On trying to play a recorder in tune

John Beasley, July 2021

The recorder is an easy instrument on which to start playing, but a difficult instrument to play really well. This paper tries to bridge the gap. It discusses the nature of tuning, shows how the correct tuning of a note may depend on its musical context, and considers how best to achieve this result in practice.

The nature of tuning

Pitch is a matter of frequency, and tuning is a matter of ratios of frequencies. The most important ratios are the minor third (6:5), the major third (5:4), the fourth (4:3), the fifth (3:2), and the octave (2:1). Thus if, to simplify the arithmetic, we have a reference note with a frequency of 240 cycles per second, we have the following:

Interval	Ratio	Frequency
Reference note	1	240
Minor third above	6:5	288
Major third above	5:4	300
Fourth above	4:3	320
Fifth above	3:2	360
Octave above	2:1	480

The frequencies for the notes below the reference note can be calculated similarly. Thus the note a minor third below the reference note (ratio 5:6) has frequency 200, and that a fourth below (ratio 3:4) has frequency 180.

With this in mind, let us build up a chromatic scale starting at C.

Note	Ratio	Definition
C	1	Reference note
C#	25:24	Major third above the A below
D	9:8	Fifth above the G below
Eb	6:5	Minor third above the reference note C
E	5:4	Major third above C
F	4:3	Fourth above C
F#	45:32	Major third above D
G	3:2	Fifth above C
G#	25:16	Major third above E
Ab	8:5	Minor third above F
A	5:3	Major third above F
Bb	9:5	Minor third above G
B	15:8	Major third above G
C	2:1	Octave

It will be noticed that G# and Ab have been given different ratios. *They are quite different notes*. In due course, we shall see just how different.

All these ratios have been between some other note and the reference note. To find the interval between two other notes, divide the larger ratio by the smaller, or, perhaps more conveniently, put the smaller ratio the other way round and multiply them. This to find the ratio between E (5:4) and G (3:2), we have

$$(3:2) / (5:4) = (3:2) \times (4:5) = (3\times4) : (2\times5) = 12:10 = 6:5$$

giving the minor third that we would expect.

If we do this for all the intervals which we would expect to be thirds or fifths, we obtain the results given on the next page.

(Table repeated for convenience)

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- C-G, C#-G#, Eb-Bb, E-B, F-C, G-D, Ab-Eb, A-E, and B-F#, which we would expect to be fifths, are indeed so (ratio 3:2);
- D-A, F#-C#, and Bb-F, which we would expect to be fifths, have ratio 40:27, which is narrow by a factor 81:80;
- C-E, D-F#, Eb-G, E-G#, F-A, G-B, Ab-C, A-C#, and Bb-D are indeed major thirds (ratio 5:4);
- C-Eb, C#-E, E-G, F-Ab, G-Bb, G#-B, A-C, and B-D are indeed minor thirds (ratio 6:5);
- D-F and F#-A, which we would expect to be minor thirds, have ratio 32:27, which is narrow by a factor 81:80.

Appreciation of this factor 81:80, which is known as a 'comma', is essential to any understanding of tuning.

There is one further point. Suppose we write out a second chromatic scale with reference note G instead of C. In this new scale, the note A will be given ratio 27:16 (a fifth above D) instead of 5:3, making it a comma sharper. *Even if your recorder is perfectly in tune in one key, if you try to play it in a different key you will have to lift or lower at least one note by a comma*. This constraint is fundamental and unavoidable.

The width of a comma

So, how wide is a comma, and what is its effect musically?

Physically, it amounts to one part in eighty, or one-and-a-quarter per cent. A typical violin string has a length of from 30 to 35 centimetres, and the lower notes on the string have a sounding length of typically 25 centimetres. One and a quarter per cent of this is slightly more than three millimetres, and good violinists place their fingers more precisely than this. The comma is therefore an appreciable interval.

Musically, consider an accurately tuned major triad C-E-G or minor triad A-C-E. Shift one of these notes by a comma, and the result, depending on the note shifted and on the sensitivity of your ear, will vary from mildly unpleasant to frankly horrible. A lifted major third, or a lower minor third, may be particularly nasty.

To shift a note by a comma makes a very significant difference.

How do you shift a note by a comma?

On a violin, it is easy, in principle if not in performance: you simply put your finger down at a different point on the string. On a recorder, it isn't so easy.

There are only two ways of altering the pitch of a note on a recorder: by blowing harder or softer, or by changing the fingering. Blowing harder raises the pitch of the note, but it also makes it louder. However, if at

the same time you constrict your air passage so that less air comes through, you can raise the pitch of the note without increasing its volume. This can be thought of as "squeezing the note higher", and the reverse operation as "gentling it lower". Professional woodwind players do these almost instinctively (my daughter's husband, who is a professionally trained oboist, can pick up my recorders and play them in tune). People like myself have to work at it.

Changing the fingering is cruder, and normally gives only a closer but still inaccurate approximation which needs fine tuning by breath pressure. Even so, it has a definite role to play. When playing on a descant recorder in D minor or a variant thereof (perhaps C natural as the leading note instead of C#, or B natural instead of Bb), I need to lift both the F and the A of our basic C scale by a comma. If we denote the left-hand index, middle, and ring fingers by 1-2-3, the equivalent right-hand fingers by 4-5-6, and the right-hand pinkie by 7, the F on my present rccorder can be lifted very satisfactorily by fingering 1-2-3-4-6 instead of the textbook 1-2-3-4-6-7. The Bb also tends to sound better in this context if I finger 1-3-5 instead of the textbook 1-3-4. For the A, no convenient alternative fingering is available and the note has to be squeezed up, though there is a clumsy fingering 1-3-4-5-7 which on my instrument is only a fraction sharp and can easily be gentled down. But playing it in a complicated passage is another matter.

I stress that these are merely fingerings which work well on my current recorder. I make no guarantee that they will work on anyone else's; it is for the player to experiment, and find out what works and what doesn't. But one thing I have found on almost every rcorder I have used is that the textbook fingering 1-2-4-5 for G# is unpleasantly sharp, and that adding finger 6 to give 1-2-4-5-6 works much better.

One error that cannot easily be corrected by squeezing or gentling is an incorrect harmonic, where the upper register is not an exact octave above the lower. If the upper E flies sharp, which too often seems to happen, get another recorder.

Simultaneous and consecutive tuning

If you are playing with one or more other instruments, you have to tune to the note or chord which others are playing simultneously. If you are playing on your own, you have to tune to the note or notes you have just played.

The only real solution to learning to tune to another instrument is to have a friendly cellist or violinist who can give you an accurate bass note as a reference. The piano is useless, partly because it is equal-tempered (we'll come to this in a moment) and partly because we want a steady note and not one that starts dying away as soon as it has been struck. Having such a reference note, try to play an accurate fifth, major or minor third, major or minor sixth, or octave above it. Play the fingering that the textbook gives you, and waver it up and down by breath pressure. With any luck, suddenly you will hit on a breath pressure at which the note sounds lovely. This is the one that is in tune. Try to remember what you did, and repeat it,

(I hate trying to tune a unison to another recorder. If the two notes are slightly different, I never know which is mine, and so I do not know which way to shift it. If I am second recorder in a duet which ends on a unison, I mime the final note and leave the first to play it alone. This means that the note is less loud than it should be, but this is much the lesser evil.)

There is a lot to be said for the principle that elementary teaching of woodwind instruments should always be done with a cello on hand to provide a bass. This teaches the player, right from the start, that it isn't enough to put the fingers down as stated in the textbook; you also have to humour the note to get it just right. The tuition fees would be doubled, but the benefits would be immense.

Tuning to the note you have just played is much more difficult, but it has the advantage that you can practise it on your own. The procedure is much as before: play an interval with different breath pressures on the two notes until suddenly you get a combination where one note seems to blend seamlessly into the other. This is the one that is in tune. If it involves an unorthodox fingering for one of the notes, adopt this fingering as standard whenever the music is not too complicated. Then do the same with a different interval, and eventually you will have a usable scale.

And don't try to tune every note individually in a complicated passage. I doubt if even the professionals can do this. Just concentrate on the important notes, and deal with the others as simply as possible. If the important notes are in tune, the audience (if any) won't notice if some of the others aren't quite spot on.

A digression: Just how bad is equal temperament?

A short answer: fairly awful. Let me elaborate.

With equal temperament, all the intervals are the same regardless of key. Specifically, the semitone is the twelfth root of two, the minor third is this to the third power (the progression is multiplicative), the major third this to the fourth power, and so on. This gives the following table.

Note	Ratio	Decimal Equivalent	Equal Temperamemt	Error (% of comma)
C	1	1.0	1.0	0
C#	25:24	1.0417	1.0595	+136
D	9:8	1.125	1.1225	–18
Eb	6:5	1.2	1.1892	–72
E	5:4	1.25	1.2599	+63
F	4:3	1.3333	1.3348	+9
F#	45:32	1.4062	1.4142	+45
G	3:2	1.5	1.4983	–9
G#	25:16	1.5625	1.5874	+127
Ab	8:5	1.6	1.5874	–63
A	5:3	1.6667	1.6818	+72
Bb	9:5	1.8	1.7818	–81
B	15:8	1.875	1.8877	+54
C	2:1	2.0	2.0	0

The first two columns give the note and its true ratio as previously, the third column this ratio to four decimal places, the fourth column the equal-temperament approximation also to four decimal places, and the fifth column the error expressed as a percentage of a comma. I don't guarantee the units digits of the percentages, but the general pattern is clear enough:

- the equal-tempeered fourth and fifth are accurate to within a tenth of a comma;
- the major third is wide, and the minor sixth narrow, by nearly two-thirds of a comma;
- the minor third is narrow, and the major sixth wide, by nearly three-quarters of a comma.

To put these figures into a physical context, we saw earlier that a comma was equivalent to slightly over three millimetres in a 25cm violin note. The error in the major third is therefore about two millimetres, and that in the minor third a little more. Again, a good violinist's fingers will be placed more accurately than this.

It is also instructive to consider the difference between G# and Ab. The ratio is 125:128, so the difference is three parts in 125 or 24 parts in a thousand (2.4 per cent). If our violin E string is 30-35 centimetres long, the sounding length of G# will be 24-28 centimetres (fourth-fifths of the string length), and 2.4 per cent of this will be well over half a centimetre.

In my experience, people who haven't looked at the figures before tend to be most surprised when I point out that an equal-tempered major third is two millimetres sharp, and an equal-tempered minor third more than two millimetres flat, on a typical violin string. They are even more surprised, often to the point of open disbelief, when I tell them that the difference between G# and Ab on an E string is more than half a centimetre. These are in truth very different notes.

The trouble is that we have become so used to equal temperament that we have come to regard its evolution as the summit of human musical achievement. The piano at home is equal-tempered. The piano at school is equal-tempered. The piano in the church, village, or town hall is equal-tempered. The organ in church is equal-tempered. The fixed frets of guitars and similar instruments are equal-tempered. Even the recorder on which we first learnt to play was probably approximately equal-tempered, at least if it was a school-quality instrument intended for use with a piano accompaniment. In truth, we have been drowned in equal temperament since birth.

This is the physical reality. What are the musical consequences?

When I was first teaching myself to sing at sight (we had a piano at home and my mother had taught me the rudiments of music, but I was never a choirboy treble and did no serious singing until I joined the school choir at sixteen), I would play the key note of something on the piano, sing the first line or two of the tenor part, ping the note on which I should have finished, and see where I had got to. All too often, my note, although basically correct, was a little below the piano's. "Oh dear," I thought, "I've gone flat again." Well, very probably I had, but even had I kept pitch perfectly, if the line had ended on the third of the scale, the piano would have pinged perceptibly sharp.

But much worse is the minor third. The true minor third (ratio 6:5) is quite a bright sound. In comparison, the equal-tempered minor third is sadly dismal, When I used to lead a small singing group ("choir" would be too strong a word, we being merely a group of fifteen or so friends who used to meet in each other's houses to sing madrigals), I was always telling them to forget the piano and to keep the minor third bright. Let the minor third sag flat, and the second is dragged down with it, and the whole piece quickly loses pitch. Keep the minor third bright, and everything is quite different.

I was perhaps 30 when I first realised the defective nature of equal temperament (many people cotton on much earlier). I had read in my school physics book that the equal-tempered tuning of a piano was imperfect and that accurate intervals gave a much smoother sound, but the point had not really registered. However, I was listening to a piano record when staying with my father, and it suddenly occurred to me, "That doesn't sound right." My first thought was that the hole in the record was off centre, but there was no wavering up and down so it couldn't have been that. It then occurred to me that perhaps I was hearing the effect that the school physics book had been talking about. So I did the arithmetic, and indeed this was the explanation.

Even now, my antipathy to equal temperament is somewhat selective. I still find that deep bass notes on the piano give the most offence. A harpsichord doesn't worry me so much, possibly because the jangle of overtones masks the errors, and neither does a piano when playing the thicker jazz and swing harmonies of the 1920s and 1930s, probably because most such music was composed at the keyboard of an equal-tempered piano. But Beethoven's "Moonlight Sonata"? No, thank you; and when I hear a song with piano accompaniment, I normally have to try and close my ears to the accompaniment and concentrate on the voice.

If I were a member of a cathedral choir, I would hate the days when the anthem had an organ accompaniment.

Tuning in practice

Fine. You can squeeze a note up and gentle it down, you have a few useful alternative fingerings on which you can call, and you have learnt by experience how the major and minor thirds, the fifth, and the major and minor sixths should sound. How do you exploit these weapons in practice?

There are three main cases: (a) you are playing in an unaccompanied recorder group, (b) you are playing a sonata with continuo, (c) you are playing alone. Let us consider them in turn.

If you are part of an unaccompanied group, you are probably playing either sixteenth/seventeenth-century consort music or arrangements of pieces originally written for strings or other similarly-voiced instruments. Here, the question is, do you tune to the top line, or to the bass, or to the group as a whole? The short answer is that in a good group these are all the same, but from time to time things won't sound quite right. At this point, *stop playing* for a note or two. If the music suddenly sounds better, it was you.

The shifting of one or more notes by a comma when the music changes key is less of a problem than it might seem. There will usually be an accidental in one of the parts to tell you what is happening (music of this kind is normally played from score, so all players can see all parts), and even if you don't spot the accidental the feel of the music will change and after a while you will adjust almost automatically. Until you reach this stage, you can normally get the right result simply by looking at the bass line. Suppose that you have started in C major, and need to play an A. If the note in the bass is C or F, the music is still in C, and you can play your normal A (a major third above F, a major sixth above C). If the bass note is D or F#, the music has modulated to G, so you squeeze your A up so that it becomes a fifth above D and a minor third above F#. And if the bass note is E, G, or B, you won't be playing a sustained A at all, at least not in ordinary consort music.

I cannot speak with authority on the playing of eighteenth-century sonatas with continuo. never having been a player good enough for the situation to have arisen, but trying to play such a sonata with an equal-tempered piano as continuo must be a horrible experience (I dislike playing even simple recorder pieces with piano accompaniment, and avoid it whenever I can do so without giving offence). But if you are a player of this standard you probably have a competent cellist among your acquaintance, and keyboard players with an interest in eighteenth-century or earlier music are increasingly owning at least simple harpsichords; even a little bottom-of-the-range four-octave virginal with its lid up is quite strong enough for continuo work with a cello and two or three melody instruments (I have known one bravely hold its own against two violins, viola, cello, a chorus of twenty, and a mute cornett playing the trumpet parts). Furthermore, harpsichord players, unlike pianists and organists, normally tune their own instruments, and I am told that programs are now available for smartphones and similar devices which give the reference frequencies for a wide range of historical and other tunings and tell the tuner when he has got it right. If your keyboard player has one of these, you can play your sonata with the keyboard tuning for which it was originally conceived.

The third and most interesting case is when you are playing alone. The question now arises: are you playing somebody else's tunes (for example, have you been roped in by the local Morris men), or are you making up your own as you go along? If you are playing someone else's tunes, all you can do is play them in the most suitable key for your instrument, and cope with any difficult intervals or notes as best you can. But if you are making up your own tunes as you go along, which is both more fun and more satisfying, you can concentrate from the start on the keys, notes, and intervals which go well on your instrument, and use phrases built on these as the bases for your improvisations.

And of course there are dividends from practice. On my present instrument, the fingerings 1-2-4-6 and 1-3-5 give an F and Bb which go well in D minor and variants thereof, but the standard fingering for A gives a note which needs to be squeezed upwards, and gentling 1-3-4-5-7 downwards gives a note which sounds much better. But alas, when I try to use it other than in the slowest pieces, my fingers soon get imbrangled.

But it *does* sound better. Perhaps I should persevere.

Acknowledgement

My thanks to Rogers Covey-Crump for pointing out to me that a good unaccompanied choir, on modulating from C to G, will not only sing F# instead of F, but will lift the A so as to tune with the D and not with the F and C as previously