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# VALLOTTI AS THE IDEAL GERMAN GOOD TEMPEARMENT

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## 1. TEMPERAMENT IN A NUTSHELL

This article assumes familiarity with basic concepts of temperament, easily available nowadays (e.g. from Lindley, 1980 or Di Veroli, 2009), but anyway let us briefly review the main concepts. Intervals are mostly nowadays measured in Cents, where 100 Cents is an Equal-Temperament semitone: thus the octave has 1200 Cents. In 12-note music, instruments (e.g. keyboards) are usually tuned starting from any note, then following the Circle of Fifths up and down:

Eb - Bb - F - C - G - D - A - E - B - F# - C# - G#

One tunes the above 11 fifths (pure or tempered) and the last fifth (G#/Ab-Eb) is left to "close the circle". In Medieval Pythagorean Intonation one tunes the 11 fifths pure: the result is a very mistuned G#-Eb, "wide" by 23.46 Cents, the "Pythagorean comma". That is a problem, but the real issue of temperament lies elsewhere. Every 4 fifths "produce" a major third (e.g. C-G-D-A-E), but if we tune the fifths pure, the major third is too "wide" by 21.51 Cents, the "Syntonic comma". This is much wider than modern Equal Temperament (ET) major thirds, barely acceptable with their deviation of 13.60 Cents. The 24-Cents-wide "Pythagorean major thirds" are perceived as truly dissonant. When Renaissance and Baroque musicians needed consonant major thirds, they adopted Meantone Temperament. In its usual variant, every one of the 11 fifths is tuned "narrow" by 1/4 Syntonic Comma, yielding 8 perfectly pure major thirds: Eb-G, Bb-D, F-A, C-E, G-B, D-F#, A-C# and E-G#. The sound quality is ravishing, but here also—and inevitably—the tuning leaves a "wolf fifth" at G#-Eb: much more significantly, the remaining 4 thirds are unplayable "wolves", each wide by 41 Cents.

## 2. GOOD TEMPERAMENTS AND VALLOTTI

In High Baroque times in Germany c.1690-1750 meantone quickly lost ground (Rasch 1984) to Good temperaments (Werckmeister's "Gute Temperatur") whereby fifths were tuned with different "sizes" in diverse ways. The diatonic fifths (from F to B, meaning leading from F through the circle of fifths through Bb Eb Ab Db F# to B) were still tuned quite narrow, but the others were pure or slightly wide. This arrangement of fifths yielded a Circle of Major Thirds whereby the most usual ones were very good (much better than ET) while others were much worse yet still playable. The main advantage of Good temperaments over Meantone was that, with different degrees of consonance, they were "circular", i.e. all the fifths and all the major thirds were now playable, as required by the music of the time. A well-known German Good Temperament is Werckmeister III (Werckmeister, 1691). In the table below dV and dIII are the deviations from purity of fifths and major thirds. The "Note" is the bottom note of the interval, thus dV under D is the deviation of D-A, while dIII under E is the deviation of E-G#.

Note:	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#
dV	0	0	0	-5.87	-5.87	-5.87	0	0	-5.87	0	0	0
dIII	15.64	9.78	3.91	3.91	9.78	9.78	15.64	15.64	15.64	21.51	21.51	21.51

Table 1: Werckmeister III Temperament

This temperament is said to have enjoyed some popularity in the 1st half of the eighteenth century in Germany. However its 4 narrow fifths are quite dissonant. More than one keyboard tuner is likely to have found a very obvious improvement when tuning in practice: extending the narrowing of the fifths to A\_E\_B: this is today known as Vallotti/Young temperament (see below). A very similar system is first discussed in letters between Vallotti and other Northern Italian

theoreticians from the 1730's on, becoming widely known in Italy after Vallotti's tuning criteria were enthusiastically endorsed in a treatise that reached wide diffusion (Tartini, 1754). Vallotti's temperament avoids the very narrow fifths of Werckmeister's III, yielding a similar Circle of Major Thirds. For more details see Lindley, (1980). A full analysis of good temperaments and particularly Werckmeister's and Vallotti's ones may be found in Di Veroli, (2009, (Chapters 9 and 11).

Note:	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#
dV	0	0	-3.91	-3.91	-3.91	-3.91	-3.91	-3.91	0	0	0	0
dIII	13.69	9.78	5.87	5.87	5.87	9.78	13.69	17.60	21.51	21.51	21.51	17.60

Table 2: Vallotti's temperament (Pythagorean comma version)



Fig. 1: Pages from Tartini's *Trattato di Musica*, Padua 1754.

Vallotti's tuning slightly "favours" tonalities with flats. Versions of Vallotti shifted one fifth clockwise—slightly favouring the sharps instead—are also likely to have been in use in ancient times: they are an obvious modification of Werckmeister III, tempering his pure A\_E\_B. The earliest descriptions of shifted-Vallotti all date from the 2nd half of the eighteenth century (Barbieri, Vicenza 1986, p.44). In modern times the first source found for it was Young's N° 2 temperament (Young, 1800), hence shifted-Vallotti is usually called Vallotti/Young.

Note:	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#
dV	0	0	0	-3.91	-3.91	-3.91	-3.91	-3.91	-3.91	0	0	0
dIII	17.60	13.69	9.78	5.87	5.87	5.87	9.78	13.69	17.60	21.51	21.51	21.51

Table 3: Vallotti/Young temperament

Truly circular and enharmonic, these tunings are ideally suitable for High Baroque music that needs full circularity-cum-diversity (see Di Veroli, 2009, section 9.8). This includes the works of J.S. Bach, for which Vallotti provides precisely the amount of diversity required by his frequency of use of major thirds (*ibidem* sect. 21.10). Vallotti can be tuned easily and accurately in keyboards utilising either ancient or modern methods (*ibidem* sect. 13.16). It is also easy to fret in lutes and viols, quite natural in instruments of the violin family (*ibidem* sect. 15.11 and 16.5) and it can be followed with no issues on Baroque wind instruments.

### 3. VALLOTTI'S MODERN POPULARITY AND CRITICISM

Vallotti is a very popular unequal temperament nowadays. A few dates in its modern history: 1951: Dr. Barbour in his widely-read treatise (Barbour, 1951, pp.182-183) formulated 'the ideal form of Werckmeister's "correct" temperaments and of Neidhardt's "circulating" temperaments and of all "good" temperaments that practical tuners have devised by rule of thumb as a "Temperament by Regularly Varied Fifths". Though he only knew Young's variant, Barbour's system was actually an exact mathematical average between Vallotti and Young which, as Barbour acknowledged on p.184, "cannot be surpassed from the practical point of view". 1977: Dr. Lindley in his paper in Early Music (Lindley, 1977) stated that "German 'Good temperaments' ... Dozens of 18th-century musicians praised this kind of tuning. ... One such tuning, praised by Tartini ... was used at Padua by Francescantonio Vallotti, organist and resident composer from the 1720s ..." This was the only Good temperament described by Lindley in this very influential paper.

1980-1: First sales of this author's book *Unequal Temperaments*, which may also have aided Vallotti's diffusion. Writings on "Bach's Temperament" in *Early Music* (Barnes, 1979 and Di Veroli, 1981) justify the "optimality" of both Barnes's temperament and Vallotti for the music of J.S. Bach. (Note: no document has ever been found relating Bach to any temperament). From the 1980's on quite a few leading Baroque period instrument ensembles adopted Vallotti, which is in widespread use today. However, the modern world seems to need the continuous revision of our knowledge, writers often embarking in "crusades" and "counter-reformations". Inevitably most modern-day deductions about past musical customs are correct: therefore their revision sometimes can be misleading. In recent years the modern use of Vallotti has been criticised on two types of grounds: musical and historical. In musical terms, some are against the use of Good temperaments in Baroque music making.

Some influential musicians in the mid-18th century, like Gottfried Silbermann and Telemann (1742) advocated 1/6 Syntonic comma meantone instead, supported in modern times by Prof. Duffin. Those proposals were misguided. The deviations of the 12 Major Thirds show clearly how Vallotti is a circular temperament, while 1/6 Syntonic comma is not: not only does it sport a wolf fifth, but also four major thirds are intolerably wide (full details in Di Veroli, 2009 section 5.8).

Note:	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#
1/3 S.c.	7.17	7.17	7.17	7.17	7.17	7.17	7.17	7.17	26.72	26.72	26.72	26.72
Vallotti.	13.69	9.78	5.87	5.87	5.87	9.78	13.69	17.60	21.51	21.51	21.51	17.60

Table 4: Major Thirds: 1/6 Syntonic-Comma Meantone vs Vallotti's temperament

On the historical side it has been argued that Vallotti, however useful for Baroque music, is a proposal too much restricted in time (around mid/late eighteenth century) and space (North-Eastern Italy). To disprove these objections is the main goal of this article.

## 4. BAROQUE HISTORICITY OF VALLOTTI

Vallotti's temperament in its early version by Riccati was actually formulated years earlier than Tartini's endorsement. At least one Italian church organ was tuned to Vallotti before the *Trattato* was published in 1754. Unfortunately there are no documents showing how/where widespread its use was at the time. Therefore, there would seem to be *prima facie* no historical justification for its use in German High Baroque music. We have already seen a first justification for Vallotti if we consider it as a minor modification—though with important consequences—of tuning following Werckmeister III (1691): this is something most practical Baroque tuners could easily achieve. Unfortunately again this fact, however likely, was not documented in ancient times and cannot be proved. Another way to look at the issue is to try and verify Barbour's assertions—which he stated without any supporting statistics—about Young (thus also Vallotti) as the "ideal form ... of 'good' temperaments". Let us start from the circular temperaments proposed by the main German High-Baroque writers on the matter, Werckmeister and Neidhardt, and see how much their *opera omnia* compares with Vallotti. One way to do that, both intuitive and acoustically correct, is to find out the shape of the Circle of Major Thirds for "the average circular 'Werckmeister's' temperament and "the average circular 'Neidhardt's' temperament.

## 5. AVERAGING TEMPERAMENTS

Nowadays, when accurate numerical data for the main historical temperaments are available neatly arranged in computer spreadsheets (<http://temper.braybaroque.ie/spread.htm>), it is not difficult at all to compute an average of a set of several temperaments: one simply computes the arithmetical average of the deviations in Cents for each one of the 12 Fifths. It can be mathematically proved that the result is an acoustically-correct 12-note temperament.

PROOF. The only requirement for a succession of 12 deviations of Fifths in Cents  $D_i$  ( $i=1\dots 12$ ) to be a musical temperament, is that their sum  $\sum_{i=1,12} D_i$  has to add up to the Pythagorean Comma ( $P_c = 23.46$  Cents) with negative sign. Let now  $n$  different temperaments be defined as  $n$  successions of 12 deviations each,  $k=1\dots n$ , each one fulfilling the above requirement. We thus have  $\sum_{i=1,12} D_{ki} = -P_c$ , for each  $k=1\dots n$ . Their averages are a succession of 12 Fifth deviations obtained as

$$\begin{aligned}
 A_i &= (\sum_{k=1, n} D_{ki})/n, \text{ for each } i=1,12. \text{ Let us now add them up:} \\
 \sum_{i=1,12} A_i &= \sum_{i=1,12} (\sum_{k=1, n} D_{ki})/n \\
 &= [\sum_{i=1,12} (\sum_{k=1, n} D_{ki})]/n \\
 &= [\sum_{k=1, n} (\sum_{i=1,12} D_{ki})]/n \\
 &= [\sum_{k=1, n} (\sum_{i=1,12} D_{ki})/n] \\
 &= [\sum_{k=1, n} (-Pc)/n] \\
 &= n \times (-Pc)/n = -Pc
 \end{aligned}$$

We have thus proved that the average deviations  $A_i$  are a musical temperament.

## 6. WERCKMEISTER'S CIRCULAR TEMPERAMENTS AVERAGE

Let us now average Werckmeister's five circular temperaments:

- "Werckmeister III", his 1st circular temperament, also named "Werckmeister 1st"
- "Werckmeister IV", his 2nd circular temperament, also named "Werckmeister 2nd"
- "Werckmeister V", his 3rd circular temperament, also named "Werckmeister 3rd"
- "Werckmeister VI", his last system of 1691, which he also called "Septenarius"
- "Werckmeister Continuo" temperament from his continuo treatise of 1698.

The result of the spreadsheet calculations is shown in the chart below: the Circle of Major Thirds is clearly, to all practical purposes, very near to Vallotti/Young temperament: not even an experienced tuner can tell the difference by ear.

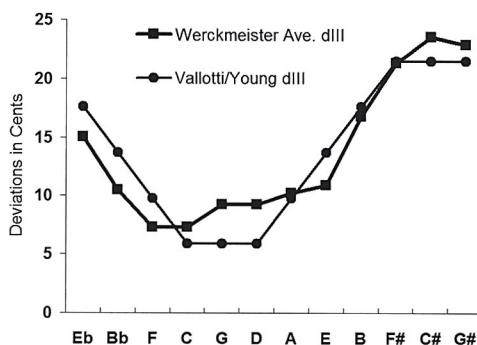


Fig. 2 Average of Werckmeister's Circular temperaments vs Vallotti/Young.

## NEIDHARDT'S CIRCULAR TEMPERAMENTS AVERAGE

Let us now average Neidhardt's circular temperaments, collected in his magnum opus (Neidhardt 1732) and revived by a few modern tuners. Here the matter is more complicated because there are now 21 temperaments and many of them are not circular temperaments. The following 10 ones are clearly to be excluded from the average:

- Neidhardt Pythagorean - Pythagorean tuning
- Neidhardt 5th Circle #1 - Equal Temperament
- Neidhardt 5th Circle #2 - Major Thirds all equally-tempered
- Neidhardt 5th Circle #3 - Major Thirds all equally-tempered
- Neidhardt 5th Circle #4 - Major Thirds all equally-tempered
- Neidhardt 5th Circle #5 - Major Thirds randomly tempered between 10 and 16 C.: coarse approximation to Equal Temperament
- Neidhardt 5th Circle #6 - Major Thirds all equally-tempered
- Neidhardt 5th Circle #9 - Major Thirds all equally-tempered
- Neidhardt 5th Circle #12 - (same properties as 5th Circle #5)
- Neidhardt Chapter VII Example #1 - This is a Just Intonation variant

We will thus average Neidhardt's remaining 11 temperaments only, all of them circular:

- ▶ Neidhardt 5th Circle #7
- ▶ Neidhardt 5th Circle #8, suitable for a Big City
- ▶ Neidhardt 5th Circle #10
- ▶ Neidhardt 5th Circle #11
- ▶ Neidhardt Chapter VII Example #2
- ▶ Neidhardt Chapter VII Example #3
- ▶ Neidhardt 3rd Circle #1, suitable for a Village
- ▶ Neidhardt 3rd Circle #2, suitable for a Small Town
- ▶ Neidhardt 3rd Circle #3
- ▶ Neidhardt 3rd Circle #4
- ▶ Neidhardt 3rd Circle #5

The Figure below shows the resulting Circle of Major Thirds: clearly the average is quite near to Vallotti's temperament. Both curves in the chart can be heard and described as "mid-unequal" by comparison against other circular systems, some much more unequal, some much less unequal, utilised in other ancient times and pieces.

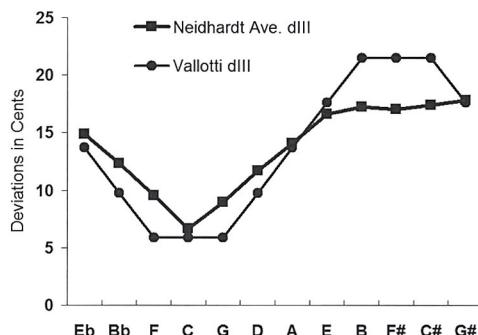


Fig. 3. Average of Neidhardt's Circular temperaments vs Vallotti.

Certainly the curves in the chart show Neidhardt's temperaments to be on average slightly less unequal than Vallotti, but this does not detract from the argument for the latter. There is scarce evidence for the practice of Neidhardt's circular temperaments in Baroque times and, after all, he was a supporter of Equal Temperament. Some modern writers have described how Baroque German musicians evolved" from an openly unequal Vallotti into Equal Temperament "via" intermediate mildly-unequal systems à la Neidhardt (like his "3rd Circle No.2 for a Small Town" or the even less unequal "3rd Circle No.5"). However, the historical record seems to shows otherwise. The change was quite swift indeed: by the mid-eighteenth century-eighteenth century, old musicians like J.S.Bach and Telemann would still be following very unequal tunings, while young C.P.E. Bach and others were already tuning in Equal Temperament, which was quickly gaining ground and would soon become predominant.

## 8. CONCLUSION

Vallotti and Vallotti/Young temperaments are ideal historical and practical tuning systems for High Baroque music making. Most importantly, regardless of their initial time and area coverage, they also match very closely the "average" of the circular temperaments described by the main German High Baroque writers on temperament: Werckmeister and Neidhardt.

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