Zeitschrift: Publikationen der Schweizerischen Musikforschenden Gesellschaft. Serie 2 = Publications de la Société Suisse de Musicologie. Série 2

Herausgeber: Schweizerische Musikforschende Gesellschaft

Band: 46 (2006)

Artikel: Temperament and intonation in ensemble music of the late eighteenth century : performance problems then and now

Autor: Poletti, Paul

DOI: https://doi.org/10.5169/seals-858752

Temperament and intonation in ensemble music of the late eighteenth century: performance problems then and now*

Paul Poletti

How should we temper the tuning of keyboard instruments for the performance of solo and ensemble music of the second half of the eighteenth century? Musical forms and instruments were developing rapidly, placing new demands on instrument makers and performers alike. How was the practice of tuning of keyboard instruments adapted to these conditions? As a professional tuner and instrument maker, I am often confronted with practical questions about which temperament to use, either by musicians seeking advice or when requested to tune for concerts or recordings. I can best summarize my experience by quoting the first few lines of Thomas McGeary's article on classical temperaments, published in 1989:

> Many modern performers on the fortepiano [...] cognizant of the great role tuning plays in the timbre and harmonic quality of music played upon the harpsichord [...] have begun using unequal temperaments [...]. Their choice of temperaments, however, seems to be rather subjective and arbitrary, and performers in general seem unaware of the historical evidence regarding temperaments and tuning.[1]

While I agree with McGeary here, I do not share all his conclusions. His examination of tuning recipes published in the eighteenth century led him to conclude that equal temperament was the dominant system used for German and Viennese music from about 1770 onwards, a conclusion which he implies may be unpopular today among those intent on 'historically informed performance' because equal temperament is thought to be another of those 'inauthentic'

* The author would specifically like to acknowledge his debt to the following individuals: first and foremost, to Mark Lindley, whose numerous writings on temperament have been both inspirational and invaluable sources of information; to Bruce Haynes for his monumental work on pitch levels; to Alfredo Bernardini and Eric Hoeprich for their insights into historical woodwind instruments; to Ibo Ortges for providing a wealth of information on organ temperaments; to Johan Norrback for providing data on Neidhardt's temperaments, and to Brad Lehman, Owen Daly, James Bunch, Thomas Dent, and a host of others who find no end of pleasure in debating the fine points of temperament on the Harpsi-L internet discussion group.

1 Thomas McGeary, 'German-Austrian Keyboard Temperaments and Tuning Methods, 1770–1840: evidence from contemporary sources', *Journal of the American Musical Instruments Society* XV, 1989, 90–118.

aspects – like continuous vibrato and legato phrasing – of modern conventional performance practice. While there can be no doubt that a gradual move toward equal temperament was well underway during these times, there are additional considerations which have to be taken into account. For example, some temperaments, handed down by oral tradition, may have persisted among professional musicians. These temperaments would not necessarily be the same as those found in the published *Klavierschule* which McGeary used as his primary sources. In addition to his discussion of the tempering of stringed keyboard instruments, easily tuned to a different temperament by the performer himself, we should also consider the tuning of organs, which are fixed in their temperaments during construction and require drastic and time-consuming action on the part of an organ builder if a change in temperament is required. We should also consider the relationship between the temperaments used for keyboards and the prevailing intonation practices for other strings and winds when they were used together in ensembles.

Temperament, by definition, always involves compromises. Those compromises which are acceptable in any time and place are determined by a wide variety of musical and practical considerations. A thorough exposition of all the relevant considerations would easily fill a large book. In the brief space I have here my intent is to provide neither an exhaustive study nor definitive answers but rather to discuss some aspects of temperament of which many modern musicians are apparently unaware, to challenge some commonly held notions and to draw attention to important research which has been unduly neglected.[2] My aim is to reinvigorate the discussion of the topic of eighteenth-century temperaments among players, musicologists, instrument makers and tuning technicians.

Temperaments

Among those who strive to recreate historical performance practices there has long been a small core of individuals with a mastery of the subject of temperament. Nevertheless, the general level of sophistication in this respect is far from adequate. Many players receive little or no training on the topic during their education, even those who major in organ, harpsichord and fortepiano. Most know only a handful of temperaments, usually those which are programmed in

2 Throughout this article I use the term 'modern musicians' to mean those who are involved in the so-called 'historical performance practice' movement, not modern classically-trained musicians in general.

the cheapest of electronic tuning devices. I would therefore like to begin with a review of some temperaments.[3]

Meantone temperaments

In general, meantone temperaments are intended to produce acceptable thirds, that is, thirds which are either pure or close to pure. The term 'meantone' however is often mistakenly thought to apply only to that temperament which uses fifths tempered by a quarter of the Syntonic comma in order produce pure major thirds. In fact the 1/4-comma version of meantone temperament is but one of many versions. As remarked by Mark Lindely:

> Many authors [from Zarlino's time] until today quite naively consider it [1/4-comma meantone] to be the only "genuine" meantone tuning.[4]

The earliest precise mathematical description of a meantone temperament was Gioseffo Zarlino's 1558 formula for a 2/7-comma version, giving no pure thirds but major thirds which are slightly too small and minor thirds which are slightly too large, thus striking a compromise to the benefit of both.[5] It was not until 1571 that Zarlino described the 1/4-comma system; this he did alongside his

3 This presentation is intended for those with at least a basic level of knowledge regarding the fundamental aspects of temperament, including an understanding of the terms Syntonic and Pythagorean commas, the diesis, the Schisma, etc. For those who require information on these subjects, there are numerous sources available, both in print and on-line. In particular I can recommend Thomas Donahue, *A Guide to Musical Temperament*, Lanham 2005 and Mark Lindley, 'Temperaments', in: Stanley Sadie (ed.), *The new Grove dictionary of music and musicians*, 2nd ed., 29 vols., London 2001, vol. 25, 248–64. [Editor's note: temperament involves making at least some intervals a fraction impure in order to accommodate discrepancies which emerge when tuning using only pure intervals. If, for instance, a keyboard instrument were tuned using a succession of twelve pure fifths starting on a C, the last note tuned, B♯, would be considerably higher than the appropriate C seven octaves higher than the starting point. The difference between the B♯ and the C is known as the Pythagorean comma. Similarly, a succession of four pure fifths starting on C will give a wide major third (C-E) two octaves higher. The difference between such a wide third and a pure one is known as the Syntonic comma. Many temperaments are aimed at creating acceptable thirds using the notion of the Syntonic comma. The small difference between the Pythagorean comma and the Syntonic comma is known as the Schisma.]

4 'Bis heute halten viele Autoren es ganz naiv für die einzig "wirklich" mitteltönige Stimmung.' Mark Lindley, 'Stimmung und Temperatur', *Geschichte der Musiktheorie*, Darmstadt 1987, 6, *Hören, Messen und Rechnen in der frühen Neuzeit*, 162.

5 Gioseffo Zarlino, *Istitutioni harmoniche*, Venice 1558, 128. One cannot have both pure major and minor thirds, even though the amount of correction required to produce both is the same – the Syntonic comma. For major thirds, the comma must be compensated over four fifths, while minor thirds require the same compensation over only three fifths. Correcting for the one thus always excludes correcting for the other.

description of a 2/7-comma system and a 1/3-comma system which produces pure minor thirds.[6] He drew no distinctions between these temperaments as types, only offering his opinion on their various qualities, mentioning that the 1/4-comma version was 'very pleasing to the ear; not very difficult to set' and that he found the 1/3-comma version 'not as sonorous as the other two.'[7]

Divisions of the Syntonic comma (most notably 2/9 comma, 1/5 comma, and 1/6 comma) which result in major thirds larger than pure have been described for centuries. From our modern point of view, we might think that the tempered fifths in these systems, less narrow than those in 1/4-comma meantone, must be intended to reduce the size of the gap in the circle of fifths known as the 'Wolf' fifth. In this respect however, none of these systems really offers much improvement. At the same time, the loss in the quality of the thirds becomes significant in any version with fifths tempered by comma fractions smaller than 1/5. The main historical importance of these versions may well be that they provided starting points for modifications of the underlying logic of meantone.[8]

The characteristics which define the family of meantone temperaments as they are generally recognized in temperament literature today can be summed up as follows:

1) All tempered fifths are of the same size, that is, narrower than pure by the same degree. For this reason, these temperaments are said to be 'regular'.

2) The degree to which the fifths are tempered is specifically chosen to benefit the quality of the thirds. It is therefore always assumed to be some fraction of the Syntonic comma.[9]

3) The purpose is to provide for either pure or near pure thirds (either major or minor). To attain this, the fifths must be sufficiently narrow. Regardless of the precise amount by which the fifths are tempered, the inevitable cumulative result is one of overcompensation: by narrowing the fifths more than is necessary to close their circle, the final terminating 'fifth' is exceedingly wide. But this last 'fifth' is neither described by the logic of the system, nor

6 *Dimostrationi harmoniche*, Venice, 1571/R, 2/1573, rev. 1588.

7 Zarlino, *Dimostrationi*, *op. cit.*, 212. 'Molto all'udito gradito: ne è molto difficile da fare'; 'non è cosi sonoro come li due primi.' Quoted in Lindley, 'Stimmung und Temperatur', *op. cit.*, 157.

8 Mark Lindley cites a number of French references from the seventeenth and early eighteenth century which would indicate a fairly wide-spread use of 1/5-comma meantone and also mentions that Georg Andreas Sorge reported that he had found 1/6-comma meantone temperament used for two organs by Gottfried Silbermann. See: Lindley, 'Temperaments', *op. cit.*, 248–64.

9 '1/5-comma meantone' will thus suffice to identify this temperament – the inclusion of the qualifying 'Syntonic' to define which comma is involved is unnecessary.

is its size manipulated during the tuning of an instrument; it is merely the result of other considerations and procedures. This undefined hiatus in the circle is the reason that all meantone temperaments are said to be 'open' or 'non-circulating'. Any interval which spans this gap – not just the Wolf fifth – will be much too wide and sound exceedingly out of tune.

4) No note, neither a natural nor an accidental, can be used in an enharmonic function; each can only fulfil those functions dictated by its spelling. Thus, E-G♯ is a good-sounding major third, while G♯-C is a bad-sounding diminished fourth; A♭ simply does not exist unless we choose to tune the note between G and A as an A♭, but then we loose G♯. Likewise, F-G♯ is an augmented second and cannot be used as a minor third.

5) Finally, it is important to emphasis that a regular meantone temperament of any degree does not produce any sonic differences between the usable keys. All of the correctly spelled consonances and dissonances of a kind sound identical, as do all of the incorrectly spelled consonances which thereby become dissonances.

Modified meantone temperaments

This family of temperaments is perhaps the most important historically, being second only to equal temperament in terms of historical usage.[10] Today's historical performance movement has largely neglected modified meantone temperaments, despite repeated descriptions of them in modern literature.

The first significant historical description of a meantone modification was that of Arnolt Schlick in 1511.[11] He suggested tempering the fifths to produce thirds slightly wider than pure, though the thirds formed by chromatic inflection (for instance E-G♯ or B♭-D) should be slightly wider than those formed by pairs of natural notes (for instance C-E or F-A). His system therefore requires two different sizes of tempered fifths, making it an 'irregular temperament'. Beyond this use of fifths wider than those of 1/4-comma meantone, he added another deviation: the placement of the G♯/A♭. Usually, this note is reckoned as a fifth above C♯, the last of the tempered fifths among the sharps and as part of a third, it functions only as a G♯ above E. This gives one of the major disadvan-

10 In equal temperament, practically always used for the modern piano, all twelve fifths are equally tempered by 1/12 of a Pythagorean comma to close the circle of fifths. It should be noted that a well-tempered keyboard instrument does not have to be one which is tuned in equal temperament, it only has to function adequately in all tonalities.

11 Arnolt Schlick, *Spiegel der Orgelmacher und Organisten*, Speyer 1511 (reprint: Mainz 1932; English translation in *Bibliotheca organologica* CXIII, Buren 1980).

tages of regular meantone: c minor has no usable subdominant triad, because there is no A♭. Schlick recommended taking this note as a slightly larger than pure fifth below E♭, allowing it to have the dual function of making a fairly good minor third with F while at the same time forming a Pythagorean major third above E – not ideal, but certainly usable. It should be noted that the purpose of the scheme is to resolve the G♯/A♭ problem; fifths wider than those used in 1/4-comma meantone are used to lay the foundations of the temperament not to 'close the circle', as we might assume today, but rather to create passable thirds.

More than a hundred years later, Michael Praetorius, usually noted for his unequivocal description of regular 1/4-comma meantone, also mentions such a modification:

> ... the old [musicians] called the third f g♯ the wolf, because these two keys [...] give a completely false minor third [...] and so in order nevertheless to help them somewhat, they deducted a very small amount from [the purity of] all the other keys and made the major third e g♯ not so absolutely pure, but rather drew [the two notes] somewhat further from each other so that the g♯ comes a little higher, closer to the a but further from the f, and thus although not entirely a minor third, one which can be used in need.[12]

Praetorius provided his own suggestion for improving the modification of meantone. His alternative was to temper the fifths C♯-G♯ and F♯-C♯ differently from the others:

> The fifths c♯ g♯ and f♯ c♯ must not be so very false and not so very pure, but only a little so that they do not beat as much as the other fifths so that when something is played in foreign keys or with semitones it is not so dissonant, Although some believe that the fifths c♯ g♯ and f♯ c♯ must be absolutely pure, which in my opinion is not possible.

By making these two fifths less narrow, his system lessened the traditional gap in the circle, improving the quality of any third, major or minor, which spanned the gap.

The same basic approach is found over and over again in tuning instructions throughout the seventeenth and eighteenth centuries and comprises two primary deviations from regular meantone procedures:

1) One begins by using fifths slightly larger than those used for 1/4-comma

12 'Darumb dann auch die Alten das f g♯ den Wulff genennet haben / Diesweil diese beyde *Claves* [...] eine gar falche *Tertiam minorem* geben: Und damit ihnen gleichwol in etwas geholffen würde / haben sie allen andern *Clavibus* ein gar geringes abgebrochen / und die *Tertiam Majorem* e g♯ nicht zu gar reine / sondern etwas weiter von einander gezogen / damit das g♯ ein wenig in die höhe dem a näher / dem f aber weiter kommen / und also fast / wiewol nicht gar *pro Tertia Minore* zur Noth könne gebraucht werden.' Michael Praetorius, *Syntagma Musicum*, 3 vols.: II: *Syntagmatis musici tomus secundus: De Organographia*, 2nd ed., Wolfenbüttel 1619 (facsimile: Kassel 1958), 155.

meantone in order to reduce the width of the wolf fifth gap. This reduces the distance between all those notes which can be combined to produce a major or minor third which spans that gap.[13]

2) At a certain point, usually after only eight to ten tempered fifths, the use of narrow fifths is abandoned and the remaining notes are positioned so as to smooth over the transition across the gap. Sometimes these notes are positioned by adjusting the quality of thirds, sometimes by adjusting the qualities of the fifths. Regardless of how the notes are positioned, however, these 'gap filling' fifths will inevitably be either very close to pure (slightly narrow), pure or wider than pure.[14]

It is important to note that although it was not the intention in practice, such systems do in fact go some way towards closing the circle of fifths. For this reason, I call them 'semi-circulating'. Some modified meantone systems do in practice make all tonalities tolerable (for which reason they could be deemed better than those which do not), as do the truly circulating temperaments of the eighteenth century.

Many of the better-known modified meantone recipes which have survived are of French origin and are often described as the 'normal' or 'ordinary' manner of tuning a harpsichord.[15] Those few modern musicians who are aware of modified meantone temperaments therefore usually think of them as being French, despite their German origins. Another fact which is often overlooked in this context is that a meantone modification was published by Andreas Werckmeister, normally considered to be the originator of circulating temperaments.[16]

In contrast to the uniform fifths of any regular meantone temperament, the

13 The meantone modifications suggested by Rameau and D'Alembert are both exceptions to this general rule: Rameau uses 1/4-comma fifths from B♭ to B while D'Alembert restricts their use to the first four only (C to E). See: Jean-Philippe Rameau, *Nouveau système de musique théorique*, Paris 1726, 107–8; Jean le Rond d'Alembert, *Eléments de musique, théorique et pratique, suivant les principles de M. Rameau*, Lyon 1762, 55. Both temperament recipes are quoted in Lindley, 'Stimmung und Temperatur', *op. cit.*, 233 and 251 respectively.

14 The ear can usually detect no difference between two tempered versions of a consonance, one which is slightly too wide and one which is slightly too narrow, provided the amount of tempering is identical in both case and the interval is heard in isolation. Equally wide and narrow versions of a tempered consonance will however produce subtly different sonorities when combined in triads.

15 See: Lindley, 'Temperament', *op. cit.*, 255–8.

16 See: Andreas Werckmeister, 'Kurzer Unterricht und Zugabe, wie man ein Clavier Stimmen und wohl temperieren könne', *Die nothwendigsten Anmerckungen und Regeln, wie der Bassus continuus oder General-Bassus continuus oder General-Bass wol könne tractiret werden*, Aschersleben 1698. Werckmeister's modified meantone temperament was the first alternative to equal temperament. It was made widely available to the revivalist movement through its description in: Frank Thomas Arnold, *The art of accompaniment from a thorough-bass as practised in the 17th and 18th centuries*, London 1931. Despite this early availability in modern times, this temperament has subsequently been almost completely ignored.

use of fifths of various sizes in these modified systems created a new aspect previously unknown in western music: a graduation in the quality of harmonies from more pure to less pure as one moved around the circle of fifths in either direction away from the 'home' keys – those with no or few sharps or flats – towards the 'distant' keys – those with more.

Circulating temperaments

Circulating temperaments are well known to many modern musicians, although the most familiar systems were, historically speaking, quite likely the least important.[17] These include 'Werckmeister III', 'Kirnberger III', 'Vallotti/Young', and the modern hypothetical reconstructions 'Barnes Bach' and 'Kellner Bach'.[18] The logic which today is assumed to underlie these systems is that they are intended to close the circle of fifths by narrowing a number of them in order to compensate exactly for the Pythagorean comma. According to this logic it would thus be counterproductive to have any fifths wider than pure. Such fifths are therefore forbidden. One modern author even pejoratively describes the use of wide fifths as 'harmonic waste'.[19]

It is often mistakenly assumed that circulating temperaments were developed directly from regular meantone systems. It was supposedly discovered at a certain point that the Syntonic and Pythagorean commas were almost the same size and that the circle of fifths could therefore be as good as closed if the total number of 'meantone' fifths were restricted to the denominator of the fraction by which the Syntonic comma was divided. In other words, instead of using a fraction of the Syntonic comma to temper most of the fifths in order to obtain a series of satisfactory thirds, the same fraction was used to temper a small number of fifths – only four if the Syntonic comma were divided into four parts (the fraction used for all the tempered fifths in regular 1/4-comma meantone), five if it were divided into five – to almost close the circle of fifths. In order to complete the process and close the circle entirely, the remaining tiny difference

17 Circulating temperaments are often referred to as 'well temperaments', but this term should be avoided as it is grammatically incorrect; 'well' is an adverb, not an adjective. The origin of this modern term is unclear but probably derives from the title given to Bach's 48 preludes and fugues, for which the *Klavier* must be 'well-tempered', i.e. one must set a 'good temperament'.

18 I use the names of these temperaments here as the are commonly referred to among practicing modern musicians, that is, with no specific reference to sources, dates of publication, etc.

19 Owen Jorgensen, *Tuning: containing the perfection of eighteenth-century temperament, the lost art of nineteenth-century temperament, and the science of equal temperament complete with instructions for aural and electronic tuning*, East Lansing, MI, 1991.

(known as the Schisma) between the Syntonic comma and the slightly larger Pythagorean comma was distributed among the accidentals where no one would notice the difference. The case of 'Kirnberger III' is thought to be an example, for it can be viewed as an aborted setting of 1/4-comma meantone; one simply stops tempering after the first four fifths (which produce the pure third C–E) and the remaining true fifths are all tuned pure, eliminating any overcompensation. The Schisma is absorbed by the 'fifth' $F^{\sharp}$–$D^{\flat}$. 'Werckmeister III' is another circulating temperament which is supposed to have been derived from meantone. This time the Pythagorean comma is distributed among the four fifths C–G, G–D, D–A, B–$F^{\sharp}$ (the latter instead of the more usual A–E) and A–E and E–B are tuned pure. This last detail reduces the unbroken chain of pure fifths from eight to six, thereby reducing the number of harsh Pythagorean thirds. Other circulating temperaments with smaller divisions of the Pythagorean comma are assumed to have derived from similar regular meantone temperaments; 'Vallotti/Young' and 'Barnes Bach', both 1/6-Pythagorean comma temperaments, are assumed to be related to 1/6-comma meantone. The simplicity and straightforwardness of this explanation is indeed compelling, hence its popularity. The real story is however quite different.

Werckmeister may well have been the first to publish schemes for truly circulating systems in which all of the fifths of the circle are defined such that they cumulatively compensate exactly for the Pythagorean comma.[20] However, the only one of these to have been adopted for use by musicians today, Werckmeister III, was initially proposed for the purpose of re-tuning an organ tuned in 1/4-comma meantone to a temperament passable in all tonalities but with a minimum of adjustment to the pipes.[21] To achieve this goal, Werckmeister left a number of fifths tempered as they are for 1/4-comma meantone so that the pipes sounding the notes comprising those fifths could remain untouched. His retention of the primary kernel of 1/4-comma meantone thus had more to

20 In his 1681 *Orgel-Probe*, Werckmeister did not actually specify the comma with which he was dealing, he only mentions tempering fifths by fractions of 'a comma'. (See: Andreas Werckmeister, *Orgel-Probe*, Frankfurt and Leipzig 1681.) His summing of comma parts, however, leaves no other possible interpretation than that the comma to which he was referring was the Pythagorean comma. This is not to say that Werckmeister was an imprecise theorist, for his later publications do include exact monochord engravings. As a practising musician and a licensed inspector of organs, he was equally at home in the practical and theoretical spheres and his usage may indeed reflect a general disregard for the difference between the two commas among tuners. In practical terms, the Schisma can easily be absorbed by distributing it among any number of the tempered or theoretically pure fifths, leaving any need for drawing a distinction between the two commas to theoreticians.

21 The numbering system for Werckmeister's temperaments is his own and can be found in: Andreas Werckmeister, *Musicalische Temperatur*, Frankfurt and Leipzig, 1691.

do with practical considerations than any realization about the near equality of the Pythagorean and Syntonic commas. It may also be noted that while there are obvious reasons why the adjustment of the temperament of an organ might be kept to a minimum (time and the concomitant expense), there is no reason for using a temperament specifically designed with this constraint in mind when tuning stringed keyboard instruments. Nonetheless, many modern musicians choose this temperament over the modified meantone system Werckmeister himself recommended seventeen years later in his continuo treatise.

Werckmeister's other circulating systems, IV and V, were newly devised with no compromise regarding time and effort and were, I believe, the better for that, especially system V. Both make use of fifths larger than pure by the same amount that the narrow tempered fifths are smaller than pure, allowing the accumulation of a small amount of overcompensation in the natural keys which is then corrected among the accidentals. It thus seems more likely that Werckmeister's circulating temperaments are rationalizations of modified meantone temperaments rather than the direct descendents of regular meantone. This makes sense: it was undoubtedly the modified meantone temperaments which were in widespread use during Werckmeister's lifetime.

In his *Musicalishe Paradoxal-Discourse*, published posthumously in 1707, Werckmeister wrote that he had wanted to give monochord string lengths for equal temperament as well as for his own systems but that the engraver had balked at the difficulty of the task.[22] Werckmeister thus appears to have approved of equal temperament in principle but preferred that the 'home' keys remained somewhat purer than the 'distant' keys. Such systems which approach the evenness of equal temperament while yet retaining key quality variation were not only proposed by Werckmeister but also by his followers Johann Georg Neidhardt and Georg Andreas Sorge.

We ought to take more note of the suggestions of Werckmeister, Neidhardt and Sorge than we do; all three were organists and official organ inspectors, not mere theoreticians. Furthermore, all three published in German, the language of so many of the composers of the Classical era for whose work we seek temperament solutions.

Neidhardt's writings are also interesting because they may indicate a German flirtation with equal temperament quite early in the eighteenth century. His most important comments on temperament are contained in two works, one published in 1724, the other in 1732. Neidhardt claimed to have tried all the various temperaments and decided upon a handful of those which were the most useful; his writings are thus not mere armchair musings. He ranked his temperaments according to different social settings: the court, the city, the town and the village. Presumably the logic was that the more cosmopolitan the

22 Andreas Werckmeister, *Musicalische Paradoxal-Discourse*, Quedlinburg 1707.

context, the greater the likelihood that the organist would have to transpose up or down by various intervals to accommodate the different pitches used by visiting musicians. In 1724, Neidhardt recommended equal temperament for the court and three systems with progressively greater contrasts between good and bad thirds for the progressively more provincial social settings. In 1732, however, while the court temperament remained unchanged, the temperaments allotted to the other localities were shifted one position in the hierarchy of increasing contrasts in the thirds: the city was given the town temperament of 1724, the town was given that of the village while the village was given a new temperament, slightly more conservative than it had had in 1724.

Neidhardt's apparent backing away from equal temperament and his return to more conservative systems may reflect a broader trend. For reasons we shall soon see, there may have been an initial flurry of excitement and interest in equal temperament in the first few decades of the eighteenth century. We can imagine that a number of organs were re-tuned in equal temperament but that after a time the harsh sound of the equal-tempered thirds probably began to grate and the organs were returned either to meantone or to a modified meantone.

Despite their nearness to equal temperaments, the temperaments of Neidhardt nonetheless display their roots in the modified meantone temperaments of the previous generation. One in particular, the 1724 village – 1732 town temperament, stands out as having a logic clearly based in meantone modification procedures. C-E is a slightly wider-than-pure third consisting of fifths tempered by 1/6th Pythagorean comma.[23] $G^{\sharp}$ is located exactly midway between E and C so that it functions equally well as $G^{\sharp}$ and $A^{\flat}$. The remaining notes are defined by filling in the gaps between E-$G^{\sharp}$ and $A^{\flat}$-C using the following steps; the gap between E-$G^{\sharp}$ is filled by first tuning two pure fifths downward from the upper note ($G^{\sharp}$ to $C^{\sharp}$, $C^{\sharp}$ to $F^{\sharp}$) and the final note B is defined by placing it 'between' E and $F^{\sharp}$ so that it functions equally well with them in the two fifths E-B and B-$F^{\sharp}$ (both thus tempered by 1/12-Pythagorean comma). The gap between $A^{\flat}$-C is closed in the same manner.

After Neidhardt, Sorge carried on with ever more subtle divisions and distribution of the Pythagorean comma. One might say that his temperaments are as close to equal temperament as can be without being equal. While the

23 I wish to stress again that while it may seem strange that Neidhardt's system divides the Pythagorean comma rather than the Syntonic comma, in practice the difference between the two commas is negligible such that this temperament can easily be started by using the standard procedure for determining the size of a 1/6th Syntonic comma major third. Following the process described above, the Schisma would automatically be absorbed among the four fifths technically tempered by 1/12 Pythagorean comma, producing fifths actually tempered by about 5/48 of a Pythagorean comma – a difference which not even the finest ear will perceive.

differences in key colour are subtle, they are there nonetheless. In this respect these systems offer at least some variety, whereas equal temperament offers only merciless monotony.

Johann Philipp Kirnberger

No discussion of eighteenth-century temperaments would be complete without mentioning Johann Philipp Kirnberger. Most keyboard musicians involved with period instruments are familiar with the temperament known today as 'Kirnberger III'. This temperament is however of little or no real historical importance for it remained unknown until well after equal temperament had become the norm.

Kirnberger's original system, now called 'Kirnberger II', is not a circulating temperament at all; in fact it can hardly be called a temperament, since no real tempering is required to set it.[24] It consists of two chains of pure fifths, one stretching from $D^{\flat}$ to D, the other from E to $F^{\sharp}$, joined by a pure major third between C-E. The Schisma is absorbed by default (that is, not while tempering) in the last 'fifth' $F^{\sharp}$-$D^{\flat}$. In this manner, Kirnberger retained the absolute purity of the tonic and dominant chords in C major found in Just Intonation, but the traditional problem of the narrow fifth between D-A he resolved in a heavy-handed manner by placing A so that it produced equally bad intervals with both D and E. The result is that the D major and A major triads are ruined by fifths which are too narrow by almost half a Syntonic comma, more extreme than in any known historical system. Worse yet, the long chain of pure fifths results in an unusually large number of harsh major and minor Pythagorean thirds.

Kirnberger's system fits nowhere in the history of temperament, neither flowing from, nor leading to, any other near-contemporary systems or trends. His system could also not have helped to solve any of the practical problems musicians faced at the time. As we shall see, its extensive dispersion had more to do with its incorporation within a larger debate on musical aesthetics.

Today's 'Kirnberger III' is a variant of the original system Kirnberger proposed in a letter to his friend and advisor Johann Nicolaus Forkel. Despondent about the brutal criticism heaped upon his system by Frierich Wilhelm Marpurg and others, Kirnberger abandoned one of his own principles: because (as he claimed) the ear cannot 'recognize a tempered interval', a tuning system must

24 Rita Steblin incorrectly refers to Kirnberger's original tuning as a 'Pythagorean-meantone' tuning system, when actually it is a mixture of Pythagorean and Just Intonation. See: Rita Steblin, *A history of key characteristics in the eighteenth and early nineteenth centuries*, Rochester 1983, 80. This work unfortunately remains unknown by a majority of modern musicians.

be based on pure intervals. However, in order to eliminate the two sour fifths on D and A, he grudgingly admitted that one could fill in the pure major third C-E with a chain of four fifths each tempered by a quarter Syntonic comma, exactly as in meantone. Thus while Kirnberger's modification of his own system may resemble a meantone-based circulating system, the actual route which took him there demonstrates no contiguity with the earlier systems. In any event, Kirnberger's letter to Forkel was not published until 1877; this date should cause us to reject 'Kirnberger III' outright for the performance of eighteenth-century and early-nineteenth-century music.

The affects of the keys

Many musicians today believe that eighteenth-century composers subscribed to the idea that each key was imbued with a particular emotive connotation, or *Affect*, and that the differences in affects from key to key were the result of the unequal temperaments used in those times. Accordingly, if we hope to rediscover the true essence of the music of the Baroque and Classical eras we must not only be mindful of which particular affects belong to which keys, but to seek temperaments which support these emotive qualities acoustically.

Rita Steblin's survey of these notions starts with the Greek attribution of different affects to different modes and continues with the later application of this idea to church modes by Medieval theorists.[25] Having survived the harmonic distillation of the Renaissance, the original modal affects re-emerged in the early Baroque as key affects. Nonetheless, theorists were at somewhat of a loss to explain their causes. Naturally, the subtle sound differences between triads caused by unequal temperaments, then at the apex of their historical usage, offered a convenient explanation. However, Johann Mattheson, among others, pointed out that the differences between the ancient modes were much greater than those between 'modern' keys because the different relative positions of the semitones resulted in much greater differences than the subtle variations in scale and harmony caused by unequal temperaments. He postulated that it is the relative pitch of the tonic which caused us to perceive certain keys as being more lively or languid than others.

French writers also attempted to explain and catalogue key affects. Jean-Jacques Rousseau added his voice to those who claimed that key affects were the result of the differences in precise interval sizes of each major or minor scale. Jean-Philippe Rameau initially agreed, but later, after becoming an equal temperament proponent, rejected this notion and claimed that it was the 'artful

25 Steblin, *A history of key characteristics, op. cit.*

intertwining of keys' which a composer used to create the contrasting affects. Thus began a literary battle, Rousseau championing the conjoined causes of key affects and unequal temperament, Rameau promoting equal temperament and arguing for compositional skill.

While Rameau's views on temperament were eventually to triumph in the actual practice of making music, Rousseau clearly dominated in the literary sphere. His articles written for the *Encyclopédie* of Denis Diderot and Jean le Rond d'Alembert had a tremendous impact and were widely distributed and imitated.[26] Steblin traced their influence throughout France and Italy during the remainder of the eighteenth century and well into the nineteenth and notes how the argument came full circle in the writings of Jean Benjamin de Laborde and Francesco Antonio Vallotti:

> It is remarkable that writers now regarded unequal temperament as such a vital cause of key characteristics – no doubt through Rousseau's influence – that they were convinced that temperament had also produced the ancient modal effects.[27]

Germany, too, had its own version of this debate; it began, somewhat later, with the publication Kirnberger's *Der Kunst des Reinen Satzes* in 1776.[28] Kirnberger also argued that only temperament could induce the emotive key qualities which everyone undoubtedly perceived. Like Rousseau, he offered his own temperament, ostensibly designed to produce a maximum of contrasting keys. His ideas, and even more so his temperament, were harshly attacked by Marpurg who, like Rameau, was an advocate of equal temperament. Kirnberger used the power of the printing press to defeat his advocate, just as Rousseau had done before; Kirnberger's ideas were incorporated in various articles written under his direction by his student Johann Abraham Peter Schulz and published in Johann Georg Sulzer's *Allgemeine Theorie der schönen Künste* (1771–74).[29] These articles, much like those of the *Encyclopédie*, had a tremendous distribution and influence throughout German-speaking lands; they were widely quoted and paraphrased well into the nineteenth century.[30]

No wonder then that many musicians today think that there is a link between key affect and temperament. If we attempt to define either of these in concrete terms however, the whole house of cards comes tumbling down. The surviving lists of key affects demonstrate little consistency, sometimes vaguely agreeing

26 Denis Diderot and Jean le Rond d'Alembert (eds.), *Encyclopédie, ou Dictionnaire raisonné des sciences, arts et metiers,* Paris and Neuchâtel 1751–1765, suppls., Amsterdam 1776–7.

27 Steblin, *A history of key characteristics, op. cit.*, 77.

28 Johann Philipp Kirnberger, *Die Kunst des reinen Satzes in der Musik, aus sicheren Grundsätzen hergeleit und mit deutlichen Beyspielen erläutet*, Berlin and Königsberg 1776–1779, II/3.

29 Johann Georg Sulzer, *Allgemeine Theorie der schönen Künste in einzeln, nach alphabetischer Ordnung der Kunstwörter auf einander folgenden Artikeln abgehandelt*, Leipzig 1771–1774.

30 Diderot and D'Alembert (eds.), *Encyclopédie, ou Dictionnaire raisonné, op. cit.*

with one another, sometimes contradicting each other markedly – except in those cases when a list was borrowed or paraphrased from another. Many of the most important writers – Mattheson and Kirnberger, for example – state that there are no hard and fast affects; each person must decide for himself.[31] This point inevitably escapes those modern performers who include key affects in their arsenal for the interpretation of Baroque and Classical music; rather than deciding on an affect which seems to them appropriate to a given piece, the key of the piece in question is declared *a priori* to have a certain affect and that therefore the piece must be performed in a way corresponding to that affect. Arguing against such an approach, George Buelow came to the conclusion that today's underlying assumption that key affects were some kind of 'practical guidelines' which were followed by composers is largely the invention of early twentieth-century German musicologists.[32]

Even if we were to accept such a rigid interpretation of the historical evidence, it is difficult to imagine which artful distribution of good and bad thirds might cause C major to be the key for 'gay things and grandeur' while making G major more suited to 'tenderness'.[33] Furthermore, there is no overall agreement in the distribution of good and bad thirds among the various temperaments of the late seventeenth and early-to-mid-eighteenth centuries, at least not subtle enough to produce the sort of nuances evident in any surviving list of affects. There is only a general tendency for keys with few accidentals to sound more pure than those with many. Some temperaments shift the harshness of wide major thirds in the 'distant' keys more towards those with sharps, others more toward those with flats. In 1726 Rameau restated his point of view that key affect was the result of unequal tuning.[34] By contrast, Johann David Heinichen made the following astute observation in 1728:

> Indeed! If these imaginary properties [of the tonalities] had any validity of their own, we would constantly be suffering shipwrecks at the smallest variation in temperament (by which the instrument tuners are never accurate).[35]

31 Mattheson cautions that each person will perceive his own key affects based upon his personal character. See: George J. Buelow, 'Johann Mattheson and the invention of the Affektenlehre', in: George J. Buelow and Hans Joachim Marx (eds.), *The New Mattheson Studies*, Cambridge 1983, 402. Kirnberger's statement that there are no definite rules regarding key character is quoted and translated in Steblin, *A history of key characteristics*, *op. cit.*, 81.

32 Buelow, 'Johann Mattheson', *op. cit.*, 403.

33 For a table of Rousseau's affects, see: Steblin, *A history of key characteristics*, *op. cit.*, 40.

34 See: Rameau, *Nouveau système*, *op. cit.*

35 Johann David Heinichen, *Der General-Bass in der Composition, oder Neue und gründliche Anweisung*, Dresden 1728, 84. Quoted and translated in: Bruce Haynes, *A history of performing pitch: the story of A*, Lanham 2002, 192.

Perhaps this more reasonable assessment was indicative of the tendency which, almost a decade later in 1737, caused Rameau to recant and begin recommending equal temperament.[36]

Without doubt, if we go fishing through the works of any given eighteenth-century composer, we will undoubtedly be able to find musical moments which sound particularly striking in this or that temperament, moments which may well match one or another description of that particular key. However, this is no proof that the composer conceived of the music in that particular temperament. As Steblin concludes, the best that we can say is that many who wrote about music in these times believed that keys had affects and that a number of those writers believed that these affects were at least partially due to the use of unequal temperaments. Beyond that, the issue must then have been entirely open to the whim of the performer, exactly as it is now.

Transposition and temperament

In a somewhat equivocal remark, Daniel Gottlob Türk pointed out that the doctrine of key affects was incompatible with the common practice of transposition:

> And is it not true that almost everywhere in church orchestras the organist must play a whole tone or a minor third lower than the violins, etc.? Why should the organist even be allowed to take part in the performance at all, when the piece thereby acquires a double affect?[37]

The combined use of instruments built at different pitch levels and the corresponding need for transposition was one of the primary forces driving temperament development during the eighteenth century. In his remarks about the incompatibility of different temperaments with the key affects, quoted above, Heinichen further cautioned that the severity of the 'shipwrecks' would have been exaggerated by transposition:

36 See: Jean-Philippe Rameau, *Génération harmonique ou Traité de musique théorique et practique*, Paris 1737. Quoted in: Steblin, *A history of key characteristics*, *op. cit.*, 59.

37 'Und spielt denn nicht der Organist bey einer Kirchenmusik beynahe überall *) einen ganzen Ton oder eine kleine Terz tiefer, als die Violinist u.? Warum läßt man den Organisten an der Ausführung Theil nehmen, wenn das Tonstück dadurch einen doppelten Charakter bekommt? Warum versetzt man die Hörner, Trompeten u. noch immer in das C? Oder ist etwa ein A-Horn anders temperirt, als ein C-Horn? *) Wie bekannt stehen nur wenige Orgeln im gewöhnlichen oder so genannten Kammertone, sondern wenigstens einen Ton höher, das heißt, in Chortone.' Daniel Gottlob Türk, *Clavierschule oder Anweisung zum Clavierspielen für Lehrer und Lernende*, Leipzig and Halle 1789 (facsimile, Kassel etc. 1997), 382.

> ... we would constantly be suffering shipwrecks at the smallest variation in temperament [...] – and how much more so due to transpositions between choir, chamber, French, and the extravagant Venetian pitch levels.[38]

There is much evidence to suggest that many organs remained tempered in regular 1/4-comma meantone well into the nineteenth century, sometimes even later. Transposition by a whole tone is often possible in meantone, provided the piece does not exceed a limited range of good and bad triads. Transposition by a minor third is also possible in some cases, though this increases the limitation for modulation considerably. Not surprisingly, pieces survive for which transposition simply would not have worked. For instance, in the manuscript of one of the fantasies for organ and oboe by Johann Ludwig Krebs, the organ part is written in F minor and the oboe in G minor.[39] The usual meantone distribution of accidentals includes a $G^{\sharp}$ and not an $A^{\flat}$ but there is nothing about this piece which would indicate Krebs wanted the sour harmonies this would produce in F minor, especially not in combination with the Baroque oboe's G minor, one of the loveliest minor keys on the instrument.

One possible solution to such problems would have been to use an organ with divided keys, so-called split sharps. For instance, the key which, in meantone, would normally play $E^{\flat}$, would be divided into two keys, front and back, one for $E^{\flat}$, the other for $D^{\sharp}$. A number of organs either have or are reported to have had split sharps on at least one manual, often on the *Rückpositiv* or the *Brustwerk*, divisions commonly used for orchestral accompaniment. On a keyboard with both $E^{\flat}/D^{\sharp}$ and $G^{\sharp}/A^{\flat}$, an organist could easily transpose by a whole tone without inadvertently wandering into sour harmonies.

Another solution to the problem of transposing on an organ tuned to meantone was to include one or more stops tuned at a lower pitch. This not only resolved the temperament problem but also freed the organist from having to transpose at sight. Arp Schnitger included an 8' stopped flute at *Cammerton* in his 1693 organ for the Jacobi church in Hamburg. Even as late as 1815, Joseph Wolfram mentions the practice of such transposed stops, though he argues against it:

38 See note 35. These pitch levels were probably roughly centered around 465, 415, 390, and 440 Hz respectively. The meaning of the terms 'Chor' and 'Cammer' exchanged relative position in different times and places, so one must always be careful about interpreting these levels in the absence of any specific indication. See: Haynes, *A history, op. cit.*

39 The manuscript is located in the Hessiche Landes und Hochschulbibliothek, Darmstadt, and bears the title *Fantasia a Oboe. 2 Clavier e pedale. Adagio non molto*. Two modern editions exist: Breitkopf and Härtel, Leipzig 1942, no. 4177, in which the oboe part has been transposed to F minor; and Nova Music, London 1980, in facsimile, along with a modern notation version in which the organ has been transposed to G minor.

> When the word *Cammer* stands beside a register, it signifies a stop tuned a tone lower, in order to eliminate the need for transposition .... A most superfluous affair! Either the entire organ should be in *Cammerton*, or no one should be allowed to be an organist who cannot transpose![40]

Both of the above solutions to the transposition problem allow the organ to be tuned in strict meantone. Another historical solution would have required a more accommodating temperament, at least in some cases. This is the device known as the *Kammer-Kopple* by which the keys (and pedals) could be made to slide down so that they physically connected to the rest of the instrument a semitone or more lower. In 1701, Thomas Balthasar Janowka mentioned a device on the organ of the Prague cathedral which allowed the sliding of both the keyboard and pedals by a whole tone. Another organ, built in 1721 for the cathedral in Frankfurt am Main, had a means of sliding the keys and pedals to positions a semitone, a whole tone and a minor third lower.[41] The 'normal' pitch must have been *Cornet/Chorton*, the one a semitone lower would have been the exotic 'Venetian pitch', a whole tone lower would have been chamber pitch while a minor third lower would have been French pitch. Venetian pitch, the *Corista Veneto* or *Tutto Punto*, the pitch of many new wind instruments then arriving from Italy, became progressively more important in southern Germany and Austria as the century wore on, eventually becoming dominant after the turn of the century.[42] Interestingly enough, when Charles Burney saw the organ in the cathedral of Frankfurt am Main in 1772, the transposing device no longer functioned:

> There *has* been a contrivance in this organ for transposing half a note, a whole note, or a flat third, higher [*sic*]; but it is now useless: the instrument was built many years ago by Meyer, and repaired, with the addition of new stops, six or seven years ago, by Grosswald, of Hanau.[43]

The instrument had also been given a major rebuild in the 1750s, at which time it was, according to the contract for the work, 'tuned and voiced in an entirely different manner'; perhaps the transposing device was also disabled at the same time, but perhaps this did not happen until Grosswald repaired the organ around 1765.[44]

40 Joseph Wolfram is cited in: Haynes, *A history, op. cit.*, 196.

41 Charles Burney, *The present state of music in Germany, The Netherlands, and United Provinces. Or the journal of a tour through those countries, undertaken to collect materials for a general history of music*, 2 vols., London 1773, I, 75.

42 See: Haynes, *A history, op. cit.*

43 Burney, *The present state, op. cit.*, 75.

44 Quoted in: Haynes, *A history, op. cit.*

Sliding keyboards (like those built into many modern harpsichords) are also found on some historical harpsichords and pianos, for instance the anonymous German harpsichord, thought to date from about 1715 in the Bach-Haus, Eisenach, the 1749 *Hammerflügel* by Gottfried Silbermann in the Germanisches Nationalmuseum, Nuremberg and the small *Liegende Harfe* piano in the Vleeshuis, Antwerp.[45] On such instruments a temperament which allowed for instantaneous transposition without re-tuning would have been convenient but by no means required; the particular instrument could always have been re-tempered in either position after sliding the keyboard. For an organ with a transposing keyboard, however, such re-tempering was not an option.

Considering the problems presented by transposition, it comes as no surprise that Neidhardt and Sorge had developed irregular temperaments which come quite close to equal temperament while yet retaining sound characteristics which vary subtly depending on tonality. These temperaments not only solved the problems of semitone and minor third transposition but also serve beautifully for more adventurous compositional styles such as in the late music of Beethoven and Schubert. They are also markedly easier to tune than equal temperament. Despite their advantages, these temperaments are seldom used today, even by historically informed performers, perhaps only through ignorance.

The intonation of instruments with flexible intonation

For instruments with flexible intonation, such as the bowed stringed instruments and the wind instruments (and the voice), the octave was often described in the eighteenth century as being divisible into 55 'commas' of equal size, each 'comma' therefore being about 22 cents in modern terms. While a whole tone comprised nine such commas, semitones were of two sizes: five commas for a major (or diatonic) semitone, and four commas for a minor (or chromatic) semitone. Sharps were thus four commas above their natural note, flats four commas below, leaving one comma between any enharmonic pair such as $D^{\sharp}$ and $E^{\flat}$. References to this system can be found as far back as the early seventeenth century and in the eighteenth century, in the writings of Pier Francesco

45 Bach-Haus: inv. no. 77 (see: Herbert Heyde, *Historische Musikinstrumente im Bachhaus Eisenach*, Eisenach 1976, 129. This instrument has a keyboard extending from C to c3 which can slide down by as many as three semitones); Germanisches Nationalmuseum: inv. no. MI 86; Vleeshuis: inv. no. VH 67.1.116. Another *Liegende Harfe* piano, cat. no. 8 in the Musikinstrumenten-Museum, Berlin, transposes by one semitone, and another in the same museum, cat. no. 336, by two semitones.

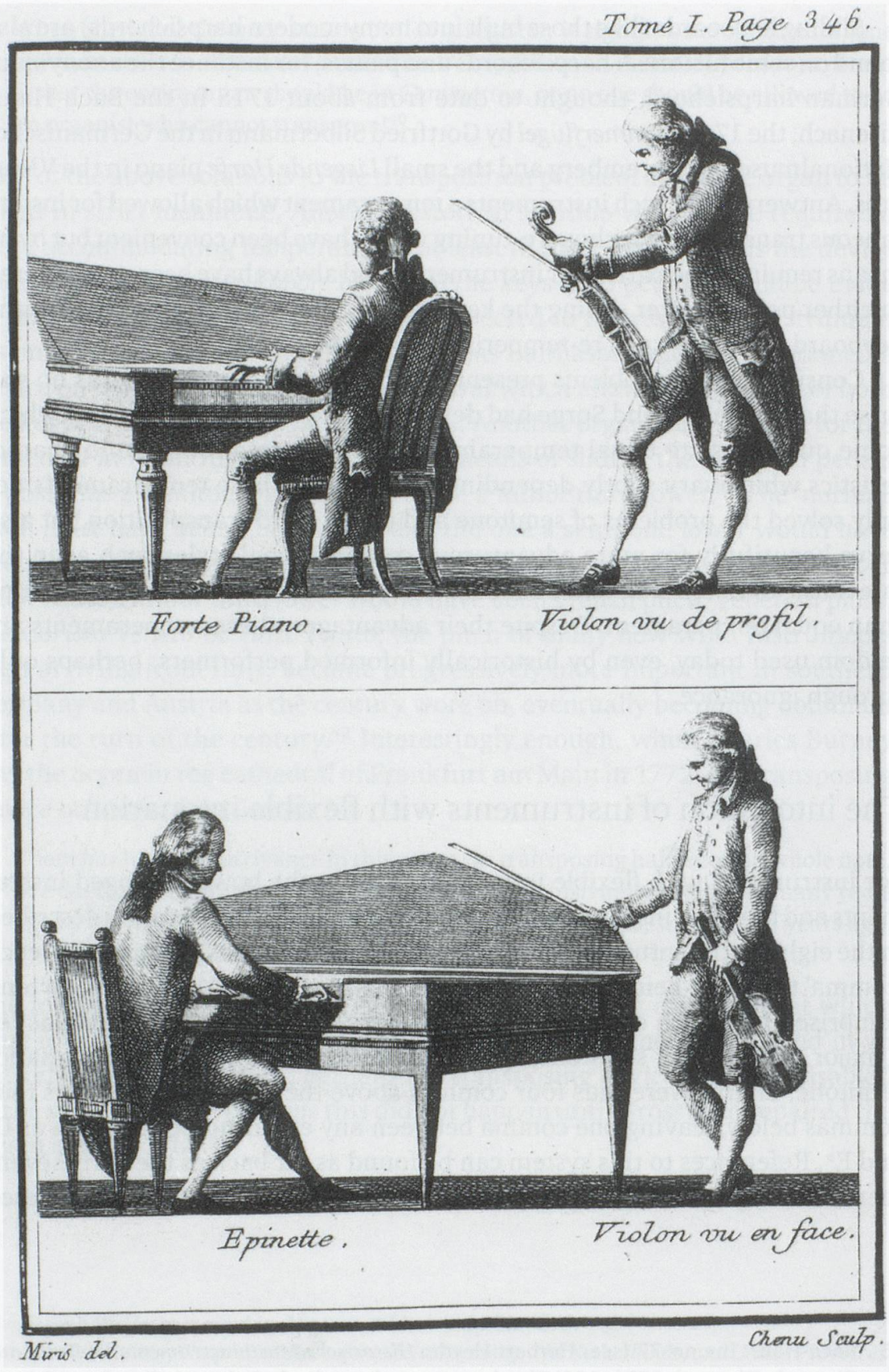

Figure 1: *Pierre Chenu (1730–?), after Silvestre David Mirys (1742–1810),* Forte Piano. Violon vu de profil / Epinette. Violon vu en face, *in: Jean Benjamin de Laborde,* Essai sur la Musique ancienne et moderne, *4 volumes, Paris 1780, I, 346*

Tosi, Francesco Saverio Geminiani, Leopold Mozart, Johann Joachim Quantz, Georg Philipp Telemann and others.[46] In this context it is interesting to note that Wolfgang Amadeus Mozart taught the young Englishman Thomas Attwood that sharps were lower than flats, although we do not know by how much.[47] Even as late as 1824, the Stuttgart piano maker Johann Lorenz Schiedmayer, while recommending equal temperament, admitted that keyboards can never really be in tune because the have no separate keys for sharps and flats.[48]

In this '55-comma' system, if we understand a major third to comprise two whole tones of 9 commas each, we arrive at a total of 18 commas or 393 cents, somewhat wider than a pure major third (386 cents) but not as wide as an equal temperament third (400 cents). As it happens, this 18-comma major third is almost exactly the same size as the major third of 1/6-comma meantone, a similarity which has led some modern writers to advocate the use of 1/6-comma meantone (or a modification thereof) for eighteenth-century music.[49] The fact that Neidhardt reported to have found 1/6-comma meantone on two organs by Gottfried Silbermann seems to add credibility to the idea. If we look at the sizes of the major thirds in many of the known late seventeenth- and eighteenth-century temperaments, we do occasionally find thirds which are the same in size as those of 1/6-comma meantone.[50] Nevertheless, there is ample evidence to indicate that the '55-comma' system, used as it was to describe subtle nuances in semitone intonation, should not be used to extrapolate the size of any larger consonant intervals in the manner described above. The proper tuning of thirds, sixths, fifths and fourths was determined by listening for resultant tones.[51] Leopold Mozart gives double-stop examples and exercises to be practiced, stating that:

46 Pier Francesco Tosi, *Opinioni de' cantori antichi e moderni*, Bologna 1723; Francesco Saverio Geminiani, *Guida armonica*, London c. 1752; Leopold Mozart, *Versuch einer gründlichen Violinschule*, Augsburg 1756; Johann Joachim Quantz, *Versuch einer Anweisung die Flöte traversiere zu spielen*, Berlin 1752; Georg Philipp Telemann, 'Neues musicalisches System', in: Lorenz C. Mizler, *Musikalische Bibliothek*, 4 volumes, Leipzig 1739–1754, vol. III/4, 1752, 713 ff. The relevant passages are quoted in: Bruce Haynes, 'Beyond temperament; non-keyboard intonation in the 17th and 18th centuries', *Early Music* XIX/3, August 1991, 357–81.

47 John Hind Chestnut, 'Mozart's Teaching of Intonation', *Journal American Musicological Society* XX, 1977, 254–71.

48 Johann Lorenz Schiedmayer and Carl Dieudonné, *Kurze Anleitung zu einer richtigen Kentniss und Behandlung der Forte-Pianos in Beziehung auf das Spielen, Stimmen und Erhalten derselben, besonders derer, welche in der Werkstätte von Dieudonné und Schiedmayer in Stuttgart verfertigt werden*, Stuttgart 1824 (facs.: Tübingen 1994), 54.

49 Bruce Haynes, 'Beyond temperament', *op. cit*, 359.

50 Two temperaments which have a large number of 1/6-comma thirds were proposed by Werckmeister. These two temperaments (neither of them the nowadays often used 'Werckmeister III') remain largely ignored by those performers who might style themselves historically aware.

51 Resultant tones are those produced by the combination of two other tones.

> if the notes be played out of tune, and one or the other be stopped even the slightest degree too high or too low, then the lower voice will be false.

Mozart clearly meant that both major and minor thirds and sixths, as well as fifths and fourths were to be tuned absolutely pure; the 'lower voice' can only be in tune if the interval itself is pure. This agrees quite well with the 'built-in' intonation of most surviving woodwinds from the time; they favour pure major thirds and pure fifths in the home keys.

It may seem incomprehensible to us, but in the eighteenth century two different and contradictory systems regarding the proper tuning of instruments with flexible intonation coexisted peacefully: first, the '55-comma' system, used to define semitones and to describe chromatic inflection; and second, pure intonation, used for tuning major and minor triads. Neither of these systems can be converted to any sort of keyboard temperament. Unfortunately, there is no space here to go into the historical advice about how this discrepancy was dealt with. A few tantalizing hints, in the form of historical quotes, will have to suffice.

In 1726, Roger North wrote:

> If the sounding part [of music] had bin left to the Voice, which conformes to all truth of accords whereof the ear is judge, there never had bin any suspicion of such majors, minors, dieses, commas, and I know not what imaginary devisions of tones, as some clumsye mechanick devices called Instruments have given occasion to speculate.[52]

In 1752 Quantz wrote:

> ... if a note lowered by a flat becomes transformed into the note just below it, the note with a sharp is a comma lower than the one with a flat. If these two notes are tied to each other, one must draw back one's finger a little [...] otherwise the third will be too high against the fundamental tone.[53]

In 1772, Charles Burney noted a similar practice in the playing of the oboist Carlo Besozzi (in the service of the court at Dresden):

> His taste and ear are exceedingly delicate and refined; and he seems to possess a happy and peculiar faculty of tempering a continued tone to different bases [*sic*], according to their several relations: upon the whole, his performance is so capital, that a hearer must be extremely fastidious not to receive from it a great degree of pleasure.[54]

52 Roger North, *Theory of sounds shewing, the genesis, propagation, effects and augmentations of them reduced to a specifick inquiry into the cripticks of harmony and discord, with eikons annexed exposing them to occular inspection*, unpublished ms., British Library Add.32535, 1726, 1-73v.

53 Quantz, *Versuch*, *op. cit.*

54 Burney, *The present state*, *op. cit.*, II, 46.

In other words, musicians used flexible pure intonation, sometimes called 'just intonation', not the rigid system of the keyboard tuning, but a system which is constantly shifting, changing like a harmonic chameleon, moulding to the musical demands of each moment. Such intonation is often used by pop musicians and folk musicians today; they often sing or play melody instruments using pure intonation but are accompanied by players of keyboard instruments tuned in equal temperament. The secret lies in the skilful realization of the harmonic accompaniment in order to hide the bad thirds of the tempered instrument.[55] This is as true today as it was then.

Conclusions

Choosing a temperament for music of the second half of the eighteenth century is perhaps easier than for any other period, at least if the primary concern is to adhere to some ideal in which present-day performance practice is to be governed by the performance practice of the past. If we pose the question, 'What sort of harmonies did musicians of the time expect to hear?', we discover that many temperaments were in use, from regular 1/4-comma meantone temperament to equal temperament, giving a wide range from which to choose. This does not mean however that an early sonata of Beethoven should be played in meantone. The temperament chosen must not make a nonsense of the harmonic texture of the piece. Nonetheless, for the larger body of Classical literature, the most likely temperaments for stringed keyboard instruments – the irregular circulating temperaments of Neidhardt and Sorge – are rarely employed. Players of harpsichords and early pianos would be well advised to add at least one or two of these to their repertoire.

That said, while the choice of a certain temperament for a keyboard instrument obviously leaves no room for intonation adjustment, others playing instruments with flexible intonation together with that keyboard instrument should feel no obligation to slavishly follow the exact intonation produced by the keyboard. Whenever possible, musicians playing flexible intonation instrument should strive to produce a more naturally inflected intonation (low sharps, high flats, and pure consonances). The fact that this is often difficult and will undoubtedly require a significant amount of effort and experimentation is no reason not to do it. As strange as this idea may seem to us, we should not forget that precisely the same sort of flexibility was employed later in the nineteenth century when the use of the so-called 'expressive' neo-Pythagorean narrow

55 In this context, equal temperament is actually advantageous, since all its fifths are as good as pure if not exactly so.

leading and leaning tones caused solo musicians to deviate from the equal-tempered intonation dictated by the piano accompaniment.

Appendix

A few remarks regarding electronic tuners

The Korg MT-1200 (now replaced by the OT-12) electronic tuning device has probably only added ineptitude and misunderstanding in the world of historical performance practice. As with all electronic tuners of this type, the needle indicator is unstable and inaccurate, a flaw inherent in the design. Unfortunately, this does not keep players from using such devices to tune their cellos, violins and even harpsichords. Some wind players 'practice intonation' by watching the Korg needle in order to learn how to 'play in Vallotti'. Furthermore, if one uses the sound produced by these devices, the programming is not accurate; even octaves are often aurally out of tune.

When tuning, trained ears are easily superior to any electronic devices. The combination of the human aural system with the most recent technology means that there is no need to spend much on a device for tuning one's instrument. By far the cheapest and most accurate electronic tuner one can use is a simple MP3 player. It is also reliable and portable. Starting with any one of a large number of signal-generating programs available today, simply generate a minute or so of each of the 12 tones of the octave for whatever temperaments you wish to use at whatever pitch levels and save them as MP3 files. Listen to them through a pair of non-isolating headphones while tuning; it is amazing how easy it is to match the tone of the instrument to the electronic tone with breath-taking precision.