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Violin intonation and two new paradoxical whole-tones in meantone tempered practice: a case-study on Bach's Grave in A minor

1. Overview

In historical performance practice and in the tradition of meantone temperament, the intentional tuning adjustments made by performers of fretless instruments that deviate from the regular temperament of the harpsichord or from the temperament implied by the tuning of the open strings, is a tacit reality. There is only so much tuning detail that the performers can bare discussing in rehearsal, and (with exceptions) they will only go as far as considering the appropriate temperament for the harpsichord or the tuning of the open strings. On one hand, this is due to all the instabilities associated with the tuning of early instruments and to the unpredictable nature of the pitch adjustments made during performance. On the other hand, for the faithful historically informed performer, meantone temperament is supposed to offer the practical solution to comma 'problems' so well-known to the just intonation advocates, its catch being that the difference between the large and small just whole-tones disappear: the tempered major third is divided into two equal mean-tones, giving way to simply one type of whole-tone.

A violinist playing with their strings tempered would manipulate the tuning of an E4, for example, played against the A string so that it also sounds 'good' when played against the tempered G string, aiming to find an E that works for both double-stops. However, the violinist quietly knows to themselves that for this to be true one must allow a certain degree of 'sloppiness' and disregard the fact that there are still two possible tunings of the E in this harmonic context: one as a 5:3 from the tempered G string, and as a 3:4 to the A-string, 2 thirds of a syntonic comma apart from each other, or 14.4 cents. In doing so, they are overlooking the existence and legitimacy of the micro-adjustments that are both logical and possible to better accommodate just sonorities in a musical work – or is it possible that these adjustments can successfully happen on-the-fly? What is the nature of these micro-adjustments? And exactly how far do they fall from a version in just intonation? Are there rules of thumb that will make these adjustments possible in performance-time? If so, are they applicable in other instrumental scenarios such as a baroque trio? How can one hear these microtonal shadings?

By precisely notating the sixth-comma deviations with respect to a justly tuned version, one can measure the degree of 'fudging' involved in tempered practice, which no doubt has proven to be quite elegant and acceptable for most historically informed performers. Bach's Grave in A minor for solo violin is used here as the case-study piece. The Helmholtz-Ellis accidentals accompanied by slash-signs that indicate 3.6 cent deviations (a sixth of a syntonic comma) allow an objective notation of: first, a regular meantone version (as it would be on a keyboard); and later, a modified meantone version appropriate for solo violin with the open strings tuned in sixth-comma meantone, which optimizes the just sonorities available within the tuning of the open strings.

This study introduces the concept that in non-keyboard meantone performance the difference between the large and small just whole-tones still remains, but is tamed down. This concept is both striking from a historical perspective for the meantone devotee, but also from the perspective of modern performers who, influenced by the sounds of equal temperament and 'expressive intonation,' have been attached to the Pythagorean whole-tone 9:8, and neglected the small whole-tone 10:9 for the past century. With an objective analysis of the micro-adjustments that would ideally happen on the violin with the strings tuned in sixth-comma meantone, this paper shows the precise possible shadings of the tempered intervals and it notates exactly how tamed down they are from their just intervals.

2. Context and notation

The following authors mentioned the practice of tempering the open strings: Jean-Philippe Rameau (1737), Jean Dumas (1756), Jean-Laurent de Bethizy (1764), Abbe Roussier (1770), and Antonio Eximeno (1775), among others. This study uses sixth-comma (syntonic comma) tempered fifths as the tuning for the violin's open strings. Sixth-comma meantone temperament is in use for baroque music performance today and was originally advocated by Gottfried Silbermann (1683-1753).The tuning of other temperaments of the time such as Vallotti's Temperament and Bach's recently discovered tuning for The Well Tempered Clavier (Bradley Lehman's Bach Temperament) also has the notes corresponding to the violin's open string fifths narrowed by a sixth of a comma, therefore making it a good candidate for the purposes of this paper.[1,2]

Figure 1 uses slash-signs in order to illustrate the pitch repertoire of regular meantone temperament. The slashes are applied to a cycle of justly tuned fifths, i.e. in Pythagorean intonation: the wide Pythagorean major third is lowered by two thirds of a syntonic comma, and the just fifths are narrowed by one sixth of a comma. One gets acceptable thirds and bearable fifths. Two equal mean-tones divide the MT major third of 393.5 cents into two mean-(whole)-tones of 196.7 cents.

With the aid of the Helmholtz-Ellis accidentals one can reduce the amount of sixth-comma slashes. The arrows inflect the Pythagorean intervals by a syntonic comma (ca. 21.5 cents). When there are inflections of +6 or -6 sixth of a comma, i.e. one full comma, the accidental becomes the syntonic comma. The aim is to simplify the amount of slashes, and later make the comparison with just sonorities more readily visible. *Figure 2* shows the same pitch repertoire of regular MT in *Figure 1*.

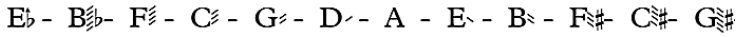


Figure 1
Regular MT pitch repertoire. Accidentals applied to a cycle of just fifths. Upward slashes indicate +3.6 cents, downwards slashes indicate -3.6 cents.

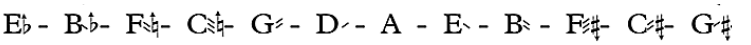


Figure 2
Regular MT pitch repertoire. Accidentals applied to a cycle of just fifths. Upward slashes indicate +3.6 cents, downwards slashes indicate -3.6 cents. Upward arrows indicate +21.5 cents, downwards arrows indicate -21.5 cents.

The just tritones 45:32 (augmented fourth) and 64:45 (diminished fifth) remain as such in sixth-comma MT. There are two different sizes of half-steps, the wide syntonic diatonic half-step (16:15, 111.7 cents) is narrowed by 3.6 cents (108.1 cents) and the narrowest chromatic one (25:24, 70.7 cents) is widened by 17.9 cents (88.6 cents). In the pitch repertory of regular sixth-comma meantone there are also a few approximations of septimal intervals, namely a pseudo-natural seventh of 983.7 cents (14.9 cents wider than the 7/4 of 968.8 cents), a pseudo-septimal minor third of 285.3 cents (18.4 cents wider than the 7/6 of 266.9 cents), and a pseudo-septimal tritone of 590.2 cents (7.7 cents wider than the 7/5 of 582.5 cents). These quasi septimal intervals appear between specific notes in a keyboard tuned in sixth-comma MT depending on what note one starts tempering

1 Silbermann and Vallotti seem to have tempered by sixths of a Pythagorean comma, rather than sixths of a syntonic comma. For the purpose of this study and the tuning representations it makes little difference that a slash means 3.6 instead of 3.9 cents. J. Murray Barbour, *Tunning and Temperament* (New York: Dover Publications, 2004), 42.

2 Bradley Lehmann, "Bach's Extraordinary Temperament: Our Rosetta Stone: 1," *Early Music*, Vol. 33, No. 1 (Oxford University Press, Feb., 2005): 3-23.

from. In keyboards, often the cycle of fifths spans from E-flat up to G-sharp, making the fifth E-flat to G-sharp the wolf fifth. There, for example, the septimal minor third would be found between E-flat and F-sharp (since there would be no G-flat) or between B-flat and C-sharp (since there would be no D-flat), namely augmented seconds, and not between B and D.

The cycle of eleven narrowed fifths and the wolf fifth can be transposed up or down depending on the key of the piece. Since the Grave contains the notes E-flat, D-sharp and A-sharp, an extended regular meantone model where the cycle of fifths spans from E-flat to A-sharp would be ideal, as if played on a split-key tempered keyboard (the D-sharp and A-sharp keys would have been split to the left of E-flat and B-flat). *Figure 3* shows the pitch repertoire for the first tuning transcription of the Grave, with A as it's starting tone since it is both a middle open string and tonic: E-flat (+6), B-flat (+5), F (+4), C (+3), G (+2), D (+1), A (0), E (-1), B (-2), F-sharp (-3), C-sharp (-4), G-sharp (-5), D-sharp (-6), A-sharp (-7) – the numbers indicate sixth-comma deviations from the Pythagorean cycle of fifths. This is the pitch repertoire that will be used in the first tuning notation of the Grave.

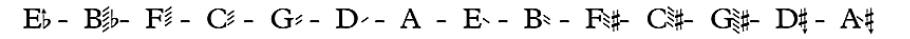


Figure 3
Extended regular MT pitch repertoire for Bach's Grave in A minor, using slashes to indicate sixth-comma deviations and the Helmholtz-Ellis accidentals]

3. An extended regular MT version of Bach's Grave: notation and practicalities

A tuning transcription of the Grave in extended regular MT is straight forward: there is only one possible tuning per note. The top stave of *Figure 4* shows the first two measures of the Grave with the simplified MT notation (fewest slashes). Whereas for a keyboard player it would be no problem to play the top stave, for a violinist it presents an array of issues that especially come to the foreground if one imagines them approaching this tuning representation in slow motion practice, (and always with their open strings tempered in sixth-comma meantone). How will the tuning detail be achieved? Are the intervals tunable by ear without the aid of a tuner?

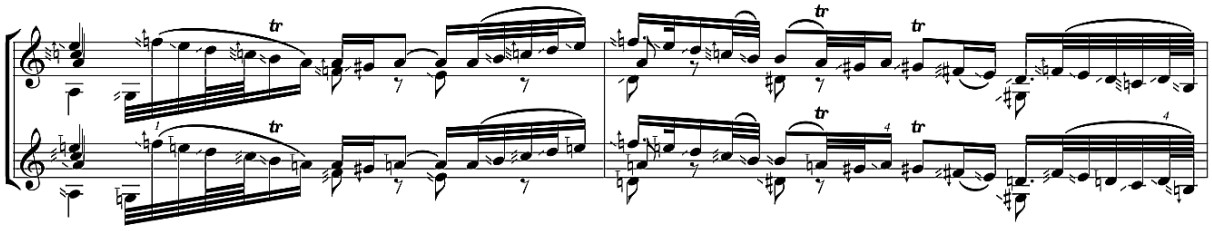


Figure 4
The first stave shows a strict sixth-comma MT tuning representation of the opening of Bach's Grave.
The second stave shows the tablature notation for the extended regular MT representation on the first stave.

If one takes a close look at the interval content from *Figure 4*, the violinist would not only need to avoid tuning justly to any open strings (e.g. the Bs are a sixth comma lower than the B tuned to the E string as a 3:4, and two sixth commas higher than the B tuned to the D string as a 5:3), but also they would need to make the whole tone sizes equal, as they would be in regular meantone, and the fingered fifths narrow – the latter clearly seems counter intuitive for the ear, since when the violinist places the fingers as a just fifth and finds that it sounds narrow they automatically correct it, compensating for it.

In the first measure, the Pythagorean E-D (9:8, 203.91 cents) is narrowed by -1 sixth of a comma on the E, and +1 on the D. Similarly, the Pythagorean D-C (9:8) is narrowed by +1 on the D, and +3 on the C. The small whole tone represented by the D and the C-comma-up ignoring the slashes (10:9, 182.40 cents) is widened by +1 and -3 sixth commas. Therefore, the 9:8 is narrowed by 2 sixth commas and the 10:9 widened by 4 sixth commas as the slashes visually show us. This gives us the two equal sizes of the sixth comma mean (or average) tones: 203.91-(3.62x2) and 182.40+(3.6x4), both ca. 196.7 cents.

To make these sixth-comma deviations precisely without reference open strings or simple ratio intervals to listen out for, seems idealistic. Not only the performer would need to resist the intuitive 'untempering' of the natural intervals mentioned above, but also would need to adjust their finger positions from what they would be in PI or JI in a violin tuned with untempered fifths. This is particularly challenging for violinists who are not used to tempering their fifths. To illustrate the brain-twist that this involves, the second stave of *Figure 4* shows the tablature notation representing the finger positions (*as if* the strings were tuned untempered in just fifths) which would result in the meantone sounds given that the strings are *actually* tempered. The natural sign with a small horizontal dash at the top indicates the fixed tuning of the tempered open string (originally designed in the Extended Helmholtz-Ellis JI Pitch Notation to indicate an equally tempered note).

In order to find the same pitch as the open A string on the G string (the G string is placed one third of a comma higher than the Pythagorean) the violinist will need to push down their finger two sixth-commas with respect to where it would have been placed if the G were tuned as a 4:9 to the A string. One can assume that with enough exposure these actions will be learnt through repeated practice, but also, because of the complicated logic, they will only take place approximately.

Given this brief analysis, it seems highly unlikely that the basis of meantone temperament, namely the splitting of the major third into two equal mean-tones will be realized in the performance of a violin solo work. The next section proposes that in a solo violin context what will take place is the *undoing of the temperament*, or the 'untempering' of mean-tones, as well as the 'JI-ification' (the prioritizing of low ratio and beat-less sounds) of thirds, fourths, sixths and fifths, leading to a modification of meantone temperament with portions of the music in just intonation, and a less noticeable tempering of the natural intervals.

4. A modified MT version of Bach's Grave: notation and practicalities

Departing from the basis that a fretless solo performance would tend towards a tuning that is achievable by ear, i.e. a just tuning rather than tempered, this section examines how the tuning choices would be made ideally to optimize the just sounds available within the limits of the tempered open strings. Why play the opening chord tempered if one could tune it justly to the open E string (since all other notes are stopped)?

Figure 5 proposes a tunable solution, the underlying principles of which are:

> (a) *use of open strings as tuning reference pillars, and in general as part of the musical passages.*
>
> For example: the D in the second beat is left tuned to the open D string, it will be a reference string throughout and the violinist will memorize the placement of the finger quickly, activating the D string resonance. This way, the 9:8 whole tone becomes 2 sixth-commas narrower than Pythagorean, as in sixth-comma MT. The C is tuned as in the opening, to the prominent E string, and makes a 10:9 with the D that is only widened by 2 sixth of a comma instead of 4. Therefore the difference between the two tempered whole-tones is now 7.2 cents (one third of a comma). If the violinist chooses to play the D as a 9:8 from the E, then the whole steps remain as a just 9:8 and 10:9. The other option would be to play the passage

(second beat of m. 1) in just intonation with a fingered E on the A string. This interpretation chooses a more resonant sound and will use as many open strings as possible/practical.

(b) *leave the reference tuning points as they would be if tuning in just intonation.*

For example: in measure 3, the C remains tuned to the A string when played on the G string but tuned to the tempered E when played on the A string (a sixth-comma different). It is logical, because when playing on the A string, it is easier to check the stopped note against the E as a double-stop than against the A by melodic ear. In m. 5, second beat, the G remains tuned to the tempered G string, and the F tuned to the A string. In m. 7, the D-comma-up should be intoned the same way as in the just version: there is no reference string, so as a 10:9 from the E or a 9:8 from the C (or checking both ways).

(c) *except: when tuning fingered pitches to a string on their left just before their open string is played.*

In this case-scenario, if the fingered pitch is raised and its open string sounded, it will create a larger interval than if the strings were untempered. This is most likely going to happen when looking for the diatonic syntonic semitone (or notes that in just intonation would have the comma arrow upwards) above the open string and is tuned as a minor sixth above the neighboring left open string (e.g. F-comma-up on the E string tuned to the A string, or B-flat-comma-up on the A string tuned to the D string). This tuning procedure will give you a too large semitone of 115.6 cents.

For instance, the F to E in the second beat should remain as a diatonic syntonic semitone. If the F is tuned to the A string it will make a too large half-step with the E string and it will sound high. The F tuned by melodic-ear as a 15:16 over the E string is the best option here (unless one recurred to stopped strings, which were also common practice in the eighteenth century). The opening E is so prominent that the F should remain melodically tuned to the E. If the musical context does not require that the note moves down to the open string straight away, then one can leave it tuned as a minor sixth to its neighboring left string, like in measure 16, first beat, for example.

In m. 3 the B-flat-comma-up should be slightly tempered, and not tuned as a minor sixth to the D, because it would make a 115.6 cent semitone too. A special case moment is the last beat of m. 16. The last F anticipates the seventh of G. One must decide if they will tune it to the G, to the D, or to the B. I am tuning the B to the D string, creating a consonant major sixth, and I decided to tune it as a just diminished fifth 64:45 to the B, which is the same as a Pythagorean compound third from the D (optimally approximating the syntonic V^7 with the Pythagorean seventh).

(d) *lastly, no fifths (unless open strings) should be left tempered.*

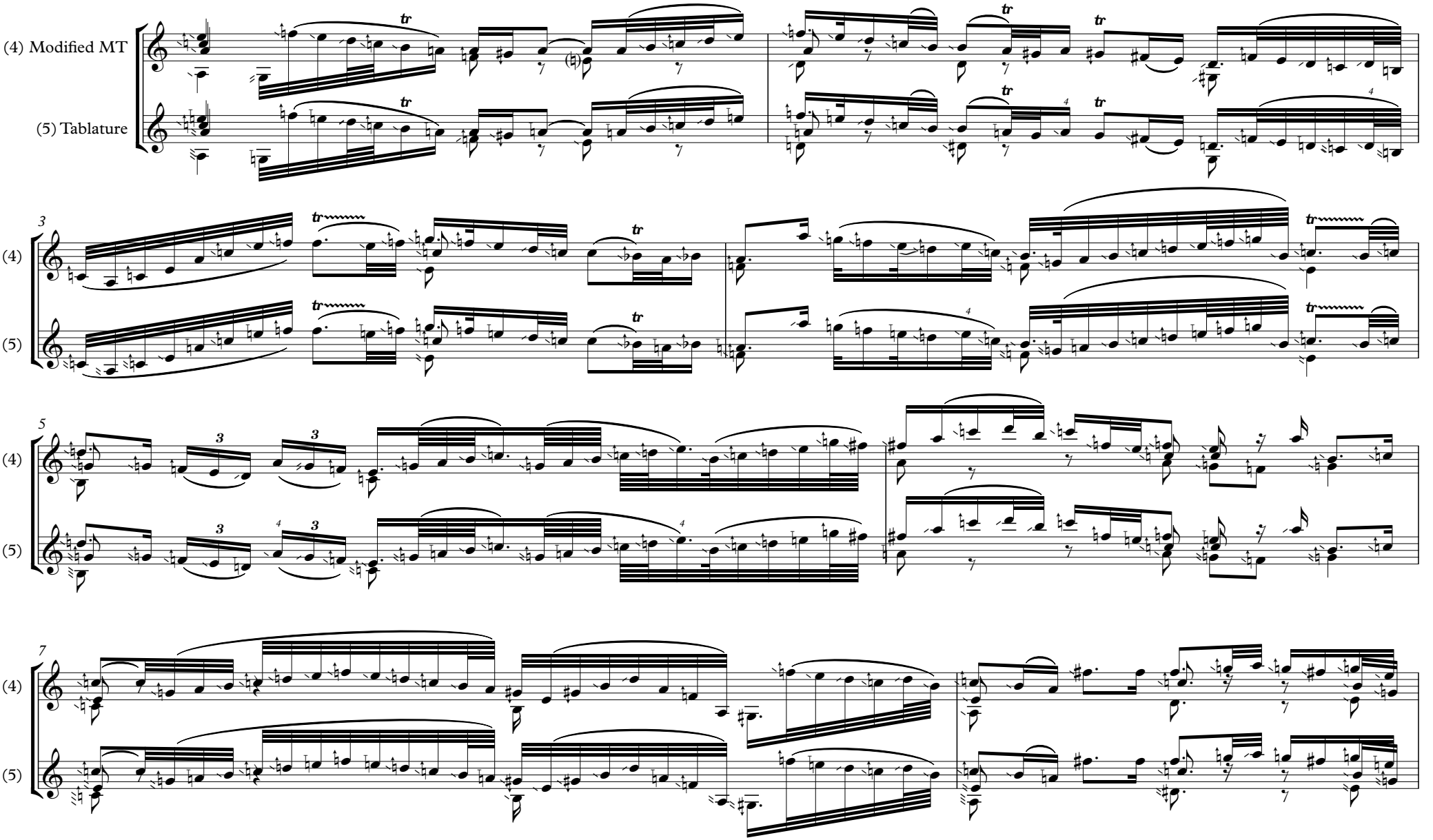
This means the violinist will need to do a slight tilting of their finger to the *right side* of the fingerboard. For example, m. 3, the *tablature notation* shows that the high G is placed one sixth-comma higher than its fifth below. At the same time, following rule n.1, this chord should be tuned to the E string, since it is a C major chord and the C is placed on the A string, enabling the checking of the C against the open E again.

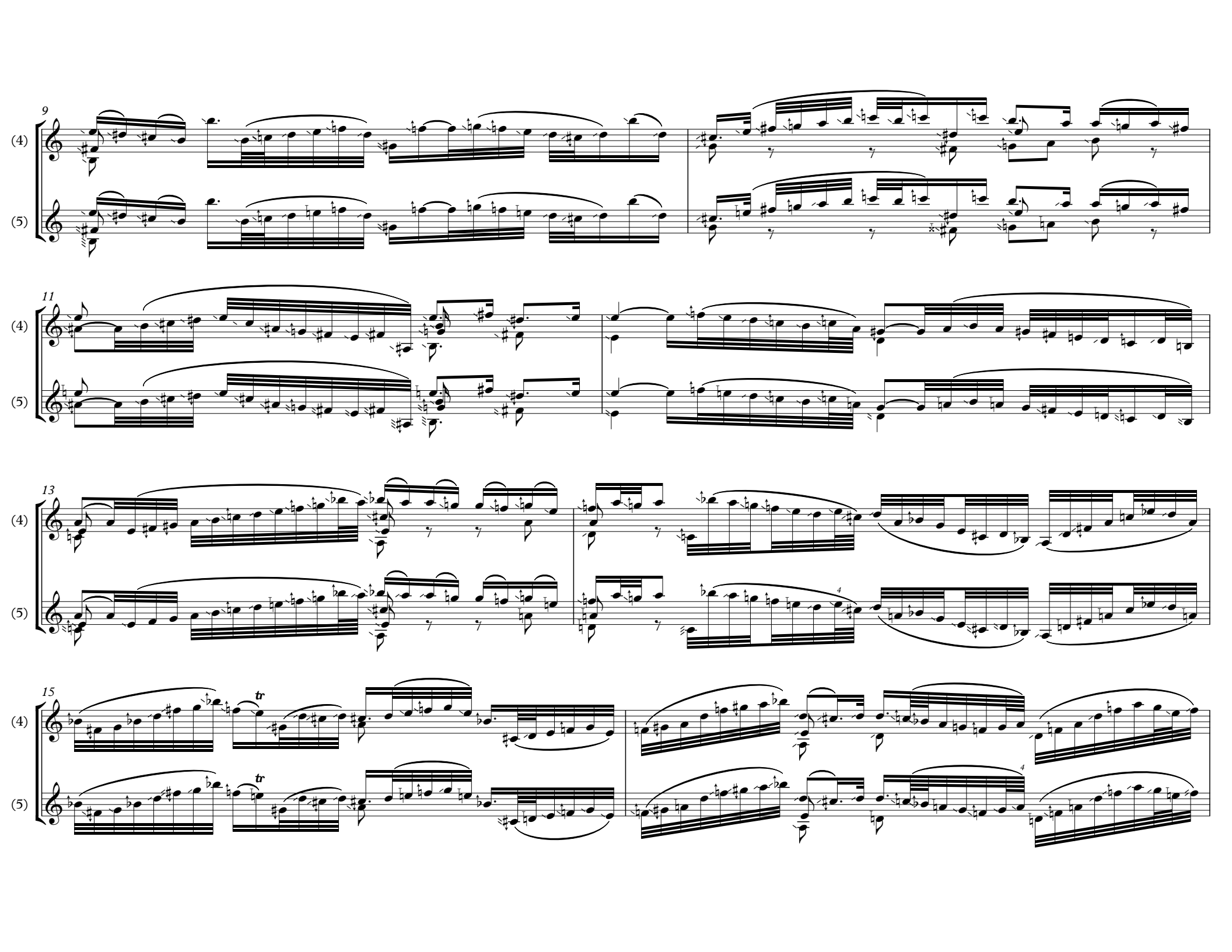
Figure 5 (next 3 pages)
Modified MT version of Bach's Grave – entire movement (first stave), tablature notation, (second stave).

Grave - Sonata n.2 in A minor for solo violin

Tuned in modified extended sixth comma meantone by Sara Cubarsi

J. S. BACH

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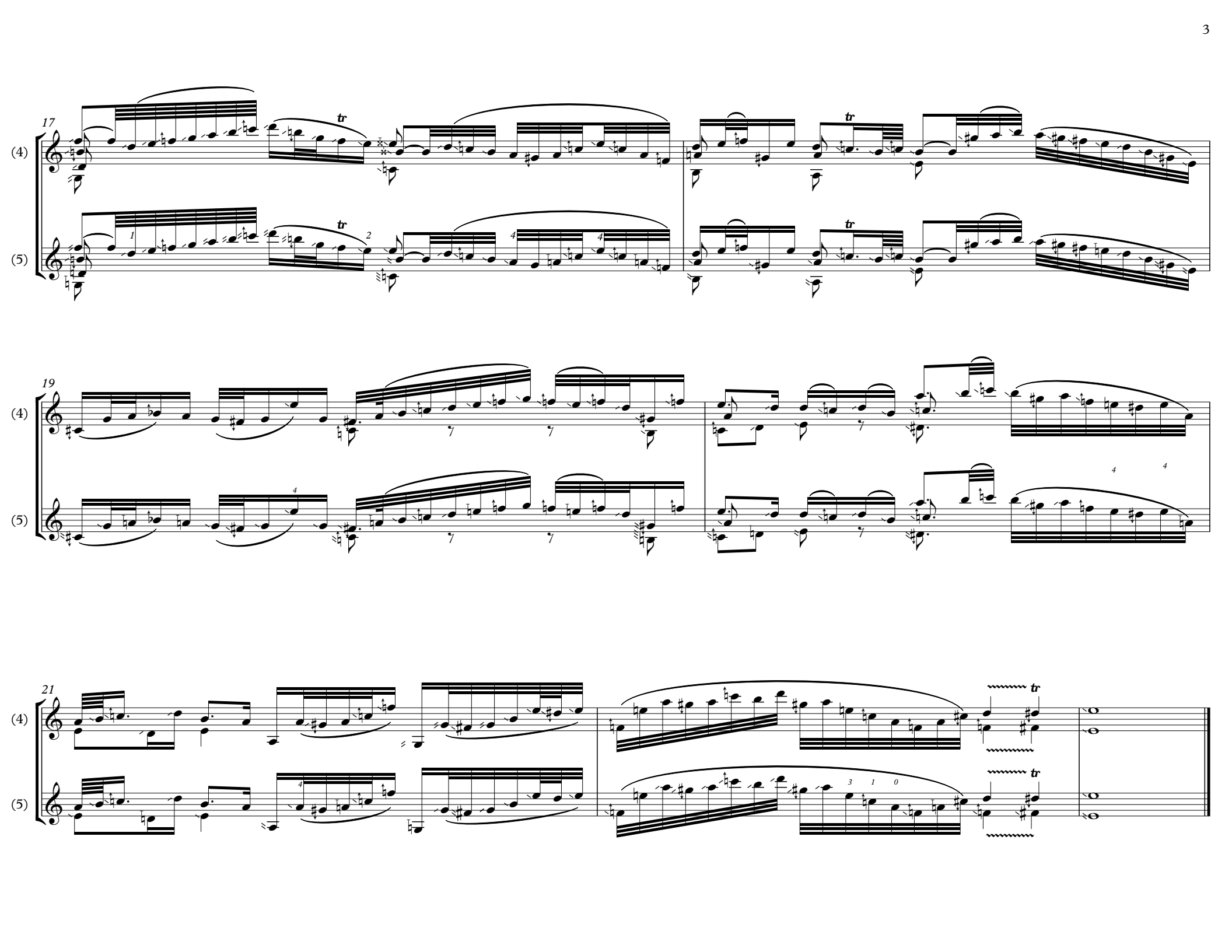
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On one hand, we have seen how the two just whole-tones will preserve some of their individual character, which here is considered a point in favor of this modified MT version. On the other side of the coin, the comma shifts will also preserve their character with variability. Measures 16 and 17 show two examples:

1) *M. 16-17 (D-G), a 3.6 cent shift.*

In regular MT the comma shift in m. 16-17 ('bass' line D-G) would be a 'modulation' of one-sixth of a comma (via a narrow fifth) and in the modified version it will remain as in the regular MT given that it is between two adjacent open strings.

2) *M. 17 (G-C), a 10.8 shift.*

Whereas in regular MT the bass line's fourth from G to C would be one-sixth of a comma too large, in the modified version it is half a comma large (one third of a comma larger than in regular MT) because this interpretation prioritizes open string sounds, therefore the C is tuned justly to the E string. In performance, the E string may not even be used in this passage (it is usually played in third position), but in practice the E string and its resonance are used as a reference point. With the ornamental passage between the two bass notes, the half-comma shift does not sound shocking at all.

The other option would be to tune the C as a just fourth from the tempered G, but then the E would be 3 sixth-commas lower than the open E string (activating a beating with the sympathetically resonant open E). The E would make a narrow 9:8 by 2 sixth-commas with the following D (which is still within the modified MT interval repertoire, and used in the first measure of the Grave).

The two different whole tones will be at their worst one third of a comma off from their just versions, and at their best they will be preserved as just – such as the G-F as a 9:8 in m. 13 (or second beat of m. 17), or the F-G as a 10:9 in m. 17, first beat. The comma modulations can range between 3.6 cents to half a comma, more subtle than in JI, and could also be modified to disappear if one compromises the ornamental passages between the 'bridge' tones. The logic of this interpretation allows flexibility in one's choices, and the violinist should be aware of what they are prioritizing in their personal interpretation: here it has been the sound of the open strings and the stability they can provide as tuning pillars, at the same time as prioritizing the different whole-step sizes. The underlying laws exposed in this case-study cannot be generalized to other instrumental scenarios, although there are similar characteristics: the tuning reference that the open strings provide, is substituted by the tempered bass line in a duo-sonata context.

5. Micro-adjustments in an ensemble context

In historically informed ensembles today, after the cellist has tuned their strings to the harpsichord, the upper string sections tune to the cellist so that all the open strings of the ensemble are tuned to the temperament of the keyboard. Here is an incidental example in sixth-comma MT of the first two measures from Telemann's Sonata n.1 in F major for violin and continuo (usually harpsichord and cello). Yet again, this would not be performed strictly in regular meantone, neither in just intonation, but in an adaptive form of tempered tuning: as justly tuned to the bass line as possible within the given tempo and note lengths.

The cellist would play and tune to the bass line performed by the harpsichordist's left hand, providing a stronger tuning reference point to the melodic upper part than the harpsichord on its own would. *Figure 6* shows the cello's bass line tuned with perfect accuracy to the harpsichord (second stave), and the violinist tuning justly to the cellist (first stave) in an ideal version rehearsed in slow motion. The smaller sized stave is the regular sixth-comma meantone tuning of the violin

part, which is not (should not be) doubled by the harpsichordist – it's there for comparison only. The tuning representation shows that the violinist would play three different kinds of Fs.

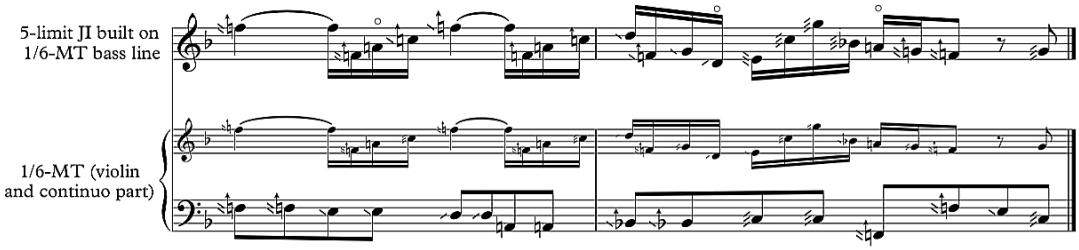

Figure 6
Opening of Telemann's duo Sonata in F.

The modified version of the violin part here is quite provocative: would the violinist actually be able to play these Fs in real time performance? Whereas it is very likely that they attempt for this tuning in slow motion practice, it is equally likely that during performance the violinist will establish a foggy area around F, going back to the art of fudging that is implied in meantone performance practice, and intuitively adjust their intonation when their ear asks for it. Perhaps determinacy in modified MT practice is only realistic in the context of solo works, as the tuning of the Grave shows a higher degree of consistency than these first two measures of Telemann's Sonata.

6. Conclusions

It's not difficult to imagine that most violinists would agree that the open strings are the most practical tuning reference points *when playing solo repertoire*, and that therefore, the tempered open strings provide, in meantone performance, the optimal references to approach the just intervals of a work in modified meantone. The question of how this would happen has been examined in this paper. The rules of thumb for an optimized and modified MT performance of a solo violin piece are: to use open strings; to tune to the same open strings one would in a syntonic performance; to pay attention to the consistency of the melodic intervals (with a special focus on half-steps), and to sound the stopped-fifths justly with a right tilt of the finger tip.

However, there is historical evidence that some musicians advocated for the avoidance of open strings, such as Roger North, suggesting for all violinists in 1726 to sound 'all the notes under the touch, and none with the strings open. […] the power of the finger in giving temper and commixture to the notes, hath a superlative effect of sweetness.'[3] Whereas this is not always possible nor practical in solo Bach, in the Telemann case-study the violinist could use the fourth finger on the D string instead of the open A string (which creates a sixth-comma augmented fourth with the bass). It is not clear how North's strings would have been tuned. Although narrowed open string fifths can indeed help tuning in a tempered ensemble context given a series of conditions (namely that the strings don't go out of tune and that everyone has them equally tuned to the keyboard), one should master the technique of stopping all notes in order to always be able to adjust their touch and pitch by ear. One might indeed not need to temper their strings then, as it might have been the case for North.

It is also not clear when the transition from tempering the open strings to tuning them in perfect fifths (as is most often done today) happened. If one tuned in just fifths, it would make sense to advocate for the use of the pinkie in replacement of the open string. It is also at the end of the 18th Century that violin intonation was officially going in the direction of Pythagorean-expressive intonation with Bartolomeo Campagnoli at its forefront with his *Nuovo metodo della mecanica*

3 Barbieri, "Violin Intonation," 70.

progressiva di suonare il violino from 1797.[4] With these changes in tuning predilections, came also the integration of vibrato, and the early twentieth century style of playing that avoids open strings at all costs, and attempts a continuous vibrato on all notes.

Given the complexity of this detailed analysis of modified meantone performance, and the discovery that if one is guided by the tempered open strings one ends up with differently sized whole tones, one might wonder if there is a simpler, more efficacious way to tune a work like Bach's Grave, perhaps without the need to temper the strings, without the need to temper with the fingertips, and without having to bind oneself to the conscious fudging of the intervals.

4 Barbieri, "Violin Intonation," 83.