle, like that of the emerging archipelago, becomes more pronounced over the course of several successive nights. Galileo was the sole witness of this extravagant display: these dark patches, unlike the large, familiar ones composing the moon's face, were visible with a superior telescope, which he alone possessed.

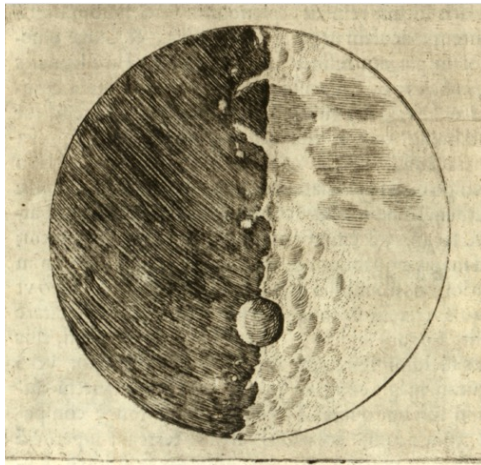


Figure 1. Galileo Galilei, *Etching*. In Galilei, *Sidereus Nuncius*, Venice, Baglioni, 1610, fol. 8. I have used the image provided by the Osservatorio Astronomico di Brera's 2009 exhibit, *Guarda Che Luna*.

Haec lunaris superficies, qua maculis, instar pavonis caudae caeruleis oculis, distinguitur, vitreis illis vasculis redditur consimilis, quae adhuc calentia in frigidam immissa, perfractam undosamque superficie acquirunt, ex quo a vulgo “glaciales cyathi” nuncupantur. (Galilei, *Sidereus Nuncius* 65)

This lunar surface, adorned with spots like the deep blue eyes in the peacock’s tail, is fashioned like those glass vessels which, still glowing with heat, are submerged in cold, and take on a fractured, wavy veneer, for which reason they are popularly called “ice chalices.”

The unwarranted description of this sort of glass ends with its alleged name, *glacialis cyathus*; whatever else they understood, Galileo’s readers would have recognized the term as an odd hybrid. *Cyathus* was a familiar word in poetic, agricultural, and pharmaceutical texts for a chalice or goblet of a specific size, but the recent, widely imitated technique in question went by the Venetian dialect *a giazo*, or “ice-like,” even well beyond the Veneto. Those in his audience unfamiliar with the glassmaking technique might have heard an echo of a mocking story told about the Cynic philosopher Diogenes:

Platone de ideis disserente & nominante mensalitem et cyathitatem: Equidem, inquit, o Plato, mensam et cyatham video, mensalitem et cyathitatem non video. Et ille, Recte inquit. quibus enim cyathus mensaque spicitur, oculos habes, quo autem mensalitas et cyathitas intelligitur, animum non habetur. (Diogenes Laertius 344)

Plato, lecturing about Ideas, referred to “tableness” and “cupitude,” when [Diogenes] responded, “In fact I see that table and cup, Plato, but nothing of this tableness and cupitude.” “Of course!” Plato retorted, “You have eyes for seeing tables and cups, but not the mind for grasping tableness and cupitude.”<sup>2</sup>

Readers who had encountered this tale neither in the Greek original, nor in this Latin version, but in the mid-sixteenth-century vernacular translation—or rather, Erasmian appropriation—of Giovanni Bernardo Gualandi, perhaps recalled that it

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<sup>2</sup> For this popular Latin translation from the Greek original, see Diogenes Laertius 344. The story appeared not just in *Lives of the Philosophers* but also in excerpted form, from around 1515 through 1700, in countless discussions of Aristotelian philosophy and in collections of witty sayings.

was padded out with a few particulars (Cherchi 213–17). The novelty of his ideas forced Plato to utter “parole dure e fittitie” (“hard and specious words”), Gualandi observed, “una certa spetie imaginaria, difficile a trattarne, oltre che qui ne anche si richiede” (“imaginary concepts, difficult to discuss, and not even pertinent here”); *cyathus*, he added, “quasi dire un bicchiere tondo” (“in our vernacular is a rotund glass, the kind we call a ‘buffoon’”; Gualandi 159).<sup>3</sup> Galileo would thus occupy the Platonic role, with his novel notions, difficult terminology, and gestures to the “cupitude” of the lunar surface; his opponents by implication would be involved in a vain search for clownish goblets associated with heavy drinking.



Figure 2. Pierre Belon, *Hand-colored woodcut*. In Belon, *L'Histoire de la nature des oyseaux*, Paris, Guillaume Cavellat, 1555, p. 234. This image comes from the copy of *L'Histoire* available online through Gallica (<https://gallica.bnf.fr/ark:/12148/btv1b8608302w/f268.item#>). A similar hand-coloured woodcut from the same edition of Belon's work is available online through the Bibliothèque municipale de Lyon (<https://gallica.bnf.fr/ark:/12148/btv1b8608302w/f268.item>).

<sup>3</sup> This observation comes from a note in Gualandi's chatty 1567 translation of Plutarch's *Apophthegms*. *Buffone*, *buffoncello*, and *buffoncino* referred both to clownish individuals and to wide-bodied glasses made for drinking; Gualandi's allusion to a “rotund glass” would have roughly the same connotation.

That admixture of roughness and over-refinement typified descriptions of both the fowl and the glass. The peacock was often said to have originated *ex barbaris* (“among non-native speakers”)—that is, those encountered by Alexander the Great—before becoming the singularly expensive possession of the Greeks and Romans (Aelian 101; see Figure 2). Its tough, unappetizing flesh was consumed at banquets, its eggs fetched remarkable prices, and its presence in country estates was tolerated despite its raucous cries and destructive habits. Martial’s epigram on a villa near the Bay of Naples best captures this ambivalence: the poet describes a vigorous working farm as an unpretentious place to be enjoyed “rure vero barbaroque” (“in a rustic, truly rugged style”), but as being populated with useless birds, including “gemmeique pauones” (“jewelled peacocks”), “picta perdix” (“the painted partridge”), and “impiorum phasiana Colchorum” (“the pheasant of the depraved Colchians”) (Martial 3.58; Nisbet 54–55).

Ice-glass, of course, had less in the way of a cultural pedigree, but here, too, primitivism and decadence seemed undifferentiated, or rather conjoined. The artisans producing this novel, difficult, and costly effect had rejected the conventional attributes of clarity, limpidity, and structural stability for something opaque, rough, and covered with fractures, as if the sustained success of the Venetian glass industry could result only in a parodic regression to the origins of the craft. Broadly stated, the hybrid linguistic register seems an index of the unstable aesthetic position of both the natural and artificial objects.

### Sound reasons

I would like to propose, however, that this verbal exuberance also has a more specific function, and that here Galileo is at least as concerned with sound as he is with sight. We can gauge the measured excess of this passage by comparing it to a letter he had written in Italian to an unknown correspondent in January 1610, about nine weeks before the publication of the *Starry Messenger*. He offered a brisk overview of his major telescopic findings up to that point; the lunar phenomena were accompanied by small ink drawings and a quick sketch of the unforeseen spectacle of Jupiter’s satellites, discovered that very evening. After stating that the moon was covered with higher peaks and deeper valleys than those on earth, Galileo explained that in the bright crescent at the beginning of the month, particularly around its lower horn, there were a great many small dark spots, oriented towards the unilluminated part of that body. “Dalla frequenza delle quali macchie” (“Because of the number of these spots”), he added, “viene quella parte

resa simile ad uno di quei vetri che vulgarmente si chiamano di ghiaccio. Siane un poco di essemplio la figura presente” (“this region is fashioned like one of those glasses popularly called ‘ice-like.’ Let this drawing serve as a bit of an example”; *Carteggio. 1574–1610* 274).

In aural terms, the passage is unremarkable, especially in comparison with the explosion of sound in the *Starry Messenger*, a point to which I will return. There is no mention of the peacock, and the reference to the ice-glass involves the popular name but not the noisy process of production. Overall, the letter is characterized by an elision between whatever it is that Galileo had seen through the telescope and the drawings within the missive. He refers, for instance, to the sights the instrument “rappresenta” (“represented”) to him, and he describes the features of the lunar globe with a draughtsman’s lexicon, distinguishing between “una parte di linea ovale, pulitamente segnata” (“a neatly marked oval”) and the ragged terminator, pointing to “il giusto tratto dell’ellipsi” (“the crisp line of an ellipse”), “altri parte oscure intaccano, per così dire, la parte illuminata” (“the dark spots that incise, so to speak, the lighted regions”), “perfettissimamente circolare” (“the most perfect circle”) of a crater, and “un’eminenza triangolare” (“a triangular peak”; Galilei, *Carteggio. 1574–1610* 273–76).<sup>4</sup> Occasionally the difference between the telescopic phenomena and its image is entirely erased, as in the suggestion that the spotted region around the lower crescent “is fashioned like” (“viene...resa simile”) an ice-glass.

In general, this letter anticipates in slightly exaggerated form the implicit claim of the *Starry Messenger* itself, one that resolutely minimized the gap between celestial objects and their graphic representation.<sup>5</sup> Matters are otherwise once that peacock emerges. The passage signals, if not the rupture between the observation and its depiction, at least the fragility of such connections, and it converts most of the visual energy to sound. For many, to see the peacock’s feathers was to hear, or perhaps to recall or to recognize, the raucous noises that accompanied this display; to observe the *cyathus* as it acquired its fractured surface was to experience, or at least to imagine, the sizzling sound of molten material plunged into cold water.

What subtends the comparison is a specific sort of sound. While the peacock was and remains known for a variety of distinct cries, the rattling noise produced when it shakes its train is the more relevant issue (Beauchamp 27–34). The sonic emphasis, moreover, is clearly a feature of the sentence itself. Galileo’s comparison is structured by the unusual rhyme of its verbs *distinguitur* (“adorned”), *redditur*

<sup>4</sup> See also Bredekamp 102–10, 139.

<sup>5</sup> For a similar effort on the part of his contemporary Caravaggio, see McTighe 45–46.



(“is fashioned like”), and *nuncupantur* (“are called”), and it moves briskly from the repetitive stresses of ten sibilants and stridents—*lunaris, superficies, maculis, pavonis, caeruleis, oculis, vitreis, illis, vasculis*, and *consimilis*—to the four staccato bilabial stops *frigidam, perfractam, undosam*, and *superficiem*. That rapid ending in combination with the emphasis on the broken but intact surface of the ice-cup echoes without endorsing Horace’s suggestion that writers “proicit ampullas” (“toss away ampoules”)—glass flasks suggesting all that was unctuous, painted, or overblown—“et sesquipedalia verba” (“and foot-and-a-half long words”; Horace, *Ars poetica* 97; Fairclough 458). The pattern, in sum, captures both the passage from the avian to the artefact and the pace of those sounds.

Given the context of his lunar observations, Galileo’s remark would also have been enhanced by particular bits of the ornithological tradition: that peacocks were best bred on small, wooded islands along the Italian coast, that they were hatched in the dark, that they had been exhibited for a fee to the elite in ancient Athens with each new moon, that they turned to the sun to show off their feathers, and that the concave surface of their plumage provided them with shade. But the crucial feature here is the peculiar, low-pitched pulsating sound of their trains. An early reference emerged around 105 CE in the exordium of Dio Chrysostom’s “Twelfth or Olympic Discourse,” which opens with a contrast between the philosophical wisdom of the night owl and the splendid sophistry of the peacock. In that oration, presented here in its mid-sixteenth century translation to Latin, the Greek philosopher offered the conventional extravagances concerning the latter bird but added the novel detail that “quando perterrere volens concutit pennas, sonumque aliquem non inucundum reddit, tanquam si ventus haud vehemens sylvam aliquam densam commoveret” (“when it wants to terrify [an observer], it shakes its feathers and produces a not unpleasant sound, as if a breeze, by no means strong, were moving for a time through a dense wood”; Naogeorgus 96).<sup>6</sup>

The unsettling elements here—the reliance on litotes, the odd passage from terror to pleasure and from a bright sight to an attenuated sound, the whiff of sophistry in an alleged affirmation of philosophy—would have been supplemented, for the early modern reader, by the Roman historian Quintus Curtius Rufus’ familiar description of Alexander the Great’s initial encounter with the bird in India.<sup>7</sup> Because we learn there that the conqueror and his men approached the

<sup>6</sup> For the original Greek, see Dio Chrysostom, *Orations* 12.3.

<sup>7</sup> Curtius Rufus, not well known in antiquity, became a popular source for Alexander romances in the medieval period. Modern scholars generally place his work in the mid-first century CE.

Hydraotes River, bordered “opacum arboribus alibis invisitatis agrestiumque pavonum multitudine frequens” (“by dense forests filled with flocks of wild peacocks and trees not known elsewhere”; Curtius Rufus 230), the net effect is to conflate Dio’s impression of the strange sound of the bird’s train with its environment, and possibly to call the former into doubt.

Adapting Dio Chrysostomus’s description a century later, the Hellenistic Roman writer Aelian chose to emphasize something closer to brute force: “Quod si quem velit exterrere, caudae pennas primum explicat; deinde ad injiciendum terrorem his, veluti armis suis miles quispiam, concrepat” (“If the peacock desires to frighten anyone, first he raises his feathers, and then to instil terror in him, he rattles them, as does some soldier with his weapons”; Gilles and Gesner 101).<sup>8</sup> The fourteenth-century Byzantine poet Manuel Philes’s poetic bestiary, beautifully illustrated in numerous sixteenth-century manuscripts for French aristocrats, likewise insisted on this militaristic quality, the peacock “alis crepans ceu miles armis horridus / aut qui pharetram concutit telis gravem” (“rustling his feathers like a rough soldier with his weaponry / or like one who shakes his shafts against a heavy quiver”; Philes 15), and in that same period, the naturalist Conrad Gesner incorporated Aelian’s notion in his own influential work on ornithology (Gesner 633).<sup>9</sup> Another account of the peacock, published in the same year as Galileo’s *Starry Messenger*, commented on the indescribable quality of this sound, even as it repeated the familiar comparison: “saevum nescio quid concrepat ut miles suis armis” (“it rattles [its train] in I know not what harsh fashion, just as a soldier does his weapons”; Paschalius 707).

The extraordinarily popular creation poem of Guillaume Du Bartas, first published in French in 1578 and soon translated to Latin and to most European vernaculars, provides a hearing test of sorts. Just after rejecting Nicolas Copernicus’s arguments for a heliocentric world system, Du Bartas compared the peacock’s train to the celestial vault, likening the eyes to stars and the blue background of the feathers to the firmament. The peacock’s preening display as he wheeled about the peahen, Du Bartas maintained, mirrored the motion and productive effect of the heavens upon the immobile and central earth, and its wings “rouiant tout à l’entour d’un craquetant cerceau” (“rolled round like a rattling hoop”; Du Bartas 223–24). This nicety meant little or nothing to some of his translators, who

<sup>8</sup> Pierre Gilles’s earlier and slightly less elaborate translation appeared in 1535.

<sup>9</sup> On the eleven manuscripts of Philes’s poetic bestiary produced by the Cretan calligrapher Angelos Bergikos, see Hofer and Cottrell, and, more recently, Peers.

suppressed the reference or converted it to the bird's shrill cry.<sup>10</sup> By contrast, those who recognized the noise, or the proxy provided by textual antecedents, amplified it: the Latin version of 1600 stated that the peacock "blanda refulgentis vibrat crepitacula caudae" ("vibrated the alluring rattles of his splendid tail"; Damman 162), the English one, first published in 1604, referred to those "rattling pinions still wheeling about" (Sylvester 96), and the Dutch version of 1609 alluded to "en drayet rondom end'om met een gekraeck der pluymen" ("the rustling round of his feathers"; van Liefvelt 83).

In sum, the suggestion of rhythmic rattles, variously inflected by the constraints of genre and of particular languages, approximate the shivering, pulsating noise of the peacock's train. Galileo's sibilant series, "Haec lunaris superficies, qua maculis, instar pavonis caudae caeruleis oculis, distinguitur," conforms to this aesthetic goal and anticipates the sonic pattern of molten glass slowly dipped into cold water, "vitreis illis vasculis redditur consimilis, quae adhuc calentia in frigidam immissa, perfractam undosamque superficie acquirunt." The latter was a controlled sort of breakage that left the chalice covered with fractures, but otherwise intact. Given the artisanal expertise involved, few readers would have been familiar with this latter sound, but likely imagined something analogous to the descriptions of molten metal in Homer's *Odyssey* 9.391–94 or Ovid's *Metamorphoses* 7.106–08, or to the quotidian realm of cooking (Krohn 134–36).

Our two main sources for the sound of the peacock's train, significantly, are men whose identities depended upon their actual or assumed status as Greeks in a world where military and political power had shifted to Rome; specifically, their self-presentation depends upon a cultural distinction signalled, in the most obvious instance, by linguistic difference (Jones 99–101, 106–10; Smith 7–8, 17–23, 67–79). This sonic particularity, in other words, is just one example of the sort they, and other writers identified with the Second Sophistic, were inclined to notice and to emphasize.<sup>11</sup> It is also possible that Dio Chrysostomus's oration provided a template for the proem of the *Starry Messenger*. Both texts emphasize the impermanence, costliness, and material limits of the visual arts, the relative durability, value, and flexibility of poetry, and the sempiternal status of the heavens themselves; both do so under the sign of the same god, the colossal statue of

<sup>10</sup> The reference to the noise of the peacock's train does not appear in Gabriel Du Lerm's Latin translation of 1583, nor in that of Jean Edouard Du Monin of 1579, nor in the Italian translation by Ferrante Guisone of 1593, nor in the Spanish translation of Joan Dessi of 1610.

<sup>11</sup> On the Second Sophistic, see Anderson; Eshleman; and most recently, Richter and Johnson.

Zeus for Dio, and giant Jupiter with its newly discovered satellites for Galileo.<sup>12</sup> As part of his intense interest in sounds, particularly onomatopoeia, Dio insists on the importance of messengers, as of course does Galileo.<sup>13</sup> Both authors also foreground their own functions as philosophers at the expense of other, earlier roles (Kasprzyk 537–40; Biagioli 159–74). The orator and the astronomer alike privilege man’s symbol-making capacity as a means of portraying the gods and the celestial bodies that they occupy.<sup>14</sup> Dio insists, by way of accounting for anthropomorphic depictions of deities, that representing the crescent moon neither required artistic skill nor awakened aesthetic responses; Galileo, as I will argue below, clearly underestimated the difficulty of such images.<sup>15</sup>

While this oration was much admired in early modernity, it is difficult to confirm Galileo’s acquaintance with it; he certainly knew something, however, of the peacock.<sup>16</sup> The villa of his close friend Girolamo Fabrici d’Acquapendente, a prominent physician and anatomist at the University of Padua, was replete with a small wooded artificial island of the sort on which peafowl were raised. The estate had been designed and decorated by Dario Varotari the Elder, famous for his realistic depictions of “tutte le spietie d’vccelli” (“every type of bird”; Ridolfi 82) on the façade of a house near Galileo’s home, and for his image of a peacock on the walls of another nearby villa (Ridolfi 83).<sup>17</sup> In his publications, Fabrici referred frequently to the peacock, commenting on its unsuitable role as a foodstuff, on its cry, on the durable, absurd belief that the peahen was impregnated by air, on the

<sup>12</sup> Dio Chrysostomus, *Orations* 12.44–46, 49–50, 58–72; Galilei, *Sidereus Nuncius* 55–56.

<sup>13</sup> Dio Chrysostomus, *Orations* 12.64, 68; see also Wilding 89–95.

<sup>14</sup> Dio Chrysostomus, *Orations* 12.59; Galilei, *Sidereus Nuncius* 55.

<sup>15</sup> Dio Chrysostomus, *Orations* 12.58.

<sup>16</sup> See Bartoli, *Povertà Contenta* 7–8; Vossius 254; La Mothe le Vayer, *Petits traitez* 18, *Suite* 408, 412; see more generally Swain 14–21.

<sup>17</sup> Varotari’s images were on the façade of the house of the Dotto family in Borgo Rovina, now via Dante, in Padova. Galileo lived nearby and was well acquainted with the architect and cartographer Vincenzo Dotto; see Galilei, *On Sunspots* 76, 171, 224. His close friend Gianfrancesco Sagredo would later befriend Varotari’s son Alessandro, the painter better known as il Padovanino, who appears acquainted with Galileo as well; see Galilei, *Opere* 12 452, 454, 458, 459, 461, 480, 490, 491; *Opere* 13 45, 220–21. On the elder Varotari’s decorations around 1580 of the nearby Villa Capodilista at Montecchia, including a peacock, see Gallucci 14–17, 23–24; Giulini 105–07.

size of the eggs, on the extravagant colours of the feathers, and especially on the musculoskeletal mechanism crucial to raising and lowering its train.<sup>18</sup>

Galileo also had access to the lengthy and well-illustrated discussion of the peacock published by the Bolognese naturalist Ulisse Aldrovandi in 1600. This account included every reference to several species of peafowl from antiquity through early modernity; of particular relevance here were its meticulous description of the bird's train, its paraphrase of Aelian's impression of the shivering noise so generated, and its careful analysis of the colour scheme of the eyes. These consisted of four concentric circles, Aldrovandi noted: the outermost was gold, the next reddish-brown, the third green, and the innermost *caeruleus* or sapphire-like, with the shape and size of a kidney bean (Aldrovandi 1–45, especially 11, 17). These details conform to Galileo's description and his sketch of the shadowed crater at the bottom of this image (see Figure 3). Aldrovandi's claim that even if the finest artists of antiquity—Praxiteles, Metrodorus, and the great Apelles—were brought back to life, they would be unable to match Nature in depicting the peacock's plumage, would have seemed at once an agreeable challenge and an elegant apology for any flaws in representation (Aldrovandi 5).



Figure 3. Galileo Galilei, *Pen and ink drawings, detail*. In Galileo, Ms. 50, fol. 68, Biblioteca Nazionale Centrale di Firenze. This image comes from the collection of Galileo's manuscripts made available online by the Biblioteca Nazionale Centrale di Firenze (<http://teca.bncf.firenze.sbn.it/ImageViewer/servlet/ImageViewer?idr=>

<sup>18</sup> These references are in Fabrici's *De formatione ovi et pulli*, *De brutorum loquela*, and *De musculi fabrica*; see his *Opera* 12, 27, 324, 384, 394, 407, 412, 444.

BNCF0003662560&azione=showImg&sequence=142&reduce=4&mode=2&height=525).

Another close friend in the Veneto, the entrepreneurial poet and artisan Girolamo Magagnati, might have provided Galileo with access to glassmaking processes; he specialized in blown glassware whose coloured surfaces resembled various precious stones (Trivellato 202; Bufacchi). Magagnati's other commercial venture, a kind of emporium for the finest food and drink, and his great enthusiasm for wine, suggest his particular familiarity with the goblet.

We might also draw on a source not conventionally associated with Galileo, but evidently of some importance to him, the renowned Franciscan preacher Francesco Panigarola; the astronomer mentioned him in passing at least once and had one or more of his works (Galilei, *Considerazioni al Tasso* 82; Favaro 25). Panigarola's paraphrase of and commentary on the influential *On Eloquence*, then attributed to the Attic orator Demetrius of Phaleron, was posthumously published in 1609 and would have complemented the recent Italian translation of that work in Galileo's library (Favaro 58). In the course of some 1,200 pages, Panigarola commented frequently on the benefits and risks of inserting rhymes in prose passages and on the means of creating cacophonous sounds in one's own prose for rhetorical effect.<sup>19</sup> His elaboration of the distinction between preaching to a small audience of *cognoscenti* and to the masses contrasts two genres of painting in terms that anticipate Galileo's multisensorial approach to this virtually invisible lunar phenomenon: the first "cose minutissime potrà mostrare, piene di fumi, e d'ombre, di scherzi, di delicatezze, di diligenze e di pazienze: E se così può dirsi più tosto miniate che dipinte" ("will contain the smallest objects, and is full of smoke, shadows, caprices, delicate touches made with diligence and patience, and is more of an illuminated manuscript than a canvas"), while the second, displayed high above its observers, or as a banner unfurled from a window, will involve nothing exquisite, but rather colossal figures, and "Tutta la diligenza sia nella proportionione delle parti, e nella vivezza de' colori... e che quei sensi abbracciamo che fanno più ribombo, e che quasi torrenti, traggono seco le menti di chi ascolta" ("requires

<sup>19</sup> The pagination for Panigarola's *Il Predicatore* is complicated both by length and by structure; page numbers start anew in successive sections, identified here and in successive notes with parenthetical numbers. On the issue of clauses with similar endings, or rhyme-like prose, see (2) 164, 216–17, 222, 230–31, 236; (3) 42, 98, 346, 388–89, 588–89, 855–59; for cacophony, see (3) 286.

attention to proportions and bright colours... for where those senses encounter something like reverberations and torrents, the minds of the listeners are swept along"; Panigarola [3] 644–45).

Panigarola, whose own very florid performance was covertly criticized by an influential peer,<sup>20</sup> also offered a memorable vignette of an extravagant preaching style, particularly one overly reliant on strongly cadenced prose:

credendo questi tali con la souerchia lor affettazione di riuscire marauigliosi, infin col moto del capo applaudono a se stessi, e quasi pauoneggiando fanno ruote; difetto, che si uede espresissimo anche ne' Cantanti, de quali alcuni per la male, e troppo affettata maniera del musicale componimento, & altri per naturale leggerezza, ò uanità, fanno nel cantare un muouere del capo tanto stomachoso, che nulla più. (Panigarola [2] 163)<sup>21</sup>

Such speakers, believing that their excessive affectations provoke wonder, applaud themselves with movements of their heads, and as if they were peacocks, display their feathers; you can also see this defect right away in singers, for some of them, either because the musical composition itself has a poor and affected manner, or because these [performers] are by nature frivolous or vain, when singing keep time with the most nauseating movement, a bobbing head.

Consider, too, Panigarola's meditation upon Demetrius's dictum that the orator's communication of rage requires no artifice, "excandescencia arte non indiget"; here the Franciscan argues for the careful simulation of artlessness (Panigarola [2] 237). This concept reappears in concretized form in Galileo's peculiar simile, where incandescent material emerges as the controlled but seemingly haphazard breakage that distinguished this glass. And it is worth noting that where Panigarola, following Demetrius, comments upon neologisms designed to capture particular sounds, the Homeric instance under scrutiny has a particular relevance to Galileo's effort in that it presents the aural phenomenon within the context of blindness:

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<sup>20</sup> Muret 222; in reality, 202.

<sup>21</sup> See also Panigarola (2) 206; (3) 856.

Ma nella prima maniera della imitatione d'alcun suono, totalmente nuoui nomi, non rappezzando la fabrica, ma facendola tutta di nuouo dice Demetrio, che formò Homero, quando parlando del colpo, che haueua dato Ulisse con una pertica accesa in cima nel l'occhio smisurato di Polifemo, e uolendo esprimere lo stridore che fece l'occhio, riceuendo il colpo, in quella maniera che fanno i ferri rouenti cacciati dalla fucina nell'acqua fredda, ne formò il uerbo. (Panigarola [3] 307)

The first way of imitating a sound is to create entirely new words, rather than to patch together the fabric [of language], as when Demetrius says that Homer offered something novel when speaking of the blow Odysseus gave to Polyphemus's oversized eye with the heated tip of a stake. Wanting to convey the harsh sound the eye made when struck, in the manner of glowing pieces of iron pushed from the furnace into cold water, he contrived the verb.

But what, within the realm of astronomy itself, explains Galileo's motivation? Why did he present the visual phenomena in terms of its sonic dimension? Broadly, this strategy conforms to the soundscape of the first pages of the *Starry Messenger*, which emphasizes his role as a speaker, the motif of the music of the spheres, the role of rumour in the development of the telescope, and the fact that Galileo's own version, the *occhiale a tromba*, was shaped like a trumpet and made from a repurposed organ pipe (Galilei, *Sidereus Nuncius* 59–62; Reeves). This particular reference builds upon that proprietary narrative in that it is premised upon the virtual invisibility of those spots, and the aural effects he proposes are a proxy for sights most readers will never observe. This is not to say, however, that the simulated rattle of the peacock's train or the sizzle of the molten glass are merely compensatory forms of sensory data, nor to suggest that they simply play upon the aesthetic sensibilities of an otherwise unconvinced elite reader. Nor can we regard this overwritten passage as no more than the ultimate form of baroque wit, the unseeing eyes of the peacock's train and the artfully fractured glass gesturing to phenomena barely perceptible to readers and to observers with telescopes. It is rather that in addition to his claim that his telescope and treatise alone would reveal “inauditam per aevum novitatem” (“novelties unheard of through the ages”), Galileo intuited a genuine connection between an elusive visual effect and a faint sonic trace.



Of all the lunar phenomena described in the *Starry Messenger*, the dark pools within the small, impermanent spots on the surface of the waxing moon were the least visible. It is not just that they, like every shadow, are ephemeral; it is also the case that they are dwarfed by the permanent spots visible to the naked eye. The bright peaks emerging like islands from the gulf of darkness beyond the terminator would have likewise been more striking than these fleeting shadows and would have grown more rather than less noticeable over the course of several evenings. Though both these dark spots and the ashen light covering the unlit portion of the globe were best viewed during these first few nights of the lunar month, the latter was much more familiar, and needed no telescope. As the moon approached the first quarter, the oversized central crater, which Galileo compared to Bohemia, would have been relatively easy to observe, but the dark spots within those on the crescent would have been rapidly fading. And the jagged contours one would expect to see on a sphere whose mountains were, in Galileo's estimate, some four times as high as the highest terrestrial peaks, were not visible, and would remain unseen and unrepresented for decades, but the astronomer argued that successive ranges and a vaporous mantle, rather than the limits of his instrument, accounted for the illusion of a smooth perimeter.<sup>22</sup> In short, Galileo's most extravagant description concerns phenomena hovering at the threshold of visibility, even for those very few observers equipped with telescopes.

For these reasons, as he rushed his treatise into print, it was perhaps disturbing to find that he was obliged to reduce the number of his lunar etchings, and to abandon the image most closely associated with his verbal depiction of the shadowy spots. Despite the enormous public interest in the *Starry Messenger*, he would also have been troubled by the amateurish quality of those printed images. As Horst Bredekamp has recently argued, these were probably etched by Galileo himself directly onto the wax-covered plates, while an unidentified artisan must have handled the acid bath required to produce the prints (Bredekamp 132–72).

It seems likely that Galileo, attracted by etching's suitability for landscapes, underestimated the demands of this medium, perhaps because at least three of his acquaintances, none of them a professional artist, appear to have produced

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<sup>22</sup> Giuseppe Campani claimed that Giandomenico Cassini, using one of Campani's telescopes, had seen the moon's limb as rough and jagged, like mountainous horizons on earth; he provided no image (39–40). I thank Albert Van Helden for this reference.

and published prints of this sort in the late sixteenth and early seventeenth centuries.<sup>23</sup> Elsewhere he referred dismissively to the sketches “o simili altre cosette” (“or other such trinkets”; Galilei, *Considerazioni al Tasso* 69) of the most influential early Italian etcher, Francesco Parmigianino (Jenkins, “Drawing”). He might also have been encouraged by the fact that the sculptor and metalworker Benvenuto Cellini and the artist and historian Giorgio Vasari had both gestured some forty years earlier to the relative ease of etching, in comparison with engraving (Cellini 43; Vasari 304–05; Jenkins, “Painter’s Medium”). But neither author had offered much technical information about the most suitable graphic conventions for the designs themselves, and when Galileo took up the process, he evidently encountered unanticipated difficulties. As the plates themselves had not been thoroughly cleaned, faint traces of previous etchings and a fingerprint competed with Galileo’s lunar globes, and his hasty execution would have further distracted the reader (Bredenkamp 145). Within a week of the publication, he had already engaged an established engraver to produce improved versions for a second, Tuscan, and ultimately unrealized edition of the treatise, and planned to bring him from Venice to Padua for this labour (Galilei, *Carteggio. 1574–1610* 299–300).

Apart from several oblique references to the flaws of the original etchings—easily overlooked in the excitement over his telescopic discoveries—and his ambitious plan to republish the *Starry Messenger* with engraved images, we have no record of his reaction to the representational challenges posed by these shadowy spots. Beyond the passing reference to the ice-glass in his letter of January 1610, neither this fractured chalice nor the preening peacock reappears elsewhere in Galileo’s work. The extensive discussion of the moon’s appearance in the *Dialogue Concerning the Two Chief World Systems* (1632) tends towards the visual and even to the painterly, but there is nothing remotely like the soundscape of this passage. That said, I will argue below that another text captures something of both his efforts to use data from one sense to augment the more fleeting percepts of another, and his lingering disappointment over the original lunar etchings of the *Starry Messenger*. I will treat this passage, drawn from his last work, the *Dialogues Concerning Two New Sciences*, published in 1638, as a supplement to that singular meditation on peacocks and glassware.

<sup>23</sup> See Reed and Wallace, especially xvi–xxviii; for discussion of the involvement of the Florentine poet Raffaello Gualterotti, the Padua-based printer Pier Paolo Tozzi, and the Neapolitan naturalist Fabio Colonna in etching, see 205–07, 246–47, 274–76. For discussion of trained printmakers in Galileo’s orbit, see 151, 158–60, 217–21, 222–29, 234–43.

**Sotto voce**

Consider the exchange between the affable Sagredo and the erudite Salviati about the material traces of sound in the first day of the *Two New Sciences*. It follows a set of familiar observations involving a cup made of fine, polished glass; this genteel version of the ice-glass will resound if one bows the lowest string of a viola, similarly tuned, near it. The glass is yet more voluble when one runs a moistened finger around its rim, and the motion involved would be evident, Salviati added, if it were placed in a larger container, likewise nearly filled with water, as in that case the waves generated by the sound would appear as circles proceeding across the surface of the liquid. It is at this point that he proposes, or perhaps recalls, a means of offering a permanent graphic record of an ephemeral sound, as if to vouchsafe the fleeting aural data to more durable, and perhaps more authoritative ocular evidence.

L'invenzione fu del caso, e mia fu solamente l'osservazione e 'l far di essa capitale e stima come di riprova di nobil contemplazione, ancor che fattura in se stessa assai vile. Raschiando con uno scarpello di ferro tagliente una piastra d'ottone per levarle alcune macchie, nel muovervi sopra lo scarpello con velocità, sentii una volta e due, tra molte strisciate, fischiare e uscirne un sibilo molto gagliardo e chiaro; e guardando sopra la piastra, veddi un lungo ordine di virgolette sottili, tra di loro parallele e per equalissimi intervalli l'una dall'altra distanti. Tornando a raschiar di nuovo più e più volte, m'accorsi che solamente nelle raschiate che fischiavano lasciava lo scarpello le 'ntaccature sopra la piastra; ma quando la strisciata passava senza sibilo, non restava pur minima ombra di tali virgolette. Replicando poi altre volte lo scherzo, strisciando ora con maggiore ed ora con minor velocità, il sibilo riusciva di tuono or più acuto ed or più grave; ed osservai, i segni fatti nel suono più acuto esser più spessi, e quelli del più grave più radi, e tal volta ancora, secondo che la strisciata medesima era fatta verso 'l fine con maggior velocità che nel principio, si sentiva il suono andarsi inacutendo, e le virgolette si vedeva esser andate inspessendosi, ma sempre con estrema lindura e con assoluta equidistanza segnate; ed oltre a ciò, nelle strisciate sibilanti sentivo tremarmi il ferro in pugno, e per la mano scorrermi certo rigore: ed in somma si vede e sente fare al ferro quello per appunto che facciamo noi nel parlar sotto voce

e nell'intonar poi il suono gagliardo, che, mandando fuori il fiato senza formare il suono, non sentiamo nella gola e nella bocca farsi movimento alcuno, rispetto però ed in comparazione del tremor grande che sentiamo farsi nella laringe ed in tutte le fauci nel mandar fuori la voce, e massime in tuono grave e gagliardo. Ho anco tal volta tra le corde del cimbalo notatone due unisoni alli due sibili fatti strisciando al modo detto, e de i più differenti di tuono, de i quali due precisamente distavano per una quinta perfetta; e misurando poi gl'intervalli delle virgolette dell'una e dell'altra strisciata, si vedeva, la distanza che conteneva quarantacinque spazii dell'una, contenere trenta dell'altra, quale veramente è la forma che si attribuisce alla diapente. (Galilei, *Discorsi* 144–45)

This discovery was made by chance, and my role was limited to the observation, to capitalizing on it, and to appreciating it as evidence of a high-minded concept, even though the method itself was fairly crude. I was scouring a plate of brass with the sharp blade of a rasp in order to remove some spots, and in moving the rasp quickly, amid all that scraping I heard a hissing sound: once and then again, a loud, clear whistle emerged. Looking at the surface of the plate, I saw a long row of delicate *virgolette*, parallel to each other, and separated from each other by very equal intervals. Returning to scrape the plate again and again, I realized that only in the strokes that whistled did the rasp leave any scratches on the surface of the plate; when it moved without this hissing, there wasn't the slightest shadow of such *virgolette*. Repeating this *scherzo*, and scraping now with more, now with less speed, I found that the whistle was sometimes higher, sometimes lower in pitch, and that the marks emerging with the higher-pitched sound were closer together, while the lower-pitched ones were more widely spaced. Sometimes, if the scraping was more rapid towards the end of the stroke than at the beginning, you could feel the sound growing shriller, and see the *virgolette* drawing closer together, but always with extreme neatness, and absolutely even in their spacing. And beyond this, during the whistling strokes I could feel the iron blade tremble in my fist, and a certain tension run through my hand. In sum, you can see and feel the rasp do just what we do when we speak *sotto voce* and then sing loudly; that is, when we breathe out

without emitting a sound, we don't feel any movement whatsoever in the throat or mouth, as compared to the great vibration that we feel in the larynx and throughout the pharynx when we project a sound, especially one that is low-pitched and loud. I have also noticed among the harpsicord's strings two that are in unison with the two hisses that were made with this scraping movement, and among those most different in tone, these two were separated by a perfect fifth. Measuring the breadth occupied by the *virgolette* of the one and other scraping, you could see that the area covered by forty-five spaces of the first one contained thirty spaces in the second, which is 3:2, exactly the ratio assigned to the fifth.

This exercise has eluded exact replication, and Marin Mersenne's paraphrase of Galileo's text, published in 1638, does not incorporate this procedure into the critical discussion that followed the translation.<sup>24</sup> Some version of the experience, like many in the *Two New Sciences*, probably dates to Galileo's Paduan period (1592–1610) and thus would precede the *Starry Messenger*. It was in Padua that Galileo bought plates of brass to produce instruments for students between 1599 and 1608.<sup>25</sup> The ability to hear and to assess high-pitched sounds, and to distinguish and to count fine lines diminishes with age, and for this reason as well the observation seems more likely to have taken place before his departure for Florence when he was forty-six years old. Its elaboration as a text, however, likely occurred in the wake of the publication of the *Starry Messenger*.<sup>26</sup>

Unsurprisingly, given the context, the passage evokes contemporaneous musical developments, though more as an aura than as a formal argument: *virgolette*,

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<sup>24</sup> See Galilei, *Nouvelles Pensées*, 95–97. See also Raphael 84–86; Walker 46–47; Baskevitch 407–18; Settle 20–26.

<sup>25</sup> See Galilei, "Ricordi Autografi" 131, 133, 134, 135, 138, 172, 173.

<sup>26</sup> Carla Rita Palmerino has shown in "Discussing What Would Happen" that certain thought experiments in the *Dialogue Concerning the Two Chief World Systems* are intended above all to reveal the theoretical presuppositions of the three speakers, the muted clash between an individual's spontaneous belief and the overlay of such theories, and differing notions about which scenarios qualify as thought experiments in the first place. I would argue that this exercise from the *Dialogues Concerning the Two New Sciences*, not a matter of dispute between the speakers, nonetheless shares this revelatory character.

the *scherzo*, and *sotto voce* are all drawn from this register.<sup>27</sup> The first of these indicated a pause in music, generally with the slightest shift in frequency, and a caesura or parenthetical break in prose or poetry. The second term was strongly associated both with the poetry of Galileo's friend, Gabriello Chiabrera, from around 1599 to 1606, and with Claudio Monteverdi's celebrated adaptation of those and other lyrics, memorable for their brevity, strong cadences, internal rhymes, and compelling meters, in his *Scherzi Musicali* of 1607 (Ossi 111–34). And while Galileo refers to speaking, rather than to singing, *sotto voce*, the phrase was used to describe nearly inaudible muttering, a subdued style of song, the impolite habit of singing along with a performer, and the simultaneous deployment of both low speech and song.<sup>28</sup> Overall, these references convey something unstated or understated, and at the threshold of articulation in song.

Less expected than the gesture to the arena of music is the text's connection to that of print production. Salviati's statement that the experience emerged when he was trying to remove the spots on a plate of brass is at once an unusually banal transcription of an actual event, and a pantomime of the printmaking process. His account appears to gesture both to the imperfections of the lunar etchings, and to the idealized and unrealized engravings of the moon Galileo had planned after the initial publication. Etching and engraving involved plates of copper, not brass, though the latter metal, more appropriate for instruments, was occasionally used for prints (Bury 30–31). In 1645, in the opening pages of his treatise on etching, the prominent French printmaker Abraham Bosse would warn his readers of an inferior sort of copper: etchers would immediately feel its resistance to the burin, hear the crackling sound it emitted when worked, and see the harshness of the images it generated. These defects would be even more evident in "yellow copper," or brass, made with the addition of zinc; it was in Bosse's view excessively hard, cloudy, and dingy, as would be prints produced with this thrifty alternative. Copper plates of poor quality, moreover, could be identified before etching by the faint noise and stony or straw-like appearance that emerged and persisted during polishing (Bosse 12, 14).

What is striking here is the relationship between Bosse's quick and dismissive description of plates of inferior copper and brass, the harsh, grubby lunar

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<sup>27</sup> On the relationship of early modern music and natural philosophy, see especially Palisca; Gouk; Tomlinson; Muir; Cypess.

<sup>28</sup> Cecchini 41; Mazzone 57r; Bottrigari 44; Guercio 227; Bonta 102–03.

etchings of the *Starry Messenger*, and Salviati's account, entirely different in spirit, of the acoustic discovery in the *Two New Sciences*. Bosse and Galileo paired the feeling of the trembling blade with the sound it generated, as if to acknowledge the dual meaning of the French and Italian verbs *sentir* and *sentire*; while both referred to a high-pitched noise, the printmaker gestured to the *criquety*, or the pulsating call of the cricket, and Salviati to something more like a whistle. These differences surely have to do with intention: Bosse's agenda was to identify and to reject inferior material for plates, and this *criquety*, especially in combination with a straw-like, cloudy, or rocky appearance, would have suggested that such substances were too close to the natural world to be reliably associated with the artefactual. Salviati, by contrast, was at pains to present this high-pitched scraping sound as a strange sort of music: it was within his control, susceptible to measure, and alluring enough to be associated with the *scherzo*. It is worth noting that in his French paraphrase of this passage, Mersenne described the phenomenon with an ambiguous doubling, but one that insisted on aesthetic pleasure: "Un sifflement, & un bruit agreable" ("a whistling, and an agreeable noise"; Mersenne 95). Galileo's assertion, in sum, differs remarkably both from the conventional contrast of rasping sound and harmonious melodies in Lucretius's *On the Nature of Things* 2.409–13 and Cicero's *Tusculan Disputations* 5.40, and from the usual reaction to this form of workshop activity; decades later, his successor Giovanni Alfonso Borelli would note that there were those who would rather be beaten or kicked than hear the shrill, dissonant whine of a knife being sharpened or a blade being filed (Borelli 306).

That idealizing impulse also subtends Salviati's several gestures to printmaking processes. There is a studiedly casual air in the generic word *scarpello* for the tool used in this chance discovery, as such an instrument was adopted by surgeons, by woodworkers, by sculptors, and by printmakers. The tiresome business of removing spots from brass, seemingly an allusion to the flawed etchings of the *Starry Messenger*, becomes a fantasy of effortlessly producing increasingly fine parallel lines not by inscribing them one after another, nor by changing tools, but simply by moving the same instrument, more and more rapidly, over the plate. These *virgolette*, parallel to each other and neatly spaced, might have been straight or curved; as the speed of the scraper increased, and the pitch it generated rose, the intervals between these lines decreased, and a slightly denser pattern emerged.

The greater compression of these *virgolette* does not necessarily suggest a darker area of this notional print, but rather that the lines themselves were finer, less deeply inscribed, less charged with ink, and thus suitable for conveying a lighter

surface, possibly one softened by distance. Such an effect, in fact, is not uncommon in the etchings, engravings, and hybrid compositions of the printmakers with whom Galileo was most closely connected from around 1610 onward: Jacques Callot, Francesco Villamena, Matthaeus Greuter, and Stefano della Bella (Harent 199–219; Lincoln 225–35; Noyes 466–87). There is some symmetry here: just as Salviati maintains a strategic silence about the exact appearance of the lines associated with the highest pitch, so too does he leave the pitch of the utterance in *sotto voce* unspecified. The structure of the analogy implies, however, that both are extremes and at the limits of representation, such that the finest lines, like a vocalization extraordinarily low in pitch as well as in volume, hover at the horizon of perception.

Galileo's association of these elusive sensory data here recalls his enigmatic presentation of the faint lunar shadows as smudge-like etchings and as a series of pulsating sounds in the *Starry Messenger*. It is worth examining the reactions of two natural philosophers who commented on and sought to replicate this acoustic and graphic exercise; while they make no explicit reference to the astronomical precedent, the conditions under which they conduct this experiment mimic Galileo's original and crucial monopoly on the instrument suitable for the observation.

Consider first the Jesuit rhetorician Daniello Bartoli's treatise on sound of 1679, which offered a brisk synopsis of the original text, but as if to distance itself from the vagaries of an embodied response, suppressed Salviati's references to the larynx, pharynx, and those barely audible utterances in *sotto voce*. Given this omission, Bartoli's unusually flat transition from the Galilean precedent to his version—"Or quel che io diceua di me" ("But what I said for my part"; Bartoli, *Del suono* 145)—seems to perform, rather than to analyze, something unspoken. Bartoli changed the *scherzo* to the more generic *opera* and depicted the artisan who performed the experiment as both a woodworker and a *maestro*; this figure was perhaps the inquiring lute-maker elsewhere mentioned in the treatise (163–64). He further qualified Salviati's account by describing the sounds emitted as *stridori*, or screeching noises, and after a reference to the original deployment of "certa non so qual piastra d'ottone" ("a certain I know not what plate of brass"; 145), turned instead to a wooden plank and to a planing instrument with an adjustable iron blade. When the blade was fully extended, the plane leapt across the wood, gouging it with single rather than doubled marks, trembling in the hand of the *maestro*, numbing his arm, and producing dramatic waves in a glass placed on the plank. As the blade was withdrawn into the handle of the instrument, it moved more smoothly, and the gouges and waves diminished; eventually, the tool generated neither indentations nor tremors.



While the treatise is devoted to Bartoli's own careful re-enactment of phenomena described by others, he introduced a crucial division of labour in this instance, limiting his role to visual observation and interpretation. His silent assistant, neither the site of tremors in the throat nor the source of *sotto voce* sound, eventually figures as an insentient extension of the much livelier instrument: "Cosi vedemmo la pialla, quando non si striscia pari sul legno, ma saltella mordendolo con ispesse intaccature, guizzare in mano al maestro, e stupidirgliene il braccio" ("Thus we saw the plane, when it did not mark the wood evenly, but rather leapt, biting it deeply with thick gouges, dart in the hand of the *maestro*, and render his arm senseless"; Bartoli, *Del suono* 175). Bartoli concluded that matching the wood and the wave patterns with the sounds emitted by the plane was more of an imaginative than observational exercise; that crucial synchronicity of ocular and aural evidence did not emerge.

A year later, in his essay on noise, the naturalist and architect Claude Perrault turned to the experiment without alluding either to Galileo or to anything resembling printmaking, despite his general allegiance to Galilean explanatory principles, and his remarkable faith in the expressive possibilities of engraving (Guerrini 124, 159; Perrault and Perrault 4). He converted the brass plate to a stone slab and repurposed the exercise to distinguish between continuous and broken sounds. The ear would detect no noise-free intervals in the former, Perrault explained, whereas the latter would be punctuated by brief ruptures, and would include "le bruit d'un racloir, qui s'échappant & se r'attachant a plusieurs reprises au corps raclé, le frappe de plusieurs coups successifs, celuy du grondement des chiens, des voix rauques, des ailes des grosses mouches, d'un archet quand il frotte les grosses cordes, celuy des bourdons des trompettes et des hautbois" ("the scraping of a file, repeatedly departing from and then gripping a body, and thus striking it with successive blows; a dog's growl; raspy voices; the throbbing wings of large flies; the sound of a bow striking low strings; or of bourdons, trumpets, or oboes [on a pipe organ]"; Perrault 92).<sup>29</sup> Revisiting the scenario silently extracted from the *Dialogues Concerning Two New Sciences*, Perrault proposed *bruits rudes*, or "harsh sounds," as a byword for those without pulsations. Taking advantage of the impersonal French pronoun *on* in this adapted experiment, Perrault further explained that "quand on mene un racloir lentement sur une pierre dure & polie, supposé

<sup>29</sup> It is worth noting that *chien*, *mouche*, and *trompette*, like *bourdon*, are parts of a hurdy-gurdy. Elsewhere, Perrault claimed that the noise of gnats, heard from afar, resembled the sound of trumpets (*Mémoires* 345).

qu'il soit capable de l'entamer, il fait un bruit rompu, & l'oreille n'aperçoit pas seulement les coups séparément, on voit mesme qu'il laisse des traces sur la pierre en maniere d'ondes éloignées les unes des autres: mais quand on le meine fort viste il fait un bruit continu rude, & les traces qu'il laisse sont fort serrées" ("when one draws a rasp slowly over a hard and polished stone, assuming that it can scratch it, it will make a broken noise, and not only will the ear detect distinct blows, one will also see marks like waves separated from each other left on the stone. But when one draws the rasp rapidly, it will make a harsh and continuous sound, and the waves will be very close together"; Perrault 95).

These two revisions of the original experiment merit comparison. Bartoli's substitution of a plane and a wooden plank for Salviati's rasp and brass plate produced less reliable results, as the link between the changing sounds of the utensil and the various gouges seen in the wood was difficult to verify, and the embodied reaction to the plane's movement was outsourced to a silent and numbed assistant. Overall, this woodworking exercise seems a studied regression: the absence of doubled, perfectly spaced marks, the peculiar division of labour, and Bartoli's mutism are the correlates of an event that falls short of quantification, replication, and articulation. Perrault, by contrast, appeared initially to preserve Galileo's implicit connection between pulsating sounds and a faithful graphic record; significantly, among his instances of low-frequency noises—growling dogs; large, hovering flies; raspy voices; and thrumming instruments—is a single high-pitched example, the whine of a file. It is the only one described in detail, and the sole instance associated with a durable trace, those compressed, wave-like marks on a polished surface. But the passing reference to stones so hard that they resist the tool introduces a note of dubiety, one with the potential, like Bartoli's wooden plank, to undercut the entire experiment. In treating Galileo's brass plate as a variable, Bartoli and Perrault reproduced the original limitations of those early observations of the shadowed lunar crater, where the astronomer alone possessed the relevant instrument.

While Bartoli admired Dio Chrysostom's meditation on the peacock, and Perrault was familiar with Aelian's work in the Greek original and in translation, and with the bird itself, and both knew the *Starry Messenger* well, there is no indication that either had that original passage in mind here.<sup>30</sup> And yet Georg Mathias Bose, in popularizing Perrault's treatise over fifty years after its original publication, converting the Frenchman's unadorned modern vernacular to an

<sup>30</sup> Bartoli, *Povertà Contenta* 7–8; *Mémoires* 32, 34, 123–25, 344–45, 395–97; Guerrini.

archaic, literary Latin, and focusing on the volatile questions of intellectual property and replication, provided an uncanny reversion to the pairing of the avian and artefactual: he planned to “Projicit ampullas & sesquipedalia verba” (“toss away ampoules and foot-and-a-half long words”; fol. 3v), and unlike the jackdaw in a beast fable, he had no desire to drape himself in the peacock’s feathers.<sup>31</sup>

My emphasis has been throughout this essay on the elusive nature of these sensory data and their notation, and my subject here has been sights unavailable to most, sounds rarely encountered or actively avoided, and images and transcriptions subject to material constraints or to fantastic correctives. At the outset of this argument, I mentioned the sonorous pictures in Gaudio’s *Sound, Image, Silence* as a recent and valuable meditation on a class of images associated with the Americas over the course of three centuries and addressed to viewers’ ears as well as to their eyes. My concern, by contrast, has been with details in an etching whose sonic dimension only emerges via an accompanying text that both describes and performs particular sounds, with a second text that seems to replace the shortcomings of the original image with the fantasy of a permanent graphic record of the aural, and with two responses to that thought experiment. Among the more obvious shared features of all these works, however, are a preoccupation with the barely visible, an occasional resistance to the eye as the least embodied and thus most trustworthy of the senses, an interest in shadowy caverns and craters as domains of potential enlightenment, and an ongoing effort to synchronize the visual and the aural. These tendencies are complemented by a readiness to associate this excess sonic energy, particularly sound produced by feathers and/or generated by dance, with a seemingly warlike foreigner; within more pacific environments, that surfeit of sound is generally the token of lower classes, of a fleshly faith, of bodies numbed by labour, but somehow still at risk of conflating hearing with feeling. But this is not to deny the attraction of the sounds evoked in these images and texts: for every gesture to discordant, harsh, and unnatural noises, there will be those who insist on their melodious potential, and for every uninformative graphic gouge in the wood, fine and subtle gradations running rapidly across the metal plate, as if the faint sibilation of their production had re-emerged in the crackling energy of the mezzotint.<sup>32</sup>

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<sup>31</sup> For a typical instance of his approach, compare Perrault’s reference to a fan (6) to Bose’s gesture to Propertius’s version, made of peacock feathers (22).

<sup>32</sup> See, in particular, Gaudio 2–4, 40–43, 48–49, 55, 73–79, 84–85, 87, 95, 102–03, 106–13, 124, 130, 135, 141–44, 149.

Let us return, by way of conclusion, to Galileo's avian protagonist. It appears that the astronomer had intuited something fundamentally correct, and startling, about the peacock, the ultimate fulfilment of his bold claim of "novelties unheard of through the ages." The term "infrasound," popularly understood to be sonic phenomena at or below the human auditory threshold of 19 hertz, would not emerge until the early twentieth century, when it was quickly seen as a kind of covert weaponry. The peacock, among other animals, generates just such vibrations when, "like some soldier," he rattles the unseeing eyes of his train; this aural rather than visual signal is most effective in the dense woods in which it often occurs (Freeman and Hare 241–50; Mühlhans 267–86; Roosth 109–24). These very low-pitched phenomena are and will remain inaudible to us: we hear only a sound slightly beyond that range, just as we see only the faintest suggestion of those cast shadows on the lunar surface. These fleeting perceptions, where one sense supplements or struggles with the other, offer the strangest of encounters.

*Princeton University*

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