

# BEYOND TEMPERAMENT

## NON-KEYBOARD INTONATION IN THE 17TH AND 18TH CENTURIES

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My system is not based on any keyboard temperament; rather, it displays the sounds found on unrestricted instruments like the cello, violin, etc., that can play purely in tune...

(G.P. Telemann, "Neues musicalisches System," 1743/44)

"Temperaments" are closed systems designed to help make the intonation of instruments with immovable pitch (like the organ and harpsichord) convincing. But singers and players of stringed and wind instruments have no such limitations -- "temperament" is too rigid a concept to apply to them.

Since keyboard temperaments have been studied and discussed for some time,<sup>1</sup> it seems odd that the intonation of singers and orchestral instruments has had very little attention.<sup>2</sup> It is a subject that is much harder to treat quantitatively, as it depends so much on context. Playing "in tune" is a relative and very personal affair, and no set of rules or abstractions from practice can possibly encompass its complexities, or substitute for an alert ear and a willing spirit. But certain basic assumptions of a singer or violinist in the 17th and 18th centuries concerning intonation were quite different from ours, and an understanding of them is not only useful in everyday ensemble work, but adds an unexplored expressive element to baroque and classical performances. Ultimately, using the available historical information, early musicians must work out this question for themselves.<sup>3</sup> The second part of

this article therefore presents extensive extracts from original sources on non-keyboard tuning.<sup>4</sup>

### Historic expedients to the tuning problem

It is a troublesome physical fact that it is not possible, either in theory or practice, to combine both pure fifths and pure major thirds in the same tuning system. A series of four pure fifths placed above each other (for instance, C-G, G-D, D-A, A-E) will produce a major third (C-E) considerably wider than pure. This is called Pythagorean tuning, a tuning commonly used in the Middle Ages; the fifths are pure, which means the thirds are large --- larger even than in equal temperament.<sup>5</sup> A different system, meantone temperament, became common by the middle of the 15th century, in response to the need for better thirds. Meantone favors thirds: in order to get them low enough, the fifths must suffer by being tuned small.<sup>6</sup>

Because of its one great advantage, practicality, equal temperament had some adherents even in the 18th century and before, but the attitude of one writer of the time was probably typical: it produced, he wrote, a "harmony extremely coarse and disagreeable."<sup>7</sup> Sauveur in 1707 said equal temperament "...is used [only] among the least able instrumentalists, because it is simple and easy."<sup>8</sup>

By contrast, the most common tuning of the time was described by a number of writers, including Telemann and Quantz, and was engagingly summarized by the singer and musical theorist Pier Francesco Tosi, who wrote in 1723:

Everyone knows that there is a Semitone Major and Minor, because the Difference cannot be known [ie. played] by an Organ or Harpsichord, if the Keys of the Instrument are not split. A Tone, that gradually passes to another, is divided into nine almost imperceptible Intervals, which are called Comma's, five of which constitute the Semitone Major, and four the Minor....If one were continually to sing only to those above-mention'd Instruments [the organ and harpsichord], this Knowledge might be unnecessary; but since the time that Composers introduced the Custom of crowding the Opera's with a vast Number of Songs accompanied with Bow Instruments, it becomes so necessary, that if a Soprano was to sing D-sharp,

like E-flat, a nice Ear will find he is out of Tune, because this last rises. Whoever is not satisfied in this, let him read those Authors who treat of it, and let him consult the best Performers on the Violin.<sup>9</sup>

Among Quantz's many comments on tuning, he explained that

What led me to add another key not previously used on the flute was the difference between major and minor semitones.... The major semitone has five commas, the minor only four. For this reason, E<sub>b</sub> must be a comma higher than D#.

From our perspective in the late 20th century, we are introduced here to two rather startling concepts:

- 1) the existence of major and minor semitones (a D# different from an E<sub>b</sub>, for instance); and
- 2) the possibility, therefore, that on some notes the harpsichord or organ might be tuned differently than the other members of an instrumental ensemble.

A system that differentiates between half-steps, according to their harmonic function, suggests refinements unknown to our ears, which have grown accustomed to a mere twelve notes to the octave. But as far as Quantz was concerned in 1752, Appreciation of [this difference between flats and sharps] is needed by anyone who wants to develop a refined, exact and accurate ear in music.

Modern players usually raise sharps and lower flats to enhance their melodic function as leading, or "tendency" tones. This practice has its roots at the beginning of the romantic period with the rise of equal temperament,<sup>10</sup> and is the reverse of the normal practice of 17th- and 18th-century musicians, for whom leading tones were low. Our contemporary preoccupation with melody is apparently recent; a stronger harmonic orientation and more "vertical" awareness naturally tended to favor the pure major third (which is much smaller than the beating, unresonant equal-tempered one).

The pure third is an interval that is both natural and very satisfying to play, and indeed most modern musicians seem to gravitate towards it, especially string players tuning to their open strings. But pure fifths are even easier and yet more tempting to tune on a stringed instrument. Since the end of the 18th century,

therefore, fifths have usually won out over thirds in string intonation (cf. the Pythagorean system, with its perfect fifths and high thirds).<sup>11</sup> Rameau in 1737, Quantz in 1752 (17/vii/4) and Sorge (1744:53) indicated that some violinists in their day were also inclined to pure fifths, but they considered this a mistake and associated it with poorer players.<sup>12</sup> They reasoned that a violin tuned to perfect fifths would be out of tune with the harpsichord or organ, but the deeper implication was that it would also be unsuited to the general intonation system of the period. As John Hind Chesnut wrote (page 271):

Modern intonation practice...is not appropriate if our goal is to play Mozart's music as he himself wanted it played. The quasi-Pythagorean "expressive" or "functional" intonation of nineteenth- and twentieth-century non-keyboard instruments is particularly foreign to the tradition in which Mozart stood.

### Tempering and "intoning justly"

We are not dealing here with a closed tuning system based on a circle of fifths like a keyboard temperament. This says nothing about the naturals; it implies a general system but does not indicate any specific temperament.

Quantz wrote

...the other instruments play [the notes] in their correct ratios, whereas on the harpsichord they are merely tempered.

"Merely tempered" is the key phrase here. If we use both D# and Eb, G# and Ab, etc.), we will need more than twelve notes in an octave. These different enharmonics are available for the singer or violinist, who is able to adjust intonation while performing, but keyboard players (unless they have instruments with split keys) are forced to resort to complicated systems of temperament.

"Temperament" in this sense means "compromise," an expedient that attempts to make the best of the fact that only one note can be played when two are needed.<sup>13</sup> It is an artifice that gives the illusion that a keyboard instrument is as well in tune as the other instruments when played by musicians with the "refined, exact and accurate ear" of Quantz's time.

For non-keyboard instruments, in fact, "temperament" is not even possible. Without a fixed tuning, intonation is influenced by technical situations, subjective perceptions, even differences in dynamics.<sup>14</sup> Players of such instruments are incapable (even if they wanted it) of the level of consistency in intonation implied by a temperament.<sup>15</sup>

But although they are not bound by any closed system, it would still be useful to see how original descriptions of their tuning might be roughly fitted into a keyboard system, since they normally perform with harpsichords or organs. A keyboard temperament can also operate as a frame of reference or model, from which singers and players of instruments with flexible intonation can occasionally depart in the context of the moment. Ideally, a "synergetic" relationship will exist, in which the keyboard is first tempered as closely as possible to the physical and musical needs of the other instruments, who in their turn refer back to it for guidance.

By definition, we can deduce that a tuning that distinguishes between enharmonic pairs, with sharps being a comma lower than flats, does not resemble either equal temperament or the Pythagorean system (in which sharps are higher than flats). If it is a system at all, it must be closer to either just intonation or some form of meantone.

Just intonation "has always had a kind of fatal fascination for musicians because of the purity within the basic scale of the tonic, subdominant, and dominant chords, and of certain melodic intervals"<sup>16</sup> that can be easily tuned to the open strings. Some early violin tutors indicate the use of a kind of just intonation, flexibly applied in a limited way (see Rameau 1726 and Tartini 1754:100-101).<sup>17</sup> But just intonation is a kind of "holy grail" that is impossible to apply continuously,<sup>18</sup> although ingenious attempts at it have been made.<sup>19</sup> As Barbour put it,<sup>20</sup>

The bulk of the violinists [in c1730] were probably still accustomed to the just thirds and greatly flattened fifths of meantone temperament.

The line between just and meantone need not, of course, be strictly drawn on instruments whose tuning is not fixed.<sup>21</sup> Some string players begin with open strings tuned to somewhat narrow fifths and tune intervals purely to the open strings. Wind players, too, tend to adjust long notes purely. Of any consistent system, this

tuning most resembles "1/4-comma" meantone ("meantone" in its strictest sense), in which thirds are pure (as in just intonation) and fifths are smaller than pure by 1/4 of the syntonic comma.

But the difference between enharmonic pairs in 1/4-comma meantone is much greater than that specified by early sources (41 cents as opposed to 22).<sup>22</sup> The consistent use of 1/4-comma meantone is not, therefore, what they describe. Georg Muffat (1698) even warned violinists to resist the temptation to play leading notes too low (sic).

Tosi said that "A Tone...is divided into nine...Intervals, which are called Comma's, five of which constitute the Semitone Major, and four the Minor." (The "comma" referred to here is just under 22 cents wide.)<sup>23</sup> An example of a major semitone would be C-D $\flat$ , a minor would be C-C#. Since the first is five commas and the second four, the difference between them is one comma.

An octave, as Francesco Geminiani wrote in 1751, can be divided "...into 12 Semitones, that is, 7 of the greater and 5 of the lesser." Since the seven "greater" or major semitones each contain five commas and the five "lesser" have four, the octave will consist of a total of 55 commas, or parts. The 55-part octave, as the sources quoted in Part 2 show, was a familiar concept in the 17th and 18th centuries.<sup>24</sup> It corresponds to a temperament known now as "1/6-comma meantone."<sup>25</sup>

### Written Sources

The term "meantone" was not used in the 18th century; in fact, like many commonly accepted assumptions, musicians were so unconscious of alternatives to a system that included major and minor semitones, that it had no name at all.<sup>26</sup>

Among the more interesting descriptions of non-keyboard tuning are those by Telemann and Quantz. Sorge (1748:61) said that Telemann's tuning system "cannot be applied to a keyboard instrument, but it may be rather convenient for the fiddle and certain wind instruments, and is the easiest for singers." Chesnut has pointed out that Mozart also apparently distinguished the small and large half steps of a

meantone temperament similar to 1/6-comma.<sup>27</sup> Major and minor semitones were discussed as late as 1813.<sup>28</sup>

In his 1707 *Méthode* (206), Sauveur classes instruments according to their ability to alter their intonation: the voice and violin are in a class in which accurate intonation depends entirely on the ear, while the keyboards are in one where no control is possible during playing. The woodwinds fall in an intermediate class, and are among instruments

...on which the pitch is governed by projections, tone-holes or touchpieces, but that can be nevertheless corrected by a sensitive ear.<sup>29</sup>

A number of woodwind fingering charts from the end of the 17th to the end of the 18th century confirm the use of higher pitches for flats and lower for synonymous sharps, although the exact difference is not specified. Recorder charts are the most informative, since that instrument's inflexible blowing technique requires alternate fingerings for correcting intonation. Among the many fingering charts that appeared for the recorder from 1630 to 1795, the earliest often choose only one of the two enharmonic pairs.<sup>30</sup> By 1700, complete chromatic charts began to appear that distinguished most pairs, especially the  $d\#/e\flat_1$ . The most interesting charts were those by Johann Christian Schickhardt (c1720), which distinguished  $g\#/a\flat_2$ ,<sup>31</sup> and Thomas Stanesby Jr. (c1732), that distinguished every chromatic note.<sup>32</sup>

To a lesser extent, traverso charts also offer useful information; Quantz's additional key indicates that tuning corrections were more limited on the traverso than on the double-reed instruments (to which such keys were never added).<sup>33</sup>

Although embouchure adjustments make the oboe's intonation relatively flexible, most oboe charts indicate alternate fingerings for some sharps and flats, from the earliest existing chart (Bismantova, 1688)<sup>34</sup> to at least 1816 (Whitely).<sup>35</sup> The synonymous pairs that are given the most alternate fingerings are the "left-hand" notes  $G\#/A\flat$  and  $A\#/B\flat$ . The development of double holes on the oboe and recorder has an obvious application for "intoning" enharmonic pairs. On both instruments they affect the most ambiguous pair,  $G\#-A\flat$ .<sup>36</sup>

Bassoon fingering charts also distinguished enharmonic pairs.<sup>37</sup> Towards the end of the century, however, keys began to be added whose purpose may have partially been to obscure these distinctions.<sup>38</sup>

### Regular vs. irregular temperaments

As Telemann wrote of his tuning system (1743/44), "It establishes a continuous proportional equality between intervals..." This implies something similar to a standard "regular" meantone temperament, defined by Barbour as one "in which all the fifths save one are the same size."<sup>39</sup>

An interesting attribute of "regular" meantones is the ease with which standard transpositions can be made, since intervals are identical in strategic keys. This would explain how German composers like Bach and Telemann were able to function in meantone while using Chorton and Cammertone simultaneously.<sup>40</sup> "Transposing" instruments were a part of life for German musicians at this time. Parts for transposing instruments were notated in different keys than the majority of the parts, because they were "pitched" differently (being tuned to Chorton/Cammerton). The "d'amore" instruments and the violino piccolo also had transposed parts.<sup>41</sup>

Obviously, however notes are notated or fingered, they should be at the same frequency for all the instruments of an ensemble. But the differences in key among transposing instruments were always either a major second or a minor third. Since in a regular meantone, parallel scales a major second or minor third apart would normally be inflected identically,<sup>42</sup> their notes would have corresponded closely.<sup>43</sup> Meantone tuning will therefore work with transposing instruments, as long as the keyboard instruments in such music are tuned in regular (rather than irregular) temperaments.<sup>44</sup>

A model based on a regular temperament is relatively simple and easy to remember.<sup>45</sup> Let us take 1/6-comma meantone as an example. Since most musicians nowadays use a Korg or similar tuning machine, the following table shows where its notes are placed in relation to equal temperament.<sup>46</sup>

	C +5 cents	
C# -8		D $\underline{b}$ +14
	D +1	
D# -11		E $\underline{b}$ +10
	E -2	
	F +7	
F# -6		G $\underline{b}$ +16
	G +3	
G# -10		A $\underline{b}$ +12
	A 0	
A# -13		B $\underline{b}$ +9
	B -4	
	C +5	

As flattened notes become more distant from C, they become gradually higher, whereas sharpened notes become lower. The note B $\underline{b}$ , for instance, is 9c higher than in equal temperament, E $\underline{b}$  10c, A $\underline{b}$  12c, etc. Going in the other direction, F# is 6c low, C# 8c, G# 10c, D# 11c, etc.<sup>47</sup>

Although a regular temperament might have been useful for the keyboard instruments, it is unlikely that other instrumentalists and singers adhered strictly to it, since the thirds and fifths would not have been completely pure. Irregular meantone systems, which favor selected keys at the expense of others, were no doubt also used together with non-keyboard instruments.<sup>48</sup> There are clear expressive advantages to these tunings, in which modulations are more colorful.

But no system, regular or irregular, could possibly have been applied rigidly on the flexibly-pitched instruments. The regular 55-part octave was no more than a convenient theoretical framework, and it can be used to advantage by present-day musicians with either a similarly tuned keyboard instrument or one tuned in an irregular temperament such as the well-known "Werckmeister III" or "Tempérament ordinaire."

### Reconciling the keyboard to the other instruments

Discussing intonation, Hubert LeBlanc (p.55) commented that

The divine artistry of Mr Blavet consists in adjusting [the tuning of his] flute by his manner of blowing. But students of the harpsichord praise the instrument for its intonation, not perceiving that it is in fact never truly in tune.

It is natural to refer to the keyboard instrument when intonation questions arise in an ensemble, since it is the only instrument with a fixed pitch. But fixed pitch has the defect of its virtue: when the music changes and demands tuning modifications, the keyboard cannot adapt as the other instruments can. It is a case of the immovable object and the irresistible force. There isn't much sense, for instance, in tuning the *G#* of a flute to a harpsichord with an *Ab*.

A number of sources (among them Sauveur, Tosi, Quantz, Telemann, Tartini, Sorge, and Mozart) accepted the fact that keyboards used different systems of tuning than other instruments.<sup>49</sup> There are suggestions as to how the problem was solved. Huygens, Rameau (1726) and Sorge (1744:53, 1758), all assumed that the melody instruments should conform to the keyboard. On the other hand, Rameau (1737), Rousseau (1743) and de Béthizy considered it self-evident that (except for unison notes and final tonics) singers purposely ignored the temperament of the accompanying instruments. Quantz (17/vi/20) proposed a more diplomatic solution in which the fixed-pitch instrument also adapted to the other instruments.

In larger settings such as orchestras, a keyboard instrument is considerably less audible than the treble melody instruments. In the case of the harpsichord, the sound dies away quickly, while pure intervals are sustained by the other treble and bass instruments. De Béthizy and Quantz [16/7] suggest that singers and other players would thus do better to adjust to the violins and oboes rather than the harpsichord (cf. also Tosi).<sup>50</sup> The problem is more acute for the other bass instruments, since they usually play in unison with a harpsichord or organ.<sup>51</sup> There are a number of possible solutions.

The idea of a harpsichord or organ with split keys was mentioned by Tosi and Quantz, and evidently used by Handel.<sup>52</sup> With both *D#/Eb* and *G#/Ab*, the

keyboard would have good major triads as far as B and A $\underline{b}$  major, making it possible to venture into tonalities with as many as four sharps or flats and still keep the thirds relatively pure.<sup>53</sup> For continuo playing, therefore, split keys clearly have a use.<sup>54</sup>

Barbour (1951:191) suggests that, when key changes were limited, it was a historic practice to retune unsplit keyboard accidentals during a program. It takes about as long to change a D $\sharp$  to an E $\underline{b}$  on a harpsichord as to tune a section of violins.<sup>55</sup>

Another solution is to use two harpsichords, one tuned (for instance) to sharps and the other to flats. Alternately, one two-manual harpsichord can be used in this way.<sup>56</sup>

Where frequent choices between enharmonics are necessary (ie., when a wide range of keys cannot be avoided), another approach is suggested by several sources. Quantz's "good temperament which allows either [synonymous flat/sharp] to be enduring" and Telemann's enharmonic pairs that are "blended together" on keyboard instruments (1767) imply either the use of an irregular meantone or the splitting of the difference between the two or three troubling accidentals within the framework of a regular meantone system.<sup>57</sup> The latter compromise (which is necessarily rather colorless in character) might look on a Korg tuner like this:

C	+5 cents
C $\sharp$	-8
D	+1
D $\sharp$ /E $\underline{b}$	0
E	-2
F	+7
F $\sharp$	-6
G	+3
G $\sharp$ /A $\underline{b}$	+1
A	0
B $\underline{b}$	+9
B	-4

C +5

This scale is based on 1/6th-comma meantone; *C#*, *F#* and *B $\flat$*  plus all the diatonic notes are left in their normal places (see previous table), and the difference between the two ambiguous flat/sharps is split.

### Some practical considerations

Quantz gave some advice on practicing intonation in 17/vii/8. He advised (as did Leopold Mozart) the use of a monochord to players of melodic instruments.<sup>58</sup>

The best manner of escape from [poor intonation] is the monochord, on which one can clearly learn the intervals. Every singer and instrumentalist should become familiar with its use. They would thereby learn to recognize minor semitones much earlier as well as the fact that notes marked with a flat must be a comma higher than those with a sharp in front of them.

Without these insights one is obliged to depend entirely on the ear, which can however deceive one at times. Knowledge of the monochord is required especially of players of the violin and other stringed instruments, on which one cannot use the placement of the fingers as an exact guide, as one can on wind instruments.

In our time, we can add that we have all grown up in a prevailing atmosphere of approximate equal temperament, making the help of a reference beyond our ears even more necessary. There is a "black box" on the market that functions much like a monochord; it is designed to play in any temperament the user wishes.<sup>59</sup>

A player using meantone as a model is theoretically expected to have alternate flats and sharps available for every note, but in practice, some accidentals are rarely used, since 18th-century music usually stays within the bounds of keys with four flats and sharps. One seldom has to play the notes *E#*, *F $\flat$* , *G $\flat$* , *B#*, *C $\flat$* , etc. There are, then, three sets of enharmonic pairs that are usually ambiguous and need attention: *A $\flat$ /G#*, *E $\flat$ /D#*, and *D $\flat$ /C#*.<sup>60</sup> The other notes (*C*, *D*, *E*, *F*, *F#*, *G*, *A*, *B $\flat$* , *B*) are normally always in the same place.

The less adaptable to different tonalities a temperament needs to be, the purer and richer it can be. Just intonation, the theoretical ideal, is practical in only one

key; equal temperament works in all of them. When planning concert programs, therefore, the choice of tonalities relates directly to the choice of keyboard temperament, and vice-versa.

### Conclusion

It is hopefully clear by now why the concept of major and minor semitones is fundamental to 18th-century tuning practice, why it can cause problems between the keyboard and the other instruments, and how it logically leads to intonation models that resemble various temperaments known nowadays as "meantone." A closed system is artificial when applied to strings, winds and voices, but it can help players and singers understand how to work with the "immovable object," a keyboard instrument with its fixed pitch, as well as provide them with a frame of reference with which to build a more expressive and "harmonious" structure of intervals.<sup>61</sup>

<sup>62</sup>

## Part Two: Sources

[? 1690s; manuscript]. Huygens, Christiaan. Oeuvres complètes, The Hague 1888-1950, vol. 20, pp.73-74.

Mais la voix ajuste tout cela, au moins quand on chante sans être accompagné de quelqu'un de ces instrumens à tons fixes.

But a singer adjusts all [these varieties of temperament], at least when singing without the accompaniment of an instrument with fixed pitch.

1691. Werckmeister, A. Musicalische Temperatur (Frankfurt a/M. and Leipzig), p.3.

Wenn alle Quinten rein gestimmt würden / wolte schon eine unreine Folge der Consonantie entstehen.<sup>63</sup>

If the fifths are tuned purely [on a violin], the result will be impure intonation.

1698. Muffat, Georg. Florilegium Secundum (Passau), "Premieres Observations:

I.Contactus. Du Toucher Juste."

...J'ay remarqué que les défauts de ceux qui Jouënt faux proviennent la plus part, de ce que des deux touches qui ensembles composent le semiton (par exemple le mi, & le fa; a & b; [natural sign] & c; ou #f & g; #c & d; #g & a &c.) Jamais il ne prennent le mi, ou la dièse # assez haut; ny le fa ou le b mol assez bas.

...I have noticed that the most common mistake of those who play out of tune involves the two notes that make up a semitone (as for example E-F, A-B $\flat$ , B-C, F $\sharp$ -G, C $\sharp$ -D, G $\sharp$ -A, etc.). The E, or the sharpened note (#) is not played high enough, nor the F, or the flattened note, low enough.

1700. Freillon-Poncein, Jean-Pierre. La véritable manière d'apprendre à jouer en perfection du haut-bois, de la flûte et du flageolet (Paris), 9.

Je ne parle point icy de la difference qu'il y a des demy tons majeurs ou mineurs, parce que aux Instrumens où l'oreille conduit les sons, on peut les faire tous égaux; ainsi la transposition sur toute sorte de demy ton se peut executer avec autant de justesse que sur le naturel.

I will not speak here of the difference that exists between major and minor semitones, since on instruments that control their tuning by ear, they can all be played alike [ie., with the same fingerings]. Thus, a scale transposed to any semitone can be played as well in tune as one without flats or sharps.

1707. Sauveur, Joseph. Méthode générale pour former les systèmes tempérés de musique, et du choix de celui qu'on doit suivre. Histoire de l'Académie royale

des sciences. p.215. Reproduced in facsimile in Rasch, R. Joseph Sauveur: Collected writings on musical acoustics (Paris 1700-1713). Utrecht: 1984.

Le système temperé de 55 comma...est celui dont les Musiciens ordinaires se servent...

The 55-part octave...is the one used by musicians in general [as distinguished from keyboard musicians in particular]...

1711. Fontenelle (Bernard le Bovier, sieur de Fontenelle). Sur les sistèmes tempérés de musique. Histoire de l'Académie royale des sciences. p.80. Reproduced in facsimile in Rasch, R. Joseph Sauveur: Collected writings on musical acoustics (Paris 1700-1713). Utrecht: 1984.

On a vû dans l'Hist. de 1709 que M. Sauveur qui a proposé un systeme temperé de Musique, par lequel il divise l'Octave en 43 parties égales, croyoit n'avoir que deux autres systemes raisonnables à combattre, l'un de M. Huguens qui divise l'Octave en 31, & l'autre du gros des Musiciens qui la divisent en 55....

In the 1709 issue of the Histoire we saw that M. Sauveur proposed a tempered musical system that divides the octave in 43 equal parts, and that only two other systems offered any reasonable competition: one by M. Huguens [Huygens] that divides the octave in 31, and the other used by the majority of musicians, that divides it into 55....

1723. Tosi, Pier Francesco. Opinioni de' cantori antichi e moderni, Chapter I, par. 15.

[See quotation at beginning of article.]

1726. Rameau, J.-P. Nouveau système de musique théorique (Paris)

[Singers need not follow the above tuning system,] ...excepté qu'elles ne soient accompagnées par des Instruments, au Temparment [*sic*] desquels elles se conforment, tant à l'aide de leur flexibilité qu'à l'aide de la sensibilité de l'oreille.<sup>64</sup>

...except when they are accompanied by instruments, to whose temperament they conform by virtue of their flexibility and the sensitivity of their ear.

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Les habilles Musiciens scavent profiter à propos de ces differens effets des Intervalles, & font valoir par l'expression qu'ils en tirent, l'alteration qu'on pourroit y condamner.<sup>65</sup>

Good musicians know how to use the different effects of the intervals, and prove their value by the expression and variety they are able to draw from them.

1728. Heinichen, J.D. Der General-Bass in der Composition. (Dresden), pp.83-85.

...bey heutigen guten Temperaturen, (von alten Orgel=Wercken reden wir nicht) die mit # und b. doppelt und 3fach bezeichneten Tone, vornehmlich im Theatralischen Stylo als die schönsten, und expressivesten vorkommen, daher ich zu Erfindung eines indeschmaskten pur-diatonischen Clavieres nicht einmahl rathen wolte wenn es Practibel wäre: allein dass man specialiter diesem oder jenem Tone den Affect der Liebe, der Traurigkeit, der Freude, &c. zu eignen will, das gehet nicht gut.

...in today's good temperaments (I am not referring to old organs) the keys with two or three flats or sharps in their signatures emerge, especially in the theatrical style, as the most beautiful and expressive. For this reason I would not even support the invention of the long-sought clavier in just intonation were it to become practicable. But that the Affect of Love, Melancholy, Joy, etc. belongs to specific keys, I cannot accept.

1730. Prellieur, Peter. The Modern Musick-Master (London); section on the Violin, p.4.

Note also that as G-sharp & A-flat, or A-sharp & B-flat, or also D-sharp & E-flat, etc. are not the same Notes you must not stop them with the same Finger. [See illustration. Note that flat notes are higher than the corresponding sharp notes.]

1732/2 1734. Neidhart, J.G. *Gänzlich erschöpfte mathematische Abtheilungen des diatonisch-chromatischen temperirten Canonis Monochordi* (Königsberg).

Wären denn die Hautbois, Flöten, u.d.g.... nach derselben eingerichtet, so müste nothwendig Chor- und Cammer-Ton durch und durch auf das reinste zusammen stimmen...

If oboes, flutes and the like... were all tuned to [equal temperament], Chor- and Cammer-Ton would naturally blend together throughout in the purest way...

1737. Rameau, J.-P. Génération harmonique (Paris). Ed. and tr. D. Hayes (diss., Stanford University, 1974)

Page 87-89:

[When a singer is accompanied by a harpsichord,] dont le Tempéramment est le plus faux,<sup>66</sup> [the singer's ear is] toujours préoccupée du Son principal du Mode... après avoir parcouru plusieurs [successions] qui ne sont pas certainement à l'Unisson de ceux du Clavecin, elle se réunit avec lui dans ce Son principal, ou dans son Harmonie.<sup>67</sup>

on which the temperament is the most out of tune, [the singer's ear is] continually preoccupied with the tonic of the key... after having passed through several [intervals] which are surely not in unison with those of the harpsichord, the voice rejoins the harpsichord on the tonic note or chord.

Page 92:

L'Oreille ne suit pas servilement le Tempéramment des Instrumens... [Ils]

The ear does not slavishly follow instrumental temperament...

servent seulement à la mettre sur les voies des Sons fondamentaux. ...elle tempère, sans réflexion... tout ce qui peut s'opposer aux justes rapports de ses Sons fondamentaux.

[Instruments] only serve to orient the voice on the principal notes... singers correct, without thinking twice..., anything that might obscure pure intonation in relation to the principal notes.

Page 91:

...les habiles Maîtres [of the violin]... diminuent un tant soit peu les Quintes, comme me l'a assuré M. Guignon Ordinaire de la Musique de Sa Majesté, pour y adoucir la dureté de la Sixte... [entre]... les deux Cordes extrêmes.

the best masters [on the violin]...as I have been told by [Jean-Pierre] Guignon [1702-74], one of his Majesty's musicians, narrow the fifths slightly, in order to sweeten the overlarge sixth... [between]... the bottom and top strings.

Page 104:

Celui qui croit que les différentes impressions qu'il reçoit des différences qu'occasionne le Tempéramment en usage dans chaque Mode transposé, lui élevent le génie, & le portent à plus de variété, me permettra de lui dire qu'il se trompe; le goût de variété se prend dans l'entrelacement des Modes, & nullement dans l'altération des intervalles, qui ne peut que déplaire à l'Oreille, & la distraire par conséquent de ses fonctions.<sup>68</sup>

To those who believe that the different impressions they receive are caused by the difference in temperament in each transposed key, giving each a special character and thereby providing more variety, permit me to tell them that they are mistaken; variety has its origin in the blending of keys and not in the modification of intervals, which can only displease the ear, thus distracting it from its [proper] work.

1740. LeBlanc, Hubert. Défense de la basse de viole. Amsterdam.

Page 54:

De tant de Tierces que... qualifie être si aimables, vous [le Clavecin] & l'Orgue en avez les trois quarts de fausses. Une Oreille fine ne sauroit chez vous entendre le joueur (pour rendre justice à deux qu'il y a d'habiles), qu'en s'imposant silence sur le défaut de justesse dans l'Instrument, & au rapport que fait l'oreille de tant d'accords qui impatientent l'Auditeur délicat, plutôt que de le flatter.

Of the many thirds that... are considered so reasonable, three quarters of yours [the harpsichord's] and the organ's are false. A nice ear would only be able to listen to someone play you (to be fair to two who are capable) by ignoring the defect of the instrument's intonation and the discord that is heard in so many harmonies, that vex the fastidious listener rather than gratifying him.

Page 55:

[On a harpsichord,] on n'a pas la faculté d'y retoucher [l'accorde] dans un Concert, au-lieu que sur les Instrumens à Cheilles mobiles, on ajuste l'accord sur chaque Ton, où l'on va jouer, & non sur la selle à tous chevaux d'un Ami l'a donné.

one cannot correct [tuning] during a concert, while on instruments with tuning pegs, the tuning is adjusted for each key in which one plays, & not in a "one size fits all" manner.

L'Art divin de Mr. Blavet<sup>69</sup> est de réparer sur la Flute, par le moyen de l'haleine modifiée. Ainsi les Ecolières de Clavecin, lorsqu'elles s'applaudissent qu'il est toujours d'accord, ne sentent pas qu'il n'y est jamais.

The divine artistry of Mr Blavet consists in adjusting [the tuning of his] flute by his manner of blowing. But students of the harpsichord praise the instrument for its intonation, not perceiving that it is in fact never truly in tune.

Page 133:

Un Seigneur qui fait la Viole a témoigné qu'ayant des Touches, elle est inférieure au Violoncel, qui n'en a

A gentleman who plays a bit of gamba remarked that as the instrument has frets, it is inferior

point: elle est sujette, dit-il, à ce que les demi-Tons Majeurs & Mineurs soient employés indifféremment, & les uns pour les autres.

Pour satisfaire à cette Objection des plus considérables, il faut remarquer que de la part de la Violle, avoir des Touches est différent d'être partagé en demi-Tons fixes, à la manière du Clavecin & de l'Orgue: on ne les accorde qu'une fois pour toutes, pour un Concert, & quelquefois pour une demi-année.

Mais sur la Violle la Cheville mobile point trop multipliée, comme sur le Luth, anéantit le défaut d'avoir des Touches, car elle le répare en accordant à chaque Ton sur lequel on va jouer.

Si l'on regarde l'Objection comme non résolue, parce qu'après le choix du Ton dans lequel on entre, lorsqu'on passera du b quarré au b mol, la difficulté reste entière à l'égard des demi-Tons Majeurs remplacés par les Mineurs.

Je répons que cela prouve que la fausseté vient d'ailleurs que des demi-Tons Majeurs & Mineurs, ils sont un objet trop peu considérable.

La preuve de leur peu d'influence est, qu'il y a des Clavecins où se trouvent les demi-Tons des deux espèces, lesquels néanmoins ne sont pas exemts des juremens dans les changemens de

to the cello, which has none: this causes it, he says, to be unable to distinguish or govern the choice of major and minor semitones.

To answer this serious imputation, it should be pointed out that on the gamba, the existence of frets is hardly the same as being split up into fixed semitones, as on a harpsichord or organ, which are tuned for a concert once and for all (and sometimes for a half-year).

For the gamba's tuning pegs, not being overly complex as on the lute, overcome the defect of fretting by being tunable in whatever key one plays.

But it may be objected that the problem is still unresolved, since even after choosing the key in which one is to play, the mode may change from major to minor, requiring minor semitones rather than major.

My answer is that this proves that bad intonation derives not from the major and minor semitones, since they are of themselves of little consequence.

The proof of their nominal influence can be seen in the fact that harpsichords are tuned with both major and minor semitones, which are nevertheless not exempt

Tons à d'autres. On s'est désisté de cette pratique comme d'un léger avantage.

L'objection du demi-Ton tire tout son degré de considération du cas où il devient le Ton capital dans lequel on joue alors sur l'Orgue & le Clavecin, il est un jurement perpétuel. Mais la Basse de Viole est tirée de pair par le changement dans son accord facile à mouvoir. On commence à accorder par ut sur le Son du demi-Ton donné.

Au contraire dans le Discours Musical, le peu d'attention que s'attirent les demi-Tons, se prouve de ce qu'ils ne tiennent lieu que de particules de liaison conjonctives, ou de transition, telles que car, néanmoins, &c. Sur lesquelles l'esprit n'appuie pas, comme dans la chute sur un Ton, lorsque le sens finit.

Il faut donc tirer d'ailleurs la raison de décider.

Ce sera des Tons Majeurs & Mineurs transposés de leur ordre naturel dans l'Octave. Car les cinq Tons entiers qui en forment plus des deux tiers, ne gardent pas une distance égale de l'un à l'autre; &, lorsqu'on change de Ton, il se fait un bouleversement général, les Tons les plus espacés viennent à être remplacés par de plus foibles,

from problems when there is a change of key. This practice has been renounced despite its occasional benefits.

The problem in using semitones derives from the cases in which it becomes the tonic note in which one plays, and in the case of the organ and harpsichord it is a perpetual curse. The bass gamba, however, escapes this difficulty because it can change its tuning easily. It tunes a scale from any given tonic, regardless of which semitone it may be.

During the act of playing music, on the other hand, the slight attention that is accorded the different semitones proves that they merely serve the purpose of conjunctive or transitive particles, such as "for," "nevertheless," etc. They hold the attention no more than the last fall of a note when a phrase comes to its end.

The cause must arise elsewhere.

It is the juxtaposition of the natural order of the major and minor semitones within the octave. For the five whole tones that comprise more than two-thirds of the octave are not placed at equal distances from each other, and, when the key changes, this produces a general confusion, as the

ceux qui ont une moyenne espace sont relevés de sentinelle par d'autres qui en ont une plus grande ou une moindre à garder, il s'enfuit des juremens exécrales sur les Instrumens, qui n'ont pas le secours des Chevilles mobiles, ou qui manquent pour les modérer d'une haleine aussi judicieusement employée que celle de Mr. Blavet.

Ainsi chaque fois qu'on change de Ton, le déplacement des parties met tout sans-dessus dessous dans la première Octave, & les autres qui en font la répétition.

larger intervals are replaced by smaller ones, and those that guarded a medium-sized interval are relieved of that function by others that were intended to serve for a smaller or larger one. Consequently, the most hideous oaths escape the instruments that are not provided with tuning pegs, or that are unable to moderate their pitch by means of breath pressure, employed as judiciously as is done by Mr. Blavet.

Each time there is a modulation, in other words, the relationships of the semitones is jumbled in the first octave, and consequently the others that are tuned to it.

1742/3. Telemann, G.P. "Neues musicalisches System" published in L.C. Mizler: Musikalische Bibliothek 3/4 (Leipzig: 1752/R 1966), 713-19 [plus tables].<sup>70</sup>

Page 716:

Mein System hat keine Claviermässige Temperatur zum Grunde, sondern zeigt die Klänge, so, wie sie auf uneingeschränkten Instrumenten, als Violoncell, Violine etc. wo nicht völlig, doch bey nahe, rein genommen werden können, welches denn die tägliche Erfahrung lehret.

My system is not based on any keyboard temperament; rather, it displays the sounds found on unrestricted instruments like the cello, violin, etc., that can play purely (if not always entirely, nearly so), as day-to-day experience teaches.

Page 718:

Es bestimmet eine durchgehends proportionirliche Gleichheit unter den

It brings about a universal proportionate equality among the

Intervallen.... Es sind etwan ein Duzend Jahre, da ich selbst noch glaubete, man würde bey Anhörung etlicher von deren Harmonie das Balsambüchchen zur Hand nehmen müssen. Allein die Erfahrung hat mir den Irrthum benommen, u. dargethan, dass C#, E $\flat$  u. Ab-C $\flat\flat$  nach einerley Gewürze schmecken.

intervals.... Only a dozen years ago, I myself still believed that the hearing of some of these harmonies would cause one to reach for the smelling-salts. But experience has taken this error from me, and shown that C#-E $\flat$  and Ab-C $\flat\flat$  taste of the same spice.<sup>71</sup>

1743. Rousseau, Jean-Jacques. Dissertation sur la musique moderne (Paris) in Oeuvres, vol.19, p.130.

La mécanique du tempérament introduit dans la modulation des tons si durs, par exemple le re et le sol diesis, qu'ils ne sont pas supportables à l'oreille... La voix ne se conforme jamais ...à moins qu'elle n'y soit contrainte par l'unisson des instrumens.

In modulations, the mechanisms of temperament cause such unpleasant notes, for example D and G sharp, that they are impossible to listen to.... Singers never conform to them ...except when forced to do so at points where they are in unison with the instruments.

1744. Sorge, Georg Andreas. Anweisung zur Stimmung und Temperatur sowohl der Orgelwerke, als auch anderer Instrumente, sonderlich aber des Claviers. Hamburg.

Page 24:

...die andere [temperament with unequal division of the comma] möchte sich zum musiciren im Cammer-Ton, wenn die Orgel im Chor-Ton stehet, besser Schicken, denn da wird der Modus As dur oft, E dur aber wohl gar

...the other [temperament with unequal division of the comma] may work better when playing in Cammertone with an organ in Chorton, since the key of Ab major is often used but E major

nicht gebraucht. Ingleichen kommt Es dur gar oft, H dur aber gar nicht vor. Wiederum muss B dur oder auch D dur oftmals herhalten, da hergegen Fis dur nicht leicht erscheinen wird.

[He gives two versions of an irregular temperament; he says that] ...die Waldhörner aus dem Es wie auch die Oboen werden ganz wohl mit dieser Temperatur zufrieden seyn.<sup>73</sup>

practically never.<sup>72</sup> Likewise, E<sub>b</sub> major appears quite frequently but B major almost never. Again, B<sub>b</sub> major or also D major will often appear, while on the contrary one rarely sees F# major.

[He gives two versions of an irregular temperament; he says that] ...the horns in E<sub>b</sub> and also the oboes will be quite satisfied with this temperament.

Page 35:

So dann fange man im  $f_1$  an, und stimme solches nach Belieben in Chor- oder Cammer-Ton, nachdem das Clavier beschaffen ist, etwa nach einer Flute douce oder Traveriere [sic].

One begins then on  $f_1$  and tunes in Chorton or Cammerton (depending on in which the harpsichord is tuned) approximately to the pitch of a recorder or traverso.

Page 53:

Die Flöten, sowohl die Traversen als die Flute douces, sind bis dato mit einer gar schlechten Temperatur versehen, und hätten die Herren Pfeifenmacher hohe Ursache, sich um die Lehre der Canonic und Harmonic mehr als andere Musici zu bekümmern, oder doch ihre Instrumente so viel immer möglich nach einer wohl temperirten Orgel zu stimmen und einzurichten. Auf den Traversen fehlet es gemeinlich am f, gis und b am meisten. Ich glaube aber, es sey gahr wohl möglich auch diesen Tönen

Flutes, both traversos and recorders, have been provided until now with a very bad temperament, and the gentlemen who make them have more need than other musicians to concern themselves with the acoustics of music, or at least to tune and regulate their instruments as closely as possible to a well-tempered organ. On traversos, the F, G# and B are generally the worst offenders. But I believe that it should be quite possible to

ihr behöriges Recht zu thun. Mit den Flutes douces siehet es noch schlimmer aus, und sind auch noch übler zu zwingen als die Traversen. Doch halte dafür, dass sie in der Stimmung zu verbessern sind. Wenn nur die Pfeifenmacher erst Harmonici wären, hernach solte es sich auch schon mit ihnen geben.

Die Oboes sind auch noch nicht mit der besten Temperatur versehen. Sol ihnen geholfen werden, so muss ein Harmonicus, ein guter Oboist und ein Pfeifenmacher bey einer wohl temperirten Orgel zugleich Hand anlegen. Der Oboiste und Pfeifenmacher aber dürffen nicht eigensinnig seyn, sondern müssen Raison annehmen und spitzige Ohren zum Werke bringen. Und solches ist auch von denen Flöten zu verstehen.

Die brauchbaren und unentbehrlichen Geigen habens am besten, jedoch müssen ihre 3 Quinten behörigermassen temperatè [sic] gestimmt werden, so dass sie ein klein wenig abwärts schweben, sonst kommen sie, wenn z.E. im g angefangen, und solches mit der Orgel vollkommen rein gestimmt worden, mit a<sub>1</sub> und e<sub>2</sub> ein merkliches zu hoch, wenn sie nämlich alle 3 Quinten ohne Schwebung rein stimmen wolten. Das übrige kömmt auf ein gutes Gehör und

correct even these notes. The situation with recorders is worse yet, and they are even harder to control than traversos, though I believe they can be improved. If only flute makers were also theoreticians, things would naturally go better.

The oboes are also not furnished with the best of temperaments. They could be helped if an acoustician, a good oboist, and a woodwind maker examined together a well-tempered organ. The oboist and woodwind maker should not, however, be headstrong and obstinate, but Reason, together with sharp ears, should govern all. And the same goes for the flutes, of course.

The useful and indispensable fiddles are the best off; still, their 3 fifths must be correctly [tuned], so they beat a little. Otherwise, if the fifths are all tuned purely without beating, and (for example) the G is tuned exactly to the organ, the A and E will be noticeably too high [compared to the organ]. For the rest, everything depends on a good ear and accurate fingering...

reinen Griff an...

Sorge also advises singers to follow the keyboard temperament (p.55).

1748. Sorge, Georg Andreas. Gespräch zwischen einem musico theoretico und einem studioso musices (Lobenstein).

Page 21:

Mit einem Wort: Die Silbermannische Art zu temperiren, kan bey heutiger Praxi nicht bestehen.

In a word -- Silbermann's way of tempering cannot exist with modern practice.<sup>74</sup>

Page 51:

Besser gefällt mir das berühmten Herrn Capellmeister Telemanns Systema Intervallorum, als welcher die Octav in 55. geometrische Abschnitte (Commata) die von Stufe zu Stufe kleiner werden, theilet.

The famous Herr Capellmeister Telemann's Systema Intervallorum pleases me better, in which the octave is divided into 55 units, or Commas, which become smaller from step to step.

Page 52:

...die kleinste Secund vom Einklange [ist] unterschieden... um den neunnten Theil eines grossen Tons, oder um ein Comma. Und um so viel ist auch #C:bD, D:bbE, #D:bE, E:bF, #E:F, #F:bG, xF:G, #G:bA, A:bbH, H:bc, #H:c und c bbd etc. unterschieden.

...the [interval of a] "smallest second" differs from a unison by the ninth part of a whole tone, or one Comma. This same amount distinguishes also C#:Db, D:Ebb, D#:Eb, E:Fb, E#:F, F#:Gb, G#:Ab, A:Bbb, B:Cb, B#:C and C:Dbb, etc.

Page 58:

O! wie mancher Geiger fängt seine Partie anzuspielden, und hat nicht einmahl seine Geige behörig gestimmt, wo will denn hernach die Reinigkeit herkommen? ...o Blindheit,

Oh! When so many fiddlers begin to play their parts without having even properly tuned their instruments, how will pure tuning ever be achieved? ...Oh blindness! Oh

o! Unwissenheit! wie gross bist du noch in der musikalischen Welt an manchen Orten.

ignorance! How great you remain in so many parts of the world of music.

Page 61:

...über Herrn Capellmeisters Telemanns Systema... Mich dünckt es sey gar schicklich, wenn man zu einer jeden Note auch einen besondern Klang oder Clavem bestimmet, und nicht einem Clavi zwey- bis dreyerley Noten zueignet, wie wir ietzo in unsern Clavier thun müssen... Auf's Clavier wird sich dieses System nicht appliciren lassen;<sup>75</sup> auf der Geige aber, und einigen Blase-Instrumenten, möchte es eher thunlich seyn; denen Sängern aber ist es am leichtesten.

...about Herr Capellmeister Telemann's Systema... I would think that it would be more appropriate if each separate note were produced by its own special sound and key, rather than, as on present-day keyboards, one key for two and even three [different] notes... This system cannot be applied to a keyboard instrument, but it may be rather convenient for the fiddle and certain wind instruments, and is the easiest for singers.

[1750]. Ellis, Alexander J. "On the history of musical pitch," Journal of the Society of Arts (March 5, 1880), reprinted in Studies in the history of musical pitch (by Ellis and Arthur Mendel), Amsterdam: 1968, p.37.

I am indebted to Mr. E.J. Hopkins, organist of the Temple, for furnishing me with a MS. note made by Mr. Leffler (d. 1819), organist of St. Katherine's, then by the Tower, with Mr. W. Russell, then organist of the Foundling, which describes the great peculiarity of this organ [Foundling Hospital, Glyn and Parker, opened by Handel in 1750 and played by him subsequently]. It had the usual 12 keys to the octave, but a means of altering the notes sounded by four of them. There was a slider with three rests above the draw stops on each side. When the sliders were at the central rest, the 12 notes were the usual 12 of the meantone temperament, E flat, B flat, F, C, G, D, A, E, B, F sharp, C sharp, G sharp. If the left-hand slider were put full to the left, E flat was changed into D sharp, and if the right-hand slider were put full to the right, B flat was changed into A sharp. If, however, the right-hand

slider were put full to the left, G sharp was changed into A flat, and if the left-hand slider were put full to the right, C sharp became D flat.... Mr. Hopkins always understood that this arrangement was due to Dr. Robert Smith of Trinity College, Cambridge.... The Temple Organ and the oldest Durham organ had an E flat and D sharp, an A flat and G sharp, that is two and not four additional notes, and these were introduced by divided keys and not by sliders...

1751. Geminiani, Francesco. The Art of playing on the violin (London), p.3.

Geminiani recommended that beginners finger enharmonic twins at the same place on the neck of the violin, but said,

This rule concerning the Flats and Sharps is not absolutely exact.

...the Octave also must be divided into 12 Semitones, that is, 7 of the greater and 5 of the lesser.

1752. Quantz, Johann Joachim. Eng. tr. 1966/2: 1987. Essai d'une méthode pour apprendre à jouer de la Flûte Traversière [in French and German]. Berlin. Chapter 3 par. 2, 3, 5, 8; Ch. 16 par. 4, 7; Ch. 17 section vi par. 20; section vii par. 4, 8, 9.<sup>76</sup>

Chapter 3/5:

On verra par là, que les tons, étant indiqués par le b mol sont d'un Comma plus hauts, que quand ils sont marqués par un Diese.

From these tables you can see that the notes indicated with a flat are a comma higher than those indicated with a sharp.

Chapter 3/8:

Ce qui m'a porté à ajouter à la Flute encore une Clef qui n'y a pas été auparavant, c'est la difference entre les Demitons majeurs & mineurs.... Le Demiton majeur a cinq Comma; le Demiton mineur n'en a que quatre. Il

What led me to add another key not previously used on the flute was the difference between major and minor semitones.... The major semitone has five commas, the minor only four. For this reason, E<sub>b</sub> must be a comma higher than

faut par consequent qu'Es (mi b mol) soit d'un Comma plus haut que Dis (re Diese). S'il n'y avoit qu'une Clef sur la Flute, il faudroit entonner l'un & l'autre, Es (mi b mol) & Dis (re Diese) de la même façon, comme on fait sur le Clavecin, où on les touche par une même touche; c'est à dire les deux intervalles sont tempérés; desorte que ni Es (mi b mol) à B (si b mol), comme la Quinte par en bas; ni Dis (re Diese) à H (si), comme la Tierce en haut, n'accordent parfaitement bien. Pour marquer donc cette difference, & entonner nettement les tons selon leur proportion, il étoit nécessaire d'ajouter encore une Clef.... Il est vrai que cette difference ne peut pas être exprimée sur le Clavecin, où l'on touche tous ces tons qu'on distingue ici, sur une même touche, ayant recours à la Temperature ou Participation. Cependent cette difference étant fondée dans la nature des tons, & pouvant être observée sans peine par les Chanteurs & les Joueurs d'instrumens d'archet, il est juste de l'exprimer aussi sur la Flute, ce qui ne se peut sans l'autre Clef.<sup>77</sup> La connoissance en est nécessaire à qui veut rendre fin, précis & net ce qui appartient à l'oreille dans la Musique.<sup>78</sup>

#### Chapter 16/4:

Dans une pièce en mode Es (mi b mol)

D#. If there were only one key on the flute, both E $\flat$  and D# would have to be played similarly, as on the harpsichord, where they are played from the same key; so that neither E $\flat$  to B $\flat$  (the ascending fifth) nor D# to B (the descending major third) would be well in tune. In order to make this difference clear, and to place the notes in their correct proportion, it was necessary to add another key.... It is true that this distinction is impossible to make on the harpsichord, where each pair of notes we wish to distinguish are produced with a single key, making it necessary to have recourse to tempering. But since this difference is based on the nature of the notes and can be produced without difficulty by singers and string players, it is reasonable to observe it on the flute as well (and this cannot be done without the extra key). Appreciation of this difference between flats and sharps is needed by anyone who wants to develop a refined, exact and accurate ear in music.

In pieces in E $\flat$  and A $\flat$ , the flute

& As (la b mol), on peut accorder la Flute un peu plus bas qu'à tous les autres modes; les modes avec les b mols étant d'un comma plus hauts que ceux avec les dieses.<sup>79</sup>

#### Chapter 16/7:

S'il se trouve que les Violons sont plus hauts que le Clavecin; ce qui peut aisément arriver, quand leurs Quintes sont accordées un peu trop haut, au lieu qu'elles doivent l'être un peu plus bas, comme il faut que cela soit observé au Clavecin; ce qui cause en quatre Quintes qui sont ainsi accordées, une différence considérable: alors le joueur de Flute est obligé de se régler plutôt aux Violons qu'au Clavecin, ceux-là se faisant entendre davantage que celui-ci.... cette faute ne se commet que par ceux qui traitent la Musique comme un métier, dans lequel ils ne trouvent pas un véritable plaisir, & non pas par des Musiciens raisonnables & expérimentés, qui aiment la Musique & qui jouent pour plaire à des oreilles délicates.

#### Chapter 17/vi/20:

Chaque joueur de Clavecin qui connoit la proportion des intervalles, saura aussi, que les Demi tons mineurs comme D (re) avec la dièse, & E (mi) avec le b mol, &c. diffèrent d'un Comma, & causent par conséquent sur cet instrument, où il n'y a pas des

can be tuned a little lower than in all the other keys, the flat keys being a comma higher than the sharp.

If the violins should happen to be tuned higher than the harpsichord, which can easily happen if their fifths are tuned a little wide rather than (as must be done on the harpsichord) a little narrow, the flute player is obliged to adjust more to the violins since they are more audible than the harpsichord. Tuning the four fifths wide on the violin causes a considerable difference with the harpsichord... it is a mistake made only by those who consider music as a mere trade from which they derive no real satisfaction, not by thoughtful and experienced artists who love music and play in order to please refined ears.

Every harpsichordist who understands the proportion of intervals will also know that minor semitones like D-D# and E-E $\flat$  etc. differ by a comma, and therefore cause on this instrument (unless the keys are split) certain intonation problems with other

touches partagées, quelque inégalité dans l'intonation à l'égard des autres instrumens, qui donnent ces tons dans leur juste proportion. Cela est surtout sensible quand le Clavecin joue avec quelques uns de ces instrumens à l'Unisson. Or comme on ne peut pas toujours éviter ces tons-là, surtout aux modes où il y a beaucoup de dièses & de b mols; l'Accompagnateur fait bien de les mettre au milieu ou dans la partie inferieure de l'accord, ou si un de ces tons fait la Tierce mineure, de l'omettre tout à fait. Car ce sont particulièrement les Tierces mineures, dont le ton est très imparfait & défectueux, lorsqu'elles se rencontrent avec la partie principale à l'Unisson dans les Octaves hautes. J'entends sous ces Tierces mineures principalement les tons C, D & E à deux lignes (ut, re & mi seconds de la Flute), quand il y a un b mol devant eux, ou pour dire brièvement, les tons Ces (ut b mol), Des (re b mol) & Es (mi b mol). Cependant j'y réfère aussi G & A à une ligne (sol & la premiers), & D & E à deux lignes (re & mi seconds), lorsqu'ils sont précédés par un dièse; car étant des Tierces majeures, ils sont trop fort dans leur temperature & par conséquent trop haut. Il est vrai qu'on ne sauroit remarquer cette difference si distinctement, en jouant seul du Clavecin, ou accompagnant dans une Musique de beaucoup de

instruments that play these notes in their correct proportions. This is especially noticeable when the harpsichord plays with any of these instruments in unison. Now, since these notes cannot always be avoided, especially in keys with many sharps or flats, the accompanist does well to put them in the middle or lower part of the chord, or if such a note makes a minor third, to omit it altogether. For it is especially these minor thirds that sound so imperfect and defective when played in unison with the principal part in the upper octaves. I am referring mainly to the minor thirds when  $c_2$ ,  $d_2$  and  $e_2$  (the second-octave ut, re & mi on the flute) are preceded by a flat, or to put it more briefly, the notes  $cb_2$ ,  $db_2$  and  $eb_2$ . I am also referring, however, to  $g_1$  and  $a_1$  (first-octave sol & la), and  $d_2$  and  $e_2$  (second-octave re & mi) when preceded by a sharp, since as major thirds, they are too wide in their temperament and therefore too high. It is true that this difference [in intonation] is not as clear when the harpsichord is played by itself, or when it accompanies a large ensemble. But when the notes are in unison with another instrument, the difference is quite audible, since

personnes. Mais lorsque ces tons se rencontrent à l'Unisson avec un autre instrument, la difference se fait entendre beaucoup, à cause que les autres instrumens les donnent dans leur juste proportion, pendant que sur le Clavecin ils ne sont que temperés. C'est pourquoi il vaut mieux de les omettre tout à fait, que d'en blesser l'oreille.

#### Chapter 17/vii/4:

Pour accorder d'une maniere précise le Violon, je crois qu'on ne feroit pas mal, si l'on suivoit la règle qu'on observe en accordant le Clavecin c.a.d. que les Quintes feront un peu foibles, & non pas tout nettes, comme on les accorde ordinairement, ni encore moins trop fortes; afin que toutes les cordes nuës soient égales avec le Clavecin. Car si l'on veut accorder toutes les Quintes nettes & fortes, il s'ensuit naturellement, que de quatre cordes il n'y aura qu'une qui sera égale avec le Clavecin. Mais si l'on accorde la corde A (la) tout égale avec le Clavecin, & E (mi) un peu foible contre l'A (la), D (re) un peu fort contre l'A (la), & G (sol) de même contre D (re); les deux instrumens seront d'accord ensemble.

the other instruments play them in their correct ratios, whereas on the harpsichord they are merely tempered. For this reason, it is better to omit them entirely, rather than offend the ear.

To tune the violin accurately, I believe one would not do badly to follow the same rule as for tuning the harpsichord, that is, with the fifths a little narrow (and not entirely perfect, let alone a little wide, as commonly happens), so that the open strings will agree with the harpsichord. If one tries to tune all the fifths purely or wide, the result will be that only one of the four strings will be in tune with the harpsichord. But if the A is tuned precisely to the harpsichord, the E slightly flat to the A, the D a little sharp to the A, and the G likewise to the D, the two instruments will be in tune together.

## Chapter 17/vii/8:

Il y a des personnes qui sentent fort bien, moyennant leur finesse naturelle de l'ouïe, quand un autre joue faux; mais elles ne s'en apperçoivent pas quand elles commettent la même faute elles mêmes, & ne sauroient y remédier. Le meilleur moyen pour se tirer de cette ignorance, est le Monochorde, sur lequel on peut apprendre le plus distinctement à connoître les proportions des tons. Il seroit nécessaire, que non seulement chaque Chanteur, mais aussi chaque joueur d'instrument s'en rendit familier l'usage. Ils acquerroient par-là, de beaucoup plus de bonne heure, la connoissance des Demi tons mineurs, & apprendroient que les tons marqués par un b mol, doivent être un Comma plus hauts que ceux qui ont un dièse devant eux; au lieu que sans ces lumieres ils sont obligés de se fier absolument à l'oreille, dont le jugement est pourtant quelquefois bien trompeur. Une telle connoissance du Monochorde se demande principalement des joueurs de Violon & d'autres instrumens à archet, auxquelles on ne peut pas, par rapport à la mise des doigts, prescrire des bornes comme aux instrumens à vent.

There are some players who have a very good ear and who can easily perceive false playing by others, but are unaware of committing the same mistake themselves, and would not know how to remedy it. The best manner of escape from this ignorance is the monochord, on which one can clearly learn the intervals. Every singer and instrumentalist should become familiar with its use. They would thereby learn to recognize minor semitones much earlier as well as the fact that notes marked with a flat must be a comma higher than those with a sharp in front of them. Without these insights one is obliged to depend entirely on the ear, which can however deceive one at times. Knowledge of the monochord is required especially of players of the violin and other stringed instruments, on which one cannot use the placement of the fingers as an exact guide, as one can on wind instruments.

## Chapter 17/vii/9:

Lorsqu'on trouve les Sous-demi tons proprement dits, c.a.d. qu'un ton baissé par le b mol se change en celui, qui lui est immédiatement inférieur & qui est haussé par un dièse, ou qu'un ton haussé par le dièse se change en celui, qui lui est immédiatement supérieur & qui est baissé par le b mol...le ton avec le dièse est un Comma plus bas, que celui avec le b mol. Quand ces deux notes sont liées ensemble, v. Tab. XXIII. Fig.6. il faut retirer le doigt un peu sur le dièse qui suit le b mol; autrement la Tierce majeure seroit trop haute contre la partie fondamentale.

If sub-semitones (to use their correct name) appear consecutively, in other words if a note lowered by a flat becomes transformed into the note just below it, raised by a sharp [or vice-versa]...the note with a sharp is a comma lower than the one with a flat. [For example, *G#* should be a comma lower than *A<sub>b</sub>*.]<sup>80</sup> If these two notes are tied to each other (as in Tab. XXIII. Fig.6), one must draw back one's finger a little for the sharp following the flat; otherwise the major third will be too high against the fundamental note.

[Table XXIII, Figs.6 and 7 from original ed. of Quantz]

Si au contraire le b mol suit après le dièse, v. Fig 7. il faut auprès de la note avec le b mol, avancer le doigt autant qu'on le retire dans l'exemple précédent... On observe la même chose à tous les instrumens, excepté au Clavecin, où l'on ne peut pas effectuer des Sous-demi tons, & lequel pour cette raison doit avoir une bonne Temperature, afin qu'on puisse souffrir l'un & l'autre de ces tons. Sur les instrumens à vent ce changement se fait par le moyen de

But if, as in Fig.7, the flat follows the sharp, the finger must be advanced as much for the flat as it was drawn back in the preceding example... This same thing is done on all instruments except the harpsichord, where the sub-semitones cannot be effected, causing it for this reason to have recourse to a good temperament which allows either note to be endurable. On wind instruments, these changes are accomplished

l'embouchure, de façon que sur la Flute on hausse le ton en la tournant en dehors, & on le baisse en la tournant en dedans. Sur l'Hautbois [sic] & le Basson les tons se haussent, quand on avance l'anche plus dedans la bouche, & qu'on presse plus les levres ensemble; & ils deviennent plus bas, quand on retire l'anche & relache les lièvres [sic].

through embouchure corrections. On the flute, the pitch is raised by turning it outwards and lowered by turning it inwards. On the oboe and bassoon, the pitch is raised when the reed is advanced in the mouth and the lips are pressed together. It is lowered by withdrawing the reed and relaxing the lips.

1754. Béthizey, Jean Laurent de. Exposition de la théorie et de la pratique de la musique (Paris), p.135.

...comment la voix s'ajuste-t-elle au tempérament... d'un... instrument: Pour entonner la première note d'un air, elle se règle sur la note tonique du mode principal, telle qu'elle est rendue par l'instrument, & forme ensuite les différents intervalles...sans égard à l'altération des notes que l'instrument fait entendre.... Lorsqu'un nouveau mode paraît, la voix est obligée de se conformer à la manière dont l'instrument rend la nouvelle tonique.... Si la voix & l'instrument forment ensemble une tenue à l'unisson ou à l'octave, la voix est forcée de se conformer à l'instrument.... Quand la voix est accompagnée de plusieurs instruments, si l'un d'eux se fait mieux entendre que les autres, la voix se conduit, comme si elle n'était ac-

how a singer adjusts to the temperament... of an... instrument: to sing the first note of an aria, the singer refers to the tonic note of the principal key as played by the instrument, and subsequently adjusts the different intervals... without reference to the notes played by the instrument.... When a new key appears, the singer is obliged to conform to the new tonic as rendered by the instrument.... If the voice and instrument play a unison or octave together, the voice is obliged to conform to the instrument.... When the singer is accompanied by several instruments of which one is more audible than the others, the singer performs as if accompanied by this instrument

compagnée que de cette [sic] instrument. Si tous ou quelques-uns se font entendre aussi bien l'un que l'autre, la voix...ne s'ajuste au tempérament d'aucune [sic] d'eux, à moins que ce tempérament ne tienne le milieu entre les autres, mais se fait alors un tempérament que lui est particulier.

alone. If several or all of them are equally audible, the singer...does not adjust to any of their temperaments (or perhaps finds their average), but performs in his own particular temperament.

1754. Tartini. *Tratatto di musica* (Padua: R 1966), pp.99-100.

...Di fatto il Basso organico rinchiude tutta l'armonia; e cantanti, e suonatori si accordano con l'organo per ben' intunare. Ma organo, e clavicembalo (se non si moltiplichino i tasti a dismisura) non hanno altro intervallo perfettamente accordato, se non la ottava; e quasi tutti gli altri intervalli di quinte, quarte, terze maggiori, e minore, tuoni, e semitoni sono accordati per discretivo temperamento, e non secondo la ragione, o sia forma dell'intervallo rispettivo. Dunque è impossibile l'uso della scala suddetta in precisione di ragioni, perchè in tal necessario temperamento le ragioni restano alterate nella loro forma.

...In fact, the organ bass contains the complete harmony; and both singers and instrumentalists tune to the organ for the sake of good intonation. But (unless the keys are multiplied excessively) the organ and harpsichord have no other perfectly tuned intervals besides the octave; almost all the other intervals, such as fifths, fourths, major and minor thirds, seconds, and semitones are tuned by arbitrary temperaments, and not in their correct ratio, or according to their respective intervals. The use of the above-mentioned [purely tuned] scale is therefore impossible in its exact ratios, because the necessity of using a temperament alters it from its true form.

...Io nel mio Violino, dove suonando a

...When I play my violin, using

doppia corda posso incontrar fisicamente la forma dell'intervallo, di cui è segno fisico dimostrativo il tal terzo suono, che deve risultare, ho il vantaggio per me, e per i miei scolari<sup>81</sup> della sicura intonazione, e in conseguenza dell'uso reale della scala suddetta in precisione di ragioni. Bisogna però avvertire, che questa scala, benchè dimostrativamente dedotta, non è perfetta intieramente in ciascun possibile confronto delle note musicali costituenti...

double stops, I find an interval's proper ratio through a physical sensation, which can [also] be established scientifically. The correct third that I play results inevitably, and gives me, and my students, the advantage of assured intonation, and in consequence the true usage of the above-mentioned scale in its precise ratios. I should point out, however, that this scale, however convincingly derived, is still not completely perfect in every possible situation in its constituent musical notes...

1756. Mozart, Leopold. Versuch einer gründlichen Violinschule (Augsburg).<sup>82</sup>

Page 66, note:

Auf dem Clavier sind *Gis* und *As*, *Des* und *Cis*, *Fis* und *Ges*, u.f.f. eins. Das macht die Temperatur. Nach dem richtigen Verhältnisse aber sind alle die durch das (b) erniedrigten Töne um ein Komma höher als die durch das (#) erhöhten Noten.

On the keyboard, *G#* and *A<sub>b</sub>*, *D#* and *E<sub>b</sub>*, *F#* and *G<sub>b</sub>* etc. are the same. That makes the temperament. But according to the correct ratios, all the notes lowered by a flat are a comma higher than those raised by a sharp.

Page 69, note:

das (b) erniedrigten Töne um ein Komma höher als die durch das (#) erhöhten Noten. Z.B. *Des* ist höher als *Cis*; *As* höher als *Gis*, *Ges* höher als *Fis*, u.s.w. Hier muss das gute Gehör

Notes lowered by a flat are a comma higher than those raised by a sharp. *D<sub>b</sub>*, for instance, is higher than *C#*; *A<sub>b</sub>* higher than *G#*, *G<sub>b</sub>* higher than *F#*, etc. An accurate

Richter seyn: Und es wäre freilich gut, wenn man die Lehrlinge zu dem Klangmässer (Monochordon) führete.

ear must be the guide here; it would be very useful for the student to make use of a monochord.

Page 191:

Ich habe die Probe auf der Violin, dass beym Zusammenstreichen zweener Töne auch so gar bald die Terz, bald die Quint, bald die Octav u.s.f. von sich selbst auf eben dem nämlichen Instrumente dazu klinge. Dieses dienet nun zur untrüglichen Probe, womit sich ieder selbst prüfen kann, ob er die Töne rein und richtig zu spielen weiss. Denn wenn zweene Töne, wie ich sie unten anzeigen werde, gut genommen und recht aus der Violin, so zu reden, heraus gezogen werden; so wird man zu gleicher Zeit die Unterstimme in einem gewissen betäubten und schnarrenden Laut gar deutlich hören: sind die Töne hingegen nicht rein gegriffen, und einer oder der andere nur um ein bisschen zu hoch oder zu tief; so ist auch die Unterstimme falsch.

I have noticed that on the violin, when two notes are played simultaneously, the third, sixth, or octave, etc. also spontaneously sound on the instrument. Everyone can use this as a reliable manner of checking if notes are being played in tune and correctly. For, if two notes (which I will indicate more specifically below) are drawn out of the violin in a good and correct manner, then the lower voice will also be clearly audible, though muffled and rasping in sound. If however the notes are not played in tune, and one or the other is fingered even slightly too low or too high, the lower note will also be false.

1758/R 1970. Sorge, Georg Andreas. "Anmerkung über Herrn Quantzens...dis und es-Klappe auf der Querflöte," Historisch-kritische Beyträge (F.W. Marpurg) IV:1-7.<sup>83</sup>

Sorge concludes that the comma described by Quantz is the same as Scheibe's (1739) and Telemann's (1742/43), as it is the only one that will fit exactly 55 times into an octave.

Betrachten wir dieses commatische System gegen das rationalgleich gestimmte Clavier, so finden wir einen beträchtlichen Unterschied...

Was nun hier von den Tonart C gesagt ist, das gilt bey allen übrigen Tonarten. Denn wir setzen voraus, dass ein Flötenist allemahl seine Flöte nach dem Grundtone derjenigen Tonart einstimmen müsse, woraus er spielt.

Hier scheint es nun, als wenn man zu wünschen Ursach hätte, dass das Clavier mit noch mehrern Tasten in der Octav möchte versehen werden. Allein wenn man erweget, dass der natürliche Sprengel einer Tonart so weit nicht gehet, dass die Abweichung ein ganzes Comma betrüge; und dass bey Aufführung eines Stücks es auch viel auf die Moderation des Flötenisten ankomme: So wird man finden, dass es nicht rathsam sey, das Clavier mit noch mehrern Tasten zu versehen.

Wenn man auch bedenket, dass die Querflöte eben nicht 24 Tonarten nöthig habe, wie das Clavier, so kann man mit einer ungleichen Temperatur der Eubereinstimmung mit der Querflöte, in den meisten Tonarten, noch näher kommen, als mit der

If we compare this system with the well-tempered harpsichord, we will discover a considerable variation...

What is said here for the key of C major is valid also for all the other keys, as we are assuming that a flutist must always tune his instrument to the tonic of whichever key he will be playing.

Now, it appears (if one could have every wish) that the harpsichord actually needs to be provided with more keys in the octave. But when we consider that the natural space required by each tonality does not exceed the divergence of a whole comma; and that, in the performance of a piece, much depends on the discretion of the flutist, we can conclude that it is not advisable to provide the harpsichord with additional [split] keys.

When we also consider that the traverso does not actually need all 24 keys, as does the harpsichord, it would be easier to approach the tuning of a traverso in most keys with an irregular temperament rather than the well-tempered

rational gleichen Temperatur.

one.

Sorge gives an example for D major and compares it with Telemann's system; while it is close, it offers only D# and G# etc. and so fails to solve the question of enharmonic equivalents. Sorge offers several other irregular temperaments, each adapted to a particular key, which, as he points out, obliges the flutist to limit strictly his choice of keys in a concert. He concludes with his own personal opinion that equal temperament would eliminate the need for enharmonic distinctions.

1767. Telemann, G.P. Letzte Beschäftigung G. Ph. Telemanns im 86. Lebensjahre, bestehend aus einer musikalische Klang- und Intervallen Tafel in Unterhaltungen 3 (Hamburg).<sup>84</sup>

Man schmelzet beyde nahen Klänge [C#/D $\flat$ ] nach Veranlassung des Claviers in einen zusammen...

Because of the harpsichord, the two neighboring sounds [C#D $\flat$ ] are fused together into one...

Dass des und és zween unterschiedene Klänge ausmachen, solches findet sich auch bey den Violinen, wo des mit dem 4ten, und és mit dem kleinen Finger gegriffen wird; desgleichen haben die Traversieren hierzu zwe besondere Klappen...<sup>85</sup>

That D# and E $\flat$  are two separate sounds is demonstrated by the violin, where D# is played with the 4th finger and E $\flat$  with the 5th; traversos are the same with their two separate keys...

1773. Burney, Charles. The present state of music in Germany, the Netherlands, and the United Provinces..., vol. 1:313. London.

...in the...divisions of tones and semi-tones into infinitely minute parts, and yet always stopping on the exact fundamental, Signora Martinetz was more perfect than any singer I had ever heard: her cadences too, of this kind, were very learned, and truly pathetic and pleasing.

[? 1774]. Rousseau Jean-Jacques. "Extrait d'une réponse du petit faiseur," Oeuvres (1781).

While not advocating equal temperament, Rousseau was very early in discussing the concept of "tendency tones." In suggesting that B natural should be higher because it leads to C, he says,

Ceci, je le sais bien, est directement contraire aux calculs établis et à l'opinion commune, qui donne le nom de semi-ton mineur au passage d'une note à son dièse ou à son bémol, et de semi-ton majeur au passage d'une note au bémol supérieur ou au dièse inférieur.

I know well that this is in direct contradiction to established reckoning and the general opinion, which gives to the passage of a note to its sharp or flat the name "minor semitone," and to the passage of a note to its next-higher flat or next-lower sharp the name "major semitone."

1777. Castillon, F. de. "Flûte traversière à deux clés," Supplement to Diderot and d'Alembert's Encyclopédie.<sup>86</sup>

Castillon included an interesting comment that applies to the over-small interval between the low IV/IV# on all the woodwinds of the period (F/F# on traverso and oboe, Bb/B on recorder and bassoon):

...les flûtes de M. Quantz diffèrent encore des autres par le tempérament. Ordinairement le fa des flûtes traversières est tant soit peu trop haut & le fa dièse est juste; dans les nôtres, au contraire, le fa est juste, & le fa dièse un peu trop bas... Rarement, ou plutôt jamais, on ne compose une pièce en fa dièse, soit majeur, soit mineur; mais on en compose très-souvent en fa, majeur & mineur. Le fa dièse ne paroît donc guère comme fondamentale, & il vaut

...M. Quantz's flutes differ from all others in their tuning. Usually the F on the transverse flute is not flat enough and the F# is correct; in his, on the contrary, the F is true and the F# a little flat.... Rarely, if ever, is music written in the key of F#, either major or minor, but very often in F major and minor. The F# appears but seldom as a tonic, and it is much better to have the F in tune, since it is the keynote of a tonality

bien mieux l'altérer que le fa qui est la fondamentale d'un mode, non-seulement très-usité, mais encore un des plus beaux pour la flûte; d'ailleurs, on peut forcer le fa dièse par le moyen de l'embouchure, mais le fa devient d'abord faux.

not only much used, but one of the most beautiful on the flute. F#, when it appears, could easily be tempered by the embouchure; but as it stands, F natural remains a bad note.<sup>87</sup>

1785-87. Mozart, W.A.

John Hind Chesnut pp.263-71 has pointed out that from a close look at Thomas Attwood's notes on his studies with W.A. Mozart in 1785-87, it is clear that Mozart's normal concept of instrument tuning distinguishes the small and large half steps of a meantone temperament similar or identical to 1/6-comma. The usual discrepancy between keyboard and other instruments exists.

1783. Barca, Alessandro. "Introduzione a una nuova teoria di musica, memoria prima," Accademia di scienze, lettere ed arti in Padova. Saggi scientifici e letterari (Padova, 1786), pp.365-418. Cited in Barbour 1951:43.

<p>Barca wrote that to make the fifths 1/6-comma smaller than pure was the ...temperamento per comune opinione perfettissimo, quale suole applicarsi alle quinte diatoniche...<sup>88</sup></p>	<p>...temperament considered generally as perfect, although it is usually applied [only] to the diatonic 5ths...</p>
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1788. Cavallo, Tiberius. "Of the temperament of those musical instruments, in which the tones, keys, or frets, are fixed, as in the harpsichord, organ, guitar, &c.," Philosophical transactions of the Royal Society of London, lxxviii, 238.

When the harpsichord, organ &c is to serve for solo playing, and for a particular sort of music, it is proper to tune in the usual manner...but...when the instrument is to serve for accompanying other instruments or human voices, and especially when

modulations and transpositions are to be practiced, then it must be tuned according to the temperament of equal harmony.<sup>89</sup>

c1790. Robison, John. "Temperament," Encyclopaedia Britannica (third edition; Edinburgh; pub. 1801)

[Players of instruments with flexible tuning] ...when unembarrassed by the harpsichord... [should not temper their scales,] but keep it as perfect as possible throughout; and a violin performer is sensible of violence and constraint when he accompanies a keyed instrument into these unfrequented paths.

1813. Busby, Thomas.

As late as 1813, the fourth edition of Thomas Busby's Universal dictionary of music (London) discusses major and minor semitones, and states that temperament is applied

in order to remedy, in some degree, the false intervals of those instruments, the sounds of which are fixed; as the organ, harpsichord, pianoforte, &c.

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- <sup>1</sup>. Aside from his articles in the New Grove on temperament, Mark Lindley has written an excellent historical survey of temperament and tuning in (1987) "Stimmung und Temperatur," Geschichte der Musiktheorie, vi: Hören, Messen und Rechnen in der Frühen Neuzeit (Berlin: Staatliches Institut für Musikforschung).
- <sup>2</sup>. Patrizio Barbieri's excellent article "Violin intonation: a historical survey" (Early Music, February 1991, pp.69-88) is a welcome exception. The present article will, I hope, complement it.
- <sup>3</sup>. Fretted stringed instruments, whose intonation is a more specialized subject, are not treated in this study (see, however, a comment in the appendix by LeBlanc). Cf. M. Lindley, 1984, Lutes, viols & temperaments (Cambridge).
- <sup>4</sup>. Other useful sources are cited and discussed in Barbieri.
- <sup>5</sup>. See J.M. Barbour, 1951, Tuning and temperament, a historical survey (East Lansing, MI: Michigan State College Press), pp.1 and 89.
- <sup>6</sup>. In classic "1/4-comma" meantone, eleven fifths are tuned one quarter of a syntonic comma smaller than pure. This produces eight pure major thirds. The placement of the twelfth fifth, known as the "wolf," determines which tonalities are usable.
- <sup>7</sup>. R. Smith (1759), "Harmonics," 2d ed., pp.166-67, quoted in Ellis 55. Smith was a respected astronomer. See Lindley 1987:297.
- <sup>8</sup>. "...a son usage chés les Joüeurs d'Instrumens les moins habiles à cause de sa simplicité & de sa facilité." Méthode générale pour former... The famous conversion of Rameau to a kind of equal temperament, recorded in his Génération harmonique of 1737 was an interesting exception. See Lindley 1987:244-47.
- <sup>9</sup>. The translation used here is by the oboist J.E. Galliard, who published an English version of Tosi's book in 1743 entitled Observations on the florid song. Tosi's book was still current enough in 1757 that it was translated by J.F. Agricola in Anleitung zur Singkunst. The words in brackets are mine.
- <sup>10</sup>. See David D. Boyden. 1965. The history of violin playing. Oxford. pp.186, 370-371; Cavallo; Lindley 1987:296.
- <sup>11</sup>. Cf. T. Podnos, Intonation for strings, winds, and singers (Metuchen, NJ and London, 1981), p.9; David D. Boyden, "Prelleur, Geminiani, and just intonation", Journal of the American Musicological Society IV (1951), p.219; J.M. Barbour, "Violin intonation in the 18th century", Journal of the American Musicological Society V (1952), p.233; John Hind Chesnut, "Mozart's teaching of intonation" JAMS (1977: 30/2), pp.255 n.9, 256; and Barbieri pp.82-85.
- <sup>12</sup>. See also Werckmeister 1691:3. Barbieri pp.70 and 74 noted other indications of both pure-fifth tuning and tempered open strings.
- <sup>13</sup>. Cf. Leopold Mozart p.66 note.

<sup>14</sup>. A violinist plays on an open string about 5c higher when playing forte than when playing piano (this is the conclusion reached by the author and a baroque violinist, in experiments using an electronic tuner).

<sup>15</sup>. This inconsistency is the hobgoblin of a theoretician of "little mind" like Sorge (cf. 1744:53).

<sup>16</sup>. Boyden 1951:202.

<sup>17</sup>. See Boyden 1951 and Robert Bremner's Preface to J.G.C. Schetky's Six Quartettos, op.6, quoted in full by Neal Zaslaw in "The compleat orchestral musician," Early Music (1979), pp. 46-57. Bremner (a student of Geminiani) gives violin intonation exercises based on pure intervals. See also Lindley, Mark (1981) "Der Tartini-Schüler Michele Stratico," Kongressbericht Bayreuth, Gioseffo Zarlino, 1588 Sopplimenti musicali, Venice, ch. 33-37, and Lindley 1987:293. LeBlanc (p.133 ff.) may also be discussing just intonation, to judge from his comments on the difficulty of modulations: "harpsichords are tuned with both major and minor semitones, which are nevertheless not exempt from problems when there is a change of key. This practice has been renounced despite its occasional benefits."

<sup>18</sup>. This is a well-known problem in choral practice, where intonation tends to be quite pure, leading the final tonic to a point remote from where it began. Sauveur also discusses this problem in his 1707 Méthode, pp.206-07. A more complete discussion of the ramifications of playing in just intonation on a violin is presented in Christine Moran (1986) "Temperament and violin intonation in baroque music," unpublished paper prepared for the Faculty of Music at the University of Montreal.

<sup>19</sup>. See Barbieri pp.69-72. An experimental, computer-controlled electronic keyboard instrument called the "mutabor" has been developed at the Technische Hochschule in Darmstadt. It is designed to play in pure temperament, and can also be used to compare the way a composition sounds in different tunings. The mutabor has the usual 12-key octave, but has more than 5,000 pitches available in each octave. See Bernhard Ganter, "Mutabor -- Ein rechnergesteuertes Musikinstrument zur Untersuchung von Stimmungen," in Acustoca: International Journal on Acoustics (Stuttgart 1985).

<sup>20</sup>. Barbour 1952:234. Barbour's article was written in response to Boyden's, and gives several convincing arguments for this statement (pp. 232-34).

<sup>21</sup>. Many musical theorists also drew this line vaguely. See Lindley 1987:293. As Barbieri put it (p.72), "Mean-tone can be considered a tempered just intonation..."

<sup>22</sup>. See Boyden 1951:215.

<sup>23</sup>. This is very close to the "syntonic comma," which is 21.5062896 cents, and is incidentally the difference between the overlarge major third in Pythagorean tuning and a pure third. See Lindley, The New Grove 4:591 and Sorge 1758.

<sup>24</sup>. See Sauveur and Fontenelle. Lindley 1987:191 registers an inexact discussion of the 55-part octave by Fernandez as early as 1626. See also p.211 on N. Mercator (1672).

<sup>25</sup>. 1/6-comma meantone is produced by tuning 11 of the 12 fifths on a keyboard smaller than pure by 1/6 of a comma (whence the name). In this temperament, a major semitone = 109.09 cents and a minor = 87.273 (see Lindley, The New Grove 9:278). The difference between them is therefore 21.817 cents, or about as close to a syntonic comma as it is possible to achieve in a keyboard tuning system. We can deduce, then, that if a consistent system is implied in the use of major and minor semitones, 1/6-comma meantone is the temperament that it most resembles.

<sup>26</sup>. Some writers, beginning in the early 17th century, conceived it in terms of the 55-part octave.

<sup>27</sup>. See W.A. Mozart 1785-87. In "Popoli di Tessaglia," KV 316, m 42, the voice has a bb and an a# in the same bar; both the oboe and violin have a#, though the piece is in c minor. The distinction between the two notes was obviously significant to Mozart.

<sup>28</sup>. See Busby. Sources that describe 1/6-comma meantone that are not included in the appendix include: Mattheson, Johann. 1739. Der vollkommene Capellmeister (Hamburg), p.55. Scheibe, Johann Adolf. 1739. Eine Abhandlung von den musicalischen Intervallen und Geschlechtern (Hamburg). Türk, D.G. 1791. Kurze Anweisung zum General-bassspielen.

<sup>29</sup>. This is reminiscent of Freillon-Poncein's statement on woodwind tuning quoted in Part 2.

<sup>30</sup>. See E. Eijken, "Een onderzoek naar getempereerd spel op houtblasinstrumenten in de 17e en 18e eeuw, in het bijzonder op de blokfluit," ["An investigation of tempered intonation on woodwinds of the 17th and 18th centuries, particularly on the recorder"] (Unpublished term paper for the course Historische Methodiek Blokfluit, The Hague, Royal Conservatory, 1982), p.19.

<sup>31</sup>. Amsterdam: Principes de la flûte. Schickhardt also published "L'Alphabet de la musique," a collection of sonatas for violin, traverso or recorder in 24 keys (1735).

<sup>32</sup>. London: "A new system of the flute à bec or common English flute."

<sup>33</sup>. Barbieri p.82 notes, however, that Charles Delusse in c1761 (L'Art de la Flute traversiere) was apparently giving fingerings that produced sharps higher than flats (he cites Pierre Sechet). At the time, this was exceptional.

<sup>34</sup>. Bismantova, Bartolomeo. 1688. "Regole...del Oboè" (Ms version of Compendio musicale). Ferrara. See Edward Tarr, (1987) Tibia 2/87.

<sup>35</sup>. See B. Haynes, (May 1978), "Oboe fingering charts, 1695-1816," GSJ, 68-93.

<sup>36</sup>. Both Quantz and Sorge indicated that woodwind players tuned their scales from the tonic note of the key in which they were playing rather than from an absolute pitch as given by a keyboard instrument. See Sorge 1758:9 par. 14; Quantz Chapter 16/4. Fred Morgan recently made a beautiful recorder for me with a doubled third hole, making it possible to distinguish db<sub>3</sub> more accurately from c#.

<sup>37</sup>. See Paul J. White (1990), "Early bassoon fingering charts," GSJ, p.98.

<sup>38</sup>. See White p.96 on Ozi 1787.

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<sup>39</sup>. Barbour 1951:xi. Many keyboard temperaments use more complex systems. In a regular meantone, any six keys related to each other by fifths (B $\flat$  F C G D A, for instance), will contain appropriately tuned accidentals and identical scale intervals. In order to use other keys, accidentals have to be retuned. Chesnut believed Quantz was describing an irregular system for his harpsichord (p.260, citing Chapter 17/vi/20), but in fact the discrepancy to which Quantz referred was between the harpsichord and other bass instruments. Thus it is quite possible that the "bonne Temperature" that Quantz suggested for the harpsichord (Chapter 17/vii/9) was a regular one.

<sup>40</sup>. See Haynes (1986) pp.40-67.

<sup>41</sup>. Instruments built in consorts are normally tuned at the more compatible intervals of a fourth or fifth. Since in meantone conjunct fifths are tuned similarly, a consort of instruments tuned in fifths (F C F C, G D G D or even G D A) would be well in tune even when instruments were separately tuned starting on different notes. **[Check Praetorius *De Organographia* page 37 on this subject, as well as FN 39 here.]** The "d'amore" instruments, on the other hand (such as the voice-flute, oboe d'amore, flute d'amore and [usually] viola d'amore), are pitched a minor third below their more standard counterparts. Looked at without consideration for how these instruments were used, certain notes that are low (from the individual player's point of view) might need to be high in the context of the of the rest of the group. Fingered F $\sharp$  (IV $\sharp$ ) on a flute or oboe d'amore, for instance (normally a low note), could as easily be a sounding E $\flat$  as a D $\sharp$ ; fingered A $\sharp$  (V $\sharp$ ) on a voice-flute (also very low, especially in the second octave, and a C $\sharp$  on the normal F-treble) could be sounding B $\flat$ . Should these instruments be tuned differently from standard ones? There are numerous examples indicating that "d'amore" instruments were used principally for their ability to play in sharp keys. The basic key (ie., six-fingered note) of an oboe d'amore or flute d'amore is sounding B major; that of a voice-flute is E. (See B. Haynes, "Questions of tonality in Bach's cantatas: the woodwind perspective", Journal of the American Musical Instrument Society [1986], p.54.) If such instruments were normally associated with sharp keys, it is unlikely that they would often have played a sounding E $\flat$ ; the note would have normally been a D $\sharp$  and thus the fingered F $\sharp$  (like the D $\sharp$ , inflected low) would have worked perfectly well.

<sup>42</sup>. Using 1/6-comma meantone in a range of six normal keys for the Cammerton instruments (E $\flat$  B $\flat$  F C G D for instance), an organ at Chorton a major second higher would have been tuned with all the accidentals as flats to produce identical parallel intervals for the keys D $\flat$  A $\flat$  E $\flat$  B $\flat$  F C. If Chorton was a minor third higher than Cammerton, the same parallel intervals would have been obtained by tuning the organ to the keys C G D A E B, produced by tuning all the accidentals as sharps.

<sup>43</sup>. There would have been a slight difference in pitch. For the interval of a major second, the difference would have been 4 cents (at A-410, 4 cents is about 1 Hz.,

which is negligible). The interval of a minor third produces a pitch difference of about 5.5 cents, or about 1 1/2 Hz.

<sup>44</sup>. Although Neidhart 1732 and Sorge 1744:24 seem to be speculating on the use of irregular temperaments in these situations, Sorge in 1748 strongly advocates what he calls a "gleichschwebende Temperatur," in which eleven, not twelve, fifths are equal (pp.14, 34). A modern instance of "transposition" is the use of portativ organs designed to play alternately at A-440 and A-415 with movable keyboards. A semitone difference is much less practical in a regular meantone, such as 1/6-comma, since an organ tuned to play the keys  $E\flat$   $B\flat$  F C G D at 440 would only be capable of playing the keys E B F# C# G# D# in tune at 415. If the keys  $E\flat$   $B\flat$  F C G D were available at A-415, switching to 440 would produce D A E B F# D#.

<sup>45</sup>. The third and the seventh, for instance, are always seven and nine cents below their placement in equal temperament.

<sup>46</sup>. Scales in the 18th century were traditionally tuned from C, not A (see Adlung 1758:310, Asselin, p.34, Chesnut, p.268, and Boyden, p.204). For string players, however, it is easier to tune to an open string. The table therefore gives A as 0.

<sup>47</sup>. Note that synonymous sharps/flats are always approximately a syntonic comma apart (ie., between 21 and 22c -- the actual figure contains decimal points that have been rounded off on one side or the other).

<sup>48</sup>. On this subject, see Heinichen (1728) and Rameau (1737).

<sup>49</sup>. "We should be less surprised by [such a situation] when we remember that from the nineteenth century to the present day, keyboard and non-keyboard instruments have characteristically been tuned according to different systems of intonation, the keyboard instruments being in equal temperament and the non-keyboard instruments usually in some form of quasi-Pythagorean tuning." (Chesnut, p.257).

<sup>50</sup>. Organs are more audible because their notes do not decay quickly.

<sup>51</sup>. On this question see Quantz 17/vi/20.

<sup>52</sup>. See Ellis [1750]. The keys that were split were D# and G#. Since it is in the regular temperaments that a choice is necessary between enharmonic equivalents, the use of split keys implies the use of a regular temperament.

<sup>53</sup>. The practical limits would be E to  $E\flat$  in major keys and e to f in minor.

<sup>54</sup>. Some history of the use of split keys can be found in Lindley 1987:186, Frank Hubbard, Three centuries of harpsichord making (Cambridge, MA, 1965), pp.35-6,168, and Klop, p.12. As might be expected, the two notes that seem to have been commonly split were D# and G#.

<sup>55</sup>. But cf. LeBlanc 55, who said "[On a harpsichord,] one cannot correct [tuning] during a concert..." and (p.133) "harpsichord or organ, which are tuned for a concert once and for all (and sometimes for a half year)."

<sup>56</sup>. In this situation, 10 of the 12 notes would normally be identical, and only D#/ $E\flat$  and G#/A $\flat$  would be different. Sympathetic vibrations on the instrument would not, therefore, be significantly affected.

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- <sup>57</sup>. Rousseau suggested the same idea by dividing the wolf over the last three fifths (thereby striking a mean between  $D\#/E\flat$  and  $G\#/A\flat$ ) in the Encyclopédie, ou Dictionnaire raisonné des sciences, arts et métiers (ed. Diderot, Denis and J. Le Rond d'Alembert [1756]). Barca's temperament also allows for irregular placement of chromatic notes and might therefore be similar to this one.
- <sup>58</sup>. The oboist Michel Piguet of Basel, who has used a system similar to 1/6-comma meantone (with Rousseau's modification) for many years, has written a useful commentary on teaching historical intonation in "Beispiele zur Intonationslehre im Unterricht," Alte Musik, Praxis und Reflexion (Sonderband der Reihe "Basler Jahrbuch für Historische Musikpraxis," [1983]), pp. 346-52.
- <sup>59</sup>. The tuner is available from Widener Engineering, 203 Westbrook Drive, Austin TX 78746, USA. (Model 110 -- cheaper than a Korg, I believe -- is recommended.)
- <sup>60</sup>. On a woodwind instrument, only two enharmonic pairs need to be ambiguously tuned so the player has a choice:  $D\#/E\flat$  and  $G\#/A\flat$ . All four of these notes are regularly demanded when playing in standard baroque keys. ( $D\flat$ 's are rarer, so tuning decisively to  $C\sharp$  is usually desirable.) On a flute,  $G\#/A\flat$  can be adjusted with embouchure or alternate fingerings, but the fingering 123 456 7 ( $D\#/E\flat$ ) gives a very decisive pitch because most of the tone holes are closed, there is relatively little leeway for adjusting breath pressure, and there is no alternate fingering. Hence the necessity of the added key.
- <sup>61</sup>. G.C. Klop observed (in a lecture on harpsichord temperaments at Bruges in 1975) that tuning was usually discussed in 18th-century treatises under the heading of composition, since it was regarded as an expressive device.
- <sup>62</sup>
- <sup>63</sup>. Quoted in Lindley 1987:263.
- <sup>64</sup>. Page 111. Quoted in Lindley 1987:244.
- <sup>65</sup>. It is interesting to compare this with Rameau's diametrically opposed later statement on the same subject (see 1737:104).
- <sup>66</sup>. Lindley 1987:245-46 thinks Rameau is probably discussing 1/6-comma meantone here.
- <sup>67</sup>. Quoted in Lindley 1987:245.
- <sup>68</sup>. Quoted in Lindley 1987:246.
- <sup>69</sup>. Michel Blavet, 1700-68. Blavet performed at the Concert Spirituel more frequently than any other performer, and was unanimously praised for his tone, intonation and technique. See Neal Zaslaw, "Blavet, Michel" in the New Grove 2:787.
- <sup>70</sup>. Telemann's system is discussed in Sorge 1748 and 1758. In 1758:2-5, Sorge equates Quantz's temperament with that described by Scheibe and Telemann, and discusses the "Comma telemann," which Telemann himself says is half that of "meantone." (As noted above, in 1/4-comma meantone --

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- "meantone" in its strictest sense -- the difference between flats and sharps is indeed about twice that in the 55-part octave.)
- <sup>71</sup>. Translation by Carlo Novi.
  - <sup>72</sup>. J.S. Bach's surviving cantatas do not bear out this observation. Cf. Neumann.
  - <sup>73</sup>. The temperament is shown in Lindley 1987:273 (20b).
  - <sup>74</sup>. Translated in Barbour 1951:196.
  - <sup>75</sup>. Cf. Telemann's own statement: "my system is not based on any keyboard temperament..."
  - <sup>76</sup>. The French version of the Essai is not, properly speaking, a translation. It appeared simultaneously with the German version and was prepared for the benefit of Quantz's patron, Frederick of Prussia, who had difficulty reading and speaking German. (see Mitford, N. 1970/R 1984. Frederick the Great [London], pp.20, 205). G.A. Sorge, in "Anmerkungen über Herr Quanzens...#D und bE-Klappe auf der Querflöte," equates Quantz's temperament with that advocated by Scheibe and Telemann.
  - <sup>77</sup>. Quantz's invention was welcomed by Castillon and other writers on the flute of this period (see E.R. Reilly, "Quantz and his Versuch; three studies" [New York, 1971], pp.55 and 91, citing J.S. Petri, Anleitung zur practischen Musik [Lauban: 1767/1782] and J.G. Tromlitz, Ausführlicher und gründlicher Unterricht die Flöte zu spielen [Leipzig: 1791]).
  - <sup>78</sup>. See Castillon 1777.
  - <sup>79</sup>. This is presumably on account of the stringed instruments with which the flute is playing, whose basic pitch is entirely unfixed. As Sorge says in 1758:9, it is assumed that the flutist tunes his instrument to the tonic of the piece he is playing.
  - <sup>80</sup>. This sentence appears in the German version only.
  - <sup>81</sup>. Cf. Lindley 1981 on M. Stratico, a student of Tartini.
  - <sup>82</sup>. "It can be shown that for whichever of the standard commas we choose, the perfect fifths in Leopold Mozart's system were theoretically flatted by about one-sixth of that comma." (Chesnut, p.260.)
  - <sup>83</sup>. See Chesnut, p.260.
  - <sup>84</sup>. Reprinted in Rackwitz, W. (ed.) Georg Philipp Telemann: Singen ist das fundament zur Musik in allen Dingen (Leipzig: 1985), pp.266-73. This is a continuation of Telemann's System of 1742/43.
  - <sup>85</sup>. Cf. Quantz.
  - <sup>86</sup>. E. Halfpenny, "A French commentary on Quantz", Music and Letters xxxvii (1956), pp.61-66 contains a complete English translation.
  - <sup>87</sup>. Translation from Halfpenny, pp.65-66.
  - <sup>88</sup>. Chromatic notes may therefore be irregularly placed in Barca's system.
  - <sup>89</sup>. It is not clear whether "equal harmony" = "equal temperament" or "a regular temperament."