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Danger: Wolf Crossing! Meantone Tuning and Froberger's Keyboard Music

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Meantone Tuning and Froberger's Keyboard Music

by

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Introduction

Keyboard tuning, for a pianist like me, is usually just a nuisance. Every once in a while, with greater frequency than is probably desirable, I would encounter a piano in a practice room that had been knocked out of tune by one too many Chopin etudes. Later, disgruntled after a mistuned piano had thrown a practice session off-kilter, I would fill out a piano maintenance request and offload all responsibility to the piano technician, appending the very vague and unhelpful note, "piano out of tune." Looking back, I am not quite sure what I had heard when I filled out those requests. I am not even sure if I knew what an in-tune interval sounded like at the time. Was I only perceiving the piano to be out of tune in relation to equal temperament?

You might imagine how confused I was when I found out that pianos could never be fully in tune. My first brush with historical tuning and temperament was during my undergraduate degree in piano, when I signed up for a month-long class on harpsichord tuning. Every day, I trudged through frigid Berkshire snowstorms to sit cross-legged around a kit harpsichord and listen to my professor lecture on the mathematical ratios of tuning for several hours. It was a rather slow and unstructured class. One day, after tuning a quarter-comma meantone together for the first time, the members of the class unenthusiastically took turns banging out the first prelude in C major from *The Well-Tempered Clavier*. I remember being somewhat unimpressed with the result. It was, as expected, in tune. However, later in the day, after returning to the piano for my daily practice, I was immediately assaulted by the nervous beating and ugliness of the piano's equal temperament, a constant grinding that was suddenly brought to the fore by a simple tuning exercise. At that moment, the mismatch of numerical ratios became inextricably tied to the bodily reaction of hearing these discordances, a feeling that immediately linked the separate spheres of analytical practice, listening practice, and performance practice.

From then on, I began to notice more and more instances in which keyboard tuning mattered deeply to issues of musical practice, even in a world that has come to accept equal temperament as more or less standard. I found crunchy ratios in collaborative piano work with violinists and vocalists, as a page turner for the late Peter Serkin (who preferred a seventh- or eighth-comma meantone temperament), and the voltage-controlled oscillators of analog synthesizers. With this new perspective that attends to the ways in which the keyboard skews pitch space, I am continuously prompted to think about tuning and temperament not as a historical mathematical problem that has been solved with equal temperament, but as a continuously evolving practice that is deeply enmeshed with practice, my own included.

This thesis is an exploration of how tuning practices can influence compositional practice, focusing on the way temperament can provide new insights to a close reading of keyboard music by Johann Jakob Froberger (1616–67). I have chosen Froberger due to his position as a transitional figure between a predominantly meantone-oriented musical environment of the 17th century and the well temperament of the 18th century. Many scholars have pointed to Froberger's characteristic chromaticism and experimentation with novel keys as indicative of his desire to compose beyond the restrictions of meantone tuning and towards well temperament. In an effort to move away from this oft-cited teleological narrative from unequal to equal, my analyses attend to the ways that Froberger works with the boundaries of meantone, ultimately arguing that a meantone tuning is integral to Froberger's musical language. Transgressions of these boundaries, as we shall soon see, involve mistunings that result in shocking discordances, a rough aural quality that Froberger exploits to craft structures of expectation in the dimension of discordance that operate independently of harmony.

My thesis proceeds in two large sections. The first, chapters one through four, is primarily concerned with developing a method for reading Froberger's music with an eye towards temperament as a situated practice. The second, chapter five, demonstrates that method through case studies of Froberger's keyboard music.

After giving a brief overview of the mathematical basis for temperament in the first chapter, I go on to identify a perceived rift between "historicist" and "presentist" work within the field of tuning and temperament studies in chapter two. While both perspectives are valid ways of doing musicology and music theory, neither allows us to understand temperament as a situated practice. Eventually, I argue that a synthesis of presentism and historicism is necessary for this end, a conclusion that reflects my serendipitous moment of connectivity in the practice room.

The third chapter provides the necessary historical contexts for my analyses, concentrating on the development of various meantone temperaments from Gioseffo Zarlino's *Le istitutioni harmoniche* (1558) to Andreas Werckmeister's *Musicalische Temperatur* (1691), in service of situating Froberger within the meantone-oriented musical environment of the 17th century, in the absence of specific indications for a temperament from Froberger himself.

In the fourth chapter I lay out my graphing method, which illustrates visually the fluctuations and flows of concordance and discordance during the span of a piece of music. Building on the work of Easley Blackwood (found in his 1985 monograph, *The Structure of Recognizable Diatonic Tunings*), I characterize the unfolding of a piece of music as a succession of vertical musical events, each quantified by its deviation from pure tuning under a selected temperament. Special attention is given to producing reductions of music through a historical lens, drawing from theoretical writings by Zarlino, Johannes Lippius, and Christoph Bernhard.

The resulting discordance contours represent listenings that collide historicist and presentist perspectives in an effort to regain "temperamental ears."

The fifth and final chapter, the bulk of this thesis, hears Froberger through temperamental ears, attending to the ways in which discordant intervals are treated, transformed, and resolved in five diverse cases of Froberger's keyboard music. Because of limitations having to do with the ongoing COVID-19 pandemic, my own practice as a tuner and performer does not figure into my analyses as intended. Rather, in order to preserve some sense of temperament as a live practice, I have chosen to discuss recordings of each piece at length and attend to the ways that a chosen temperament influences and colors a performance.

Temperamental Rudiments and Numbers

I begin by identifying the central "Pythagorean" dilemma of tuning and some of the underlying mathematics surrounding intervals and temperament. In an effort to demystify a field that often concerns itself with impossible figures, undecimals, and root extractions, I have chosen to limit my discussion to a handful of basic arithmetic operations surrounding the triad and its intervals, namely the third and fifth.

Throughout the history of Western music, it has been long accepted that the sounding intervals of human expression were founded and expressed in nature, whether in the weights of Pythagoras' hammers, Zarlino's monochord experiments, or frequencies of sound waves (more on this later). The pleasing progression of intervals related by simple numerical ratios, the unison (1:1), octave (2:1), fifth (3:2), major third (5:4), and so on, was thought to be indicative of a larger, parsimonious structure that governed the universe. While the early moderns described these ratios primarily with string lengths related proportionally to the monochord, modern acoustics usually rely on the cent, a logarithmic unit of measure based on the one hundredth part of an equally tempered semitone. Throughout this project, I will be using cents and ratios to express all intervals.

Let a and b be pitches, with frequencies f_a and f_b, respectively, where $f_b > f_a$.
Then, the frequency ratio r of the interval from a to b is determined as:

$$r = \frac{f_b}{f_a}$$

The interval from a to b in cents is determined as:

$$c = 1200 \log_2(\frac{f_b}{f_a})$$

Intervals can also be added and subtracted to yield other intervals by multiplying and dividing the interval ratios, respectively.

Let intervals r_1 and $r_2$have interval ratios $\frac{f_b}{f_a}$ and $\frac{f_d}{f_c}$ respectively.

Then,

$$r_1 \oplus r_2 = \frac{f_b}{f_a} \times \frac{f_d}{f_c}$$

and

$$r_1 \ominus r_2 = \frac{f_b}{f_a} \div \frac{f_d}{f_c}$$

Using these operations, it is possible to identify the fundamental Pythagorean dilemma that underlies tuning and temperament. Consider the standard twelve-tone circle of fifths, with C positioned at the top. It seems as if it is possible to add twelve consecutive fifths (3:2) from C to land right back at C. We can express this operation arithmetically as follows:

$$\left(\frac{3}{2}\right)^{12} \times \left(\frac{1}{2}\right)^{7} = \left(\frac{531441}{4096}\right) \times \left(\frac{1}{2}\right)^{7} = \frac{531441}{524228} \neq 1$$

$$\frac{531441}{524228} \div \frac{1}{1} = \frac{531441}{524228}$$

$$1200 \log_2\left(\frac{531441}{524228}\right) \approx 23.46$$

Interestingly, we do not arrive at the unison (1:1). Our chain of twelve fifths has gone just 531441:524288 too far from closing the circle of fifths. Something is afoot. This miniscule difference, 531441:524288 or 23.46 cents, is what is known as the Pythagorean comma. As a result, we have actually traced what has been referred to either as the "broken circle of fifths" or the "spiral of fifths." This broken quality is reflected and built into pitch nomenclature itself; what we land on after stacking twelve fifths is not C, but rather its slightly higher enharmonic cousin, B-sharp. In short, the fifth is incompatible with the octave.

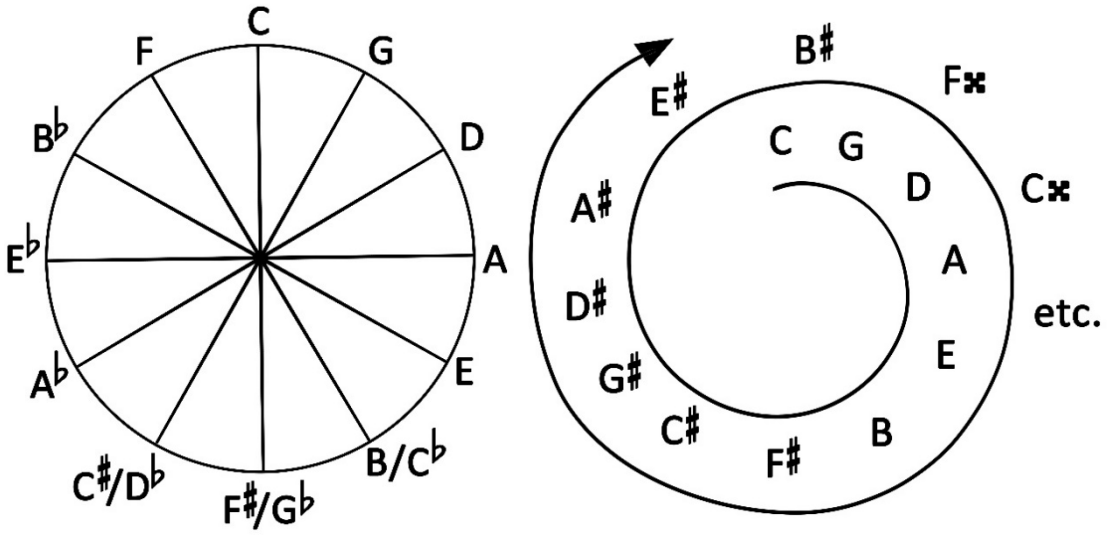

Figure 1: Circle of fifths and spiral of fifths

Now, consider another example. It again seems possible that four stacked consecutive fifths (5:4) should form a major third (3:2). This operation is expressed arithmetically as follows:

$$\left(\frac{3}{2}\right)^4 \times \left(\frac{1}{2}\right)^2 = \left(\frac{81}{16}\right) \times \left(\frac{1}{2}\right)^7 = \frac{81}{64} \neq \frac{5}{4}$$

$$\frac{81}{64} \div \frac{5}{4} = \frac{81}{80}$$

$$1200 \log_2\left(\frac{81}{80}\right) \approx 21.51$$

Again, we arrive at a pitch that is slightly higher than expected. This time, we have overshot it by 81:80 or 21.51 cents, a difference called the syntonic comma. Unfortunately, thirds are also incompatible with fifths. Notice also that the Pythagorean comma and syntonic comma are not equal. Their difference is called the schisma:

$$\frac{531441}{524288} \div \frac{81}{80} = \frac{32805}{32768}$$

$$1200 \log_2\left(\frac{32805}{32768}\right) \approx 1.95$$

And therein lies the Pythagorean dilemma. Our system of octaves and unisons is completely incommensurable with our system of fifths, which is in turn completely incommensurable with our system of major thirds. In a musical language that relies heavily on the triad, composed of the fifth and major third, this is a surprising and deeply troubling revelation, particularly for those who believed in a parsimonious, numerically ordered world. Temperament, and instrument tuning in general, can be thought of as an effort to close and repair the broken circle by distributing the comma amongst various intervals. This operation atomizes and thereby dilutes the strength of the Pythagorean and syntonic commas, rendering them inaudible to trained and untrained ears alike. Historically, the commas were situated in the more remote areas of the circle to allow for the more common keys of F, C, G, and D to be largely in tune and harmonious. As a result, distant keys such as C-sharp, D-flat, and A-flat were deemed unusable, due to their sour tuning. Under this unequal setting, keys had distinct personalities and characteristics.

For the early moderns, such as Zarlino, Mersenne, and Kircher, this careful and artful distribution of acoustic kinks in the system was a human intervention into the unknowable (and unhearable!) structure of the divine, one that carried a strong imperative to reflect on the sanctity of numbers in music. Later, at the turn of the 18th century, composers and performers expressed dissatisfaction with the limited palette of harmonious keys areas available, and began to experiment with tuning systems that increased the variety of keys. This impulse eventually led to

the equalization of all keys centuries later in our now ubiquitous equal temperament. Every key was finally equally harmonious and equally out of tune, allowing composers to transpose freely without worries. This especially was useful for composing in idioms that relied on the equal spacing of intervals, particularly those that employed pentatonic scales, octatonic scales, and tone rows, to name a few. Proponents of equal temperament tried to rule the temperament game over and decided in favor of their side. Shortly thereafter, a renewed interest in early-music performance in the 1950s seemed to revive debates regarding temperament. However, in actuality, temperament had never left the fabric of Western art music, from Debussy's imitations of Balinese gamelan to the undergraduate violinist learning to play a Beethoven sonata in tune with a pianist. Experiments in microtones, including those of Harry Partch and the spectralists, exploit the effects of tuning to create novel pitch structures, timbres and textures. And the debate is far from over.

Temperamental Historicism and Presentism

Tuning and temperament study is often characterized as a niche, fussy corner of music theory and history. Temperament discourse seems to have been struck from the popular consciousness by the ubiquity of equally tempered concert grands, and relegated to a few cloistered whisperings amongst early music aficionados and performers. Tunings, commas, and undecimals were a thing of the past. In 2001, Stuart Isacoff tailored this narrative for the general audience and published *Temperament: The Idea That Solved Music's Greatest Riddle* following this journey, presenting equal temperament as the ultimately desirable solution to the problem of tuning a keyboard.[1] What followed was a "fundamentalist fury," from both in and out of academia, rife with accusations of poor historicization that prompted a re-issuing of the monograph only two years after its publication with the markedly less provocative title, *Temperament: How Music Became a Battleground for the Great Minds of Western Civilisation*.[2] Somehow, the minutiae of tuning necessitated a book-length rebuttal of Isacoff's popular history, taking the form of Ross Duffin's *How Equal Temperament Ruined Harmony (and Why You Should Care)*.[3] Duffin repositions historical temperaments not as limiting and defective prototypes of equal temperament, but as integral to the musical aesthetics and compositional outputs of the time. The purpose of engaging the more public-facing "light" histories of temperament is not to advance the notion that either Duffin or Isacoff is correct; polemics,

[1] Stuart Isacoff, *Temperament: The Idea That Solved Music's Greatest Riddle* (New York: Alfred A. Knopf, 2001).

[2] Stuart Isacoff, "Afterword" in *Temperament: How Music Became a Battleground for the Great Minds of Western Civilisation* (New York: Vintage, 2003), 235–52. Isacoff's position on equal temperament as the logical and teleological end goal is unchanged. A new lengthy afterword appended to the re-issue reveals that Isacoff had been "stunned by the intensity of some of the reactions," attributing the "fundamentalist fury" of some dissenters to the "tendency in a postmodern environment to react with hostility toward any celebrations of Western achievement."

[3] Ross Duffin, *How Equal Temperament Ruined Harmony (and Why You Should Care)* (New York: W.W. Norton & Company, 2007).

intended or unintended (in Isacoff's case), are necessarily lacking in nuance. It is clear, however, that temperament remains an active site of discussion even today, in and out of academia. Equal temperament, patently, did not solve everything.

However, there is something to be said about the heavy-handed split between the "modern" approach taken by Stuart and the "historical" approach taken by Duffin in historical tuning and temperament scholarship in general. Specifically, I am pointing towards the tendency for scholars to either focus exclusively on matters of reconstructing historical temperaments through archival study, or the acoustic and mathematical properties of tuning. Thomas Christensen has noted this split in music theory as a whole in his essay "Music Theory and Its Histories," noting two camps of theorists who follow either "presentist" or "historicist" attitudes to theory.[4] On one hand, the presentist primarily uses contemporary analytical tools to read music and disregards the historical context in which these musical objects were produced. While this is certainly a method that has had strong, lasting roots in the field of music theory, Christensen notes that it entails a historical "myopia," in which the retroactive fitting of anachronistic structures onto objects of the past reduces the nuances of history. The insights that the presentist derives are thus heavily reflective of contemporary priorities, and inherently posit a sense of continuity between the music of the past and present. On the other hand, the historicist discards all contemporary assumptions and attempts to reconstruct historically situated ears to produce their analyses. Christensen categorizes this pursuit as "naive," since it downplays the multiplicity of musical engagements that make up a piece of music, and rests on the primary assumption that there exists an essential authentic past to be excavated. Like the presentist, the

[4] Thomas Christensen, "Music Theory and Its Histories," in *The Work of Music Theory: Selected Essays* (New York: Ashgate, 2014), 3–34.

historicist's work is also necessarily reflective of contemporary priorities due to their own situatedness.[5] In either case, there is a "historical location that can never be fully transcended."[6]

There is perhaps no better illustration of this bifurcation in tuning and temperament scholarship than the work of Mark Lindley. One of the more prolific writers on tuning, Lindley focuses on topics pertaining to tuning in the Baroque period and has employed a wide array of methods over the course of his career. The vast majority of Lindley's work is strongly historicist. Outside of writing for broad historical surveys, the most notable being his entry on temperaments in the *Grove Dictionary of Music and Musicians*, Lindley concerns himself primarily with inferring tuning practices by unpacking the writings of historical theorists.[7] For example, Lindley proposes a set of tunings by Johann Georg Neidhardt (1724) as a close approximation for what Bach may have tuned instinctively by drawing together a vast array of secondary accounts between C.P.E. Bach and Lorenz Mizler as found in Mizler's *Musikalische Bibliothek* (1754), along with tuning instructions from Leipzig instrument maker Barthold Fritz.[8] His insistence on practice is apparent in most of his publications on tuning, with many of his articles containing practical tuning instructions and diagrams for the more enthusiastic and hands-on readers. Lindley also attempts to make audible his chosen temperaments by providing analytical "listening notes" that draw particular attention to the most salient effects of a tuning in selected

[5] Taruskin in particular has taken the historicist to task in regards to "authentic" performance practice, arguing that the recovery of an "authentic" or "othered" past is a modernist project. See Richard Taruskin, "The Pastness of the Present and the Presence of the Past," in *Authenticity and Early Music*, ed. Nicholas Kenyon (Oxford: Oxford University Press, 1988): 137–207 and Richard Taruskin, *Text and Act: Essays on Music and Performance* (Oxford: Oxford University Press, 1995).

[6] Christensen, "Music Theory and Its Histories," 21.

[7] Mark Lindley, "Temperaments," in *The New Grove Dictionary of Music and Musicians, 2nd edition* (New York: Grove, 2001).

[8] Mark Lindley, "J. S. Bach's Tunings," *The Musical Times* 126, no. 1714 (1985): 721–26.

repertoire.[9] Here, careful detective work, particularly an attention to what is missing or unspoken in primary sources, lends to Lindley's tuning suggestions a certain historical and cultural situatedness. At the other end of the spectrum lies Lindley's more mathematical writing about tuning and temperament. The most extensive publication of this sort is his book *Mathematical Models of Musical Scales*, co-authored with Ronald Turner-Smith, which attempts to generate and relate tunings (including historical temperaments) using modern algebra to create taxonomies of existing tunings.[10] While historical writers are called up eventually, they are only used to corroborate and affirm arbitrary points of contact between history and contemporary analytical structures. Here, Lindley is playing the presentist.

This is not to say that the presentist does not engage seriously with history. One unabashedly presentist piece of tuning and temperament scholarship that warrants special attention is Easley Blackwood's *The Structure of Recognizable Diatonic Tunings*, which I will draw heavily from in this thesis. The prevailing presentism of the work is presented front and center in the preface, where Blackwood writes, "No attempt has been made to relate this volume to earlier works on the subject." Blackwood's analyses, which are characterized by a rigorous note-by-note labelling of tones and their tunings, is distinctly abstracted from any historical remarks. When provided, they are nonspecific and unsubstantiated. This is jarringly noticeable in Blackwood's choice of repertoire; for example, in his chapter on just intonation, Blackwood looks at anachronistic repertoires such as Bach and Franck. This perspective has drawn strongly worded critiques from Lindley in particular, who called Blackwood's book a "less thoughtful and

[9] For example, see Mark Lindley, "Zarlino's 2/7-comma Meantone Temperament," in *Music in Performance and Society: Essays in Honor of Roland Jackson*, ed. Malcolm S. Cole and John Koegel (Detroit: Harmonie Park Press, 1997): 186–7.

[10] Mark Lindley and Ronald Turner-Smith, "An Algebraic Approach to Mathematical Models of Scales," *Music Theory Online* 0 no. 3 (June 1993).

less well-informed book than the subject requires," and suggests somewhat condescendingly that Blackwood ought to have engaged more explicitly with what was written in *The Grove Dictionary*.[11] For me, this somewhat overlooks the central artifice of the monograph. Here, Blackwood's blatant rejection of any historicist tendencies provides a ground to reveal dramatically the historical situatedness of certain tunings. Justly intoned Franck and Bach are judiciously selected and set up as candidates to fail Blackwood's mathematically informed analyses. The limits of historical temperaments are brought to the fore with myopic presentism; overt rejection is one way of doing history.[12]

Unsurprisingly, much falls between the cracks of this presentist-historicist binary. One such unfortunate consequence in tuning and temperament studies is a sore lack of terminology for describing the aural effects of a non-equal tuning. It is not uncommon to have temperaments described either with impenetrable metaphorical language or with a huge table of decimals, relegating the expressivity of a selected temperament to isolated instances of voice leading and surprising harmonic movement. Neither communicate what a temperament might "sound like." Isabella van Elferen has noted this difficulty in the wider field of timbre scholarship. For van Elferen, the central challenge to characterizing and studying timbre is its "material immateriality." Timbre, since it is the product of various frequencies and partials interacting, is highly material. This has inspired a wave of timbre scholarship that has attempted to use audio technology to unpack its core nature. On the flip side, writings on timbre that focus on its immaterial aspect understand the perceptual aspect of hearing sound as fundamentally mysterious and unknowable, resulting in language that relies heavily on phenomenological

[11] Mark Lindley and Ronald Turner-Smith, "Review of *The Structure of Recognizable Diatonic Tunings* by Easley Blackwood," *Music and Letters* 70 no. 2 (May 1989): 238–40.

[12] Nathan John Martin, "History for Theorists," *Music Theory Online* 25 no. 3 (November 2019).

methods. Intonation, like timbre, results from a highly material physical property (frequency ratios) that, when processed through human perceptual organs, becomes difficult to assess empirically.

Lindley himself has expressed this difficulty of writing about temperament. Despite his nuanced historical work in suggesting a preferred temperament for *The Well-Tempered Clavier* through a detailed study of primary sources, Lindley ultimately avoids aesthetic value judgements and laments the limits of the written medium, writing that "the proof is in the pudding, which unfortunately cannot be served here."[13] These expressive elements are subsequently presented in the appendix, encoded within tables of numbers, waiting to be excavated. In a more recent project with the *Staatliches Institut für Musikforschung*, Lindley has attempted to bridge this gap between the written and the perceptual by disposing of the written medium completely.[14] Lindley packages his descriptions of temperament in audio-visual form, attaching recordings in various historical temperaments to complement his analyses. I do not share Lindley's concern regarding the limits of scholarly prose. While I agree there are limits to presenting musical objects such as timbre and intonation in text and figures, I do not think that such a methodology is out of reach, especially in music theory and musicology, which find their disciplinary footing in articulating and reading often complex and abstract musical objects in prose.

Christensen's solution is to invigorate a dialogue between the presentist and the historicist, note their complementary qualities through hermeneutics, and thereby access a state

[13] Mark Lindley, "J. S. Bach's Tunings."

[14] Mark Lindley, "Valuable Nuances of Tuning for Part I of J. S. Bach's Das wohltemperirte Clavier," *Staatlichen Institut für Musikforschung*, 2011, https://simpk.de/wtc_973.html.

of critical historical awareness ("wirkungsgeschichtliche Bewusstsein").[15] This project takes this recommendation to heart, reading contemporary and historical tuning and temperament research dialogically. In doing so, I aim to provide a method of analytically hearing temperament in Froberger that implicates a live listening, a historical awareness that is exercised here in the present.

[15] Christensen, "Music Theory and Its Histories," 28.

Meantone Temperament in the 16th and 17th Centuries

The vast majority of scholarly investigations into tuning and temperament begin with Zarlino's *Le istitutioni harmoniche* (1558), a strategy I faithfully reproduce here. Zarlino begins his multi-volume treatise, too, by engaging the distant past. He retells the apocryphal tale of Pythagoras's hammers:

> Pythagoras was the one who discovered the rationale for musical proportions in the sound of the hammers, because when [Pythagoras] was walking near a blacksmith shop, where [men] were beating hot iron on an anvil with different hammers, there came to his ears a certain order of sounds which moved his hearing with delight…he judged (correctly) that the difference in the weights of the hammers was the cause. For that reason, having weighed each [hammer] separately, he found among the numerical values of the weights the rationales for the consonances and the harmonies, having made strings of sheep's guts of equal lengths, attaching to them weights equal to those of the hammers, he discovered the same consonances – all the more sonorous, because strings by their nature render a sound more pleasing to the listener.[16]

While this tale is demonstrably inaccurate, it had been transmitted for centuries in a long game of theoretical telephone that was finally questioned and subsequently disproven through early scientific experiments by Vincenzo Galilei and Marin Mersenne beginning in the late 16th century.[17] However, it is not so much the mathematical or empirical rigor of this Pythagorean

[16] Lucille Corwin, "Le Istitutioni Harmoniche of Gioseffo Zarlino, Part I: A Translation with Introduction" (PhD diss., The City University of New York, 2008): 127.

[17] Claude Palisca, "Scientific Empiricism in Musical Thought," in *Seventeenth-Century Science and the Arts*, ed. Hedley Howell Rhys (Princeton: Princeton University Press, 1961), 91–137.

legend that is important to my historical narrative, but the fact that it reveals the vaunted position of simple numerical ratios that would come to shape the study of tuning, both speculative and practical. For many, the natural occurrence of simple numbers—in the unison (1:1), the octave (2:1), the fifth (3:2), the major third (5:4), and so on—was indication of a divine order.[18] Staunch believers in the aesthetic power of numbers believed that the ratios of the octave and fifth were not to be tampered with. This line of thinking is exemplified by Pythagorean tuning for keyboards, which tunes all fifths exactly pure; in practice, however, Pythagorean tuning results in sour, uncharacteristically large major thirds, an aural effect that would have certainly raised some eyebrows by Zarlino's time.[19] Pythagorean tuning also had to reckon with closing the sharp and flat ends of the circle of fifths, and required the use of a diminished sixth, the famous and dreaded "wolf fifth," so named on account of its howling, discordant quality. The wolf fifth, usually placed at E-flat–G-sharp, marked entire distant keys as unpalatable in practice due to its out-of-tuneness.[20]

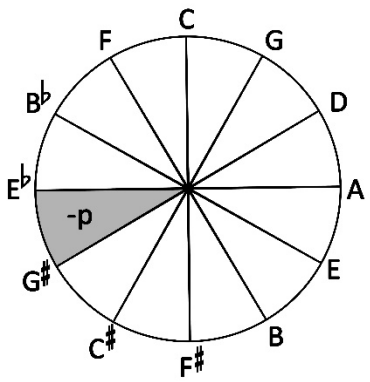

Figure 2: Pie diagram of Pythagorean tuning, where p is the Pythagorean comma

[18] Eric Jarlin Wang, "Mistuning the World: A Cultural History of Tuning and Temperament in the Seventeenth Century" (PhD diss., University of California Los Angeles, 2011): 115.

[19] The tenets of Pythagoreanism, specifically its practical inflexibility, had already been questioned by Bartolomeus Ramis de Pareia in 1482, giving an alternative system that pays attention to select thirds. See Luanne Eris Fose, "The 'Musica practica' of Batolomeo Ramos de Pareia: A Critical Translation and Commentary" (PhD diss., University of North Texas, 1992).

[20] Wang, "Mistuning the World," 54.

Zarlino's recommendations for tuning appear in Book II of *Le istitutioni harmoniche*, where he dedicates two chapters to advocating for his preferred tuning. Chapter 42's title states Zarlino's aims plainly:

> What should be observed in tempering, or tuning the intervals of certain modern artificial instruments, reducing the number of strings in the syntonic diatonic to that in the diatonic; and that such intervals are not natural, but rather accidental.[21]

For sung intervals, Zarlino recommends Ptolemy's "syntonic-diatonic" tuning (now known as "just intonation") on the basis that singers ought to present intervals in their most natural form as dictated by "true and sonorous numbers," an argument that is carried out in Chapter 45.[22] Zarlino's monochord diagram of the ancient Greek two-octave *systema teleion* of tetrachords is given in Fig. 2.To allow for a maximum number of thirds and fifths (and by extension, sixths and fourths) to be sung exactly in tune, Zarlino gives two tunings of the pitch *d* (strings *MB* and *RB* in Fig. 2), separated by the distance of one syntonic comma. This results in a total of seventeen string lengths, spanning the diatonic pitch space of two octaves. In order to provide a tuning for only seven diatonic notes to each octave, a compromise must be made between the two tunings of *d*, *MB* and *RB*, thereby reducing the seventeen string lengths to sixteen. Zarlino chooses to distribute the syntonic comma equally among the seven intervals of the diatonic octave by tempering each diatonic fifth to be flat by 2/7ths of a syntonic comma. Major and minor thirds receive the same amount of tempering, with each diminished by 1/7th of a syntonic comma. For

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[21] Gioseffo Zarlino, *Le istitutioni harmoniche* (Venice, 1558), 126. "Quel che si deve osservare nel temperare, overo accordare gli Intervalli di ciascuno Instrumento arteficiale moderno, riducendo il numero delle chorde del Diatonico sintono a quello del Diatono; & che tali intervalli non siano naturali, ma si bene accidentali." The translation is my own, although I have consulted David P. Goldman, "A New Look at Zarlino's Theory and its Effect on his Counterpoint Doctrine," *Theory and Practice* 16 (1991): 164.

[22] Zarlino, *Le istitutioni harmoniche*, 135. "Se nelli Canzoni seguitiamo cantando gli intervalli produtti da i veri, & sonori numeri, overo li mostrati; & della solutione di alcuni dubbi."

Zarlino, this necessary detuning of the simple numerical ratios was just imperceptible enough to excuse its usage on "modern artificial instruments" such as the harpsichord.[23]

This temperament is referred to by modern tuning scholars as 2/7th-comma meantone temperament, on account of its tempered fifths and its characteristic splitting of the syntonic comma (taking the "mean" of two tones or strings). Thirteen years later, in *Le dimonstrationi harmoniche* (1571), Zarlino gave two more numerical descriptions of similar temperaments. The first, now referred to as 1/3-comma meantone, flattened all fifths equally by 1/3 of a syntonic comma to allow for pure minor thirds, a quality Zarlino deemed suitable for pieces of a languid character.[24] The second, for which he dubiously claims authorial origin, now known as 1/4-comma meantone or simply "meantone," instead created pure major thirds.[25] These meantone temperaments, grouped by their concern with settling differences resulting from acoustic incompatibilities with the pure major third and pure fifth, became the go-to keyboard tunings for keyboardists clear through the 17th century, of which 1/4-comma meantone was the most widely disseminated and employed.[26] While the problem of wide thirds in Pythagorean tuning had been mitigated by adjusting the size of each fifth, the meantone tunings set forth by Zarlino still housed the ominous presence of the wolf, an aural boundary at E-flat–G-sharp that, as I will soon argue, circumscribes the creative choices of performers and composers.

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[23] Zarlino, *Le istitutioni harmoniche*, 127. "Et quantunque questi intervalli siano per tal maniera hora cresciuti, & hora diminuti; non per questo l'Udito (come hò detto) abhorisce tale distributione: conciosia che essendo minima, & quasi insensibile la quantità, che si leva, o aggiunge a cotali intervalli; & essendo non molto lontani dalle loro vere forme, il senso si cheta."

[24] Zarlino, *Le dimonstrationi harmoniche* (Venice, 1571): 221 "...anzi al mio parere è un poco più languido."

[25] Ibid., 266. "...adunque volete fare un novo Temperamento: & dimostrare una nova Partecipatione." Lindley has given evidence that meantone was in circulation during the 15th century. See Mark Lindley, "Fifteenth-Century Evidence for Meantone Temperament," *Proceedings of the Royal Musical Association* 102 (1975): 37–51.

[26] Wang, "Mistuning the World," 60–1.

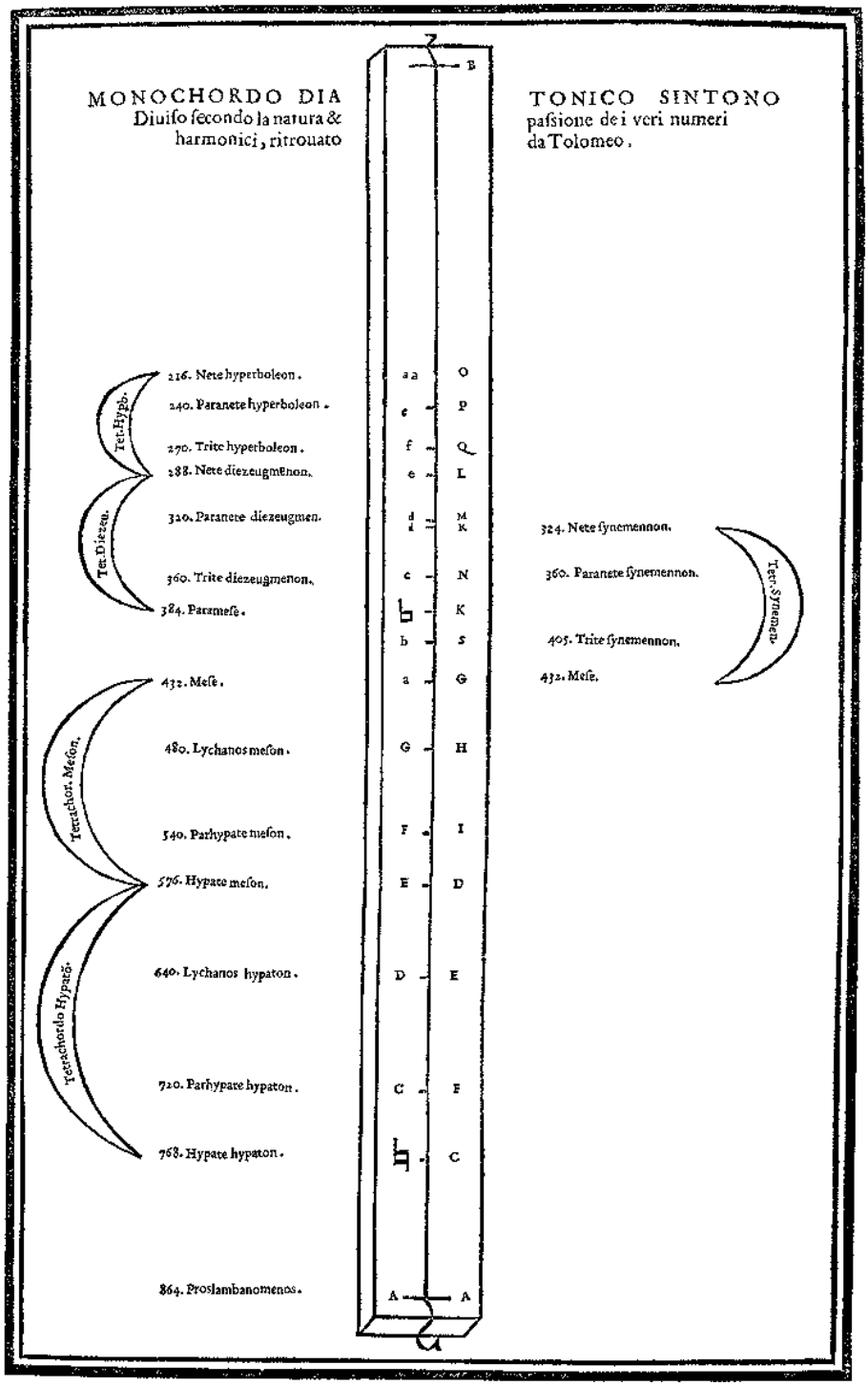

Figure 3: Zarlino's monochord diagram from Book II of *Le istitutioni harmoniche*, detailing the string lengths of his recommended syntonic-diatonic system

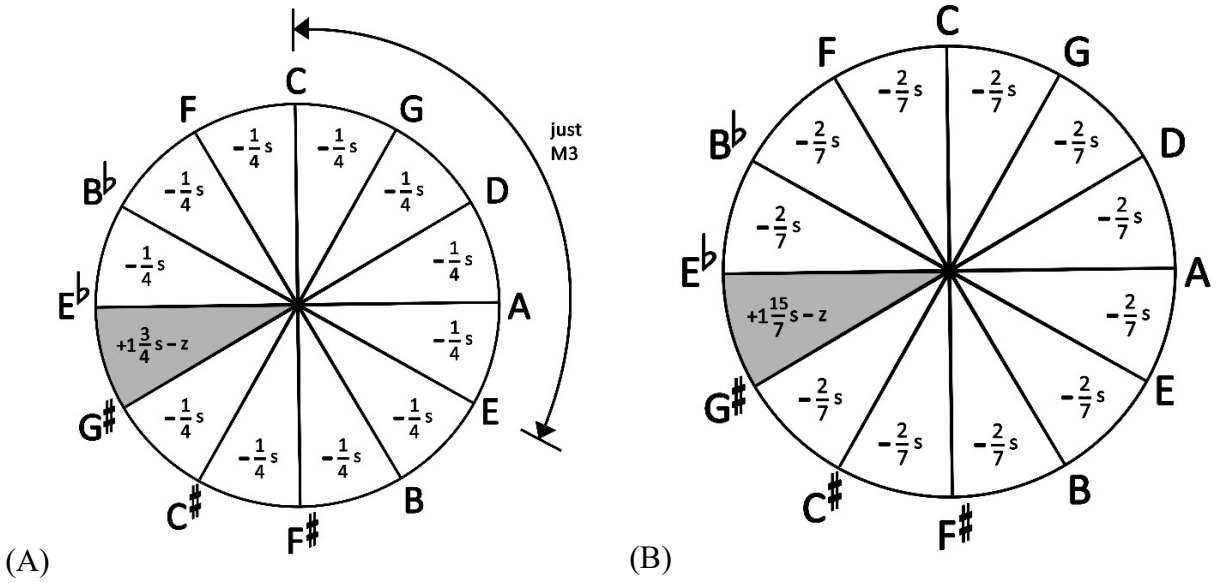

Figure 4: (A) Pie diagram of 1/4-comma meantone and (B) Zarlino's 2/7-comma meantone, where s is the syntonic comma and z is the schisma

Zarlino's tuning instructions, specifically in his careful consideration of the size of major and minor thirds, comports with his recognition of the triad, which appears later in *Le istitutioni harmoniche*.[27] Of particular interest is the way in which Zarlino discusses the consequences of his 2/7th-comma meantone temperament, referring to the triad obliquely. He writes,

> The diatone [major third] will be made imperfect by a seventh, and the semiditone [minor third] will also be diminished by the same quantity: because these two consonances participate in the formation of the diapente [fifth], which is diminished by two-sevenths, it is necessary that the diminution is distributed between the two intervals: if one makes the ditone imperfect by one seventh part, and the semiditone by the same, then it makes two seventh parts...by which their All is diminished.[28]

[27] Zarlino, *Le istitutioni harmoniche*, 181.

[28] Ibid., 126: "Si farà dipoi il Ditono imperfetto di una settima parte, et di tanta quantità si diminuirà etiandio il Semiditono: Percioche se queste due consonanze concorreno alla integratione della Diapente; essendo questa

Although Zarlino's formulation of a fifth created by combining thirds of different qualities may not seem like such a revelatory remark, it reveals several fundamental positionings in early modern temperament discourse that require further explication. Recall that Pythagoreans placed a premium on the simple numerical ratios vested in the unisons (1:1), octaves (2:1), and fifths (3:2), leaving the tuning of other intervals a secondary priority. Under this strict Pythagorean tuning scheme, the major third is constructed by the process of stacking four consecutive pure thirds and then transposing it down two octaves, which results in an interval with the frequency ratio 81:64. This is the same uncomfortably wide third that was discussed previously. Zarlino instead begins with the major third (5:4) and minor third (6:5) and derives the fifth, a surprising and exceptional reversal of the age-old Pythagorean strategies.[29] This struggle, between what one might term the "Pythagorean major third," which favored just fifths, and the "just major third" played out in writing only several decades earlier between Franchino Gaffurio and Bartolomeo Ramis.[30]

This new focus has often been identified by multiple scholars as a reflection of the changing practices of the time and a recognition of the third as central to musical language. A common historiographic strategy is to trace this shift back to English musicians in the fourteenth century, who had already been practicing *le contenance angloise*, a style that would have certainly benefited from harmonious thirds.[31] In German lands, Lippius eventually produced the

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diminuta di due settime parti, è necessario, che tal diminutione si divida tra questi due intervalli: conciosia che facendo imperfetto il Ditono di una settima parte, et il Semiditono di altra tanto, che sono due settime parti…che è diminuto il suo Tutto."

[29] Mark Lindley, "Zarlino's 2/7-comma Meantone Temperament," 179–94.

[30] Franchino Gaffurio, *De harmonia musicorum instrumentorum* (Milan, 1518), f. 62v.

[31] Richard Taruskin, "Chapter 11: Island and Mainland." In *Music from the Earliest Notations to the Sixteenth Century: The Oxford History of Western Music* (New York: Oxford University Press, 2005).

first articulation of the musical triad as a harmonic unit in his *Synopsis musicae novae* (1612), which is particularly indebted to Seth Calvisius' German dissemination of Zarlino's theories at the turn of the 17th century.[32] While Lippius never explicitly discusses tuning and temperament, the general musical practice of the time, replete with root position triads (incidental within counterpoint or otherwise) that sound vaguely tonal to modern ears, must have necessitated a significant level of attention to the third.[33] In fact, Praetorius names 1/4-comma meantone as the only usable temperament for keyboard instruments in *De organographia* (1619), the second volume of his magnum opus *Syntagma musicum*, writing that "all octaves and perfect or major thirds should be tuned pure…all fifths are not tuned straight and pure, but rather beat flat against each other."[34] 1/4-comma meantone was henceforth known as the Praetorian temperament throughout the 17th century.[35]

It must be noted once again that Zarlino is ultimately reproducing Pythagorean tenets, particularly in his central fixation on simple numerical ratios of the major and minor thirds. While it may be true that much of his speculative writing was deeply enmeshed with the activities of practicing musicians, he nonetheless gives a strikingly numerological explanation for his support of the major and minor thirds.[36] For Zarlino, the number six (or the *senario*), due

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[32] Joel Lester, *Between Modes and Keys: German Theory 1592–1802* (Stuyvesant: Pendragon Press, 1989), 21–35. Also see Benito Rivera, *German Music Theory in the Early 17th Century: The Treatises of Johannes Lippius* (Rochester: University of Rochester Press, 1995).

[33] For an investigation into the particularities of Lippius' writings and its application, see Benito Rivera, "The Seventeenth-Century Theory of Triadic Generation and Invertibility and Its Application in Contemporaneous Rules of Composition," *Music Theory Spectrum* 6 no. 1 (Spring 1984): 63–78.

[34] Michael Praetorius, *Syntagma musicum II: De Organographia* (Wolfenbüttel, 1619), 150–1. "Dass alle *Octaven* und *Tertiae perfectae seu majores* gar rein gestimmet werden…dass alle *Quinten* nicht gerade und rein, sondern gegeneinander niedrig schewebend gelassen werden."

[35] Wang, "Mistuning the World," 62.

[36] Benito Rivera, "Theory Ruled by Practice: Zarlino's Reversal of the Classical System of Proportions," *Indiana Theory Review* 16 (1995): 155.

to its properties as a perfect number in which it is equal in value to the sum of its divisors, manifests itself in nature and ought therefore to be imitated in art. In the realm of tuning, the *senario* crops up in the frequency ratios of all vertical consonances up to the minor third (6:5). The triad, built from the fifth (3:2), the major third (5:4), and the minor third (6:5), thus reflects the divine proportions of the *senario*. Zarlino and his most ardent followers remained Pythagorean through and through.

In practice, although the thirds of Zarlino's meantone tunings are settled and harmonious, the inflexibility of the wolf fifth at E-flat–G-sharp left many musicians in the mid-17th century unsatisfied, resulting in an increase of modified meantone tuning systems in the mid-to-late century, particularly in France.[37] I will discuss one such tuning here. A German historical connection can be made with French theorists by way of Kircher's *Musurgia universalis* (1650). Kircher defers judgement of tuning and temperament to Mersenne, writing that "various methods of tuning an instrument are offered by various authorities; see Mersenne for these."[38] Kircher's recommendation here should be taken seriously: Kircher proceeds to give a confused explanation of Mersenne's tuning, which is both mathematically and theoretically inconsistent, leaving it hard to guess what he may have been trying to express. Unfortunately, Mersenne's instructions for tuning, appearing in *Harmonie universelle* (1636), are also somewhat confused. The discrepancy lies in an imprecise use of language: when asked to tune the span from F to B-flat, Mersenne writes that the "fifth must be increased."[39] Here, it is unclear whether the interval or the note, B-flat, must be increased; the former results in wider fifths, while the latter produces

[37] Wang, "Mistuning the World," 63–9.

[38] Frederick Baron Crane, "Anthanasius Kircher, Musurgia Universalis (Rome, 1650): The Section on Musical Instruments" (MA thesis, University of Iowa, 1952): 35.

[39] Marin Mersenne, *Harmonie Universelle*, III (Paris, 1636), 109. "Mais cette quinte doit estre augmentee."

narrower fifths. Lindley, by corroborating this statement with Mersenne's other writings, particularly his endorsement of split-key manuals, is able to make a case for the latter reading, concluding that Mersenne was anticlimactically referring to 1/4-comma meantone.[40] An understandable misreading of Mersenne's instructions as advocating a widening of the fifths F–B-flat and B-flat–E-flat was committed to writing by Lambert Chaumont in his *Pièces d'orgue sur le huit tons* (1695), which received wide circulation as the aptly named *tempèrament ordinaire*.[41] A serendipitous consequence of this mistake was that the usual meantone wolf is more in-tune by an entire syntonic comma, which opens up the possibility of previously unusable keys such as F-sharp major and A-flat major.

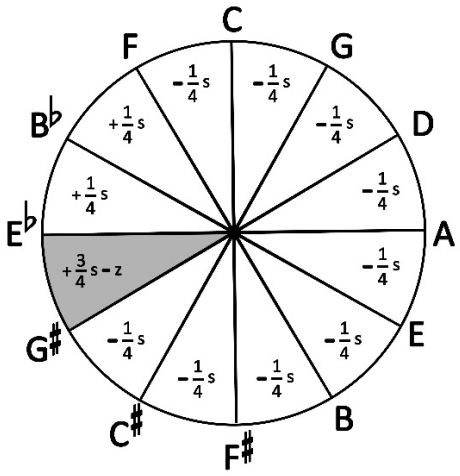

Figure 5: Pie diagram of Chaumont's tempèrament ordinaire,
where s is the syntonic comma and z is the schisma

At this point, we have reached the end of the 17th century, and perhaps the end of the unquestioned reign of meantone temperaments. Beginning with Andreas Werckmeister's *Musikaliche Temperatur* (1691), the turn of the 18th century saw a rapid proliferation of "well temperaments," a new, distinctly anti-Pythagorean philosophy of tuning that attempted to

[40] Mark Lindley, "Mersenne on Keyboard Tuning," *Journal of Music Theory* 24 no. 2 (Autumn 1980): 166–203.

[41] Mark Lindley, "Innovations in Temperament and Harmony in French Harpsichord Music," *Early Music* 41 no. 3 (August 2013): 405–8.

eradicate the wolf from all keys and render them usable, a well-rehearsed history that will not be reproduced here.[42] In this chapter, I hope to have given a view of the 17th century that recognizes a family of meantone temperaments, or as Wang puts it, "shades of meantone" clustered around the ubiquitous 1/4-comma meantone.[43] These alternative systems point to a much livelier and more creative 17th century tuning and temperament discourse than is usually told; indeed, musicians and theorists adopted age-old Pythagorean tenets and modified them to fit their practical and expressive needs.

[42] See, for example, Murray Barbour, *Tuning and Temperament: A Historical Survey* (East Lansing: Michigan State College Press, 1951; reprint, Mineola: Dover Publications, 2004).

[43] Wang, "Mistuning the World," 176.

Graphing Temperamentally

This chapter will build on the work of Easley Blackwood's note-by-note labelling technique by providing a means of graphical representation.

Easley Blackwood's work, as it appears in *The Structure of Recognizable Diatonic Tunings*, studies the intonation of various musical passages using a notational system that denotes the pitch class and deviation by syntonic comma in the subscript.[44] Zarlino's syntonic-diatonic monochord for variable-pitch instruments and the singing voice can be represented accordingly in Blackwood-style notation:

[…] $B♭_0$ C_0 D_{-1} D_0 E_0 F_0 G_0 A_0 B_0 C_0 […]

It takes some time to grow accustomed to identifying the sizes of common intervals in this row of tones. I will step through the intervals by increasing size. The easiest to identify is the syntonic comma (81/80) appearing at $D_{-1}D_0$, demonstrating the utility of Blackwood's subscript. The diatonic semitone (16/15) appears at E_0F_0 and B_0C_0. The major tone (9/8) appears between notes containing the same subscript such as C_0D_0, while the minor tone (10/9) is diminished by a syntonic comma, appearing at C_0D_{-1}. Minor and major thirds come in two sizes each: the just major third (5/4) at $B♭_0D_{-1}$, the just minor third (6/5) at $D_{-1}F_0$, the wide Pythagorean major third (81/64) at C_0E_0, and the narrow Pythagorean minor third (32/27) at A_0C_0. Intervals related by vector addition of both subscripts retain interval identity; $A_{-0.25}C_{-0.25}$, for example, would also be a Pythagorean minor third, like A_0C_0. The ordering of pitches from low to high is nontrivial in determining their tempering: a narrow fifth C_0G_{-1} inverts into a wide fourth C_0G_{-1}.

[44] Easley Blackwood, *The Structure of Recognizable Diatonic Tunings* (Princeton: Princeton University Press, 1985), 68–9.

When these annotations are applied on a note-by-note basis on staff notation, it becomes possible to judge the sizes of all intervals in a piece of music, both vertically and horizontally. This method has been used to great effect by Ross Duffin in an analysis of Giovanni Battista Benedetti's musical puzzles to Cipriano de Rore from the 16th century.[45] His analysis is reproduced in Fig. 6. Blackwood's annotations here are particularly advantageous in revealing the progressive sharp-ward drift of the two-measure musical fragment, a pitch migration caused by the tenor voice tuning a just minor third (or major sixth) with the suspended soprano voice in mm. 2, 4, 6, and so on. Furthermore, with some effort, the size of melodic and harmonic intervals can be discerned: melodic just fifths and fourths ($G_{0+n}D_{0+n}$ and $C_{1+n}G_{1+n}$ in the tenor), harmonic just fifths ($G_{0+n}D_{0+n}$ in tenor/alto and $D_{0+n}A_{0+n}$ in tenor/soprano), harmonic just fourths ($D_{0+n}G_{0+n}$ and $E_{0+n}A_{0+n}$ in alto/soprano), and harmonic just major thirds and major sixths ($C_{1+n}E_{0+n}$ in tenor/alto and $C_{1+n}A_{0+n}$ in tenor/soprano).

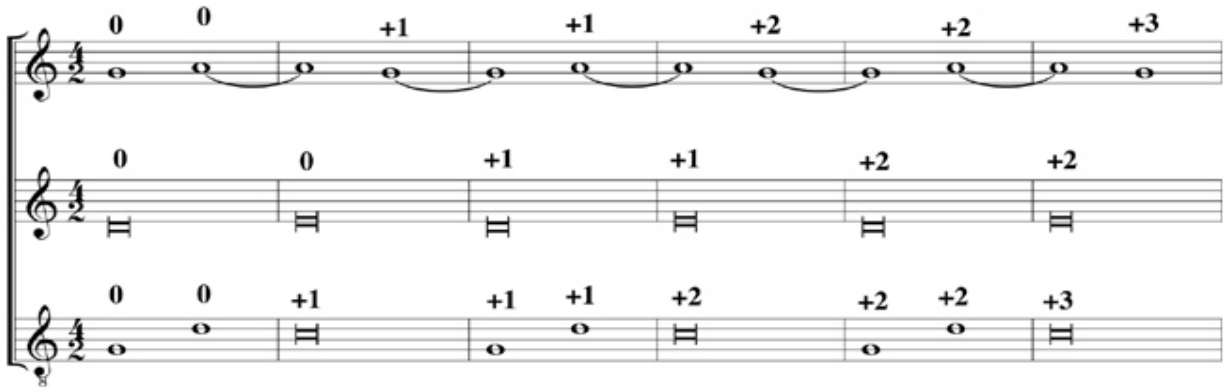

Figure 6: Duffin's analysis of Benedetti's first musical puzzle, with Blackwood annotations

The annotation method is most successful in Blackwood's analyses of music by Machaut, di Lasso, Bach, and Franck under just intonation.[46] As we have seen, the just tuning of *all*

[45] Ross W. Duffin, "Just Intonation in Renaissance Theory and Practice," *Music Theory Online* 12 no. 3 (October 2006).

[46] Blackwood, 129–50.

sonorities in a piece of music is troublesome and most likely impossible given only twelve pitches per octave. Blackwood gives five principles for just intonation:

> 1. Perfect fifths, perfect fourths and octaves must be pure; hence two notes forming any of these intervals must have the same subscripts.
> 2. Major triads must be pure; hence the third of a major third must have a subscript one less than that of the root and the fifth.
> 3. Minor triads must be pure; hence the third of a minor triad must have a subscript one greater than that of the root and fifth.
> 4. Thirds and sixths in which both notes have the same subscripts are Pythagorean, and should be avoided if possible.
> 5. The root and fifth of a major triad should generally have 0 subscripts; the root and fifth of a minor triad should generally have -1 subscripts. This arrangement tends to minimize the occurrence of the syntonic comma as a melodic interval.[47]

In addition, Blackwood provides several ideal just tunings for augmented triads, diminished sevenths, half-diminished sevenths, and secondary dominants, which figure into his analyses.[48] These ideals, as expected, tend to result in conflicts, especially as the music becomes more harmonically adventurous. Blackwood, rather than resolving these disputes, instead allows for "split-key" provisions for several tunings for various pitch classes; for example, his ideal keyboard for the *Kyrie* from Machaut's *Messe de Nostre Dame* has two tunings each for C, G, D,

[47] Ibid., 129–30. Major thirds of the same subscript such as C_0E_0 are Pythagorean major thirds, and are a syntonic comma wider than a just major third (5:4). Thus, C_0E_{-1} would be a just major third. Minor thirds of the same subscript such as B_0D_0 are narrow Pythagorean minor thirds, and are a syntonic comma narrower than a just minor third (6:5). Thus B_0D_{+1} is a just minor third.

[48] Ibid., 106–10.

and A.[49] Blackwood is thus able to identify pitches that require multiple tunings as problematic from a keyboard tuning perspective, and to judge the suitability of various tuning and temperament systems for specific pieces of music. Historical tunings and temperaments, under Blackwood's principles, are distortions of a speculative, perfectly intoned keyboard that afford greater or lesser degrees of harmonic flexibility depending on their deviation from just intonation. Implicit in this dialogue is the idea that considerations of tuning and temperament exert pressures and set limits on what is and what is not possible in selecting intervals for composition; for Blackwood, the aesthetic goal of tuning is to *avoid* as many out-of-tune intervals as possible.

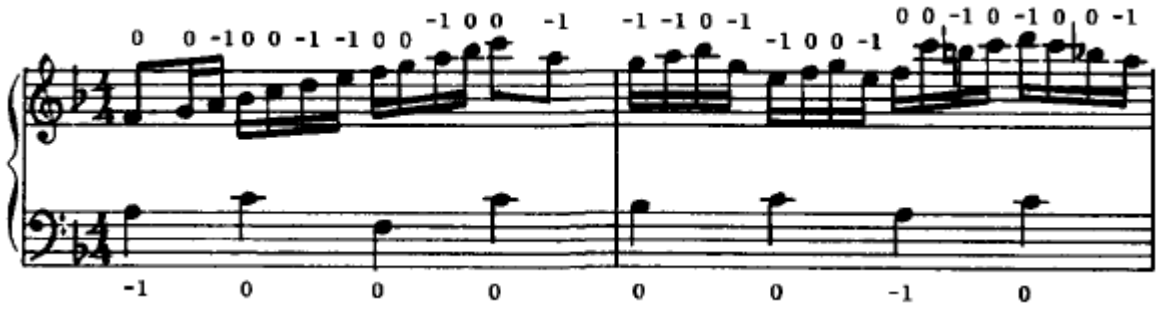

Figure 7: Blackwood's analysis of Mozart's Piano Sonata in F Major, K. 533, mm. 126–7

There are, however, several difficulties with this notational system. Blackwood strongly favors the pure fifth, a bias that is endemic to his project of understanding scales as generated by fifths of varying sizes. One can level this same critique at my chosen method of displaying temperaments in pie diagrams. In this respect, we might liken Blackwood's frame to that of the Pythagoreans; we might also notice a striking similarity between Blackwood's rows of tones and Pythagorean monochord diagrams. What results, as can be seen above, is a notational system that

[49] Ibid., 132.

implies unwittingly that tunings built largely on pure fifths are somehow unproblematic without deviation. In particular, there is no indication of the uncomfortably wide C_0E_0 major third. Blackwood himself seems to keenly recognize this difficulty of notation, and works assiduously to highlight these difficulties with interval ratios, measurements in cents, and esoteric historical interval nomenclature. Furthermore, Blackwood's notation is unable to capture succinctly the overall tuning of verticalities beyond the dyad. Most notably, the tuning of triads must be understood as a composite of a fifth and a third, which both must be gleaned separately. One can imagine how cumbersome this notation becomes as the music to be analyzed becomes more florid and chromatic (for example, see Fig. 7). It is perhaps due to this limitation that Blackwood abandons his annotations completely when analyzing with more complicated systems such as meantone tuning and well temperament, opting instead to discuss the relative frequency of pleasant and unpleasant intervals in suitable repertoires.

My graphing method attempts to modify Blackwood's annotations to center the flux of impure and pure triads over the course of a piece of music rather than the tuning of isolated pitches, while preserving his commitment to the close reading of interval sizes. In order to avoid the clutter of Blackwood's annotations in particularly florid passages of music (such as the Mozart example), I first reduce each passage of music to rid the texture of non-chord tones and arpeggiations, thereby revealing an underlying succession of triads under various tunings. Particular attention is given to approaching this "harmonic" reduction of music from a historical lens, by drawing from Christoph Bernhard's catalogue of diminutions from *Tractatus compositionis augmentatus* (ca. 1657).[50] For the sake of simplicity, I will be dealing exclusively

[50] Walter Hilse, "The Treatises of Christoph Bernhard," in *The Music Forum* 3, ed. William J. Mitchell and Felix Salzer (New York and London, 1973), 1–196.

with the "triadic" parts of verticalities and will not consider the tunings of sevenths and ninths. For each verticality, the out-of-tuneness of each triad can then be measured as the sum of the positive deviation of the fifth and its two component thirds away from pure tuning in cents (see Fig. 8). In the case of diminished triads, I use Blackwood's "extended just tuning" as a measurement for the "pure" diminished fifths, measured at an interval ratio of 7:5. These indexes are plotted onto a Cartesian plane.

A just fifth is measured at 701.955 cents.
An equally tempered fifth is measured at 700 cents.
Then,

$$deviation\ of\ fifth = \Delta j = |701.955 - 700| = 1.955\ cents$$

A just major third is measured at 386.314 cents.
An equally tempered major third is measured at 400 cents.
Then,

$$deviation\ of\ major\ third = \Delta k = |386.314 - 400| = 13.686\ cents$$

A just minor third is measured at 315.641 cents.
An equally tempered minor third is measured at 300 cents.
Then,

$$deviation\ of\ minor\ third = \Delta l = |315.641 - 300| = 15.641\ cents$$

And therefore,

$$deviation\ of\ triad = \Delta j + \Delta k + \Delta l = 1.955 + 13.686 + 15.641 = 31.283\ cents$$

Figure 8: Calculation of the deviation in cents of a triad under equal temperament

To briefly illustrate my graphical method, I have produced a short analysis of the opening measures from the C major prelude from *The Well-Tempered Clavier* (Book I) with my proposed method under equal temperament, Zarlino's 2/7th meantone tuning, and a well temperament, Kirnberger II (see Fig. 9 on p. 41). By graphing the contours on the same axes, it becomes possible to compare each temperament's effects on a piece of music diachronically.

There are several trends to note in my sample analysis. The first is that both historical temperaments, which attempt to prioritize the tuning of intervals in areas of the circle of fifths with fewer sharps or flats, tune this passage markedly more concordantly than the persistent

discordance of equal temperament that modern ears are used to. Second, the barely tempered triads of Zarlino's temperament impart an absolute settled quality to the short passage, represented visually by the uniform contour in the graph. However, we must remind ourselves that this harmonious tuning is only possible thanks to sacrifices made elsewhere; this passage from BWV 846 does not move far afield. Transgressions into the domain of the wolf are pungent even to modern ears, and reveal themselves graphically as uncharacteristic spikes in the contour. Lastly, I have included Kirnberger II (a temperament outside of this project's purview) to illustrate that certain harmonic schemata, such as the exordial I–ii–V–I in mm. 1–4, can generate discordance contours that comport with or subvert the directionality implied by the harmony. In this case, a departure from a concordant tonic is recuperated by a progressive decrease in discordance from pre-dominant to dominant to tonic, a resolution aided by the Kirnberger II tuning.

In this respect, I am like Blackwood in considering temperaments as distortions of a speculative just intonation. This deviation from pure tuning has been studied under different names across music studies, reflecting the research priorities of each subdiscipline. In historical musicology and theory, it is often simply referred to as "impure" or "pure," measured by the frequency of "beats" resulting from the destructive and constructive interference between the pitches of impure intervals.[51] This is most in keeping with historical discussions found in historical tuning manuals, which instruct tuners to listen to these pulsations.[52] Other musicologists have chosen to use the term "dissonance."[53] While this certainly conjures up the

[51] For example, see Mark Lindley, "J. S. Bach's Tunings," 721–26.

[52] Barthold Fritz writes that the "beating [of tempered fifths] amounts to about the speed of quavers in common time." Ibid., 721.

[53] For example, see Masumi Yamamoto, "The Use of Meantone Temperament in the Performance of Keyboard Music by Johann Jacob Froberger" (PhD diss., University of York, 2015).

pungent aural qualities of out-of-tune intervals in the common usage of the term, its usage in a scholarly context risks conflating notions of contrapuntal dissonance with tuning. The same ambiguation of terms can be found in music cognition and perception, which has led to the differentiation of an "acoustic" or "sensory dissonance" from "musical dissonance."[54] However, further research has shown that even sensory dissonance is culturally and historically situated, and varies greatly with an individual's exposure to and expertise in performing Western art music styles.[55] In an effort to further distance research from these perceptual mediations, acoustics research has selected the term "roughness" to refer exclusively to the physical phenomena regarding beat frequency.[56] It is clear from this instability of terminology that "out-of-tuneness" is a complex, culturally situated perceptual phenomenon resulting from calculable physical properties. In this thesis, in order to refer to out-of-tuneness as separate, but linked to the structures of dissonance in counterpoint and harmony, I employ the term "discordance." The graphed contours, then, will henceforth be referred to as "discordance contours." A primary assertion of my graphing method is that tuning and temperament can suggest a partially autonomous level of musical hierarchy outside of counterpoint and harmony. In revealing the flow of discordance throughout a piece, I hope to render audible an interaction between a structure of dissonance and a structure of discordance that has been flattened by the ubiquity of equal temperament in the modern day. It is worth noting explicitly that I do not claim any mathematical or acoustical perceptual rigor with my measurements, and only seek to implicate

[54] See William A. Sethares, "Relating Tuning and Timbre," *Experimental Musical Instrument*s 9 no. 2 (1993) and R. Plomp and W. J. M. Levelt, "Tonal Consonance and Critical Bandwidth," *The Journal of the Acoustical Society of America* 38 (1965): 548–60.

[55] T. Popescu, M. P. Neuser, M. Neuwirth, et al., "The Pleasantness of Sensory Dissonance is Mediated by Musical Style and Expertise," *Scientific Reports* 9 no. 1070 (2019).

[56] Václav Vencovský and František Rund, "Roughness of Two Simultaneous Harmonic Complex Tones On Just-Tempered and Equal-Tempered Scales," *Music Perception* 35 no. 2 (December 2017): 127–43.

the perception of out-of-tune intervals in my graphs. Absolute numerical values are used only to judge the discordance of events relative to others; in this respect, the persistent and uniform discordance of the equally tempered triad (see Fig. 8 above) serves as a useful perceptual point of departure for modern ears. This analytical framework pointedly moves away from Blackwood's view of discordance as a limiting factor for composers by considering discordance as a musical structure that provides a field for creative expression: bright, beating discordances can be artfully deployed for rhetorical effect. While this is certainly true at the moment of realization at the hands of the tuner-performer, the claim I wish to advance is one at the level of composition and text. Novel harmonic moves, beating triads, and enharmonic spelling penned by the composer or scribe are not errors to be corrected, as Blackwood claims, but musical expressions at the boundaries of the historical tunings of the time. Wang puts it bluntly: "[they are] *supposed* to sound wrong."[57] This project looks at these moments that push the temperamental envelope.

[57] Eric Jarlin Wang, "Mistuning the World," 190.

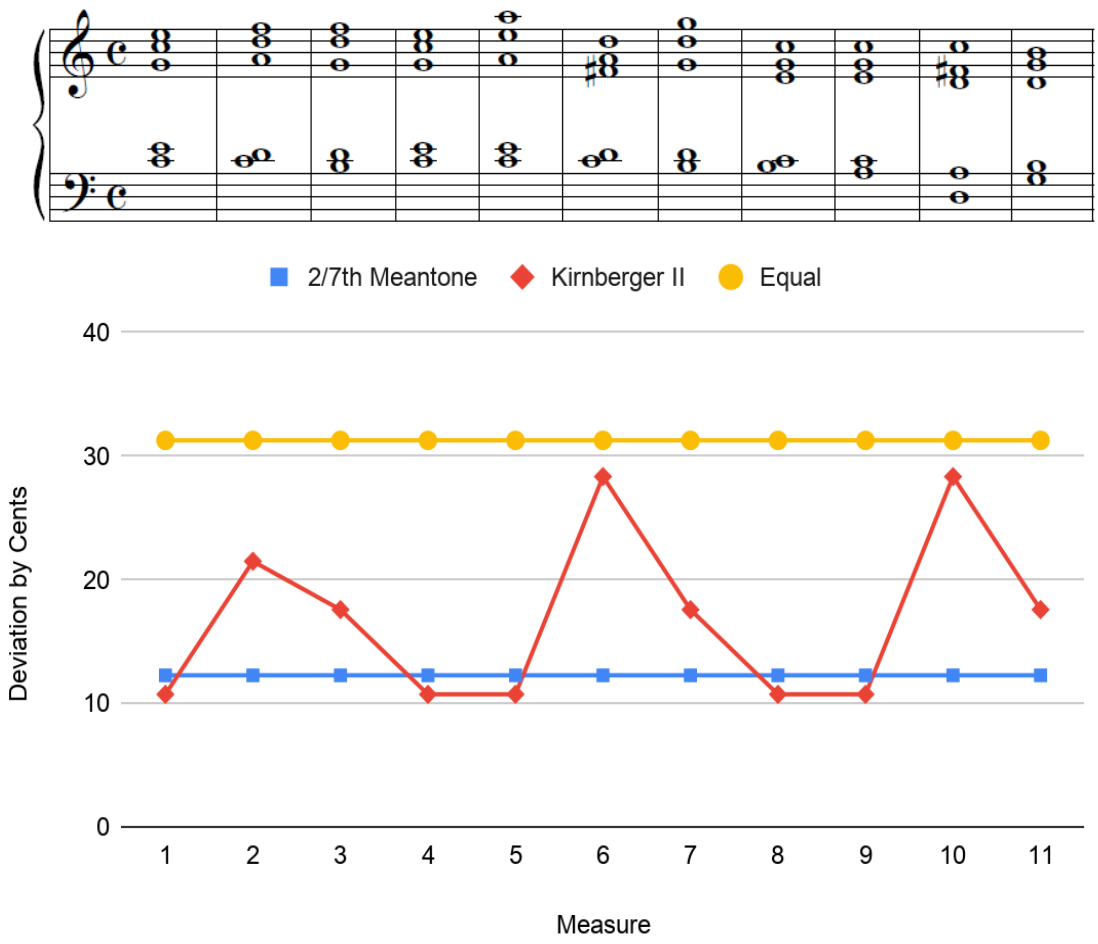

Figure 9: Discordance contour of Prelude in C Major, BWV 846, mm. 1–11

At the Fringes of Meantone: Case Studies

In this chapter, I highlight examples of Froberger's keyboard repertory and draw out the ways in which the meantone boundary, situated at E-flat–G-sharp in the normal disposition of meantone, exerts pressure on his compositional language. Crossing the meantone boundary, as we shall soon see, involves a noticeable and, at times, ugly increase in discordance that provokes certain reactions in figuration, voice leading treatment, and harmonic movement. While Froberger's problematic crossings and enharmonic spellings have often been construed as a desire to supersede the limits of meantone in anticipation of the well temperament of the eighteenth century, the claim I wish to advance here is exactly the opposite. Froberger does not commit meantone-temperament atrocities because he wishes to disregard them in order to access a wider range of keys. Rather, Froberger's temperamental "errors" indicate a keen awareness of and a desire to work within the peculiarities of the mistuned keys of the wolf, a visceral aural presence that is hidden within the score in a conventional reading. My narrative prose and discordance contour graphs aim to unearth this interaction. Far from just a matter of coloration, considerations of tuning regarding that meantone boundary cast long-range expectations and thereby generate a structure of discordance often independent of the structure of dissonance; what might be construed as cases of smooth, conventional voice leading and figuration become moments of poignancy that exploit out-of-tuneness for expressive means.

I have chosen to analyze five of Froberger's keyboard works. Each plays at the fringes of meantone, a precarious activity that often results in the music landing straight in the jaws of the wolf. My analyses are ordered in the degree of severity regarding its wolf crossing. The first piece, Toccata IV in F Major, FbWV 110, remains largely in its concordant key of F major but introduces discordance in isolated instances of voice leading error. The second and third,

Lamentation in G Minor, FbWV 614, and Meditation in D Major, FbWV 620, also begin in concordant keys, but they move too far afield flatward and sharpward—past the meantone boundary—for expressive purposes linked to their programmatic titles. The fourth, Allemande in E Minor, FbWV 627, is in a key that is problematic on account of its discordant leading tone; my analysis treats meantone crossings in conjunction with a lengthy program that appears in the SA4450 manuscript. Lastly, in the Lamentation in F Minor, FbWV 633, an F minor tonic itself crosses the meantone boundary; this "forbidden" key should be too discordant to warrant usage. By engaging this gradient of interactions, I hope to show that striking discordances appearing in Froberger's keyboard pieces under the normal disposition of meantone are not problems to be corrected by fixing their tunings, but striking sonorities that are integral to Froberger's musical rhetoric.

My analyses largely rely on Siegbert Rampe's Froberger New Edition of the Complete Works, published by Bärenreiter. However, when there exist discrepancies between manuscripts, especially in the case of mismatched accidentals, I will briefly discuss my decision to select a particular manuscript for analysis. Although the aim of these analyses was originally to give tuning recommendations, due to the COVID-19 pandemic, I was not able to access a kit harpsichord to experiment with tunings. In an effort to engage at least tangentially with temperament as a live practice, I have chosen to compare recordings that employ different temperaments, where possible, attending to the ways that the effects of a meantone temperament can influence the performance of a piece of music.

Toccata in F Major, FbWV 110

Froberger's Toccata in F from *Libro Quarto* (1656) is laid in four major sections: mm. 1–10, 11–19, 20–25, and 26–35. Throughout this toccata, Froberger plays with the enharmonic

spellings of D-flat/C-sharp, A-flat/G-sharp, and E-flat/D-sharp in each of their incarnations as a third in various triads. In the normal disposition of meantone, these tones would have been tuned as C-sharp, G-sharp, and E-flat respectively. While Froberger's characteristic chromaticism can often be explained away hierarchically by categorizing chromatic inflections as non-chord tones, FbWV 110 resists this impulse by placing enharmonically misspelled notes in strong metrical positions, an aspect that has drawn scholars such as Wang and Lindley to point towards this toccata as an early example of a composer attempting to fight against a meantone-oriented keyboard style. Lindley uses this toccata as evidence of Frescobaldi's influence on Froberger (Frescobaldi advocated equal temperament) and discounts the possibility of a meantone reading due to the repeated usage of enharmonic spellings.[58] My analysis, which is particularly indebted to Wang, attends to these enharmonic moments and shows how Froberger engages meantone in a calculated game of discordance "punning."[59] In each section, Froberger makes an issue out of a particular "black" key, presenting first its misspelled tone in consonance, a setting that causes it to howl noticeably within an otherwise perfectly in-tune environment. These misspellings are later corrected by presenting that same black key concordantly with its correct enharmonic spelling, usually in the same register, before the end of each section. The rhetorical thrust of the toccata is thus built on a calculated overstepping of the wolf boundary, casting a structural expectation to be resolved in the dimension of discordance.

The first section of the toccata (mm. 1–10) can be broken up into two parts, mm. 1–5.4 and mm. 5.5–10, each ending with a half cadence in F major.[60] The toccata opens

[58] Mark Lindley, "Tuning and Intonation," in *Performance Practice: Music After 1600*, ed. Howard Mayer Brown and Stanley Sadie (New York: W.W. Norton and Co., 1990), 175–6.

[59] Wang, "Mistuning the World," 185–92.

[60] M. *x.y* refers to the *y*th quarter-note beat of measure *x*.

conventionally, with an extended section of quick passages to establish the key of F major and allow the performer to show off their improvisational skills. After reaching the B-flat major predominant in m. 4, a dominant pedal in mm. 4–5 builds pressure before reaching a half cadence. However, already, in what seems to be a conventional exordial progression, Froberger has already introduced a wolf tone. In m. 5, just before the resolution of the cadential 6/4 into a C major 5/3 on the third quarter-note beat, the top voice drops to an acrid A-flat instead of an A-natural, forming a discordant minor third above F. While this can be characterized as a successful half cadence on all accounts of voice leading and harmony, the completely unstable nature of the tuning of the A-flat throws out any attempt at closure. Restarting as if nothing had happened, we begin again in F major on the third half note of m. 5, but with rapid passages in the left hand punctuating the tonic, leading into a brief foray into D minor in mm. 6–7 by painting with large brush strokes across all registers. The music is somewhat reluctant to move back to F major, however; a weak arrival in the tonic on the third half note of m. 8 is thrown off immediately by the strong presence of B-natural, followed immediately by a run embellishing D minor in the left hand. Landing prominently on an A minor 6/4 in preparation for a cadence in A, Froberger surreptitiously slips in a G-sharp, incidentally in the same register as the problematic A-flat, as an incomplete neighbor to A. Here, G-sharp, unlike its howling sibling A-flat, sounds concordantly above E in a major third, a tuning "pun" that corrects the mistakes of the past. With the A-flat corrected, the music now feels at ease, ready to reattempt the thwarted cadence of m. 5. Almost too eager to move back to F major, the music evades A minor with a strange 6/4–6/5/3 voice leading, forcefully reinstating F major in m. 9. Now firmly in the tonic F major, the rest of the section proceeds conventionally, bringing the first section finally to a close, both in counterpoint and in tuning.

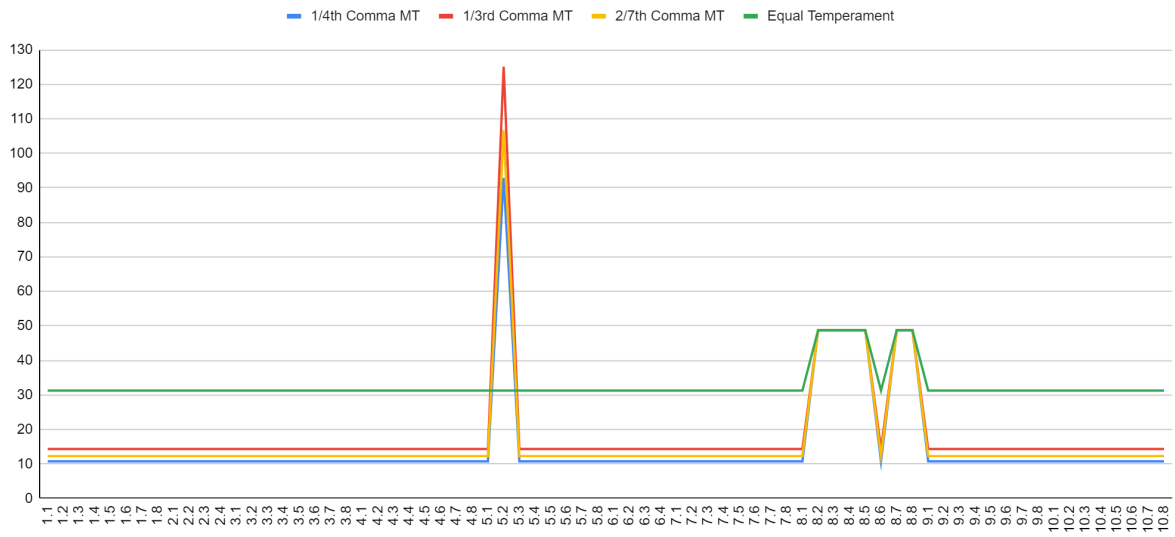

Figure 10: Discordance contour of FbWV 110, mm. 1–10

The second section (mm. 11–19) breaks into a tuneful imitative section and wastes no time in F major, moving quickly through A minor, D minor, and finally E minor in mm. 11–13. While the E minor triad itself does not contain any wolf tones, the key area of E minor presents problems due to the presence of D-sharp in its B major dominant, which appears prominently at the outset of m. 14 in a cadence in E minor. Here, D-sharp, tuned treacherously high as E-flat, forms a discordant major third above B major. Pulling away from this overstepping of the wolf, the music retreats up the circle of fifths in mm. 15-16, through D major and A minor, finally cadencing in C major, far from D-sharp. Taking a bit of a respite, the music crawls cautiously to D minor through C-sharp in half notes, prompting the performer once again to improvise before recalling the figuration of the opening section in m. 18. Perhaps recalling the move into the undesirable E minor from D in m. 13, a reinterpretation of the F in D minor as a seventh permits a move into C minor. Here, D-sharp is enharmonically respelled and revoiced again in a case of tuning "punning," sounding as a concordant E-flat in a minor third above C. Realizing that this strategy was successful in moving the music in the flat direction on the circle of fifths, another

recontextualization is employed by interpreting E-flat in C minor as a seventh, thereby setting up a half cadence in B-flat. Again, we have reached a concordant and consonant end by domesticating the howling D-sharp.

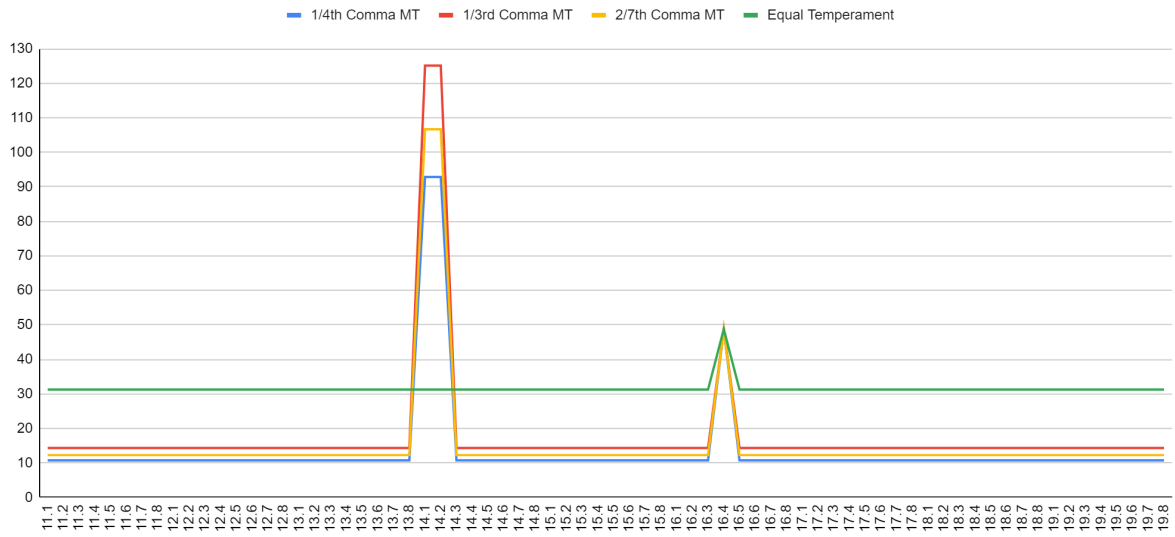

Figure 11: Discordance contour of FbWV 110, mm. 11–19

Without warning, Froberger pulls the rug out from under us, slamming the music into A minor and sending it tumbling; this initiates the third section (mm. 20–25). In mm. 21–22, a thwarted cadence in A minor throws off any chance at recuperation; the music begins to become increasingly flat, introducing B-flat in G minor in m. 22 and E-flat in C minor in m. 23. Again, a recontextualization of E-flat into a seventh is used to set up a cadence in B-flat major. However, this ends in catastrophe, with the E-flat moving down not to D-natural, its intended resolution, but to a D-flat tuned as C-sharp. An effort is made to continue towards B-flat by simply pushing past the discordant howling 6/4 into the dominant 5/3, a level-headed and assertive solution by the right hand that is matched with equal vigor by the left hand. Sounding a G-sharp, the left hand permits a move to the more neutral and concordant A minor, and successfully pivots back to the F major tonic through D minor in mm. 24–25, echoing the flourishes of the opening. The

right hand, rising through D minor, apologetically sounds C-sharp as a lower neighbor, in the same register as the mis-tuned D-flat, rectifying its grievous misstep. The bass responds sympathetically with a flourish of its own, setting up a peaceful half cadence in the tonic.

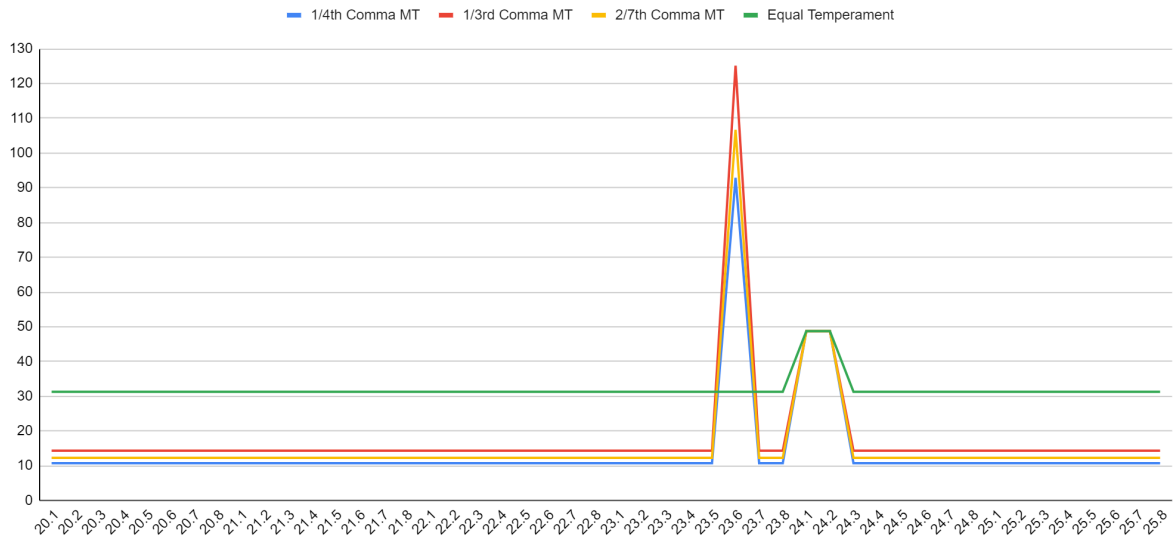

Figure 12: Discordance contour of FbWV 110, mm. 20–25

By this point, in each of three sections, the discordant misspellings of D-flat, G-sharp, and D-sharp have been corrected, and the music launches a victory lap with a final fugato section (mm. 26–35). Containing no enharmonic spellings outside of the normal disposition of meantone, the piece moves seamlessly along through F major and its related keys, hitting the once problematic tones of C-sharp and E-flat as if to show off its newfound discretion and concordance.

The toccata, surprisingly, does not move very far afield from its home in F major; a broad swath of pitches is accessed through deception and recontextualization, allowing Froberger to move through different tempered dyads without jarringly shifting gears into remote key areas. These problematic tones that encroach on the wolf fifth seem to present a dilemma to a meantone-oriented compositional mind that must be resolved through tuning punning, thereby casting a

long-range structural goal to rectify them by the final cadence. This is done both in the far reaches of the flat side of the circle as in A-flat, but also in the outskirts of the sharp side in D-sharp, a broad reach that has led Wang to characterize Froberger's compositional strategy as an "[outlining of] the boundaries of meantone in … mechanical fashion."[61]

For a tuner, this toccata presents difficult challenges regarding enharmonic spellings. It is certainly possible to play this entire toccata perfectly in tune with a split-key manual, which Froberger was certainly aware of from Frescobaldi. The majority of keyboardists, who only have access to keyboards confined to twelve keys per octave, must thus choose between the harsh tones of traditional meantone tunings or a modification that ameliorates the size of the wolf by mistuning the concordant spellings. The most drastic modification would be to tune the keyboard equal or something close to it. In the case of E-flat/D-sharp, the only discordant enharmonicism that is a product of a key area and the only wolf tone not corrected in the same register it appears, a historical argument can be made for a split-key reading. According to Joseph Pollard, E-flat/D-sharp was the first key to receive split-key treatment, due to its prevalence in the music of the low countries.[62] Christopher Stembridge has also traced an increase in Frescobaldi's usage of D-sharp after a trip to the low countries, a regional style that may have influenced Froberger.[63] This attests to the possibility of a completely concordant E minor in mm. 13–14. In the case of A-flat/G-sharp and D-flat/C-sharp, both of which entail semitone missteps in voice leading by the right hand which are then sheepishly corrected in passing, a sour tuning heightens the rhetorical

[61] Ibid., 192.

[62] Joseph Victor Pollard, "Tuning and Temperament in Southern Germany to the End of the Seventeenth Century" (PhD diss., University of Leeds, 1985), 94.

[63] Christopher Stembridge, "Music for the Cimbalo Cromatico and Other Split-Keyed Instruments in Seventeenth-Century Italy," *Performance Practice Review* 5 no. 1 (1992): 21.

effect of misspelling. Under an equal temperament, as in a performance by harpsichordist Timur Khaliullin, the wolf tones sound inherently "wrong" by virtue of their voice leadings, a surprising but ultimately passing moment of error.[64] However, when played in a severe meantone temperament as in a recording by Tobias Sing, the wolf tones take on a completely unpleasant quality that almost requires a solution due to their beating and discordance, casting an expectation that is fulfilled by their respective "puns."[65] This sense of urgency and resolution is only audible in the throes of meantone. Meantone tuning provides a discordance/concordance structure that unfolds independent of harmony and counterpoint.

Lamentation, from Partita in G Minor, FbWV 614

In lieu of a traditional Allemande, Froberger opens his Partita in G Minor with the evocatively titled Lamentation, "*Lamentation sur ce que j'ay été volé et se joüe à la discretion et encore mieux que les soldats m'ont traité*," or "Lamentation on what was stolen from me, to be played with discretion and even better than how the soldiers treated me." The title refers to Froberger's experience of being robbed by soldiers during a trip in 1650 from Brussels to Louvain, a struggle staged in the dimension of tuning by fleeing from, struggling against, and lavishing in the wolf fifth. His indication of *à la discretion* should be read as a performance direction indicating some degree of rhythmic freedom to be determined at the discretion of the performer.[66] While G minor is quite a conventional key, a quick scan of the score alerts the

[64] Timur Khaliullin, "Johann Jakob Froberger Toccata in F FbWV 110 / И.Я. Фробергер Токката in F," 25 March 2014, https://www.youtube.com/watch?v=ZxRKYzXUkMM.

[65] Tobias Sing, "Froberger: Libro Quarto (1656), Toccata IV in F, FbWV 110," 20 June 2020, https://www.youtube.com/watch?v=a4leaEPY1f8.

[66] Howard Schott, "Parameters of Interpretation in the Music of Froberger," in *Froberger: Musicien Européen* (Paris: Klincksieck, 1998): 102–4.

temperamental ear; Froberger's manuscript is inundated with instances of A-flats, particularly in the first section of the binary form. Unlike the previous toccata, which was more or less well-behaved in terms of its movements between key areas, with wolf crossings limited to a couple instances of voice leading error, Froberger's movements in this lamento are deliberate in its movement into the wolf's territory, exploiting the discordance of the resulting sonorities for dramatic and expressive ends.

Froberger curses his misfortune immediately in the first moments of the lament, opening with a sour dissonance over the tonic bass. The subsequent resolution into the G minor tonic initiates a cascade of falling gestures. It serves both to lend a stable footing for G minor in the wake of the lament's unorthodox opening, but also introduces E-flat in mm. 1–2 and pulls the music towards the wolf's territory. Detecting this flatward drift, the bass attempts to awkwardly recuperate by landing on B-natural instead of B-flat in m. 3 to evade a cadence in G minor, a strategy that encourages an upward climb by the right hand through a G major scale, passing through a bright E-natural. As if to insist on the possibility of a bright C major to come, the right hand again stresses the E-natural in a quick rising figure. This delusion only lasts just shy of a full octave ascent, revealing G major as a dominant seventh of C minor, thus marking the return of the portentous E-flat. Another attempt to move sharpward is made by canceling out the flat with an E-natural at the end of an octave descent in m. 4. For the moment, having circumvented C minor, the music moves back to G minor in preparation for a cadence in the tonic. However, instead of landing on an A-natural in beat 3 as part of a pre-dominant ii^6, the melody trips onto the dreaded, howling A-flat in the top voice, suggesting a discordant Neapolitan.

A temporary stopgap is deployed by recontextualizing the A-flat as a seventh, allowing an escape into a tenuous respite of E-flat major. Unfortunately, E-flat permits a move straight

into the wolf in full force, an arrival of A-flat major triad on the second beat of m. 6. In order to avoid a prolonged tonicization of A-flat, the bass moves up to B-flat in m. 7 in an effort to reinstate E-flat major. This solution is denied by a deception into C minor, eventually descending to A-flat once again. The resulting F minor sonority of m. 8, decorated by a sinuous upper voice, twists the meantone knife by harping repeatedly on both a howling major third, A-flat–C, and the wolf fifth, A-flat–E-flat. The music finally escapes the wolf by inching up to A-natural in the bass, an escape that finally proves successful in leading into a cadence in the D minor dominant in m. 11. A discordance contour of the first section is given below.

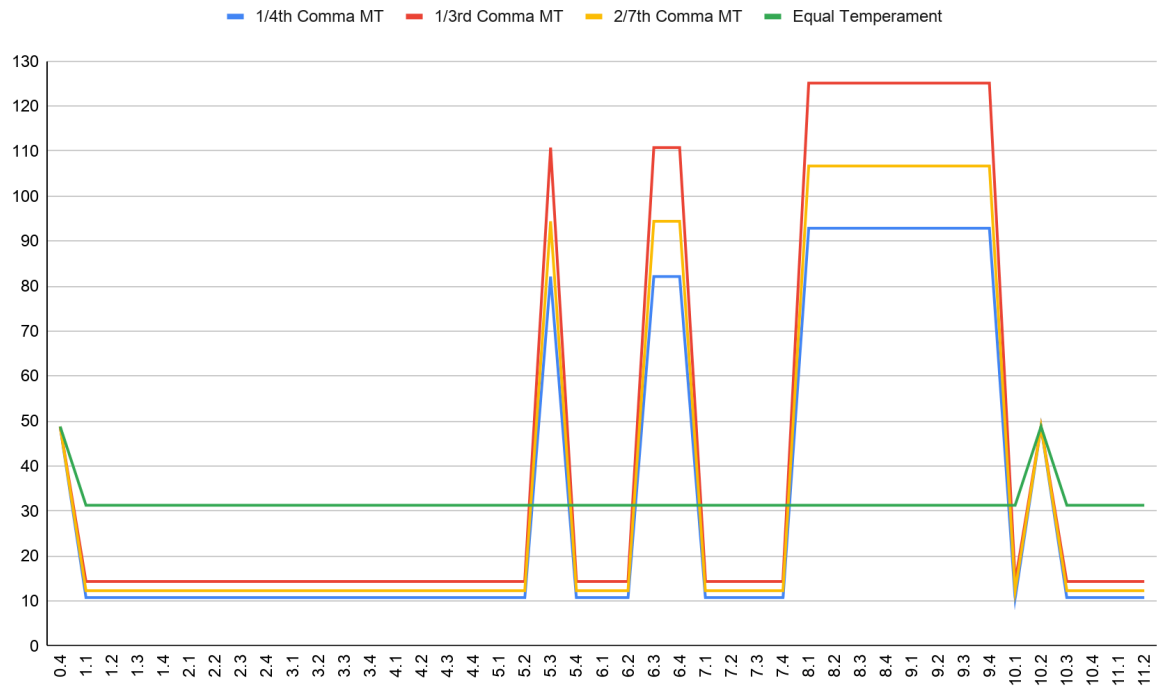

Figure 13: Discordance contour of FbWV 614, mm. 1–12

As clearly shown in the graph, the crossing of the wolf has disastrous consequences for the tuning of the triads containing A-flat. With each appearance of the wolf, it becomes harsher and more brazen: the pungent flavor of a single beat in m. 5 grows into a two-beat howl in m. 6, eventually culminating in the protracted, measure-long writhing of m. 8. Wang has also noted

that the wide spacing of the A-flat major arrival in m. 8, made up of a twelfth and seventeenth, maximizes the overtone beating of the triad.

The second half of the lamento, although not nearly as dramatic as the first, also treads into the territory of the wolf. Leaving the D minor dominant for F major and B-flat major, there is a distinct warm and undisturbed quality to the upward gestures of melody, which eventually give way to G minor in m. 16, unfolding blissfully in the distinct absence of a worrying E-flat. In m. 17, a dramatic octave flourish over the C major dominant sets up expectation for a drawn-out cadence in F major, which is dashed by a sudden deception into F minor. This calamitous event, recalling the discordance of the first section, proves much more disastrous. The music moves even further flatward to a discordant B-flat minor with D-flat tuned as C-sharp, successfully tonicizing F minor in preparation for a perfect authentic cadence in the wolf's territory, accompanied once again by a twisting of the melody about A-flat. At the outset of m. 19, the dreaded cadence is completed, with all three voices converging on F. However, as if by sheer luck, the music finally breaks through into F major and slays the wolf, with A-flat corrected in the same register into A-natural. This return to stability allows the music to move conventionally back to G minor for the final cadence. A-flat is henceforth eradicated from the fabric of the suite, with all subsequent dances firmly planted in the harmonious G minor tonic. The discordance contour of the second section reveals again how severely an innocuous move past E-flat on the circle of fifths can affect the tuning of triads, an aural effect that is completely missing when played under equal temperament.

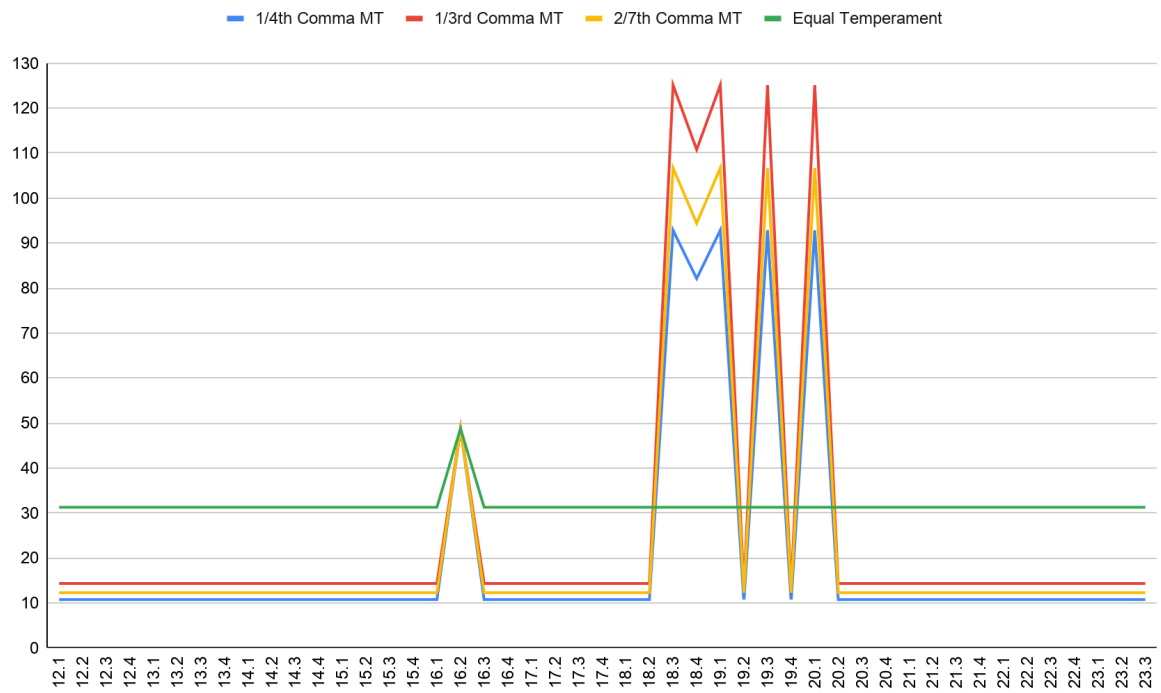

Figure 14: Discordance contour of FbWV 614, mm. 12–24

These discordance contours leave us at a theoretical crossroads. It is possible to throw out Zarlino's Pythagorean concern by correcting the tuned G-sharp to A-flat before performing the Lamento, a small operation that would result in perfectly concordant A-flat major and F minor triads. In the context of the entire suite, this adjustment would also be acceptable, since A-flat/G-sharp is not used. However, I might point out the characteristic ways in which the A-flat behaves in the lamento, particularly in the way that it is introduced by way of deception, especially prone to obsessive repetition, and expanded upon by a writhing melodic pattern unused elsewhere. Coupled with the programmatic title of the piece, this treatment leads me to believe that Froberger exploits the wolf fifth in order to express in music his physical and emotional trauma of being robbed. Viewed thus, the highly discordant wolf triads of A-flat major and F minor are not problems of temperament to be fixed, but are integral to the rhetoric of the lamento. A recording of the lamento by Blandine Verlet, who chooses to perform it in the severe quarter-

comma meantone, takes this reading to heart.[67] Each time the wolf appears, Verlet luxuriates in its discordance, increasing the agogic stress of her articulations and slowing the metrical pulse to allow for the overtones to beat audibly. In comparison, a recording by Gustav Leonhardt, who has corrected the sour tuning of the A-flat, treats the crossing of the wolf in the opposite manner.[68] For example, the surprising arrivals of A-flat in mm. 5–6 are treated warmly as unbothered arrivals, basking in the bright major quality of A-flat major without regarding its place on the circle of fifths. For me, this kind of tuning affords an interpretation that runs contrary to the primary rhetorical thrust of the piece by inoculating the discordance contour. Froberger's anguish breathes in the dimension of tuning, housed in the den of the wolf.

Meditation, from Partita in D Major, FbWV 620

As in the Partita in G Minor, FbWV 614, the Partita in D Major also swaps out a traditional allemande for a programmatic piece. This time, Froberger elects to include a Meditation, dealing with the very strange subject of his future death, entitled "*Meditation faite sur ma mort future, la quelle se joüe lentement avec Discretion*." Rebecca Cypess in particular has linked this Meditation's autobiographical, introspective nature to the larger context of 17th-century French prayer practices.[69] For Cypess, Froberger's marking for the piece to be performed out of time "enables the contemplation of death—repeatable in every performance—through the dream-like state of devotional meditation."[70] However, matters of pitches and their

[67] Blandine Verlet, "Suite No. 14: I. Lamentation," 31 March 2020, https://www.youtube.com/watch?v=6xBRlIwvRzc.

[68] Gustav Leonhardt, "Lamentation sur ce que j'ay été volé," 18 September 2015, https://www.youtube.com/watch?v=F8aG0VIBBOg.

[69] Rebecca Cypess, "'Memento mori Froberger?': Locating the Self in the Passage of Time," *Early Music* 40 no. 1 (February 2012): 45–54.

[70] Ibid., 51.

tunings are absent from her analysis. A cursory scan already reveals a striking sharpward drift in the first section of the binary form, with the frequency of sharps increasing at a rapid rate as the music approaches the double bar, culminating in a strange, highly discordant arrival in F-sharp major. From the very comfortable tonic of D major, Froberger tumbles into the far reaches of the sharp side of the circle of fifths, employing D-sharp, A-sharp, and E-sharp, all mistuned under traditional meantone temperaments as E-flat, B-flat, and F-natural respectively. In contrast, the second half of the Meditation fits almost completely within the normal disposition of meantone, except for a small instance of D-sharp. As in the Lamento from FbWV 616, my analysis will seek to show how discordance is used for expressive purposes, and thereby provide a reading that stages Froberger's struggle to accept his mortality and his eventual acceptance of it.

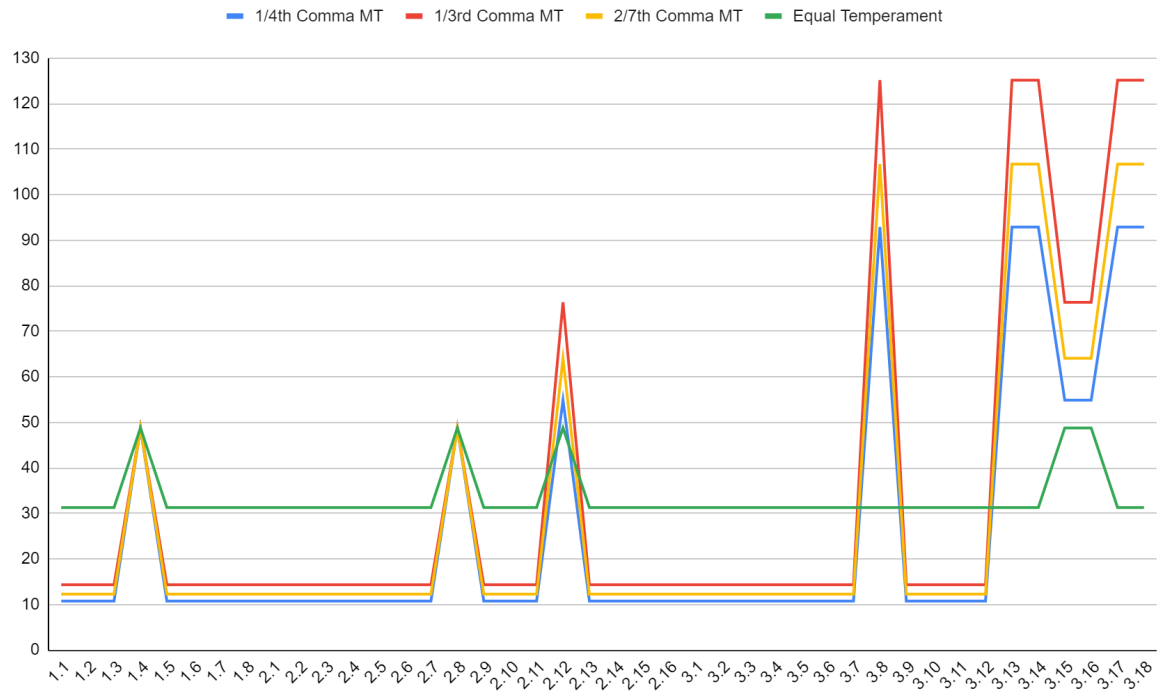

Figure 15: Discordance contour of FbWV 620, mm. 1–3

Right from the outset of the Meditation, the right hand reveals itself to be somewhat of a flighty and nervous narrator terrified of its mortality: in the opening gambit, aimed at

establishing the D major tonic, the top voice droops from the leading tone onto C-natural, shuddering in repeated thirty-second notes. Thankfully, the other voices move to meet it halfway, recontextualizing its nervous moaning as a seventh and moving into G major by the end of the first measure. In m. 2, the music moves up the circle of fifths through D major to A major, which is successfully tonicized with the introduction of G-sharp and an E dominant pedal in the bass. Drawing out a *cadenza doppia* in A major, the bass moves down to D, permitting the right hand to veer off suddenly onto B diminished, cancelling out F-sharp and C-sharp on the way. The bass, again accommodating the whims of the right hand, moves up to an E to form a cadential 6/4 in A minor with the right hand, completing all the necessary signs for a perfect authentic cadence in A minor. Unfortunately, the right hand, faltering in perhaps in the worst way possible, oversteps the meantone boundary and screams out in a discordant A-sharp instead of A-natural, a transgression that evades A major completely and leads directly into B minor. Again, to rectify the situation, all the voices move once again to recontextualize the D-natural of B minor as a seventh, permitting a move back to A major in m. 3. Celebrating, the right hand sings above an A major pedal. However, just as the right hand finds its existential bearings, the bass begins to doubt itself, moving angularly up to its own howling wolf tone, a discordant D-sharp, and tonicizing E minor in preparation for a cadence. Mirroring the bass's anxiety, the melody twists through the pre-dominant A minor, eventually landing prominently on that same D-sharp in the B major dominant, shaping up to be the first stable arrival of any key in this Meditation. And in a final ungraceful misstep, the right hand nervously flubs its resolution once again, reaching up to a discordant E-sharp diminished, with a howling G-sharp–B third. Interestingly, E-sharp and G-sharp are concordant against each other as F-natural and A-flat respectively, a result of moving completely past the wolf. This mistake sends all voices slipping into a weak arrival in F-sharp

major. Here, the A-sharp cries out as a B-flat above F-sharp as a diminished fourth, a fitting end to a frenetic, discordant section.

After the double bar, by contrast, Froberger seems to suddenly reach a moment of clarity. Adjusting from F-sharp major to minor, the music sings out completely concordantly, a harmonious quality enhanced by its close proximity to the discordant F-sharp major triad. Proceeding with the utmost caution, the music gingerly snakes sharpward towards D major, through an A major dominant seventh. The bass, still mistrustful of the right hand, does not move directly into D major, but rather lingers on A as if to test the right hand's resolve. The right hand obediently moves up the A major scale, which manages to convince the bass to move to confirm a stable A major with another ii–V–I at the outset of m. 5. Unfortunately, just after this moment of collaboration, the right hand falters, dropping directly into D-sharp tuned as E-flat, instating yet another scramble into E minor. Perhaps learning from its past mistakes, the right hand swiftly cancels its D-sharp blunder in a run up the diatonic octave, allowing the music to move comfortably back into D major through its dominant in m. 6. Finally back in the tonic, all voices move to commemorate the tonic, confirming it successfully twice in the course of mm. 6–7, without a wolf tone in sight. By the end of this long journey from D major to F-sharp major and back, Froberger seems to have, at least momentarily, found acceptance or even solace in his mortality.

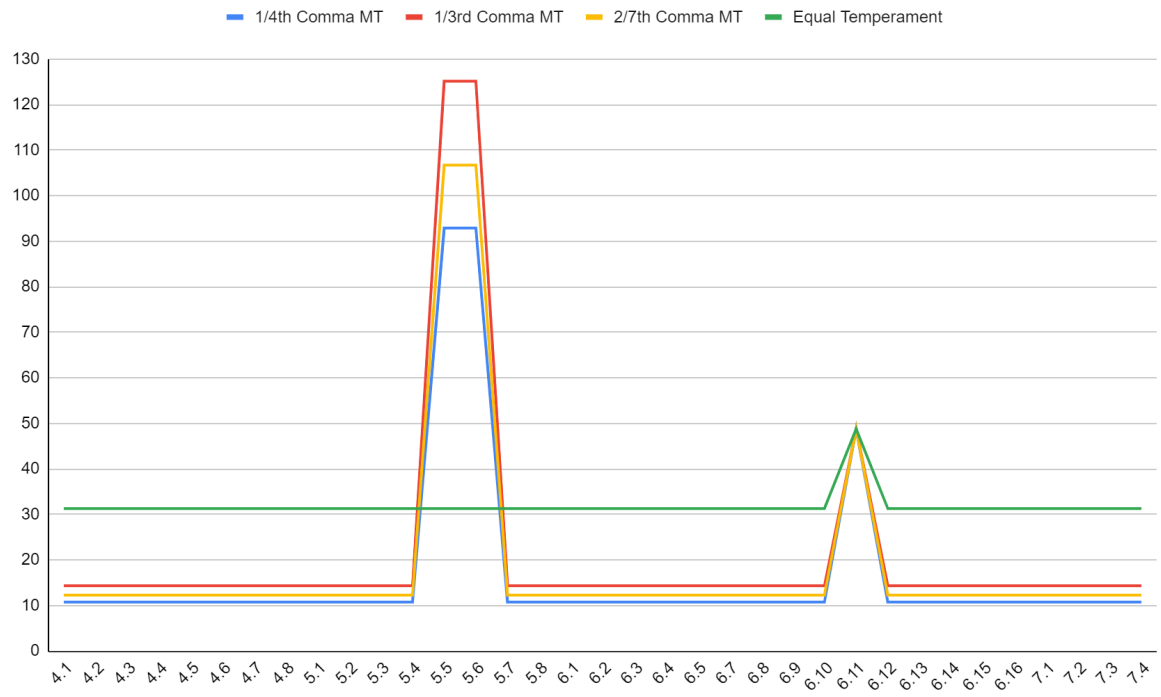

Figure 16: Discordance contour of mm. 4–7

The discordance contours reveal that the acceleration of movement into the sharp side of the circle of the first section is accompanied by a parallel increase in discordance that culminates in the extended howling of the wolf at the double bar. This sort of dramatic unraveling, aided by the wailing of this piece under meantone, belies any reading of this meditation as simply a dream-like state, as Cypess intimates; Froberger's eventual acceptance of his future death comes only with a great struggle in the wolf's territory. The second section is notably more concordant except for a short foray through B major, which produces a howl on account of its mistuned D-sharp. In the manuscript, Froberger's makes an odd choice to mark only D-sharp with the traditional ♯ sign, while E-sharp and A-sharp are marked with ✕ signs, an aspect that had led Yamamoto to suggest that D-sharp is meant to be tuned as spelled, while A-sharp and E-sharp are meant to be out of tune, a conjecture that leads Yamamoto to infer that this Meditation was

meant to be played on a split-key manual.[71] This split-key solution would benefit the overall contrast between a frantic and discordant first half by allowing the entirety of the second half to sound completely concordantly, and would project a performer's acceptance of a future death. In the case of a traditional manual without split keys, I would venture to suggest that a short foray into discordance may actually be beneficial to the overall rhetorical thrust of the Meditation, by showcasing the tenuous and unpredictable nature of a person's relationship with their own mortality and by referring aurally back to the discordance of the first section. Froberger himself seems to express this exact trepidation; the final cadence of the Meditation, which is musically settled both in harmony and tuning, is marked by a haunting programmatic note: "Memento Mori Froberger?" Mortals, unlike pitches or tunings, are never fully settled, and a pungent D-sharp serves to remind us of that unfortunate fact.

This temperamental crosstalk between sections is quite apparent in a recording by Mark Edwards, who elects to use a tuning that is adjacent to a meantone in normal disposition, possibly due to the wide range of repertoire present in his album.[72] As a result, there are some sonorities that unexpectedly ring out as discordant, often more so than those that cross the meantone boundary; this is most noticeable in the case of a discordant A major, which should be relatively concordant, and B major, which involves a wolf crossing. Although Edwards also attends to these moments resulting from his modification of meantone by altering his performance style, I will only focus on those that result from listening to the normal disposition of meantone. Starting in m. 2, Edwards's temperament causes a marked increase in discordance,

[71] Yamamoto, "The Use of Meantone Temperament in the Performance of Keyboard Music by Johann Jacob Froberger," 84.

[72] Mark Edwards, "Partita No. 20 in D Major, FbWV 620, 'Meditation sur ma mort future'," 19 January 2017, https://www.youtube.com/watch?v=y7FF191Ans4.

a sour quality that begins to overtake his performance. Most notably, the howling A-sharp of m. 2 brings Edwards's flow to a grinding halt, treated with a wide agogic accent on first pass and subsequently highlighted with a nervous, shaking ornament on the repeat. The discordant passages leading up to the cadence in F-sharp at the double bar are played irreverently by rushing into resolutions with gritty, simultaneous keystrokes, a marked contrast to the patient treatment of the meditation's opening. The resulting F-sharp major is played with an almost blunt, militaristic articulation that allows the offending A-sharp to howl audibly, before returning to the elegant *style brisé* on either the repeat or the second half. This angular articulation comes back to haunt us briefly on the sour B major triads of m. 5, a stress that evaporates quickly in the subsequent run-up embellishing E minor. The echo of the wolf is heard here, aided by Edwards's articulations. Such difficulties only serve to sweeten the final, concordant cadence in D major, an absolutely settled quality that Edwards lavishes in with slow keystrokes. After listening to Edwards's performance, shaped by an awareness of the wolf's presence, Froberger's contemplation takes on a certain *gravitas* that is completely missing from recordings that choose to use (or can only use) equal temperament and domesticate the wolf, such as Luc Beauséjour's performance on a modern piano.[73]

Allemande, from Partita in E minor FbWV 627

The Allemande from Partita in E minor, FbWV 627 stands out as one of Froberger's most obviously programmatic pieces. Like many of Froberger's keyboard suites, FbWV 627 exists in various forms with slight differences. Guido Adler, in DTÖ, pulls together and compromises between Tappert (c. 1670) and Bulyowsky (1675) manuscripts, appearing as the "Waterfall

[73] Luc Beauséjour, "Suite in D Minor, FbWV 620 'Méditation sur ma mort future'," 15 April 2021, https://www.youtube.com/watch?v=BVKXP_Q8zXk.

Allemande." In the more recently discovered Sing-Akademie 4450 manuscript, the allemande appears with the title, *Allemande faite en passant le Rhin dans une barque en grand peril, la quelle se joüe lentement â la discretion*, or "Allemande composed in crossing the Rhine, on a boat, in great peril, that is to be played slowly with discretion." The allemande also appears in staff notation with twenty-six numbered musical motifs (*Notenfälle*, or "note cases," as referred to by Mattheson). These annotations refer to a lengthy program that appears after the score, with each musical motif corresponding to a specific event in the program (see Fig. 18). Read together, the allemande details a dramatic journey on the Rhine after a night out during which Monsieur Mitternacht (literally "Mr. Midnight"), steward to the Count of Thurn and Taxis, stumbles overboard and nearly drowns. Mitternacht's blunder, which can almost certainly be attributed to a level of drunkenness, prompts an equally clumsy attempt to save him, resulting in a shoulder injury caused by a hooked pole meant to reel him in. Among this motley crew, Froberger himself also makes an appearance. Waking up from a drunken stupor amidst chaos and panic, Froberger jumps to conclusions and assumes that the boat is capsizing. Froberger becomes strangely fatalistic, writing that "as there is nobody to help him, he resolves, upon hearing the cries and howls of the others, to drown slowly and with good grace." My reading, attending to the details of the *Notenfälle*, will use the SA4450 manuscript exclusively to draw analytic insights. Measure numbers are taken from DTÖ and Bulyowsky.

With such a vivid document from the composer himself, many events can be correlated and understood as text painting, explaining some of the more erratic figuration of the Allemande. For example, mm. 7–8, marked *Notenfälle* 20–26, correspond to Mitternacht's desperate attempt to return to the boat before being hauled up by one of the ship's crew. *Notenfall* 20, detailing Mitternach's swimming and resolve to return, paints the methodical strokes of a man determined

to save his own life with falling thirds in the right hand. When he begins to sink deeper despite his efforts in *Notenfälle* 21 and 23, the music responds by falling rapidly in the bass. On the final cadence, *Notenfall* 26, Mitternacht is finally hoisted back onto the boat by a member of the ship's crew, a comforting end marked by a bright Picardy third. My analysis of this allemande reads these programmatic details in conjunction with the dimension of tuning in meantone. As we have seen, the key of E minor presents the problem of its D-sharp leading tone; in traditional meantone tunings, D-sharp would be tuned as E-flat. Particularly egregious in the case of the B major dominant, in which the D-sharp forms a howling major third with B, usage of the dominant must be handled with care. Froberger, as I hope to show, stages his musical drama by colliding D-natural and D-sharp in close quarters, a shift that is especially jarring when played under meantone temperament.

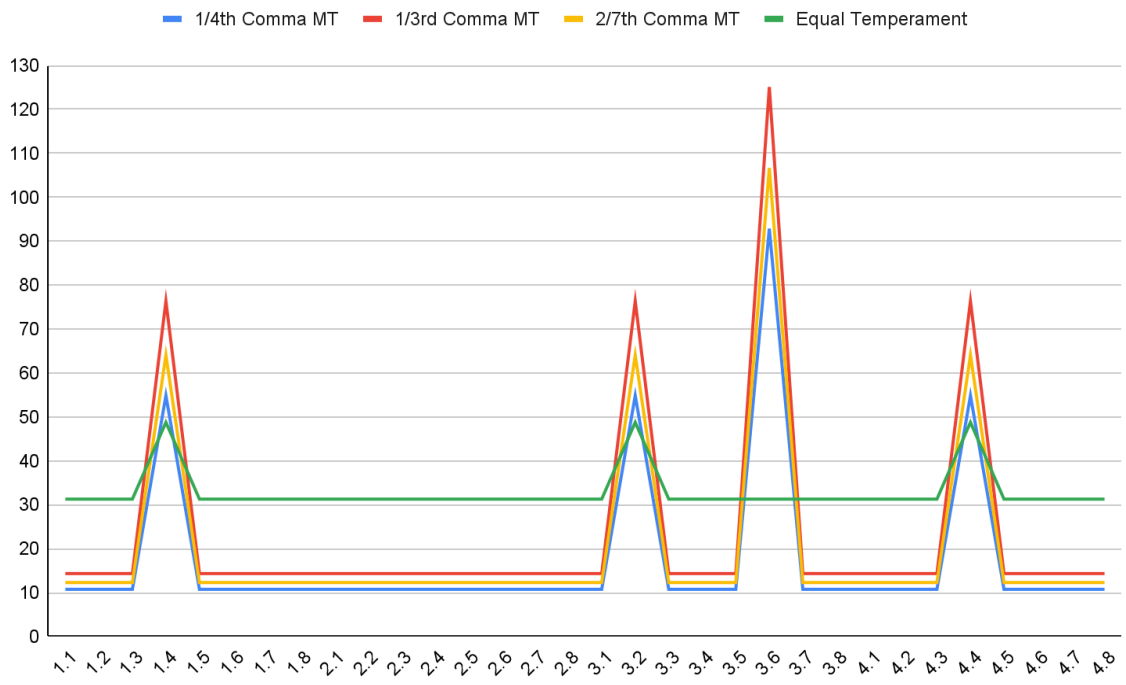

Figure 17: Discordance contour of FbWV 627, mm. 1–4

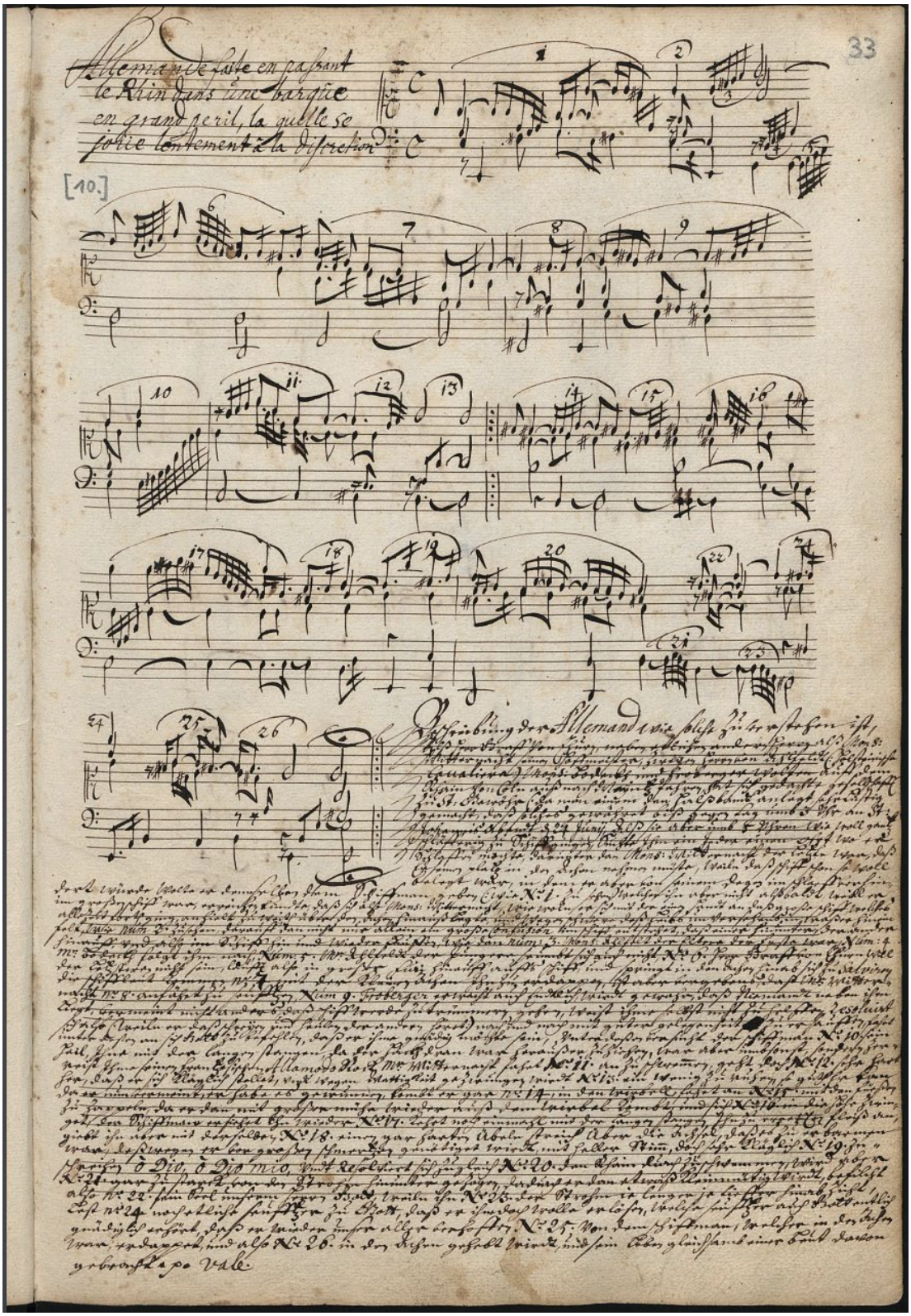

Figure 18: Manuscript SA4450 in facsimile, *Allemande faite en passant le Rhin*

In this key, even the most conventional progressions present problems. In attempting to establish the tonic at the outset of the allemande, we run straight into the D-sharp within the first measure. The subsequent resolution arpeggiates E minor down into the lowest reaches of the keyboard, a *Notenfall* denoting Mitternacht's descent into the Rhine. A shift to G major is marked by erratic bursts of quick-moving passages that mirror the sudden chaos that erupts on the ship in response to Mitternacht's blunder. Finally a rescue skiff is launched, an event that completes a cadence in G in m. 2, followed by a hurried rowing through the water depicted by flowing sixteenth notes ending on D-natural over a G major bass. Still a distance away from the drowning Mitternacht in m. 3, the D-natural suddenly lurches up a semitone to the dreaded D-sharp in D-sharp diminished to depict Mitternacht's groans in dotted rhythm, returning the music to E minor. This groaning finally awakens Froberger, whose E minor crisis moves straight through the discordant B major, with D-sharp in the left hand. A crew member, arriving with a hooked pole, cancels Froberger's whining D-sharp in an ascending run up the scale, permitting a move to a more hopeful C major harmony and inspiring Mitternacht to begin swimming through the water, a strenuous activity that is painted by dotted rhythms. C major reveals itself to be VI in E minor, leading to a half cadence that may or may not be accompanied by a discordant B major triad, depending on which manuscript one follows. The main text of the Rampe edition suggests a half cadence in E minor. Overcome with the exhaustion of swimming through the Rhine and the meantone boundary, Mitternacht rests in a catatonic, third-less resolution onto an un-tonicized B.

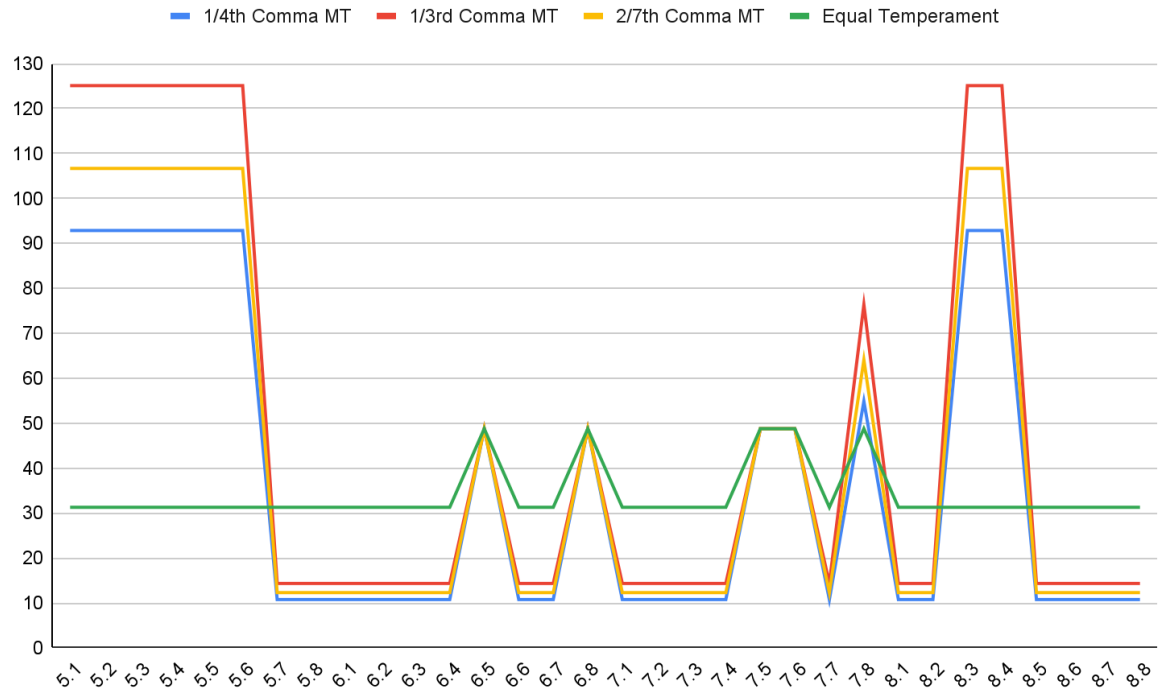

Figure 19: Discordance contour of FbWV 627, mm. 4–7

The second half of the binary form begins with Mitternacht caught in a whirlpool in the midst of a now-explicit, highly discordant B major. Twisting over a B pedal, Froberger seems to delight in the sour tuning of the D-sharp, inundating the texture in all voices with its presence in m. 5. At the end of the measure, a crew member again cancels Mitternacht's D-sharps with a D-natural in the bass, and comes running again with the hooked pole on the selfsame C major (m. 6). This attempt to hook and reel in Mitternacht goes awry on *Notenfall* 18, resulting in a shoulder injury that causes him to cry out in wide and sometimes dissonant melodic jumps. Nonetheless, this inspires Mitternacht to resume swimming at the beginning of m. 7, this time pointedly over a D-natural in flowing sixteenth notes, as a reflection of his resolve, according to *Notenfall* 20. As Mitternacht begins sinking and losing hope (as discussed previously), the music moves sharpward towards the wolf boundary in angular, diminished sonorities, eventually crying out to God by lurching up from D-natural to D-sharp. This cry resolves into the first forthright

statement of E minor since the double bar in preparation for a final cadence. Moving again through the discordant, beating B major dominant, Mitternacht is finally reached by a crewman and hoisted onto the ship for the final cadence. Unlike the end of the first half, Mitternacht has actually reached peace here, safely aboard on a rich, concordant Picardy third.

The discordance contours of the allemande clearly show that appearances of D-sharp are clustered around moments of high stress and drama of the imperiled Mitternacht in Froberger's program, while D-natural is used to depict events regarding those on board the ship (with the exception of Froberger himself, who still seems to be sorting through the situation). While many *Notenfälle* pertaining to Mitternacht's troubles are emphasized with diminished triads, a reading that turns an ear towards meantone reveals crucial moments in which a harmonically stable B major refuses to cooperate in the dimension of tuning. This is most apparent heading into the second half of the allemande, in which the final Picardy third of the first section (if one accepts its existence) launches a protracted reveling in the mistuned D-sharp to reflect Mitternacht's thrashing within the twisting waters of a whirlpool. A severe meantone tuning, alternating between sections of complete concordance in D-natural and harsh discordance in D-sharp, is integral to and intensifies Froberger's program.

It is my opinion that any attempt to ameliorate or fix the D-sharp by a modified tuning should be discouraged in the context of this allemande. Looking towards the other dance movements of the suite, however, D-sharp is used almost indiscriminately, unlike its careful treatment in this allemande. This has led performer-scholars such as Masumi Yamamoto to devise creative strategies to preserve the discordance of the allemande while circumventing it in subsequent dances; Yamamoto suggests using a harpsichord with two choirs tuned independently, one with an E-flat and the other with a D-sharp, thereby allowing the performer

to choose a tuning without retuning during performance.[74] While I understand Yamamoto's trepidation regarding the harsh B major, I do not share her concern that a discordant dominant can throw off the musical logic or rhetoric of a passage of music. Rather, a beating dominant can highlight the settled quality of a concordant tonic by comporting with the directed motion of dissonance resolution from unstable to stable, a quirk unique in meantone tuning to the key of E minor. Fixing the tuning of D-sharp would rid E minor of one of its defining traits by causing it to behave like A minor or G minor. Mitternacht's struggle is staged, not only through Froberger's allemande, but also by the key characteristics of E minor itself. Unfortunately, almost all easily available recordings use at least some measures to ameliorate the howl of the D-sharp or employ recording methods that are unable to capture the nuances of temperament. The latter is the case with Thomas Ragossnig's performance, which seems to use some sort of modified meantone, if we are to trust the recorded audio.[75] While it is somewhat hard to discern, the D-sharp does register as discordant, especially when presented within B major in cadences to a concordant E minor, a welcome addition to an overall frenetic and active performance that indicates an intimate familiarity with the program of the allemande. However, although Ragossnig seems to acknowledge the pungent flavor of B major by lingering slightly on its appearances, I do not think his treatment differentiates these discordant moments from other arrivals, which also employ phrase-lengthening techniques. Accessing a different register of expression by listening to the temperament, either by altering timing or articulation, can lend a

[74] Yamamoto, "The Use of Meantone Temperament in the Performance of Keyboard Music by Johann Jacob Froberger," 81.
[75] Thomas Ragossnig, "JOHANN JACOB FROBERGER (1616–1667): Allemande, FbWV 627/1," 5 January 2018, https://www.youtube.com/watch?v=xu_gcBXbMek.

greater degree of urgency to a performance that already deals successfully in narrating the program.

Lamentation in F Minor, FbWV 633

The Lamentation FbWV 633, entitled *Lamentation faîte sur la mort tres douloureuse de sa majésté Imperiale Ferdinand le troisième; et se joüe lentemente avec discretion*, again takes mourning as a central program, this time in reaction to Emperor Ferdinand III's very painful death in 1657. The piece is formally unusual in that it contains three reprises rather than two. The musical text comes from two manuscripts, WMin 743 and SA 4450, which seem to disagree on the key signature of the piece. WMin 743 gives two flats, while SA 4450 gives one; this has caused performers to refer to the lamentation interchangeably as both F major and F minor. This confusion in identifying a stable modern key is due to a feature of the piece that is presented front and center: opening with a flourish in F, the right hand sounds the third twice, first A-natural and then A-flat, presenting both the major and minor triad. This major-minor alternation appears both in WMin 743 and SA 4450. Unfortunately, to make matters worse, Guido Adler, in *DTÖ*, decides that the first A-natural is a typo and fixes Froberger's opening gambit to be completely in F minor. This correction is reversed in editions by Schott, Rampe, and Wollny. Regardless of who is "correct," I will point out that while these alterations seem negligible from a harmonic perspective, they are very significant from a tuning perspective, in that F minor contains A-flat, a wolf tone, while F major does not; Adler's correction begins the piece with the howl of the wolf front and center, sounding A-flat tuned as G-sharp above F. By taking a tuning perspective attending to the wolf tones of A-flat and D-flat, tuned as G-sharp and C-sharp respectively in the normal disposition of meantone, the rhetorical conceit of the lamento is not so much an alternation between the major and minor colors, but rather a tumultuous drama that

eliminates the wolf of A-flat and D-flat by controlling cadential expectations, evaded or completed, throughout the piece.

As discussed previously, the lamentation begins with an opening flourish that presents a concordant F major and follows it immediately with a discordant F minor, on account of its A-flat tuned as G-sharp. By the outset of m. 2 a decision is made in favor of F minor, a tonal center confirmed by a bass motive that moves through the howling D-flat. In an effort to clear the air of D-flat and get back to the concordant F major, the music repeats the opening gesture in B-flat, presenting a concordant B-flat major, but again followed by its howling minor variant, B-flat minor. At this point, in only three measures of music, both relevant wolf tones have already been introduced as diatonic members within the particularly problematic key of F minor. F major and B-flat major triads now seem like concordant colors of the past, a recognition that launches a gargantuan effort by the music to pull itself out of the discordant F minor and back into the concordant F major. We might relate this difficulty back to the programmatic title, as a reflection of the emotional trials that Ferdinand faces on his deathbed. The music moves to confirm the howling key of F minor, passing again through D-flat in m. 4 and landing on a dominant C major in m. 5. In an effort to fight the impending F minor, the music stalls, dropping down in the right hand to E-flat and recontextualizing it as a seventh to point sharpwards towards B-flat major, a key area that would eradicate both D-flat and A-flat wolves. This strategy proves too ambitious, permitting a deception back onto an F minor triad above what would have been an F dominant pedal. A compromise is reached by cadencing in C minor at m. 7, away from D-flat, but still with the A-flat wolf near. An attempt to move into B-flat by recontextualizing E-flat as a seventh is finally successful, landing squarely on a B-flat triad in m. 8. From here, the music moves increasingly sharpward away from the wolf, attempting to establish D minor. This optimistic

escape is swiftly denied by a deception in the bass to E-flat instead of E-natural. Again, compromising, the music begins to confirm B-flat major with a prominent dominant pedal in m. 10. Unfortunately, during the cadential 6/4, the right hand crosses straight into wolf territory in an error of voice leading, sounding a howling D-flat. This error sends all voices into panic, halting all motion into B-flat and returning to the dreaded F minor. Both A-flat and D-flat return prominently in m. 11, one after another. Scraping up the remains of concordance, the music refuses to complete an authentic cadence in F minor to end the first section (it would be formally anomalous at this point), opting instead for a half cadence, remaining on the concordant, but portentous, C major dominant.

A discordance contour for this section traces this movement away from and then ultimately back to the wolf throughout the first section. The return, in particular, is marked by a long period of uninterrupted howling before the half cadence.

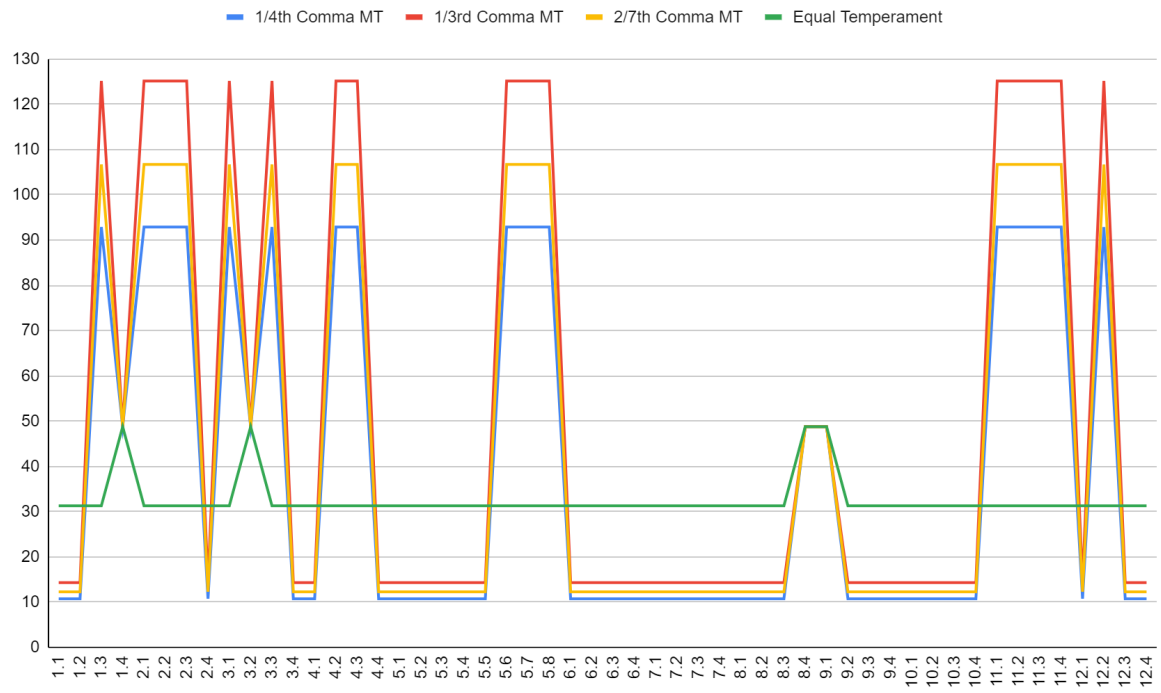

Figure 20: Discordance contour of FbWV 633, mm. 1–12

The second section, while exhibiting the same eagerness to leave the wolf territory, does not fare much better. C minor, although lacking the D-flat of F minor, still contains the howling A-flat, which appears prominently as a bass note in mm. 15–16. An attempt to move away from this discordance is made by cancelling out the A-flat and inching up to A-natural. While this results in a relatively concordant diminished sonority, the music, as if to confirm itself of its concordance, improvises up and down the keyboard while striking A-natural in all registers. After almost two measures of stalling, a somewhat weak tenor cadence is finally reached in m. 18, revealing a bright, concordant G major. Satisfied with its newfound bearings in sharp territory, the music finally makes an attempt to move back to F in hopes of a major-mode arrival. However, in m. 19, everything goes awry with an arrival in F minor, with A-flat howling in the top voice. Almost as if touching a hot stove, the music pulls away from the wolf tone by recontextualizing A-flat as a seventh to move towards E-flat major. This move is denied by a

deception into C minor. Things seem to be looking up when the music ascends another fifth to G minor (mm. 20–21). An unwelcome A-flat on beat three of m. 21 seems for an instant like a discordant Neapolitan in G minor, but beat four brings the howling D-flat, confirming that A-flat major is our destination. A dominant pedal on E-flat in m. 23 twists through both wolf tones in the right hand, eventually cadencing squarely in A-flat, in what is perhaps the first stable arrival of the entire movement.

Again a discordance contour reveals two attempts to leave the wolf territory, neither of which is successful. We might note, however, that the arrival in A-flat major can be construed as "progress" in some sense; A-flat major is slightly less discordant than F minor.

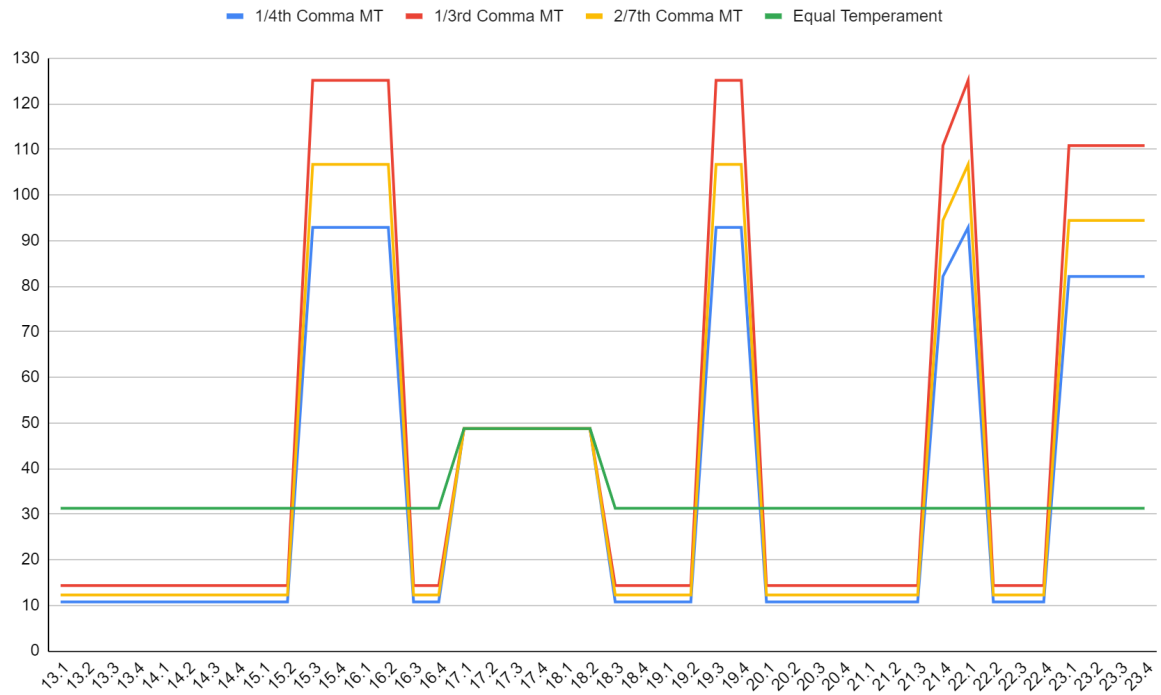

Figure 21: Discordance contour of FbWV 633, mm. 13–23

The third section, picking up from the catastrophic key of A-flat major, has a long journey ahead of itself if it is to arrive eventually in the concordant F major. Beginning in A-flat major, the music moves conventionally to confirm this key center, harping on the howling D-flat

in m. 25 and reaching a dominant in m. 26. On this dominant it begins the familiar pattern of the *cadenza doppia* and makes it as far as the 6/4 (beat two). In an effort to avoid the mistakes of the past, the music resolves deceptively onto a diminished 6/3 chord on D-natural, cancelling the D-flat. Eventually, in m. 27, this diminished sonority is revealed to be a fully diminished 4/3 in C minor, a pivot that is completed. With D-flat eradicated from the key, the music, self-assured, now moves to correct the A-flat in a bold gambit involving several deceptions in mm. 28–29. First, recasting A-flat as a seventh, the music implies E-flat. However, noticing that this has not worked in the past (the most catastrophic attempt being m. 20), the music snakes chromatically through the inner voice to imply C minor by the end of the measure. Just as the music is about to move onto C minor, however, the left hand moves instead to a bare A-natural octave, cancelling the wolf completely. The right hand throws off its guise to reveal a cadential 6/4, accelerating the music into a bright, triumphant half cadence in D minor in m. 29, including a concordant C-sharp. For now, the wolf has been completely eradicated, and we find ourselves comfortingly close to F major from D minor. Launched by a celebratory run through the entire range of the keyboard without a single wolf tone, the music moves conventionally through the circle of fifths towards F major, a long-awaited key that arrives in m. 32. All that is left is to confirm F major in preparation for the final cadence. Just as we have finally found concordance, however, the bass missteps onto A-flat, causing a massive unraveling in the right hand that moves through D-flat and pulls the music back towards F minor. A dominant pedal is initiated in m. 33. Unfazed, the music mobilizes to remove the discordant intruders. In m. 34, a run up the keyboard, reminiscent of the optimistic run of m. 30, leads straight into the wolf D-flat, a tone that is forcefully pushed to a corrected D-natural in the following beat. Now, with a concordant D-natural ringing out and throwing off F minor, the music finally moves from the dominant, after two full measures, to

cadence in F major. A concordant A-natural sounds out in a slowly rising arpeggiated figure, painting Ferdinand's peaceful rise up to the concordant heavens. Pointedly, this is not a Picardy third, but rather a properly prepared arrival in F major, thanks to the conspicuous D-natural in m. 34; F minor, with its A-flat and D-flat, are finally quashed. This figure can be correlated with similar endings with rising figures that carry obvious programs; in a similar lamentation for Ferdinand IV (FbWV 612), the final rising gesture literally ascends into an illustration of radiant clouds in A-Wn Mus.Hs.1870, and is marked with a cross and "Requiescat in Pace. Amen" in SA 4450. Ferdinand III has reached peace in F major.

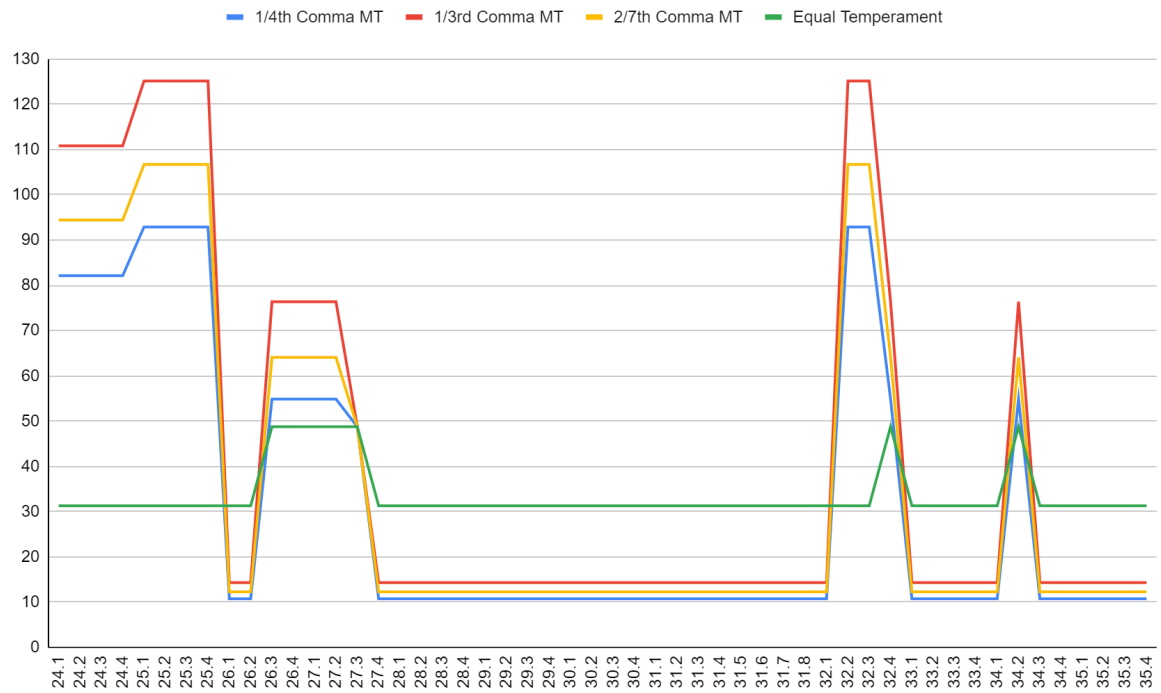

Figure 22: Discordance contour of FbWV 633, mm. 24–35

Unlike other pieces we have looked at, which access the wolf either by voice-leading errors or as a closely related key area, this lamentation has the unique struggle with reckoning with its own howling tonic. Through my analysis, I have highlighted a certain tendency for the music to access stability in a proper final cadence to F major from its roots in F minor, a process

that involves the stripping of wolf tones A-flat and D-flat over three sections. While it might be possible (if somewhat confrontational) to play this lamentation in a severe meantone tuning—a highly discordant effect that would correlate with the "painful death" of the program—most performers opt for an unequal tuning that preserves the alternation of discordance and concordance between F minor and major. For example, in Stanislav Gres's performance, recorded in a way that leaves much to be desired, the F minor triad seems to beat audibly, especially in the first opening gesture, when it is presented in close quarters with the consonant F major.[76] This quality is only amplified by Gres's choice to deliberately showcase A-flat's discordance in F minor by slowing the music to a halt and allowing its beating to ring out. However, this howl is ameliorated in such a way that it is largely unnoticeable when presented in rapid figuration and in isolation away from F major, at least to my ears. This absence of registrable discordance can be heard when A-flat is presented prominently in mm. 5 and 15, where A-flat enters within a relatively busy texture. When presented in a completely isolated setting, as in m. 23, the listener is given time to register the subtle, but ugly, beating of the A-flat major triad. What does howl severely and noticeably, however, is the D-flat. Passages inundated with D-flats take on an incredibly ugly quality. For example, the "cancellation" of D-flat to D-natural in m. 4 almost comes as a relief from the discordant howling of mm. 3–4; Gres colors this interaction by rushing through the discordance into the third beat before bringing the music to a grinding halt, as if to clear the air before moving into concordance. This strategy is used to great effect in the final moments of the piece. After a period of turbulent action resulting from a misstep into the wolf in m. 32, Gres accelerates through the discordant music with increasingly

[76] Stanislav Gres, "Johann Jacob Froberger - Lamentation sur la Mort de Ferdinand III," 30 October 2016, https://www.youtube.com/watch?v=FEkM17cdKLo.

percussive keystrokes, a flurry of activity that comes to a grinding halt on the D-flat on the second beat of m. 34. Allowing D-flat's discordance to ring out, Gres then moves patiently into the concordant D-natural with markedly softer articulations, ultimately leading into the graceful F major arrival. Concordant F major is made sweeter not only by Froberger's choice to collide F major with a wolf tone, but also by Gres's choice of articulation. Here, even under an ameliorated and modified meantone temperament, performance choices that are aware of and attend to the meantone boundary preserve the drama shown by the discordance contours.

Conclusions

Through my analyses, I have shown that an attentiveness to temperament reveals sonic peril in passages that may seem harmonically anodyne. Danger: Wolf crossing! Such passages, sour to the unaccustomed ear, have powerful expressive potential. For Froberger, who was a composer, performer, and indeed tuner, reckoning with the wolf was an integral part of everyday musical practice. I have attempted to draw out the ways in which Froberger expresses an acute awareness of the meantone boundary at E-flat–G-sharp, a boundary enforced by acrid discordance throughout his compositions. This shocking aural effect, out of place in a meantone-dominated musical environment, necessitates special treatment, shaping the gestures and motions of Froberger's musical rhetoric by presenting opportunities to emphasize, avoid, or rectify them. Discordance often operates independently of harmony, troubling entire key areas and thwarting arrivals that would be construed as stable when considered only through the lens of voice leading and equal-tempered pitch. As we have seen, Froberger uses the discordance of meantone boundary crossings to provide the impetus for a musical drama that is often reflected in a programmatic title. Discordant, even ugly sonorities become visceral aural markers of the pain of mortality, mourning, and perilous river crossings. To this end, my discordance contours illustrate visually a listening that hears in meantone temperament, allowing us to inspect more closely the ways in which the wolf's territory is accessed and the gestures required to transgress that boundary.

For performers who use some variety of meantone temperament, the flow of discordance naturally influences the ways wolf crossings are played, particularly in the dimensions of expressive timing and articulation. Many performers, especially the ones I have discussed in this thesis, go so far as to highlight these effects dramatically, varying their articulations and timing

to set up stark contrasts between sections of concordance and sections of discordance, and taking the required time to allow discordant intervals to ring audibly. To me, performances that "perform the wolf," so to speak, transform the coloration of out-of-tune intervals into memorable moments of heightened expression, particularly in a modern world unaccustomed to the unequal, thorny paths of meantone temperament. However, I do not want to expound the moralistic imperative that Froberger *must be played* in a specific meantone temperament in the modern day. In the first place, since Froberger left no indications of a particular temperament for any specific piece, it is a questionable move to claim any sort of historical authenticity regarding the performance of his keyboard pieces; my historiography only attempts to couch Froberger within the predominantly meantone backdrop of the seventeenth century. What I suggest is that crafting an interpretation that demonstrates an awareness of the effects of the meantone boundary is crucial to communicating the prevailing musical language of Froberger's time. This is applicable to all performances, including those on historical keyboards tuned to historical temperaments and those on modern, equally tempered pianos. A move into a key such as A-flat major (as in FbWV 633) is never untroubled, even if the voice leading is completely smooth. To attend to the meantone boundary through articulation, dynamic, and timing is to reclaim a rich source of expression flattened by equal temperament, particularly in the case of performance on the modern piano.

This thesis is only a first step toward recovering temperament in close-reading analysis through the study of discordance contours. Looking forward into the late seventeenth and early eighteenth centuries, which saw a veritable explosion of well-temperaments, we might begin to articulate specifically what may have been heard to produce the catalogue of key characteristics in Charpentier's *Règles de composition*. Or we might begin to understand how J. C. Fischer

"[walked] along the paths of difficulties, and [slayed] the Minotaur of errors" while composing in a wide range of keys in his expansive collections of preludes and fugues, *Ariadne musica* (1702).[77] And finally, we may be able to unpack the almost mystical loss of J. S. Bach's well-temperament for *Das Wohltemperirte Clavier* (1722), which has deeply troubled scholars and performers for centuries, tethering the music back to the quotidian realms of heard and performed sound.[78] What might we discover with new, temperamental ears?

[77] Anita Heppburn Plotinsky, "The Keyboard Music of Johann Kaspar Ferdinand Fischer" (PhD diss., City University of New York, 1978), 119.

[78] Perhaps most notoriously, Bradley Lehman mystically derives a tuning for the forty-eight preludes and fugues from a decorative squiggle drawn in Bach's hand on the work's cover page. See Lehman, "Bach's Extraordinary Temperament: Our Rosetta Stone: 2," *Early Music* 33, no. 2 (2005): 211–31. For a point-by-point rebuttal of Lehman's discovery, see Mark Lindley and Ibo Ortiges, "Bach-style Keyboard Tuning," *Early Music* 34 no. 4 (November 2006): 613–24.

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