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RESEARCH ARTICLE

Tuning Sounds in Italy, 1750–1885

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Abstract

This essay takes as its point of departure the so-called 'Verdi A', 432Hz. From the late 1860s through to the 1880s, the opera composer was intensely preoccupied with the question of tuning, weighing in several times on the matter of where A should sit. Verdi was concerned for the strain that high tunings should place on singers' voices. He advocated on multiple occasions for global acceptance of an A well below 440, and sent Arrigo Boito to argue in favour of A=432 at the Congresso dei Musicisti Italiani, held in Milan on 16–21 June 1881. In the 1880s, Italy remained one of the only nations in Europe that had not adopted equal temperament wholesale for fixed-tone instruments; as in the case of its spoken languages during this same period, and the locations of its A, temperament varied by region, with the southern part of the peninsula clinging to meantones. This article argues that 'Verdi tuning' represents the end point of a number of longer shifts in the conceptualization of musical sound, particularly in the Italian context: from temperament to tuning (*accordatura*); from relative conceptions of musical pitch to an absolute one; from local and regional variations towards a standardized system; from an older notion of all-encompassing nature to a presumed separation between nature and culture. Tracing this history through the Italian long nineteenth century will involve concentrating on what this article calls music-adjacent sound: that is, interrogative play with musical pitch; sound experiments from musical materials and operatic voices; instrument tuning by ear; listening for overtones; legislating preferred ratios and (eventually) frequencies for musical use; and constructing a theory of music that draws together these means of sounding. Music-adjacent sound is where the conditions for music-making were and still are established. This article argues that an attention to these sonic and nearly musical moments can demonstrate how listening and the musical imagination were cultivated outside the boundaries of any work or performance.

You Can Feel the Difference!

Amongst the many products marketed online for the wellness crowd, surely one of the strangest is the Verdi Tuning Fork, which sounds a pristine middle C of 256 Hz, also known as 'Verdi Scientific Pitch' or 'Philosophical Pitch'. Available on multiple wellness websites, Verdi forks are designed to recalibrate concert-A pitch downwards to 432Hz from the concert standard of 440Hz, on the grounds that the lower A is a 'healing frequency' and offers greater attunement within the body and with nature. The tuning fork represented in Figure 1, for instance, is useful for a broad array of tasks, ranging from musical tuning and 'sound experiments' to 'healing tuning, science lab, [and] calibration'. ('Teachers love this one'.)[1] According to Texas-based firm Tools for Wellness 'you can feel the difference'

[1] SWB 256 Tuning Forks, https://swb256.com/product/c256hz-verdi-tuning-fork/ (accessed 25 April 2023).

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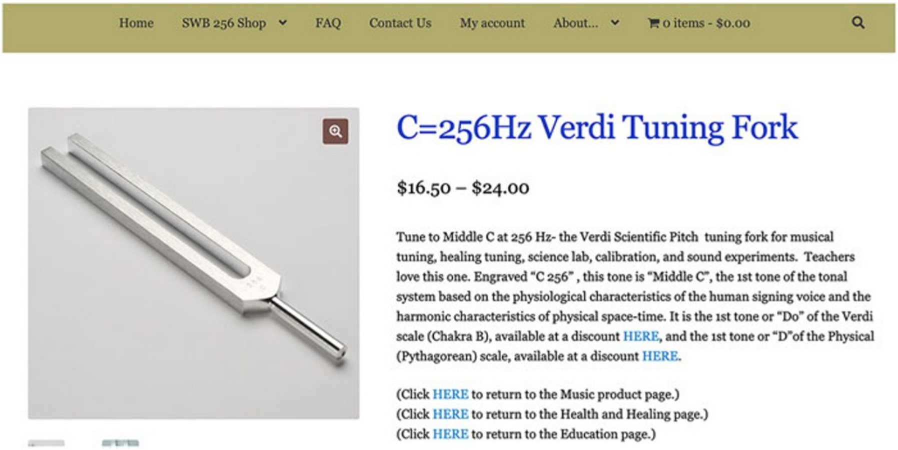

Figure 1. Verdi Tuning Fork, sold at swb256.com/product/c256hz-verdi-tuning-fork/.

with Verdi A. The lower tuning 'vibrates/oscillates on the principles of natural harmonic wave propagation and unifies with the properties of light, time, space, matter, gravity and electromagnetism. The Sun, Saturn, Earth and Moon, all exhibit ratios of the number 432'.[2] When you sound a Verdi tuning fork, the company promises, 'your atoms and DNA starts to resonate in Harmony with the PHI spiral of nature'.[3]

These ideas are not merely the province of the anonymous digital marketplace. A432 has powerful support from the Schiller Institute, an international organization with far-reaching political and cultural influence, which dedicates its energies toward global reform of all thought systems, based on the ideas of Friedrich Schiller.[4] The Schiller Institute began to promote 'Verdi tuning' in the late 1980s, briefly enjoying the support of such notables as Placido Domingo, Joan Sutherland, and Mirella Freni. It sponsored a number of demonstrations of the superiority of Verdi tuning for Italian and American audiences during the 1990s, and was responsible for introducing a bill to the Italian parliament to have 'the natural tuning' made mandatory for Italian orchestras, reportedly including provisions for fining musicians who do not adopt the new A, or are caught in possession of tuning forks of calibrations other than 'Verdi's scientific tuning fork, A=432'. The Institute also sought to establish an orchestra that used only 'Verdi tuning' in Busseto in 1999, in preparation for the composer's centenary.[5]

What has Verdi to do with any of this? Not much, of course, and yet not nothing either. From the late 1860s through to the 1880s, Verdi was intensely preoccupied with the question of tuning – what Italians called the *corista* or (following the French) *diapason normale*. The composer weighed in several times on the matter of where A should sit, advocating an A of 435 Hertz in the case of his Requiem, and on another occasion suggesting that A=432 was more comfortable. As with the standardization of clock time, the standardization of A followed upon the rise of rapid and frequent transit of musicians between European capitals. And parallel advancements in acoustic technology and political infrastructure

[2] Tools for Wellness, www.toolsforwellness.com/product/432-hz-tuning-fork/ (accessed 25 April 2023).
[3] Tools for Wellness, www.toolsforwellness.com/product/432-hz-tuning-fork/.
[4] The online arm of the think-tank may be found at https://schillerinstitute.com/.
[5] 'New fronts open up in the "War of the Tuning Forks"', *EIR* 16/25 (16 June 1989): 18–19. See also Enzo Crotti, *Integral 432 Hz Music: Awareness, Music and Meditation*, trans. Maddalena Rossi (Morrisville: Wenz Books, 2016).

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put sound frequencies in the hands of national governments across Europe, allowing for the dissemination of centrally established pitch standards outward to the provinces and colonies.

Predictably, it was in terms of standardization – and not embodiment, nature, or (god forbid) chakras – that Verdi phrased his pronouncements on the matter of pitch. He wrote, 'Why is it that the note which is called A in Paris, or Milan, should become a B- flat in Rome?'[6] He was concerned for the strain that 'too high a tuning fork' should place on singers' voices, advocated on multiple occasions for universal (global) acceptance of an A well below 440, and sent Arrigo Boito to argue in favour of A=432 at the Congresso dei Musicisti Italiani, held in Milan on 16–21 June 1881.[7] In the 1880s, Italy remained one of the only nations in Europe that had not adopted equal temperament wholesale for fixed-tone instruments; as in the case of its spoken languages during this same period, and the locations of its A, temperament varied by region, with the southern part of the peninsula clinging to meantones, apparently to the surprise and horror of travelling soloists.[8] In intonation as in politics, as we will see, the Italian imperative to globalize was most attractively couched in terms of love, interconnectedness, and ecstatic warm fellow-feeling.

There are many ways in which 'Verdi tuning' – both in the narrower and the broader senses – represents the end point of a number of longer shifts in the conceptualization of musical sound, particularly in the Italian context: from temperament to tuning (*accordatura*); from relative conceptions of musical pitch to an absolute one; from local and regional variations towards a standardized system; from an older notion of all-encompassing nature to a presumed separation between nature and culture; from an older paradigm in which music, as an embodied, affect-laden practice, was approached through number and proportion to one in which connections between number, proportion, and feeling were solely the domain of crackpots and online snake-oil peddlers.

Tracing this history through the Italian long nineteenth century will involve concentrating on what we might call music-adjacent sound: that is, interrogative play with musical pitch; sound experiments from musical materials and operatic voices; instrument tuning by ear; listening for overtones; legislating preferred ratios and (eventually) frequencies for musical use; and constructing a theory of music that draws together these means of sounding. Such activities involve sound that is not precisely music, nor is it strictly non-musical, for it plays with musical materials. Music-adjacent sound is where the conditions for music-making were and still are established. An attention to these sonic and nearly musical moments can remind us how listening and the musical imagination were cultivated outside the boundaries of any work or performance. In what follows, I will point to several factors which contributed to the unique epistemology of Italian acoustics and tuning. Key among these was the Tartini tone or *terzo suono* ('third tone'), widely known, but uniquely important for Italian acoustical scientists and music theorists during the century to follow. What is more, increasingly during the Risorgimento decades, the impetus to standardize pitch and temperament across the peninsula was driven by anxieties over the nation's persistent regionalism and historical backwardness.

6 Letter, 10 February 1884, in *Carteggio Verdi-Ricordi, 1882–1885*, ed. Franca Cella, Madina Ricordi, Marisa Di Gregorio Casati (Milan: Ricordi, 1994): 423.

7 David Rosen, Introduction to *Giuseppe Verdi Messa di Requiem,* critical edition (Milan: Ricordi, 1990); see also the *Gazzetta musicale di Milano*, 13 November 1881; and John Sigerson, Lyndon LaRouche and Kathy Wolfe, *A Manual on the Rudiments of Tuning and Registration: Introduction and Human Voice* (Washington, DC: Schiller Institute, 1992), unpaginated.

8 For a marvellously detailed history of regional tunings in eighteenth- and nineteenth-century Italy, see Patrizio Barbieri, 'Temperament', trans. Hugh Ward-Perkins, in *The Piano: An Encyclopedia*, ed. Robert Palmieri (New York: Routledge, 2002): 393–4.

Trust the Ear

In his *Present State of Music in Germany, the Netherlands, and United Provinces* (1775), Charles Burney recounted an experience he had with two renowned Italian castrati, Gaetano Guadagni and Venanzio Rauzzini, in the bath house at the palace of the court of Nymphenburg in 1772. In one of these rooms that had particularly resonant acoustics, singing as loudly as possible, the two sopranos struck and held a major third: *c″* and *e″*. Then, emerging 'in the air' from no perceptible source, a third sound made itself heard: *c′* (middle C), a perfect octave below the lower sung note. The third tone, or *terzo suono*, was also known as a Tartini tone, in honour of its supposed discoverer, the violinist and composer Giuseppe Tartini (1697–1770). Burney recounted that the two castrati 'went successfully through all Tartini's experiments, in order, by sustaining with their voices consonant intervals, to produce a third sound, which is generated in the air, and is their true fundamental base'.[9]

Burney's claim that the two castrati went through 'all Tartini's experiments, in order' suggests that one of these musicians had access to a copy of the theorist's notorious *Trattato di musica secondo la vera scienza dell'armonia* (1754). Few documents in the music-historical archive embody the eighteenth-century union of nature, mathematics, and music better than Tartini's *Trattato*, which attempts – as its subtitle describes – to systematise the study of music according to 'the true science of harmony'. The foundation of his system was the *terzo suono*, which Tartini claimed to have discovered as a young man while practising double-stops.[10]

As we will see, the nineteenth century supplied an acoustic explanation for the Tartini tone: that is, an explanation relating to the behaviour of sound waves. In the process it became understood as an acoustic phenomenon. For Tartini, by contrast, it was a musical phenomenon, described in terms of tonal intervals. Tartini, who had no means to calculate vibrations per second, could only point out that the *terzo suono* was closely related to the sounding notes, often being a fifth or an octave below one of the treble notes when they were a third, fourth, or fifth apart from one another. Yet he could not explain why the third note should sound at all, given that there was no origin for it. Perhaps, he speculated, it was the result of the impact (*urto*) of one burst of air against another; in his view, this would also explain why the *terzo suono* was loudest for a listener halfway between the sources of the two notes.[11]

What was important for Tartini was the fact that the *terzo suono* was generated from small interval ratios (3:2; 2:1; and so on, numbered according to the Boethian system), meaning that the third note would sound when the upper two notes were likewise closely related. Thus it provided proof that the scale, triad, and tonal harmony more broadly were rooted in both nature and number: what he called the *scienza fisicarmonica* (*Trattato*, 47). Tartini consequently made the *terzo suono* the basis also of his compositions and playing techniques. The *terzo suono* gives this article its earliest instance in which music-adjacent sound – in this case, unexpected harmonies heard within the composer's violin practice – both legitimated an existing tonal paradigm, and fed back into newer, specifically discernible practices

[9] Charles Burney, *The Present State of Music in Germany, The Netherlands, and United Provinces* (London: Becket, 1775): 1:139.

[10] The oft-repeated fact that other musicians may have discovered these sounds independently in other locations is not important for my purposes. After all, the development of a violin technique in the early eighteenth century that involved sustained melodic thirds, fourths and fifths makes multiple simultaneous accidental discoveries of the 'Tartini tone' inevitable. A summary of the competing claims may be found in Robert T. Beyer, *Sounds of our Times: Two Hundred Years of Acoustics* (New York: Springer, 1999): 20.

[11] Tartini, *Trattato di musica secondo la vera scienza dell'armonia* (Padua: Giovanni Manfrè, 1754): 13–14.

within musical works.[12] His resourcefulness was justified by a belief that nature was the source of all truth; and as one of nature's most closely guarded secrets, the *terzo suono* was a regulatory principle governing music and nature alike, entrusted to him in the manner of a revelation.[13]

Tartini's reliance, in his music theory, on an understanding of occult nature, and his numerous mathematical errors, have been amply interrogated in recent years.[14] Yet it is important not to imagine him wandering amongst the forests of northern Italy, as the trees whisper their secrets to him under the cover of night, as the mythology of Stradivarius has bizarrely held.[15] For Tartini, 'nature' did not denote verdant biological matter, flora and fauna, but rather (as Pierluigi Petrobelli inimitably phrased the matter) 'all the phenomena which fall under our senses and are exempt from any intervention of man throughout history'.[16] Indeed, Tartini's nature, which pervades nearly every page of his writing, has very little of the verdant or biological about it. His treatise speciates a *natura armonica, natura contrarmonica, natura aritmetica*, and *natura geometrica*, as well as insisting that each natural object or concept had its own 'intrinsic nature', yet these were all manifestations or subcategories of a universal *natura* which was frequently in opposition to (and must be victorious over) human taste in the practice of music. Nature – and, by extension, music – was regulated by complex laws, elucidated by mathematics. And yet its ultimate condition was unity. As one of his readers summarized the matter: 'Tartini shows the nature of harmony to be a unified nature' (Tartini dice essere la natura armonica natura di unità).[17]

The density of mathematical calculations within Tartini's *scienza ficisarmonica* was off-putting to the uninitiated, while mathematicians were put off by his frequent errors.[18] To the extent that Tartini has received scholarly attention in recent decades, he has been depicted as something of a crackpot or historical anomaly, steeped in Catholic mysticism and covetous of an intellectual prestige that far outstripped his capabilities.[19]

[12] The topic is treated in brief in Patrizio Barbieri, *Quarrels on Harmonic Theories in the Venetian Enlightenment* (Lucca: Libreria Musicale Italiano, 2020): 31–3.

[13] The mystic, recondite qualities of Tartini's world view are described with considerable patience in Petrobelli, 'Tartini, Giuseppe', *Grove Music Online*, 2001 (accessed 31 Dec. 2019). For an early English-language reception document, see B. Stillingfleet, *Principles and Power of Harmony* (London: Hughs, 1771). We may also see the relationship of harmony to 'nature' helpfully defined in the second volume of Francesco Galeazzi, *The Theoretical-Practical Elements of Music*: 'Harmony has its beginning in nature, and it cannot be subject to human fancy, since man is not able to alter its laws at will. It is therefore a true science, the unalterable principles of which Nature herself suggests to us. It is for us to follow them step by step, and it is not permissible to deviate from these in any way at all without gravely offending the hearing, which is to say, the organ destined by the greatest architect to enjoy the effects of this wonderful science. For a long time, composition was done by groping in the dark and with few, scarce rules dealing with melody. A fanciful harmony was therefore invented that never corresponded to the ends for which it had been destined because it was not the harmony of nature. The great discovery of the true physical harmonic principle was left to two great men of this enlightened century: one of these was M. Rameau, a Frenchman, and the other Sig. Giuseppe Tartini of Padua'. 'On the Physical Harmonic Phenomenon', in *The Theoretical-Practical Elements of Music, Parts III and IV*, First published in 1796, trans. Deborah Burton and Gregory W. Harwood (Champaign: University of Illinois Press, 2012): 147.

[14] See Alejandro Planchart, 'A Study of the Theories of Giuseppe Tartini', *Journal of Music Theory* 4 (1960): 32–61; Barbieri, *Quarrels on Harmonic Theories*, 61–110.

[15] See, for instance, John Laurenson, 'Stradivarius Trees: Searching for Perfect Musical Wood', *BBC News*, 14 April 2013.

[16] Petrobelli, 'Tartini, Giuseppe'.

[17] Pizzati, *La scienza de' suoni, e dell'armonia: diretta specialmente a render ragione de' Fenomeni, ed a conoscer la Natura e le Leggi della medesima, ed a giovare alla pratica del Contrappunto. Divisa in Cinque Parti* (Venice: Gatti, 1782). Pizzati references pages 62 and 64 in Tartini's *Trattato*.

[18] Barbieri, *Quarrels on Harmonic Theories*, 61–2, 111–40.

[19] See, for instance, Pierpaolo Polzonetti, 'Tartini and the Tongue of St Anthony', *Journal of the American Musicological Society* 67 (2014): 429–86.

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However – and this brings me to my first thesis – Tartini remained central to Italian music theory in the late eighteenth and early nineteenth centuries; and his influence, as well as the conception of nature which he used to regulate harmonic theory, determined the preconditions for music-making in Italy well into the nineteenth century.

The *terzo suono* after Tartini

There was a rich corpus of speculative, post-Tartinian Italian writings on musical sound: one that historians of theory have largely overlooked until very recently. During the final two decades of the eighteenth century, several Italian theorists sought to relate elements of musical practice to the behaviours of musical sound, as interrogated through experimental play with music-adjacent sounds including resonance, scale-tempering, and especially the Tartini tone. Pietro Lichtenthal's four-volume *Dizionario e bibliografia della musica* (Milan, 1826) gives an early account of the Italian reception of Tartini's treatise, as well as its limited reception in other places. (Lichtenthal wrote: 'The ideas of Tartini were admired greatly in Italy; not much in France, and not at all in Germany'.[20]) As Patrizio Barbieri has noted, many of Tartini's early disciples were also from Padua or Venice, and they moved in the rich intellectual and artistic circles surrounding University of Padua and the St Anthony's Basilica.[21] The Italian music theorists considered below – Giuseppe Pizzati, Alessandro Barca, and Francesco Vallotti – marked an early point of consolidation of Tartini's influence, synthesizing his findings on the *terzo suono* for nineteenth-century readers.

Like Tartini's *Trattato*, Giuseppe Pizzati's *La scienza de' suoni, e dell'armonia* (1782) was concerned with generating a 'science' connecting the study of sound as rigorously as possible to musical practices, including not only intervals and modes but even more complex procedures of melody and part-writing.[22] Pizzati's goal was nothing less than a 'complete and exact system' of sound, which he ultimately calls a 'Harmony of Nature', derived from a study of Rameau's *corps sonore* and Tartini's *terzo suono*. Like Tartini, but unlike Giuseppe Barca (considered below), Pizzati believed that music theory could be derived entirely from physical principles. His theory of sound is, in fact, a theory of musical consonance; Barbieri notes that his primary contribution to the history of music theory lay in his assertion that the *terzo suono* was determinative of the level (or *forza*) of consonance of a chord, and thus its 'tonal function'.[23]

His title notwithstanding, one may read Pizzati's book in vain for a definition of sound: indeed, from the first pages to the last, *suono* – or *tuono*, as it is sometimes called with no evident differentiation of meaning – is elusive and irreducibly relative. Elsewhere *tuono* is synonymous with mode – is the material of music, the starting matter. *Il suono* is what we would understand to be any consistently pitched sound (though Pizzati does not say as much); in his system, any *suono* can be *do*, the tonic, 1, whatever you might call it. Pizzati does not use pitch letters, nor does he notate his examples. Indeed, the primal sound is

[20] 'In Italia fu ammirato molto, in Francia poco, ed in Germania quasi niente'. Lichtenthal, *Dizionario e bibliografia della musica* (Milan: Fontana, 1836): vols. 3–4: 238.

[21] Patrizio Barbieri, *Quarrels on Harmonic Theories*, vii–xv.

[22] Pizzati acknowledges in the preface that, while Tartini made 'una utilissima scoperta del fenomeno del *terzo suono*', the Paduan violinist was nonetheless 'inesperto di giustamente filosofare, accozza insieme nel suo Trattato, e nella sua Dissertazione sulla musica, idee si stravaganti, e sconnesse, e conseguenze sì disparate e illegittime, che ci vuol gran pena a poter dare a ciò che dice, un qualche ordine intelligibile'. Pizzati sought to do well what Tartini had done badly, 'esaminare i due fondamentali fenomeni uno della risonanza del corpo sonoro, e l'altro del terzo suono ... per formar un completo ed esatto sistema' (Pizzati, *La scienza de' suoni, e dell'armonia*, Preface, v–vi). Pizzati's treatise received a degree of recognition not only on the Italian peninsula but more broadly throughout Europe; Charles Burney described it in his *General History of Music* as being devoted to 'explain[ing] the phenomena of sound, as far as they may be useful to the practice of counterpoint' (4: 576).

[23] Barbieri, *Quarrels on Harmonic Theories*, 268.

always *do*; the sounds that can be generated with it or alongside it are subsidiary, existing in analogous or disanalogous relationship with *do* (that is, belonging or not belonging to the sound's *corps sonore*, and/or existing in simple numerical ratio with it). The inescapable relativity of sound in Pizzati's treatise is amply evident from the fact that he uses ratios to describe pitches other than *do*, resorting to solfeggio (not musical notation) only after the proportions of the scale have been established, to give examples of melodies and bass lines.

This mathematical approach to music theory – without notated examples, with all tones put in relation by means of ratios, and with a focus on the *terzo suono* – is even more evident in the work of the chemistry professor Alessandro Barca.[24] Barca's *Una nuova Teoria di Musica* was written around the same time as Pizzati's treatise, and published in instalments in the *Saggi scientifici e letterari dell'Accademia di Padova*. Barca was as preoccupied as Pizzati with the *terzo suono*, which he found useful in proving the priority of simple ratios and consonance within the science of harmony ('quel fenomeno atto a facilitare la percezione e l'effetto de' rapporti nell'armonia e nelle consonanze efficaci').[25] Barca's project, which he pursued from the mid-1780s until his death in 1814, was to create a general theory of consonance that moved beyond the simplicity of numerical ratios, valorizing instead (or in addition) the listener's perception and musical intuition. A brief sample of Barca's writing on the *terzo suono* will provide ample evidence of the ways in which the post-Tartinian science of harmony embraced intuition, listening, and ratios:

> Now it is clear that the *terzo suono* must have much influence in the determination of the bass, that is, the principal sounds in consonance and harmony. And in fact if in the relationship 2:3, the second ratio being less simple than the first, the placing of 2 below and 3 above suffices because the 3 resonates with 2 rather than the reverse, why then will [the *terzo suono*] not have its part in this effect, given that in these circumstances of sounds 2 and 3 a third sound, 1, is produced of precisely the same pitch as 2? Likewise in the relationship 3:4, duplicating the ratio in 4:6 or 2:3, the greater simplicity of the latter ratio means that in 3:4 the 3 below resonates with the 4 above and not vice versa; why, given the same effect under the same circumstances, does it not occur that, from 3 and 4, a 'terzo suono' of 1 is produced that is exactly the same pitch as 2 and 4? From this, we have decisively proven the influence of the third tone in determining the basis of consonance and of harmony.[26]

Barca's goal here is to show the harmonic simplicity of the Tartini tone, its tendency (at least for lower-integer ratios) to supply the harmonic bass where, for instance, the two sounded notes were a perfect interval apart. Thus, it is a confirmation from nature of what had already been determined in culture. What is more, the fact that the *terzo suono* is a heard

[24] Barca and Pizzati make up two thirds of the influential post-Tartini Paduan school of sound-based music theory; the third member was Francesco Vallotti, whose writings circulated primarily in manuscript and who seems to have been more sceptical about the explanatory power of the Tartini tone.

[25] Barca, 'Memoria I del P.D. Alessandro Barca C.R.S. di una nuova teoria di Musica', in *Saggi scientifici e letterari dell'Accademia di Padova* III (1794): 70–87, here 80.

[26] 'Ora è manifesto dovere il terzo suono aver molta influenza nella determinazione delle basi, ossia de' suoni principali nelle consonanze e nell'armonia. E di fatto se nella ragione 2:3 essendo il rapporto secondario meno semplice del primo, il collocamento in grave del 2 e del 3 in acuto basta perchè il 3 suoni col 2 piuttostochè al contrario; perchè poi non avrà la sua parte in quest'effetto che poste le medesime circostanze da' suoni 2 e 3 se ne produca un terzo 1 del medesimo tuono precisamente col 2? Così se nella ragione 3:4 duplicandosi il rapporto in 4:6 ossia 2:3 la maggior semplicità di questo secondo rapporto influisce perchè nel primo 3:4 il 3 grave suoni col 4 acuto piuttostochè al contrario; perchè poi nel medesimo effetto poste le medesime circostanze non influirà ancora che dai suoni 3 e 4 si produca il suono 1 dello stesso tuono precisamente del 2 e del 4? Nè al discorso nostro concludentissimo per provare l'influenza del terzo suono nella determinazione della base delle consonanze e dell'armonia si obietti da alcuno.' Barca, 'Memoria', 80.

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phenomenon, not one that is calculated or produced, places us firmly within the domain of empiricism, albeit an empiricism that constantly seeks grounding in mathematics, with links on the one hand to existing musical practice and on the other to kinds of reasoning drawn from ancient thinkers.[27]

Both Vallotti and Pizzati mention, only in passing, the possibility that pitch could be quantified or fixed outside of these relativist systems (the 'musical notes ... as eternal and immutable as the physical laws upon which they depend!' heralded by the Italian War Ministry in 1884). Their treatises supply the earliest Italian accounts of what would later be known as the *diapason* or *corista*: in other words, a fixed and externally regulated pitch. Vallotti and Pizzati referred to the pitch as *il suono fisso*, an Italianization of the term *son fixe* given it by the early eighteenth-century French scientist Joseph Sauveur. Sauveur's idea was (as Pizzati paraphrased) to make pitch 'absolute, not relative': 'il suono fisso ... dovesse servire di limite inalterabile a dividere i suoni in gravi, e in acuti, di maniera che questa denominazione fosse per l'avvenire assoluta, e non relativa'. While he (and others) mistakenly believed that Sauveur's 'A' sounded at 100 vibrations per second, Pizzati praised the invention for its potential to eliminate geographical variation, imagining how marvellous it might be if 'one could be certain of the precise pitch should a symphony, an aria, a musical work be performed in whatever location' (si potrebbe sapere il tuono preciso di voce nel quale in qualunque luogo eseguita si fosse una sinfonia, un'aria, un'opera in musica).[28] And yet, Pizzati noted that Sauveur's *suono fisso* had not caught on. The problem, he suggested, might be that it was simply impracticable on a large scale. After all, the tuning instrument on which Sauveur made his calculations around 100 cps was a five-foot-long organ pipe. Tuning forks – the instrument *par excéllence* of the 'immutable' A – remained a novelty throughout the eighteenth century, particularly outside of England.[29]

Ultimately, then, the matter of the 'suono fisso' remained a matter of passing interest, a mere aside, in late eighteenth-century discussions of sound; while the *terzo suono* remained unexplained, and perhaps because of this, it retained a profoundly generative potential, being called upon again and again to explain musical knowledge. Both kinds of sounds were decisively reframed in Italian thought beginning in the 1850s, with far-reaching consequences for tuning and for the disciplinary configurations around music, listening, and acoustics.

Do Not Trust the Ear: The *terzo suono* in the 1850s

The centrality of the *terzo suono* to Italian sonic discourses was consolidated again at mid-century in the writings of Francesco Zantedeschi, who was, like Barca several decades earlier, a professor of physical sciences at the University of Padua. Zantedeschi's experiments on the *terzo suono* show a decisive shift taking place in its theorisation and framing. 'I encourage scholars to read Tartini's original work, and also that of Pizzati and Vallotti,

[27] Tartini's cosmology owes much to Plato. See Giovanni Guanti and Marcello Piras, 'Chi ha paura della "scienza platonica fondata nel cerchio" di Tartini?', *Rivista italiana di musicologia* 38 (2003): 41–73.

[28] Sauveur's *son fixe* was set at 100 cps when he proposed it in 1700, and he revised this in 1713, proposing what is now known as 'philosophical' or 'scientific' pitch, C256. One of the appeals of this frequency was that every C was an integer. See also Abraham Wolf, *A History of Science, Technology, and Philosophy in the Eighteenth Century*, first published 1938 (New York: Routledge, 2019): 85. Wolf names Sauveur alongside Chladni as the two major figures in eighteenth-century acoustical science.

[29] Haynes and other historians of pitch generally rely little on tuning forks before the late nineteenth century, noting that there was enormous variation in the pitches supplied by tuning forks, and these devices were rarely marked with any information about pitch, location of manufacture, or usage. They were manufactured in England well before they were used in other places. Bruce Haynes, *A History of Performing Pitch: The Story of 'A'* (Oxford: Scarecrow, 2002): 31–2.

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who spoke of this phenomenon', wrote Zantedeschi in his 1857 pamphlet 'On the Doctrine of the *Terzo Suono*, or, On the Combining of Vibrations'.[30] But Zantedeschi did not intend to discuss their theories at length, 'because I would go on at too great length, perhaps to the boredom of my readers and with little benefit for science, these authors not having had such precise and accurate means as we now do to determine the number of vibrations in a given pitch'.[31] Such means to measure pitch were available to Zantedeschi and his contemporaries thanks to Charles Cagniard de la Tour's siren, which became widely available in the middle decades of the nineteenth century. The siren allowed Zantedeschi to recreate Tartini's experiments with the *terzo suono*, arriving at an acoustical explanation that is still accepted today, with an important caveat to which we will return below.

Zantedeschi's investigations into the *terzo suono* led him to retrace the steps of the first Tartinians, and Tartini himself, through Padua. But his methods were different. Working with the organ of St Anthony's Basilica, operated by the organist and instrument maker Marzolo, as well as assisted by a younger physicist, Luigi Borlinetto, and, crucially, armed with the siren, Zantedeschi was able to confirm the hypothesis – which had circulated since the early years of the nineteenth century – that the frequency of the Tartini tone was equal to the difference between the two sounded frequencies.[32] Zantedeschi and his friends began where Tartini had, and Burney and the castrati subsequently, with the first 'chord' in his treatise. Rather than giving these in musical notation, though, Zantedeschi identified the notes in Hertz (or cycles per second) based on the reading of the siren. The experimenters combined a note (*Do*) of 512 Hz with the major third above, *Mi*=640 Hz; on the organ, these were two-foot pipes. The resulting tone, which Zantedeschi tellingly called the 'differenza', was *Do* two octaves lower, 128 Hz. Fourteen subsequent experiments on the Basilica's organ confirmed the principle, with the experimenters noting that 32 Hz represented the lower pitch limit of a perceptible *terzo suono*. The physicists and the organist repeated these experiments on other local organs: that of the chapel of the Madonna Mora, where the *terzo suono* was also heard clearly; on the pipe organ in Marzolo's home; and with pipes that were at Zantedeschi's disposal for a course on physics that he was teaching that academic year at the University of Padua.[33]

Zantedeschi then shifted his experiments to his own home, inviting a group of musically minded friends to listen collectively for these 'difference' tones as created by other means. For this sociable evening of music and science, which took place on a Holy Thursday, 9 April 1857, the physicist enlisted the talents of two professional oboists resident in the area, a father and son with the family name Pighi. Suddenly he found that the question of the *terzo suono* became considerably more complicated, with even musically educated listeners recording different 'third tones'. Of the sixteen experiments with oboe tones, loudly sustained and with the listeners placed carefully between the two instruments, a full eight, or 50 per cent, produced results other than the 'difference tone' calculated from the frequencies given by the siren. 'I am happy to relate these discrepancies', wrote Zantedeschi, 'to give a sense of the difficulty that is sometimes encountered in determining the resulting *terzo suono*'.[34]

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[30] Francesco Zantedeschi, *Delle dottrine del terzo suono, ossia della coincidenza delle vibrazioni* (Vienna: Gerold, 1857).

[31] 'Io non amo di entrare in lunga discussione delle loro teorie, … perchè mi dilungherei troppo soverchiamente, e forse con noja de' miei lettori e con poco frutto della scienza, non avendo avuto essi mezzi così precisi e perfetti, quali noi possediamo a' nostri giorni per determinare il numero delle vibrazioni, che costituisce un dato tono'. Zantedeschi, *Delle dottrine del terzo suono*, 146.

[32] This hypothesis originated in Thomas Young's writings on acoustic interference in the first years of the nineteenth century, articulated before the existence of tools to measure frequency. See Julia Kursell, 'A Third Note: Helmholtz, Palestrina, and the Early History of Musicology', *Isis* 106/2 (2015): 353–66.

[33] Zantedeschi, *Delle dottrine del terzo suono*, 5.

[34] Zantedeschi, *Delle dottrine del terzo suono*, 15.

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Zantedeschi's third-tone house party resembled Burney's bath-house fun in its sociability. But the two differed in important ways: in the separation of performers and listeners; in the organizing presence of a professional physicist specializing in acoustics; in the use of the siren to measure frequencies, and the paradigm-shifting explanation it generated. Perhaps the most important distinction lay in the discrediting of aural perception. The ear's findings differed often from the official 'difference' tone, but in ways that could be explained with the known limitations of human hearing; for instance, very low tones were mistaken for tones an octave or two higher, perhaps because only the upper partials were heard. Thus the true 'third tone' was the mathematical finding of frequency difference; it was sometimes heard correctly, and other times misheard, and sometimes sat outside the range of human hearing but nonetheless existed. Zantedeschi's confirmation of the acoustic formula of the Tartini tone was less interesting than his methods, which demonstrated conclusively that perceptions of this tone varied according to circumstances of timbre, volume, instrument, location, and observer. In this sense, his investigations contributed to a burgeoning pan-European discourse regarding the perception of sound, of which Hermann von Helmholz was the most famous exponent.[35] Zantedeschi's conclusion – its importance cannot be overstated – was that one could not fully trust the ear in the matter of the *terzo suono*.

What The Siren Also Said

As this last statement suggests, there was considerable tension in mid-century Italian acoustic theory between, on one hand, a tendency to seek abstract truths, and on the other, empirical methods of investigation rooted in Enlightenment sociability and perception. In the ensuing Risorgimento decades, this tension gained political inflections as acoustic science metastasized to a national arena, the body politic replacing the domestic body, a shift traced in microcosm by Zantedeschi's career. While Zantedeschi was conducting the experiments described above, he began to notice troubling inconsistencies in the pitch standards of different instruments: a note from Pighi's oboe, a mere 50 years old, sounded a full tone below the same note sounded on the organ. Armed, again, with his siren to measure frequencies, the indefatigable Zantedeschi set out again to compare the *diapason* across Padua, from organ pipes across various musical instruments to tuning forks and church bells. The experiments confirmed on the regional level what the French acoustician Jules-Antoine Lissajous had recently determined about pitch: there was immense variation of tuning, both within cities and between European cities. What is more, historical evidence suggested that standard pitch was continuously rising, and at an accelerating pace.[36] Zantedeschi published his own conclusions that same year, in another pamphlet, 'On the Standardization of Musical Sound Measurement'.[37] Here, Zantedeschi called for the adoption of a universal *diapason*, A=435, as Lissajous had recommended for France two years earlier.

If the gradual standardization of A across Europe, first to 435 Hz and then to 440 Hz, seems inevitable to us now, that is because either its propaganda was successful or at least the promises of that propaganda have been filled. These promises, that positive international connectedness would follow upon shared measurement, and that external scientific measurement of sound was a benign or neutral vector in European musical cultures, are

[35] Zantedeschi may or may not have been aware of Helmholz's essay 'Ueber Combinationstöne', published the year prior in the *Annalen der Physik und Chemie* 99 (1856): 497–540.

[36] Jules-Antoine Lissajous, 'Note sur l'élévation progressive du diapason des orchestres depuis Louis XIV jusqu'à nos jours et sur la nécessité d'adopter un diapason normal et universel', *Bulletin de la Société d'encouragement pour l'Industrie Nationale* 54/2 (1855): 293–7.

[37] Zantedeschi, *Della unità di misura dei suoni musicali* (Vienna: Gerold, 1857).

part of the insidious rhetoric of external 'norms' that cast them as inevitable while ignoring the richly textured local practices that they obliterated. In the case of A, the triumph of an acoustic, external measurement-based understanding of pitch over the relative one – the triumph of A as pitch rather than as *la* or tone – has been such that it is now difficult to think around or outside of it. As Fanny Gribenski has noted, paraphrasing Simon Schaeffer, 'standards' power entirely depends on their invisibility'; pitch standardization is 'one of music's blackest boxes'. She argues that much can be learned from looking at the historical formation of these standards: 'because they are the products of negotiations between different interests, fields of expertise, and actors, often the subject of controversies, standards provide unique insights into the fabric of social life'.[38]

The 'fabric of social life' that produced standard tuning in France is well known, having been laid out by Gribenski, but also described with unusual perspicuity by the historical actors themselves as part of a large-scale and highly politicized race to establish the standards that others would adopt. Lissajous likened his project of creating a *diapason normal* to the metric system:

> France now possesses a complete and authentic collection of various measures. The care brought to the confrontation between the secondary standards and the prototypes stored at the archives, the means employed to control, continually, the exactitude of commercial and industrial measures, grant the indefinite conservation of this admirable system. It would be desirable that the same principles be applied to the establishment and the maintenance of pitch, which serves, in some sort, as a sonic unit and for which there is no official standard up to today.[39]

Lissajous' project involved collecting data on the frequencies of the various As in circulation across Europe, which were published as an appendix to the final report of the Ministère d'état; he also assembled a congress of composers, performers, and instrument makers. The resulting A established as the *diapason normal* in 1859 was supported in France by an imperial decree, insisting on its use in all musical institutions receiving state support; its frequency was preserved as a monumental tuning fork on a marble pedestal, placed in the archives of the Conservatoire, and replicated in more portable tuning forks sent to all the major theatres and conservatories across France.

The Italian threads of this history of pitch standardization, and the concurrent decline of unequal temperaments, have been largely ignored; but they too bear witness to multiple rich overlapping networks of musical and acoustic-scientific practice in the second half of the nineteenth century. Zantedeschi's *Della unità di misura dei suoni musicali* – his titles were almost too on-the-nose – is evidence against Bruce Haynes' assertion, in his monumental *History of A*, that 'Italy seems at first not to have noticed the Diapason normal'. Italy absolutely noticed the Diapason normal. Indeed, as we will see, the anxieties that attended the lack of a shared standard, and the triumphalism upon its adoption, were particularly pronounced in Italy, and became only more so during and immediately after Unification. The As found on the Italian peninsula were amongst the highest of all, frequently sitting well above 450 Hz, as noted by Haynes and as attested by multiple nineteenth-century sources of which he was seemingly unaware. The rise of the belting tenor in Italian opera, and attendant anxieties about voices ruined by strain in the upper registers, made the quickening ascent of

[38] Fanny Gribenski, 'Sounding Standards: A History of Concert Pitch, between Musicology and STS', in *Rethinking Music through Science and Technology Studies*, ed. Antoine Hennion and Christophe Levaux (New York: Routledge, 2021): 26–46, here 26–7; Bruce Haynes, *A History of Performing Pitch*, 343–50.

[39] Lissajous, 'Note sur l'élévation progressive du diapason' (1855); quoted and translated in Gribenski, 'Sounding Standards', 29.

'A' in Italian opera particularly troubling.[40] What is more, the failure of the different musical centres across the peninsula to arrive at a consensus, the failure of the south to align itself with the north, the insistence of Neapolitan piano makers to continue to use unequal temperament, and the extreme heat in the south (which was increasingly recognized to have a dilatory effect on instruments): all these mirrored larger political, cultural, and linguistic concerns regarding the viability of Italy in the European 'concert of nations'.[41] At the same time, the diverse characters of the various unequal temperaments were acceding to an aural regime in which people or instruments were merely either in-tune or out-of-tune, and *temperamento* (relational tuning) gave way to *accordatura* (tuning to an external standard) as the organizing principle of intonation.

And it is here that strands of Italian sound discourse begin to accumulate around what would later be called 'Verdi A'. The pitch difference between northern and southern Italy – and the disinclination of southern Italy to standardize – was what drew that composer first to engage with the question of the *diapason normal*, in the late 1860s and early 1870s. It first comes up in his correspondence in the leadup to *Aida*'s premiere in Cairo; Verdi wrote to the orchestra director of the Khedivial Opera House, Nicola de Giosa, in the early days of 1871, to assert that he supported the universal adoption of the French diapason, A=435: it is the first issue he raises, clearly in response to a letter from de Giosa (now lost?) that sought to dispel any 'ill will' (*malinteso*) between the two.[42] One might be tempted to assume, given the colonial resonances of pitch standardization that Gribenski has charted, that it was the unheard-of prospect of a major opera premiere in Cairo that worried the composer.[43] But Verdi's correspondence makes evident that he was insisting on the diapason precisely because of an earlier argument between the two regarding the A employed at the Teatro San Carlo in Naples, when de Giosa was director of the orchestra there: 'there cannot be *ill will* between us, because I have never had the opportunity to be in contact with you, except, two years ago, on the subject of the *diapason* in Naples .... It is true that, to return to the question of the *diapason*, we were not in agreement then, and I see that we are now still not [in agreement].'[44] Only a few months later, in 1872, there was a prospective performance of *Aida* at the Teatro San Carlo; it had just been mounted in Milan with considerable success. The composer wished for guarantees that the San Carlo would provide the same choral forces and mise en scène, and guarantee the same diapason, as La Scala. The orchestral director there, Vincenzo Torelli, was reluctant to make the guarantee, possibly noting that it would be expensive; Verdi fired back that one did not need money, but rather good will (*buona volontà*), to embrace the diapason.[45]

Here again, then, we find the notion that the globalizing impulse was a matter of warm fellow feeling, a good attitude, a commitment to the 'social fabric' to which Gribenski alludes; by implication, in Verdi's correspondence, only the truculent refused to cooperate. But Verdi was being disingenuous, or at the very least optimistic, when he suggested that

[40] J.Q. Davies, *Romantic Anatomies of Performance* (Berkeley: University of California Press, 2014): 123–51.

[41] On the imagery of a 'concert of nations' as relates to pitch standardization, see Fanny Gribenski, 'Negotiating the Pitch: For a Diplomatic History of *A*, at the Crossroads of Politics, Music, Science, and Industry', in *International Relations, Music and Diplomacy: Sounds and Voices on the International Stage*, ed. Frédéric Ramel and Cécile Prevost-Thomas (London: Palgrave Macmillan, 2018): 173–92.

[42] Letter to de Giosa, 5 January 1871; *I copialettere di Giuseppe Verdi*, ed. Gaetano Cesari and Alessandro Luzio (Milan: Stucchi Ceretti, 1913): 235–7.

[43] Fanny Gribenski, 'Nature's 'Disturbing Influence: Sound and Temperature in the Age of Empire', *19th-Century Music* 45 (2021): 23–36.

[44] Letter to de Giosa, 5 January 1871, 235. 'Non vi può essere *malinteso* fra noi, perchè non ho mai avuto la fortuna di trovarmi in rapporto con Lei, se si eccettui, or sono due anni, per la questione del *diapason* di Napoli ... È vero che, per tornare alla questione del *diapason*, noi non fummo d'accordo allora, e vedo che no'l siamo nemmeno adesso.'

[45] Letter to Vincenzo Torelli, 22 August 1872, *Copialettere*, 682. 'E per il Diapason? non vi vogliono denari, ci vuole buona volontà!'

there was no financial outlay involved in the wholesale shift of an orchestral pitch. The instruments simply could not cooperate, even if the players were inclined to. One of the most frequently mentioned concerns of the regime of *accordatura* was that of collective or social tuning: could the instruments of the orchestra accord with one another, strings with winds, ensemble with organ or fortepiano?[46] The issue was complicated on the one hand by the fact that equal temperament had historically been regarded as a compromise only for fixed-tone (i.e., keyboard) instruments, and on the other by the fact that even relatively pitch-flexible wind and brass instruments could not easily adapt to a new pitch standard imposed from outside that was significantly different from shared practice. (A full tone separates 'Verdi A' from the very high As in use in Italian orchestras in the second half of the nineteenth century.) And then, of course, there was the ever-present concern of temperature variation and the slow degradation of instrument materials over time. Zantedeschi, again working with his siren, had put forward a theory that organ pipes made of hard woods like ebony were actually more reliable than steel pipes at keeping in tune; indeed, he wondered whether steel pipes were to blame for the gradual rise in pitch that was charted by Lissajous: because they were filed during the tuning process, their pitches were raised by the rubbing, without tuners even being aware of the slow shift.[47]

Ultimately, the siren revealed minute discrepancies in frequency and slow changes over time that the ear could simply not be trusted to hear. 'Amongst the ears of different individuals of the human species', asserted Zantedeschi, 'there is a considerable deficiency of perfection'. This deficiency stemmed from biological differences in the organs of hearing, as well as differences of education. One consequence of this new distrust was the rise of phonometrics in Italy, first in the form of specialized mechanical imports from abroad, and later as a native industry that (perhaps unusually) originated in the south. As early as 1827, the periodical *I teatri* advertised Roller and Blanchet's 'Cromametro'; in 1852 Catterino Catterini advertised his 'Glicibarifono', a simple way of tuning organs, in the *Gazzetta musicale di Milano*; two years later, the same periodical announced a new invention by Giuseppe Kail, from Prague, that would tune brass instruments 'based on mathematic-acoustic principles'.[48]

But the most elaborate and pompously advertised device was surely the series of 'phonometric tuning forks' announced by a Sicilian surgeon, Arcangelo Camiolo, in 1873.[49] Camiolo, born in 1831, practiced medicine for only about ten years before devoting his life to thinking about the intersections between acoustics, music aesthetics, and psychology. We will encounter Camiolo twice in the remainder of this article: the trajectory of his musical career, between his first writings on *accordatura* in the 1870s through to his death in 1909, may tell us much about the ways that the discourses of *accordatura* and temperament fed into a burgeoning discipline of psychoacoustics that presages many of the contemporary discourses on 'Verdi tuning'.

Effective advertising relies on creating needs that people may not have known they had. The problem identified by Camiolo, in the opening pages of his 'I Coristi (diapasons) fonometrici per la precisione del temperamento armonico', was that no two keyboards were ever tuned exactly alike, even by the same tuner using the same tuning fork: the problem was the unreliability of the tuner's ear. There were multiple different temperaments, each using different methods of eliminating the comma, Camiolo wrote, giving a brief overview (this was true in the south at the time of his writing but not in the north). However,

[46] See, for instance, Arcangelo Camiolo, *I Coristi (Diapasons) fonometrici per la precisione del temperamento armonico* (Turin: S. Francesco di Sales, 1873).

[47] Zantedeschi, *Della unità di misura dei suoni musicali*.

[48] *Gazzetta musicale di Milano*, 7 March 1852: 44; *Gazzetta musicale di Milano*, 8 October 1854, 327.

[49] Camiolo, *I Coristi*.

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> all these methods and these calculations entrusted to the variable judgment of the ear are not sufficient, and never will be, for the desired ease and precision of tuning [*accordatura*] … therefore the ear, not following any more the secret calculus that the soul makes unknowingly, proceeds always without a compass, without an exact norm, because the ear is no more a precise measurer of phonic changes than the eye is of linear quantities.[50]

In short, tuning could not be entrusted to the ear: one needed an external fixed pitch for every note of the scale, matched, of course, to the standard of the *diapason normal*. This would not only expedite the tuning of keyboard instruments, Camiolo announced, but also 'unif[y] with precision all the sounds of different instruments that until now could not play exactly in unison'.[51] Camiolo had invented two scales of forks, each based on the most exact and recent studies in acoustic science: one in equal temperament, and the other based on intervallic principles (*il sistema partecipato*).

Camiolo does not specify what he means by 'il sistema partecipato', the principle for the second series of tuning forks; it could be a temperament (though he does not say which), or it could be the untempered or Pythagorean scale. It is a curious fact of these debates that, while in practice the *diapason normal* and equal temperament proceeded alongside one another in Italy and used many of the same justifications, in acoustical science, as a series of numbers, equal temperament was unsightly; all the numerical beauty was on the side of ratio-based intervals. This was why Italians like Camiolo, and subsequently Bartolomeo Grassi-Landi and Pietro Blaserna, who approached tuning from the perspective of acoustics, embraced equal temperament as a necessary compromise but venerated the Pythagorean scale as an ideal. If Camiolo's two complete series of tuning forks appear a cumbersome concession to these competing principles, they have nothing on the four-manual harmonium built for the private laboratory of physicist Pietro Blaserna: the instrument, created by the Hanau-based firm of Anton Appunn, offered a different tuning system on each manual, including the Pythagorean or just intonation.[52]

It was this beauty of clean numerical ratios and just intervals, based on whole numbers, that led Italians finally to embrace the A of 432 Hz – recall, the pitch now known as 'Verdi tuning' – as a viable alternative to the French *diapason normal*. The frequency was first put forward as a 'Pythagorean diapason' by Charles Meerens, on the basis that it could generate an entire keyboard using only whole numbers. Meerens's ideas took hold in Italy more firmly than elsewhere in Europe. This was perhaps because his ideas were published and gained traction just as the new national governmental institutions such as the Italian War Ministry were beginning to regulate 'national' practices like military band tuning.[53] Meerens' most voluble advocates in Italy were Gioacchino Muzzi, who translated his treatise into Italian, and Bartolomeo Grassi-Landi, who, along with the like-minded Archimede Montanelli, argued for the adoption of 432 Hz in institutions across Italy in the first half of

[50] Camiolo, *I Coristi (Diapasons) fonometrici*, 7, 13: 'tutti questi metodi e questi calcoli affidati alla variabile discrezione dell'orecchio non sono sufficienti e non lo saranno giammai alla desiderata agevolezza e precisione dell'accordatura … quindi l'orecchio, non seguendo più il calcolo occulto che l'anima fa inconsapevole, va sempre senza una bussola, senza una norma esatta, poichè l'orecchio non è misuratore preciso delle alterazioni foniche come l'occhio non lo è delle quantità lineari'.

[51] Camiolo, *I Coristi (Diapasons) fonometrici*, 7: 'unificare con precisione tutti quei suoni di strumenti diversi che finora non corrispondono esattamente unisoni'.

[52] Miriam Focaccia, *Pietro Blaserna and the Birth of the Institute of Physics in Rome: A Gentleman Scientist at Via Panisperna*, trans. Christine V. Pennison (New York: Springer, 2019): 71–2.

[53] See, for instance, Acts 153 and 154 in the *Giornale Militare Ufficiale of the Ministro della Guerra*, dated 25 August 1884, which announced the diapason of 432 as well as a standardized nomenclature and construction of brass band instruments and percussion for cavalry and infantry bands.

the 1880s. Even Verdi, so enthusiastic in support of A=435 during the 1870s, came to voice a slight preference for 432 Hz on the grounds that it was even more comfortable for singers. As noted above, A=432 became the Italian diapason following a meeting of the Congresso dei Musicisti Italiani, held in Milan on 16–21 June 1881. But the most enthusiastic official endorsement of A=432, and the terminus point for relativist understandings of musical sound, came from the Italian War Ministry. A decree from the Italian War Ministry in 1884 prescribed A=432 for all orchestral and military ensembles on the grounds that 'music is one thing the world over, and musical notes are as eternal and immutable as the physical laws upon which they depend!'[54] The document functions as a useful reminder of the restrained violence that lay behind state-sponsored exhortations to standardize.

Italy had no time to adopt A=432 nationally, though, before the Musical Congress in Vienna of 1885 voted in favour of broad European acceptance of the French *diapason normal* (435 Hz). Verdi's librettist Arrigo Boito had been charged with representing the Italian interests of 432 Hz, which he did by marshalling a distinctively Italian imagery of modernization. His reference to a 'scientifically preferred pitch' suggests an awareness of Meerens' work, probably thanks to its above-mentioned Italian proponents:

> Our century is totally turned to the sun of science. The rays of this sun warm through and penetrate all disciplines of human knowledge, even also art. Were we to avoid the influence of this on us by not selecting the scientifically preferred pitch and [instead] choosing 435, we would be committing a type of anachronism.[55]

Boito's language here, his ecstatic endorsement of science as a unifier of people in all nations, may remind us yet again that globalist propaganda in the late nineteenth century drew heavily on an imagery of love and warm fellow feeling. I would like also to draw attention to his related idea, that a shared A would unify not only people but also disciplines, the arts and the sciences. As several historians (including me) have recently argued, a public discourse of science-inflected aesthetic connectivity flourished particularly in northern Italy during the 1870s and 1880s, most famously in Luigi Manzotti's ballet *Excelsior* (1881), but also in Italian theoretical writings on music that emphasized the value of communal listening.[56] Boito here displays what we might call a Manzottian aesthetics of connectivity, wherein a common light – variously construed as enlightenment, knowledge, science – shines over all people in all domains of human activity.

Conclusion

In one sense, we seem now to be right back where we started with Tartini: with a conception of music that insists above all on its connectedness to other domains of knowledge, particularly the sciences. A Latourian emphasis on actors' categories – that is, the things our Italian writers said they were thinking about – will only get us so far. So, for instance, we may say with confidence that the term 'acoustics', which dominates the second half of our narrative, was not used by Tartini, and occurs in the writings of the next generation of Paduan theorists (Vallotti, Pizzati, Barca) only as a translation of the title of Joseph Sauveur's book. Likewise, 'nature', the organizing concept of these early Paduans and especially Tartini, all but disappears for our later sources. This shift in categories maps with a degree of precision onto another one, from temperament to *accordatura*, a practical as well

[54] Quoted in Sigerson, LaRouge and Wolfe, *Manual on the Rudiments of Tuning and Registration*, 30.

[55] Cited in Gribenski, 'Sounding Standards', 36.

[56] See Gavin Williams, 'Excelsior as Mass Ornament: The Reproduction of Gesture', 251–68, and Ellen Lockhart, 'Circuit Listening', 227–48, both in *Nineteenth-Century Opera and the Scientific Imagination*, ed. David Trippett and Benjamin Walton (Cambridge: Cambridge University Press, 2019).

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as a conceptual one; and occurs with the new availability of phonometric devices and the new political imperative to standardize. Such devices, in confirming an acoustic explanation for the 'Tartini tone' or *terzo suono*, effectively removed it from the aural domain, at the same time displacing it as a generative music-adjacent object of knowledge.

And yet what Pizzati and Barca were discussing was certainly acoustics, even if they did not have the term to hand. Stephan Vogel asserted in 1993 that 'eighteenth-century acoustics was a virtually moribund field', going on to suggest that there were only two classic lecture-demonstrations in acoustics before the advent of Chladni's figures.[57] Notwithstanding important recent work on intersections of music and science around 1800, and excepting the scholarly interest in Rameau and the *corps sonore*, this assumption about a broader eighteenth-century lack of curiosity about sound has not yet been thoroughly dismantled. Eighteenth-century acoustic science is only 'moribund' if we discount the knowledge gained from listening to instrument tuning, and honing the intonation of double-stops – an interrogative play with music-adjacent sound, the 'laboratory', we might call it, where the preconditions of musical sound are forged – as well as writings that theorized music on the basis of this listening. In these matters, the Italian conversations on sound and its relation to music, from Tartini through to Camiolo and Blaserna, were as rich and productive as any in Europe.

While I have emphasized changes in thinking and practice in Italian discourses and practices of musical sound during the period, there are many continuities and recursions as well. Pizzati's project – to generate a useful theoretical account of musical practice from the properties and behaviours of the corps sonore and *terzo suono* – has a great deal in common with that undertaken by Pietro Blaserna nearly a century later, in his Helmholtz-informed *La teoria del suono, nei rapporti suoi colla musica*, written in the 1870s, translated into German, French, and English, and multiply republished into the early years of the twentieth century. Blaserna's aim was to bring together the study of physics and music, because 'the scholar of physical things did not venture far in the study of musical subjects', and 'our artists are not aware enough of the great importance that the laws of sound have in many musical questions': language implying a new project addressing a problem of specialization.[58]

It is also possible to insist on a connection between objects in ways that serve above all to draw attention to, even reify, their separation. This argument could certainly be made for the 'arts and sciences' imagery of Boito and Blaserna described above. After all, while Blaserna may have championed public science in print, his position and influence in post-Unification Italy allowed him to insulate acoustic inquiry from musical practice in unprecedented ways. Put in charge of the newly formed Central Office of the Diapason in Rome, he diverted a substantial portion of its funds to build himself the above-mentioned four-manual organ, keeping it for his own private use: 'It is not an instrument for a concert hall, but for a laboratory, and it allows one to study and try the whole of music theory', he wrote, perhaps a little defensively.[59]

For a more consistent engagement with public knowledge, we must return to Arcangelo Camiolo, the Sicilian inventor of the *coristi fonometrici*. Camiolo never returned to practising medicine after his first forays into the diapason debates; instead, he travelled, first to France to engage in further study, and then more widely to perform acoustical demonstrations in public lectures. We may find him listed as a demonstrator as late as 1904, at the World Fair in St Louis. His final publications – *Il musicometro. Legge Metrica e psicologica della musica*

[57] Stephan Vogel, 'Sensation of Tone, Perception of Sound, and Empiricism: Helmholtz's Physiological Acoustics', in *Hermann von Helmholtz and the Foundations of Nineteenth-Century Science* (Berkeley: University of California Press, 1993): 261.

[58] Pietro Blaserna, *La teoria del suono, nei rapporti suoi colla musica* (Milan: Fratelli Dumolard, 1875).

[59] Focaccia, *Pietro Blaserna*, 71–72.

(Turin, 1898) and *Essai sur les lois psychologiques de l'intonation et de l'harmonie expliquées par les comparaisons des mouvements et des rhythmes vibratoires* (Caltanissetta, 1913) – extended his earlier interest in sound measurement toward a new discipline, psychology, seeking to find within simple numbers and vibrations the 'laws' that governed perceptions of rhythm and harmony. These ideas were heralded as revolutionary by reviewers, and quickly forgotten. A correspondent for the *Revue philosophique* predicted that 'humanity will never reach further than this into the psychological law of music':

> Just as the vascular system, exiting the heart through the aorta, divides itself continuously down to the living body's tiniest arterioles, in this way rhythm animates and organizes periods formed of multiple measures, measures formed of multiple isochronous elementary durations (principal and fractional), and finally groups of vibrations in simultaneous, successive, and isolated sounds; [rhythm] extends, in a word, everywhere there is duration to be organized by periodic numbers, that is, throughout all music.[60]

Perhaps surprisingly, Camiolo's turn towards what came to be called psychoacoustics presaged a further development in the understanding of the *terzo suono*: namely, that it existed not *in the air* but rather *in the ear*; it was itself a psychoacoustic phenomenon, undetectable by devices registering vibrations without human involvement. These later publications also presage not only the numerology and wellness discourse of the present-day 'Verdi A' set, but also the more respectably academic discourse, recently emergent, of *vibrational ontology*, which proffers a 'vibration-centred framework' through which we might interpret all human experience 'in an always already mutually vibrating world'.[61] If tracing these themes through the twentieth century must remain outside the bounds of this paper, we can nonetheless note that the imperative to focus on music as resonance seems, with remarkable consistency, to pull at once towards specialization and an ominous assertion of the total connectedness of all things.

[60] Jules Combarieu, Review of Camiolo, *Il Ritmo vibratorio, principio scientifico nei rapport dei suoni musicali*, in *Revue philosophique de la France et de l'étranger* 41 (1896): 446–54: 'de même que le système vasculaire, sortant du coeur par l'aorte, se divise toujours jusqu'aux plus minces artérioles du corps vivant, de même le rythme vivifie et organise les périodes qui contiennent plusieurs mesures, les mesures formées de plusieurs durées élémentaires isochrones (principales et fractionnelles) et enfin les groupes de vibrations dans les sons simultanés, successifs, isolés; il s'etend, en un mot, partout où il y a de la durée à organiser par les nombres périodiques, c'est a dire à la musique tout entière'.

[61] Suzanne Cusick, 'Towards an Acoustemology of Detention in the "Global War on Terror"', in *Music, Sound and Space*, ed. Georgina Born (Cambridge: Cambridge University Press, 2013): 275–91, here 278–9.

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