
Bach-Style Keyboard Tuning

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Mark Lindley and Ibo Ortgies

Bach-style keyboard tuning

BRADLEY Lehman's two-part essay 'Bach's extraordinary temperament: our Rosetta stone' published in *Early music*, xxxiii (2005), was brilliantly written, but we have noticed many weak links in his chain of reasoning. Perhaps the best way to begin to sort them out is to comment on some of his implicit premises (represented here in *italics*; our comments follow in roman).

Bach's keyboard compositions were influenced by a style of tuning whereby the 3rds among the naturals (F–A–C–E–G–B–D–F) were tempered less than those involving sharps or flats (but neither F–A nor G–B less than C–E) while the temperings of the other 3rds tended to vary gradually in keeping with their relative places around the circle of 5ths.

We agree. (See fig.1.)

The '48' are presumably the work of an expert and musicianly tuner.

We agree.

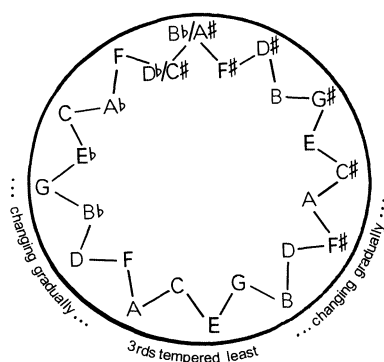


Fig. 1 General pattern of how the 3rds are treated in a Bach-style unequal temperament

Bach's tunings of keyboard instruments were always the same.

We think that his skills and tastes probably developed, and that his tunings of stringed keyboard instruments may have been influenced by (a) the musical genre for which he was tuning on this or that occasion¹ and/or (b) the timbre of the particular instrument.

He tuned certain 5ths pure, tuned others just like in equal temperament, and tempered all the rest—including C–G–D–A–E—exactly twice as much.

There is indeed a musical reason to temper C–G–D–A–E alike. If C–E is the smallest major 3rd, then the average amount of tempering in the chain of 5ths C–G–D–A–E has to be higher than in any other such chain, so it is best for none of them to be impure by more than that average. Even when the major 3rds are to be of various sizes (and we have agreed that such nuances influenced Bach as a composer), still the 5ths should be tempered as unobtrusively as possible, because impurity is more obtrusive in a 5th than in a 3rd.

But there has never been any musical reason to limit the choice of size for C–E to only two possibilities: the equal-temperament size and the size yielded by tempering C–G–D–A–E twice as much as in equal temperament. Musicians might well prefer an intermediate size.

He had a secret mathematical scheme which was passed down by word of mouth or by making exact copies of a certain drawing (see below).

There is no good evidence for this. Neither Bach nor any of his relatives or friends or enemies are known to have hinted at such a thing.² On the

contrary, 18th-century sources inform us that:

*Unser seel. Bach ließ sich . . . nicht in tiefe theoretische Betrachtungen der Musik ein, war aber desto stärker in der Ausübung*³

Our late [J. S.] Bach did not get involved in deep theoretical treatments of music, but was all the stronger in its practice

—and (more unequivocally to the point):

Selbst der in der Mathematik so gelehrte Johann Sebastian Bach habe sich in diesen Fragen nach der Natur, nicht nach der Regel gerichtet, und die ganze Mathematisirerei habe noch nicht einmal den Erfolg gehabt, die Durchführung einer einwandfreien Temperatur zu gewährleisten.

Even Johann Sebastian Bach, who was so learned in mathematics, would, in these [music-theory] questions, have complied with Nature, not with the [theorists'] rule[s], and [indeed] all the [theorists'] mathematizing would not ever have led to success in ensuring the execution [by a keyboard tuner] of an unobjectionable temperament.⁴

The secret is hidden in a decorative scroll of loops on the title-page of an autograph copy of Part 1 of the '48'.

Amateur scholars of 18th-century tuning have been entertaining this idea since 1999,⁵ but we doubt it, because (a) decorations of this kind occur now and then in 18th-century manuscripts and are nothing special, and (b) in no documentary evidence regarding Bach is there any hint of such a special use of decorative loops.

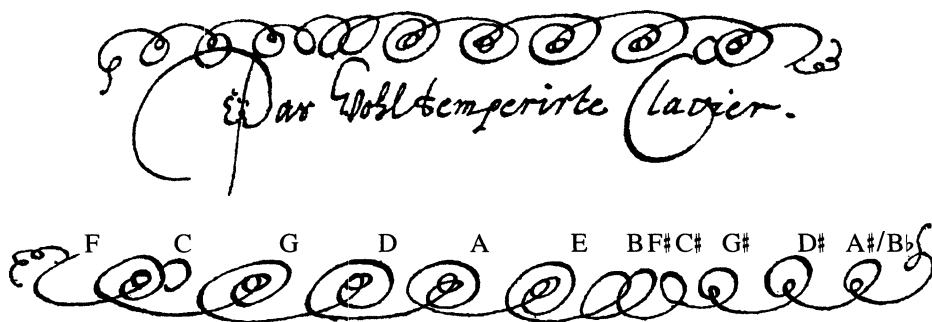
There is only one musically feasible way to interpret this alleged evidence.

Several other ways, of similar musical quality, are available on the internet, and they have, as we will show in the appendix, hardly exhausted the musically feasible solutions to the alleged riddle.

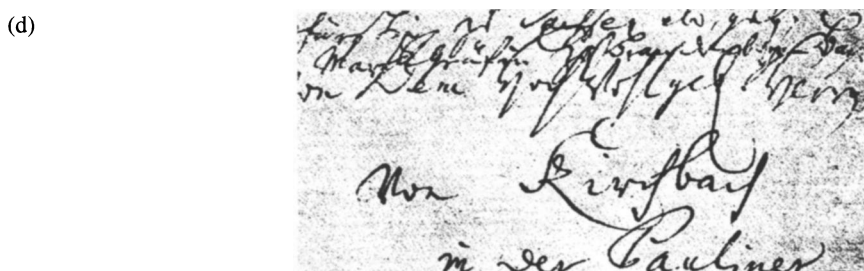
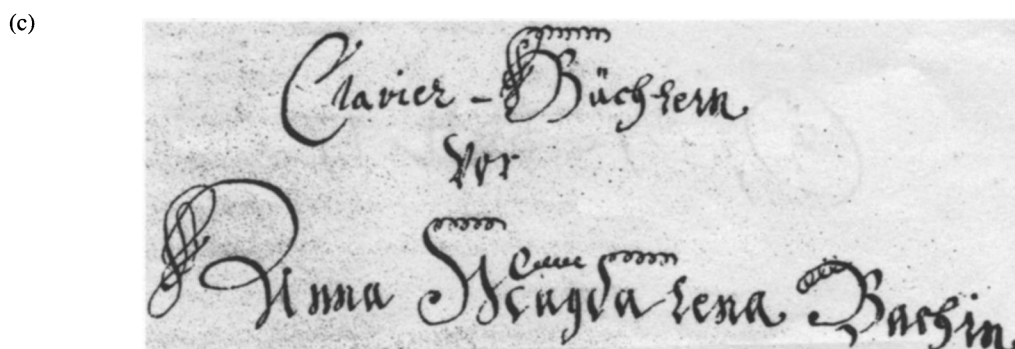
(Dr Lehman calls the decorative loops a 'Rosetta Stone', but whereas there was always a consensus as to its significance, and for well over a century there has been a fairly complete consensus as to its meaning,⁶ there will be no positive consensus about the loops.)

The secret is revealed when one looks at the loops upside down (see illus.1) after having noticed the small letter 'c' next to one of the loops.

The alleged small c is a kind of serif applied frequently in Bach's handwriting to certain capital letters, especially C, S, E, F and sometimes K. A small c in 18th-century German handwriting would look different. It would normally have a horizontal stroke at the top, but sometimes that stroke would be elided into the next letter, or sometimes, because of haste, omitted altogether, in which case the c would look like an undotted i. Let us illustrate with some details from four plates in a standard anthology of facsimiles of pages from original manuscripts of music by Bach. In illus.2a the initial capital C has a serif, and there are three small c's with top horizontal strokes of various lengths. In illus.2b the capital C in 'Concertino' has the serif, and the horizontal strokes of the small c's are, in each case, elided with the following e. In illus.2c the horizontal stroke of each small c (i.e. in 'Büchlein' and in 'Bachin') is elided with the following h (and the initial capital C has a different kind of serif). This title has obviously been written with care and therefore slowly; but in illus.2d the small c's in 'Kirchbach' look like undotted i's, and meanwhile the K has a serif like those which illus.1, 2a and 2b show adorning C.



1 How Dr Lehman associates the various decorative loops at the top of Bach's title-page with various 5ths



2 Details from various plates in Alfred Dürr's *Johann Sebastian Bach: seine Handschrift...* (Breitkopf & Härtel, 1984): (a) from plate 16 ('Concerto primo á 2 Corni di Caccia...'); (b) from plate 40 ('Concerto. Violino Concertino. '); (c) from plate 17 ('Clavier-Büchlein / vor / Anna Magdalena Bachin'); (d) from plate 35 ('... Von Kirchbach / in der Pauliner...')

Before saying more about Dr Lehman's scheme (other than that it has some 5ths tempered twice as much as others), let us recall Dr Lindley's characteristic way (fig.2) of representing the amounts by which the various 5ths, 4ths and major 3rds are tuned impure in equal temperament (the 5ths smaller than pure, the 4ths and major 3rds larger). (When we use the term '5th' for a pitch-class interval we mean of course to include implicitly the corresponding 4th.) Some German theorists in Bach's day, most notably Johann Friedrich Neidhardt and Georg Andreas Sorge, used in their discussions of temperament the same unit of measure as here, i.e. the amount of impurity which equal temperament imposes on the 5ths and 4ths. The major 3rds in equal temperament are, as indicated in fig.2, tempered just about exactly seven times as much.

Three conditions have to be met if such a diagram is to be valid in relation to what it represents.

(1) The total amount of tempering for the circle of 5ths/4ths has to be 12. (In equal temperament it is 12×1 , with each 5th tempered one unit smaller than pure, each 4th larger). Of course one does not count *both* for $D\flat-A\flat$ and for $C\sharp-G\sharp$, *both* for $A\flat-E\flat$ and for $G\sharp-D\sharp$ etc.; each of these pairs counts as only one step around the circle.)

(2) The total for each chain of four 5ths/4ths and the resulting major 3rd has to be 11 (because 11 such units of measure are almost exactly the amount by which a pure major 3rd, i.e. with the frequency-ratio 5:4, falls short of the sum of two pure 5ths minus two pure 4ths with their frequency-ratios of 3:2 and 4:3 respectively).

(3) The total for each column of major 3rds has to be 21 units. (In equal temperament it is 3×7 , with each major 3rd tempered larger than pure. It so happens that the sum of three pure major 3rds falls short of a pure octave by almost exactly $\frac{21}{12}$, the amount by which a pure octave falls short of the sum of six pure 5ths minus six pure 4ths.) For instance, if C-E is tempered by, say, exactly four units,⁷ and if either E-G# or else A-C is tempered the same as in equal temperament, then one of those two latter intervals has to be tempered by ten units, since $4 + 7 + 10 = 21$.

The correct interpretation of the loops is as shown in fig.3.

Notice that in this scheme E-G# is tempered by ten units and that this is more than the tempering of any other major 3rd.

No claim as to how Bach tuned keyboard instruments can be accepted as valid unless the result is stylistically akin to some kind of temperament that is approved of in contemporary German writings on keyboard tuning.

We agree.

Among 18th-century writers on tempered tunings, Sorge was relatively closely associated with Bach.

We agree. Neidhardt was the other contemporary writer on tempered tuning whose ideas about it may also be considered (though for different reasons) to have been in some ways relatively close to Bach's.⁸

Significant documentary support for the claim that Bach always tempered E-G# by as much as shown in fig.3 is to be found in some remarks by Sorge implying that he considered the scheme represented here in fig.4 to be the only form of unequal temperament that really works for tonal music.

We disagree, for a combination of reasons:

(a) Sorge did not call it the best or the only good form, but only

eine der besten ungleichschwebenden Temperaturen ... welche ich bey einer Chortönigen Orgel vor die beste halte.⁹

one of the best unequal temperaments, ... which I hold to be the best for an organ at Chorton.

The peculiar thing about playing on an organ at Chorton was that when accompanying other instrumentalists, one had to play in a key different from the one they were playing in. That key of theirs would be (except in the case of 'transposing' instruments) the one the music was written in; so the organist would have to transpose. But Dr Lehman says *his* scheme was applicable to *all* kinds of playing on organs or harpsichords.

(b) Neither Sorge nor Neidhardt ever countenanced tempering E-G# (for any reason whatever) by as much as Dr Lehman says Bach always tempered it.

	C#	1	G#	1	D#	1	A#
	7		7		7		7
	A	1	E	1	B	1	F#
	7		7		7		7
	F	1	C	1	G	1	D
	7		7		7		7
D $\flat$	1	A $\flat$	1	E $\flat$	1	B $\flat$	1
							F

Fig. 2 Equal temperament

	C#	1	G#	1	D#	1	A#
	9		10		9		8
	A	2	E	0	B	0	F#
	3		3		5		7
	F	2	C	2	G	2	D
	9		8		7		6
D $\flat$	1	A $\flat$	1	E $\flat$	1	B $\flat$	-1
							F

Fig. 3 Dr Lehman's scheme

	C#	0	G#	1	D#	1	A#
	8		9		8		8
	A	1	E	0	B	1	F#
	5		4		6		7
	F	0	C	2	G	2	D
	8		8		7		6
D $\flat$	0	A $\flat$	1	E $\flat$	1	B $\flat$	1
							F

Fig. 4 One of Sorge's several schemes

(c) Neidhardt would never countenance tempering E–G# more than A $\flat$ –C.¹⁰ This is relevant because Bach's student and son-in-law Johann Christoph Altnikol said that Zacharias Hildebrandt, who is known to have been paid in the 1730s and 40s to tune harpsichords in two churches in Leipzig where Bach was the Kapellmeister,¹¹ tuned in a Neidhardt-like way (see below). There is good evidence that in late-17th- and early-to-mid-18th-century France the 5ths E $\flat$ –B $\flat$ –F were tuned *larger* than pure, which happens to ensure that A $\flat$ –C is tempered more than E–G#. (This is relevant because there is good evidence that Bach as a young keyboard performer/composer was influenced by French musicians.¹²) And, A $\flat$ –C is tempered more

than E–G# in the kind of temperament described in 1756 by Wilhelm Friedrich Marpurg (a knowledgeable devotee of Bach's music who oversaw the first edition of Bach's *Die Kunst der Fuge*) as 'the best of the unequal temperaments that are in use'.¹³ These facts are only some of the ample evidence from 18th-century writings that weigh against the idea of tempering E–G# more than A $\flat$ –C under normal circumstances.¹⁴

(d) One can readily derive from the decorative loops a scheme of temperament in which A $\flat$ –C is tempered more than E–G#. The appendix will show this.

The aesthetic judgement of modern listeners can serve as one kind of evidence as to how Bach tuned.

Here we differ from each other in our opinions. Dr Ortgies believes that modern taste cannot be evidence of 18th-century taste about such a subtle thing, whereas Dr Lindley has always hoped that a broad modern consensus could serve as ancillary evidence,¹⁵ and has proposed to Dr Lehman 'a joint presentation . . . for the purpose of . . . demonstrating aurally to the same people on the same occasion' their respective musical results. Such a forum might either lift the discussion above the level of *De gustibus non disputandum* or else leave it there and confirm Marpurg's prediction (1776) that if equal temperament did not prevail, then 'from time to time we shall be presented with a new kind of unequal temperament and each [person] will regard his own as the best'.¹⁶

Bach's occult mathematical invention is of such beauty¹⁷ that it suits uniquely well the extant music of Froberger (1616–67) and Frescobaldi (1583–1643).

This finding is historically outlandish (and therefore undermines the hope which one might have entertained about the value of Dr Lehman's aesthetic judgment as ancillary evidence for the taste, in this regard, of musicians in bygone centuries). Many keyboard instruments with 14 notes per octave (and therefore presumably tuned in some form of mean-tone temperament) were routinely available to Frescobaldi and Froberger, and each of them had plenty of access to more elaborate 'enharmonic' instruments with 19 or even 31 notes per octave.

Indeed, Frescobaldi was said to be a virtuoso player of the 31-note archicembalo—and, as for instruments with 12 notes per octave, a very knowledgeable contemporary of his at Rome, Giovanni Battista Doni, published in 1640 an account of Frescobaldi's having recommended the use of equal temperament on an historically important new organ there. (The recommendation was rejected because Doni opposed it.) Froberger was at that time a pupil of Frescobaldi's, and later had access to enharmonic instruments at the Habsburg courts in Vienna, Prague and Innsbruck; he is known to have been in touch with a leading theorist (Christiaan Huygens) of a 31-notes-per-octave tuning; and one of his former students (Michael Buliowsky) published several books about it.¹⁸

A modern harpsichordist's historical misjudgments are no great moral lapse, however. The music belongs to Dr Lehman just as much as to us and we wish him well in performing it.

In fact it is ideal for all kinds of music by various performer/composers.

Evidence from Sorge, Neidhardt and Marpurg (among others) discredits this idea. Sorge recommended for a limited kind of use the scheme represented in fig.4. Neidhardt recommended different schemes for different social contexts (village, small town, large town, court). Marpurg said that unless equal temperament were adopted everyone would regard his own unequal temperament as the best one.

A significant degree of aesthetic and historical consensus is indicated when the wife of a man who is passionately committed to a certain aesthetic point agrees with him.

Caveat lector.¹⁹

DR Lehman's one-size-fits-all approach to 18th-century-style tuning is not only historically mistaken but also likely, we think, to distract one from noticing some relevant facts about church organs in those days. They were harder to tune well than harpsichords are, and more so than most modern organs, since the flue pipes had no tuning sleeves and the wind supply was powered by human muscles (not by an electric motor). Sorge said

that retuning an organ would take many weeks,²⁰ and this observation is confirmed by 18th-century church records,²¹ which also show that during an organ examination²² the tuning could sometimes not be assessed on a certain day because of unsuitable weather.

An extensive survey by Dr Ortgies has shown that, until well after the middle of the 18th century, north German organ-building contracts and organ-examination reports seldom refer to any particular kind of temperament.²³ Usually they just say that the tuning is OK or is *passabel* (i.e. tolerable but not very good) or that it needs some (unspecified) adjustments—which may well usually mean that a standard style of organ temperament had been more or less successfully achieved. There is no lack of documentary evidence that (a) equal temperament was not yet standard for keyboard instruments,²⁴ and (b) organs were, as Bach's son Carl Philipp Emanuel put it in 1753, 'seldom well tempered'.²⁵ Instead they were most often in some old-fashioned kind of temperament ill suited to most of his father's organ compositions. Sorge noted that on two Gottfried Silbermann organs that he had seen,²⁶ the 5ths were tempered, all alike, by more than in equal temperament and yet less than enough to yield pure major 3rds. On those organs, he said:

*In den 4. schlimmen Triadibus ist ein rauhes, wildes, oder, wie Herr Capellmeister Bach in Leipzig redet, ein barbarisches Wesen erhalten, welches einem guten Gehör unerträglich fällt. ... Wenn ... mancher Instrument- und Orgelstimmer nur noch so gut stimate, wie Werckmeister von 57. Jahre gestimmt hat, so wäre es noch gut.*²⁷

In the four bad [major] triads there is a rough, wild, or, as Maestro Bach in Leipzig says, a barbaric result, which is intolerable to a good ear. ... If many a [keyboard-]instrument- and organ-tuner [today] would tune only as well as Werckmeister tuned 57 years ago, even that would be good [enough].²⁷

No extant documents from Bach's lifetime say that he (or anyone else) performed on an organ his written keyboard compositions; the reports of his playing refer apparently to improvisation. Maybe all the organs in regard to which first-hand reports of his playing have been preserved (i.e. instruments that he performed on as a visitor but did not use habitually every week) were tuned in a

kind of temperament, a regular meantone temperament (albeit perhaps with the major 3rds larger than pure, as on the Silbermann organs criticized by Sorge), that would spoil most of his liturgical keyboard compositions and other organ pieces.²⁸ In this light it is notable that when he composed and compiled Part 1 of the '48' (which he completed in 1722) he was mainly a court musician in Cöthen, not a church musician with responsibilities as an organist. His position as cantor in Leipzig from 1723 on gave him no official responsibility for looking after the organs there, and we have no documentary evidence proving that he was involved in designing a temperament for any organ; but he might of course have given opinions or advice about tuning to some organ builders.

A prime candidate for such an honour would have been Hildebrandt, who in the 1730s and 40s was a colleague of Bach's in Leipzig and whom Bach is known to have admired as an organ builder.²⁹ And it was in regard to the tuning of an organ that Altnikol said in 1753 that Hildebrandt in the late 1740s had 'followed Neidhardt'.³⁰ In Neidhardt's books of 1706, 1724 and 1732 there is an evident drift from advocating equal temperament (in 1706) as the best kind of tuning to finding it not quite satisfactory (in 1732); but no one can prove for certain which of the following may have been Hildebrandt's intention:

(1) To match exactly one of Neidhardt's preferred theoretical schemes of unequal temperament. To believe this would entail accepting Dr Lehman's premise that an expert and musicianly tuner would temper some 5ths exactly twice as much as others (but it would preclude nonetheless the possibility that Hildebrandt tuned in the way that Dr Lehman says Bach did).

(2) To tune in a style akin to those schemes without matching any one of them. Dr Lindley favours this idea (and imagines that Hildebrandt, after having perhaps cut the Principal pipes to lengths determined by one of Neidhardt's schemes, would refine the temperament by ear and by using a tuning cone to manipulate the tops of the pipes).

(3) To try to tune in equal temperament. Dr Orgies considers this possibility just as likely as the other two.³¹

Appendix

The decorative scroll (see illus.1) is comprised mainly of three kinds of loops: first, five loops each of which has an elaborate internal squiggle (by 'internal', we mean that it is not on either side of the loop); then three simple loops (two of which overlap, but let us ignore that for now); and then three with a simple squiggle on the left side of each.

Dr Lehman says that the first kind of loop represents a 5th tempered by exactly two theoretical units. But since there are no numbers in the scroll, and since it is unwarranted (as we have explained) to assume that Bach must have tempered some 5ths exactly twice as much as others, one might instead assume hypothetically that the loops indicate merely a uniform tempering of the 5ths that Dr Lehman says they refer to: F-C-G-D-A-E. These 5ths must of course (for those of us who accept the premise embodied in fig.1) be slightly smaller than in equal temperament.

He says that the three simpler loops refer to E-B-F#-C# and call for them to be tuned pure, presumably because a simple loop is plainer than one with a squiggle and because he considers pure 5ths more standard than tempered ones. But those loops might refer instead to another size of 5th which some people already in Bach's day would consider standard, namely, the average size of the 5ths in any circle of 12 and their actual size in equal temperament (hence, indeed, the German theorists' unit of measure). This hypothetical interpretation is just as feasible as Dr Lehman's or anyone else's.

He interprets the three remaining loops as showing that C#-G#-D#-A# were tempered in the same way as F-C-G-D-A-E (i.e. with the 5ths smaller the pure), but exactly half as much. This interpretation ignores the fact that the squiggles here are of quite a different kind from those in the first five loops. A more feasible interpretation would be that these different loops indicate a different kind of relation *vis-à-vis* the standard type of 5ths represented by the simple loops; these different loops might, that is, indicate 5ths slightly *larger* than the standard type.

In fig.5 this interpretation is reduced to a musically feasible numerical scheme without involving any gradations finer than half of the arbitrary unit. Here the pattern of relative sizes among the 3rds involving chromatic notes conforms, better than in Dr Lehman's scheme, with the kind of evidence referred to under points (b) and (c) above.

With far less trouble, however, one can still get a reading of the tea-leaves that we consider musically better (for Bach's music) than Dr Lehman's. To accept nearly all his premises while assuming that the loop touched by the

serif refers to C–G rather than to F–C would have the effect of transposing his scheme up a 5th and thereby making the B-major triad, which concludes each part of the ‘48’, the most heavily tempered one whereas the C–major one is still tempered least (fig.6).

Two of the several interpretations posted last year on the internet are represented in fig.7. At www.bach-cantatas.com/articles/das_wohltemperirte_clavier.htm there is an interpretation based on units of 1/7 and 1/14 of the Pythagorean comma. And so on.³² None of the interpretations that we have seen takes stock of the fact that the letter D in ‘Das’ intersects one of the loops, that the W in ‘Wohltemperirte’ is aligned vertically with the two

	C#	½	G#	½	D#	½	A#	
	6½		7½		8		8½	
A	1½	E	1	B	1	F#	1	C#
5		5		5½		6		
F	1½	C	1½	G	1½	D	1½	A
9½		8½		7½		6½		
D♭	½	A♭	½	E♭	½	B♭	0	F

Fig. 5 An alternative interpretation of the scroll

	C#	0	G#	1	D#	1	A#	
	7		9		10		9	
A	2	E	2	B	0	F#	0	C#
6		3		3		5		
F	-1	C	2	G	2	D	2	A
8		9		8		7		
D♭	0	A♭	1	E♭	1	B♭	1	F

Fig. 6 Another alternative

	C#	⅔	G#	⅔	D#	⅔	A#	
	9		10⅓		9⅔		9	
A	2	E	0	B	0	F#	0	C#
3		3		5		7		
F	2	C	2	G	2	D	2	A
9		7⅔		6⅓		5		
D♭	⅔	A♭	⅔	E♭	⅔	B♭	0	F

(See <http://bachtuning.jencka.com/essay.pdf>.)

overlapping loops, that the beginning and end of the scroll of loops are not alike . . . and yet Dr Lehman says that no detail must be left unaccounted for. The whole idea is daft, but if he really wishes to pursue it, let him account for all the details and take into consideration all the ‘hidden’ German letters here and there in the upper part of the title-page that can be detected upon consulting Tafel IV etc. in Grun’s *Leseschlüssel*³³ (if he is not in a position to consult primary sources).

Dr Lindley suggests the following as an expert and musicianly approach to setting a Bach-style unequal temperament on harpsichords (and pianos) at modern pitch:³⁴

(1) Starting from E, set the major 3rds above and below it. Make tenor’s low C beat with E at least 3 but less than 3½ times per second. (Exactly what is done here will determine the overall degree of inequality in the temperament.) Make G# beat with tenor’s low E at least 7 but no more than 7½ times per second. (What is done here will determine the balance between the rates at which (a) the successive sharps (F#, C#, G# . . .) and (b) the successive flats (B♭, E♭, A♭ . . .) will make successively smaller diatonic semitones with the naturals.)

(2) Temper the 5ths/4ths C–G–D–A–E all by exactly the same amount (as if beginning to tune a strictly regular temperament with all the major 3rds the same size as C–E; for instance, the As a 4th below and a 5th above middle D should beat half again as fast with that D as that D does with the G the 5th below, and those intervals between A and D should beat 3/4 as fast as the 4th between middle D and middle G).

(3) Temper E–B and F–C rather like each other and a little less than C–G–D–A–E have been tempered, so that F–A and G–B are alike tempered a little more than C–E. Check with some appropriate musical examples (e.g. the first bar of the Goldberg Variations).

	C#	1	G#	1	D#	1	A#	
	8		8½		8		7½	
A	1½	E	½	B	½	F#	½	C#
5		5		6		7		
F	1½	C	1½	G	1½	D	1½	A
8		7½		7		6½		
D♭	1	A♭	1	E♭	1	B♭	0	F

(Contact Thomas Glueck at glueck10@aon.at.)

Fig. 7 Two more

(4) The rest is a cinch if you can (a) play Bach's music and (b) make very subtle tuning adjustments. The remaining four pitch classes make two chains of 5ths: B–F#–C#–G# and A–E–B–F. In tuning each of the six 5ths involved, make it pure or temper it less than E–B

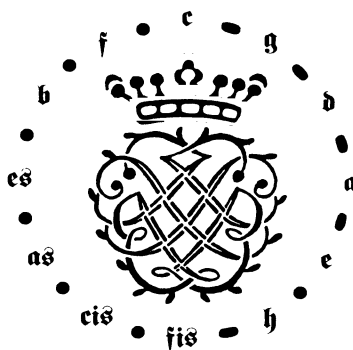
and F–C, and meanwhile for each of the four pitch-classes be guided by the effect in Bach's music of both the flat and the sharp (for instance, of both E♭ and D#, of both C# and D♭) when used in the resulting 3rds, 6ths and semitones.

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1 We should perhaps mention that neither of us think Bach tuned differently for different keys.

2 Bach put into his son Friedemann's musical notebook (which contains the oldest extant versions of 11 preludes for Part 1 of the '48') some fingerings and a table of ornaments, but nothing about tuning. The late Dr Herbert Kellner believed that the design of Bach's seal, with its seven points and five dashes (see illus.3), proves that Bach tuned seven 5ths pure and tempered the other five, viz. C–G–D–A–E and B–F#. Dr Lindley has remarked that if the design of the seal referred to music, then a more obvious meaning would be that normal keyboards provide five chromatic and seven diatonic notes, whereas if it referred to tempered *versus* untempered 5ths, an interpretation better suited to 18th-century documentary evidence and to the design of the seal would be that there was an unbroken chain of seven equally tempered 5ths while the other five were pure. Marpurg in 1756 described such a scheme (with the pure 5ths being among the chromatic notes and between B♭ and F) as 'the best of the unequal temperaments that are in use' (see n.13 below). (These remarks by Lindley led Stanley Sadie to reject an article which Dr Kellner submitted in 1985 to *The musical times*.)



3 Bach's seal, annotated with pitch names by Kellner

3 Lorenz Mizler, *Musikalische Bibliothek*, iv (Leipzig 1754), p.173.

4 Until World War II, Forkel's lectures of 1772 existed in autograph (see *Bach Dokumente*, ii, pp.240–41). Research published before World War II provides us with a précis summarizing Forkel's comment.

5 To discuss this would entail discussing an allegation of plagiarism (or something of the kind) that has been made against Dr Lehman; but to go into all that would be extraneous to our purpose here.

6 See R. Parkinson, *Cracking codes: the Rosetta Stone and decipherment* (Berkeley, 1999), pp.20, 41–3.

7 It is musically infelicitous, in Neidhardt's and Sorge's theoretical schemes attributing four units of temperament to C–E, that C–G–D–A–E are not treated all alike. This defect in their theory is due to their unwillingness to deal in fractions of their unit of measure for tempering. That same unwillingness is responsible for Sorge's incorrect statement (1748) that Michael Praetorius had (in 1619) called for all the 5ths in a meantone temperament to be tempered by 3 units. A far more correct reckoning would be $2\frac{3}{4}$. Praetorius had (relying on a well-known theoretical scheme first published in 1571 by Gioseffo Zarlino) assumed that the major 3rds were to be pure, while the 5ths would be tempered uniformly. In terms of the 18th-century German unit of measure, the amount of tempering for each 5th would thus be $11/4$.

8 Sorge and Bach were admitted in the same year to a 'Society for Musical Sciences' founded by a friend of Bach's, Lorenz Mizler. In the society's journal Mizler said that Werckmeister's temperament 'was the best in its own day, but had been improved since the time of Neidhardt' (Mizler, *Musikalische Bibliothek*, i/3, p.55). Bach's son-in-law and former pupil Joseph Christoph Altnikol remarked in 1753 that in Neidhardt's kind of tempering, 'One can modulate perfectly well in all keys without giving the ear something crude to hear.' See U. Dähnert, *Der Orgel- und Instrument-Bauer*

Zacharias Hildebrandt (Leipzig, 1962), p.115. Another former pupil of Bach's, Johann Philipp Kirnberger, published in 1774 a scheme of temperament with C-E and most of the 5ths pure; but when Sorge and Marpurg published strong criticisms of this idea, Kirnberger acknowledged (to someone else) that his time spent on such matters had been wasted. See M. Lindley, 'Stimmung und Temperatur', *Hören, messen und rechnen in der frühen Neuzeit*, ed. F. Zaminer, = *Geschichte der Musiktheorie*, vi (Darmstadt, 1987), pp.109-331, at pp.278-82.

9 Sorge, *Zuverlässige Anweisung, Claviere und Orgeln gehörig zu temperiren und zu stimmen* (1758), pp.18-20.

10 Neidhardt recommended, in his various books, five different theoretical schemes (one of which was equal temperament) for use in this or that social context. In terms of 21 indivisible units being distributed among A♭-C-E-G♯, he would give A♭-C and E-G♯ the same amount in equal temperament and in one other scheme where C-E has an odd number of units. In the other three schemes, an even number of units is accorded to C-E, and A♭-C is accorded one more unit than E-G♯.

11 See Dähnert, *Der Orgel- und Instrument-Bauer Zacharias Hildebrandt*, p.80.

12 Mizler, *Musikalische Bibliothek*, p.162.

13 Marpurg, *Principes du clavecin* (Berlin, 1756), p.5.

14 Johann Jakob Engel said in 1780 that the two major keys which unequal temperament rendered the most dissimilar in character were C and A♭ major; Muzio Clementi was reported in 1784 to have said that E-G♯ should be tempered 'very high', but A♭-C 'even higher'; etc.: see Lindley, 'Stimmung und Temperatur', chaps.6-8.

15 Lindley's hopeful attitude has been due to the consistently warm reception accorded in the last 30 years to his more than 90 public demonstrations of a style of subtly unequal temperament with A♭-C tempered more than E-G♯. An equally warm reception accorded consistently for many years to

Dr Lehman's tuning would strengthen Dr Orgies's doubt that modern taste can supply evidence one way or the other. We may mention on this subject that the distinguished harpsichordist Davitt Moroney remarked last year, after performing an all-Bach recital, that Dr Lehman's temperament would not have been satisfactory for that programme of Inventions, Sinfonias, BWV904 and BWV998.

16 Marpurg, *Versuch über die musikalische Temperatur* (1776), p.194.

17 Dr Lehman attributes to the 11 5ths F-C-G-D-A-E-B-F♯-C♯-G♯-D♯-A♯ a total amount of tempering that is more than the Pythagorean comma (i.e. more than the amount by which six pure 5ths minus six pure 4ths exceeds an octave), and he is thereby obliged to infer that Bach tuned B♭-F with the 5th larger than pure and the 4th smaller, contrary to normal 18th-century German practice. (Hence the negative number in fig.3.) His B♭ is lower than pure (by one unit) in relation to both E♭ and F. A scheme that was otherwise the same but with E♭-B♭-F pure would be easier to tune; B♭-D would not be (as it is in his scheme) tempered twice as much as F-A; and F♯-A♯ would not be (as it is in his scheme) tempered less than B-D♯ and even less than A-C♯.

18 In regard to Frescobaldi's recommendation of equal temperament, see M. Lindley, 'Instructions for the clavier diversely tempered', *Early music*, v (1977), pp.19-23, and the cover of that issue. For the other facts cited here in regard to Frescobaldi and Froberger, see Dr Orgies's postings of 20 March 2005 at www.HPSCHD-L@listserv.albany.edu.

19 Dr Lehman sets out additional arguments (of similar value) in his *EM* article and at www.larips.com and other websites. A recording of a high-quality pipe organ tuned according to his formula is available via www.goshen.edu.

20 Sorge, *Anweisung zur Stimmung und Temperatur sowohl der Orgelwerke, als auch anderer Instrumente, sonderlich aber des Claviers* (1744), p.22: '... es verlohnt sich der Mühe wohl, und

wenn auch einige Wochen damit zubringen sollte.'

21 Church records appear to indicate, for instance, that the retuning of a large organ in the Hanseatic cities (such as Lübeck) would go on for as many as 120 working days. See I. Orgies, *Die Praxis der Orgelstimmung in Norddeutschland im 17. und 18. Jahrhundert und ihr Verhältnis zur zeitgenössischen Musikpraxis* (PhD diss., Göteborg U., 2004), chap.5.

22 When a pipe organ is built or rebuilt it is customary to have one or more organists examine the instrument and say whether the terms of the contract have been filled satisfactorily. Andreas Werckmeister's first book, *Orgelprobe* (1681), was about this kind of work. His comments there on temperament were in effect a suggestion that examiners try to influence builders to adopt a new approach to it. But of course a decision about that would best be taken (in those days when there were no movable 'sleeves' at the ends of the flue pipes) when the lengths of the flue-pipes were being determined.

23 Orgies, *Die Praxis der Orgelstimmung*.

24 A relevant document from Leipzig is the letter of 1717 from Bach's predecessor there, Johann Kuhnau, which was published in 1725 in Part VII of Johann Mattheson's *Critica musica*. The discussion of keyboard temperaments on pp.233-6 shows clearly, notwithstanding its prolixity, that Kuhnau had never encountered an organ or harpsichord tuned in equal temperament.

25 C. P. E. Bach, *Versuch über die wahre Art das Clavier zu spielen* (1753), p.327: '... weil die Orgeln selten gut temperirt sind'. Even as late as 1798 a journalist in Dresden said that whereas 'old Bach' had on one occasion played the Credo in E♭ and E minor (rather than in its normal key, D minor) on a certain organ in Altenburg, '[O]nly a Bach and [such] an organ [as that one] in Altenburg could do this! Not all of us are or have that!'; see H.-J. Schulze, 'Über die "unvermeidlichen Lücken" in Bachs Lebensbeschreibung', *Bericht des Bachfest-Symposiums 1978 der Philipps-Universität Marburg* (Kassel, 1981), pp.32-42.

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26 Those two organs were at Greiz (made in 1739) and in the Schloßkapelle at Burgk (made in 1742).

27 Sorge, *Gespräch zwischen einem Musico theoretico und einem Studioso musices von der Praetorischen, Printzischen, Werckmeisterischen, Neidhardischen und Silbermannischen Temperatur* (1748), p.28.

28 'Organ repertory' (in the modern sense of a number of compositions liable to be repeated in various performances with virtually no change to each of the compositions) is never mentioned in writings from the 17th century or the first half of the 18th, so it is historically anachronistic to assess organ temperaments on the basis of a modern canon of such repertory, even though many extant non-liturgical keyboard pieces from that era are more idiomatic to the organ than to the harpsichord. The modern concept of repertory has given rise to a correspondingly modern kind of problem when it comes to deciding which kind of temperament to use when restoring an old organ or making a new one for

the performance of this and/or that repertory.

29 Dähnert, *Der Orgel- und Instrument-Bauer Zacharias Hildebrandt*, pp.90–91, 114–15; see also p.83.

30 The credibility of this remark is supported by independent documentary evidence (see Dähnert, *Der Orgel- und Instrument-Bauer Zacharias Hildebrandt*, pp.141–2) that when Zacharias Hildebrandt died in 1757 while building an organ (in Neustadt), his son Johann Gottfried completed the work and used a Neidhardt-type temperament.

31 In Kuhnau's remarks of 1717 cited in n.24 above, the phrase 'Neidhardt's Temperatur' (on p.234, which, however, is misnumbered '134') refers clearly to equal temperament. Ortgies (*Die Praxis der Orgelstimmung*) suggests that a majority of 18th-century north German writers on organ temperament tended to favour equal temperament more than they did nuanced temperaments such as Dr Lehman and Dr Lindley prefer for Bach's music.

32 See n.5 above.

33 P. A. Grun, *Leseschlüssel zu unserer alten Schrift* (Görlitz, 1935, R/Limbarg an der Lahn, 1984), the table between pp.20 and 21.

34 Some of Lindley's numerically specified schemes are to be found in the following publications: 'A quest for Bach's ideal style of organ temperament', *Stimmungen im 17. und 18. Jahrhundert, Vielsch oder Konfusion?* = *Michaelsteiner Konferenzberichte 52* (Blankenburg, 1997), pp.45–67; *Temperaments, a brief survey*, Bate Collection Handbook (Oxford, 1993); 'Enige herziene neo-barokstemmingen', *Het orgel*, xl (1994), p.442; 'Grosvenor Chapel and the eighteenth-century English organ', *BIOS journal*, xv; 'The new Stanford eclectic tunings', *Performance practice review*, iii (1990); and *Beethoven's Variations for Piano, opus 34: genesis, structure, performance* (Schott, 2006).

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