Christine Denton
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Prof. M. Fillion

The History of Musical Tuning and Temperament during the Classical and Romantic Periods

Introduction

Why is the history of tuning and temperament so important? To most musicians, the idea that the *sound* of notes and scales have changed is a foreign concept. Over the past 2000 years, tuning and temperament has changed, from region to region, from musician to musician, and from year to year. The histories of tuning and temperament are important because to understand the music of the past, you need to understand that the music didn't sound the same today as it sounded then.

The period between Bach's death in 1750, and World War I in 1914, saw a major change in the tuning and temperament of musical instruments. This paper will discuss what those changes were and why they came about, besides explaining a little of the history of tuning and temperament leading up to 1750. I will also explain what tuning and temperament are and how they differ.

Tuning and Temperament and How they Differ

Tuning and temperament are similar concepts, but it is important to note that they are not equivalent. Temperament means an adjustment in tuning to get rid of inaccuracy in the intervals between notes[1]. Tuning can relate to one note, but temperament refers to the entire tuning of a scale. For the purpose of this paper, I will explain temperament using the measure of "cents" and explain tuning in relation to 440 A (440 refers to the vibrations per second). If two instruments are tuned to the same system of temperament, but not to the same pitch, they cannot be played together, except in the case of equal temperament.

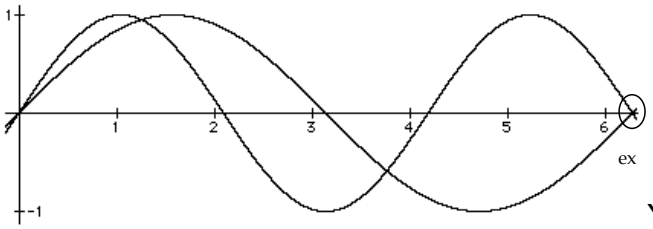
The History of Temperament

The most common type of temperament now, in the 20th century, is equal temperament. This means that each note is an equal distance from the previous note: i.e.[2]

	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C
cents	0	100	200	300	400	500	600	700	800	900	1000	1100	1200
distance[3]	100	100	100	100	100	100	100	100	100	100	100	100	

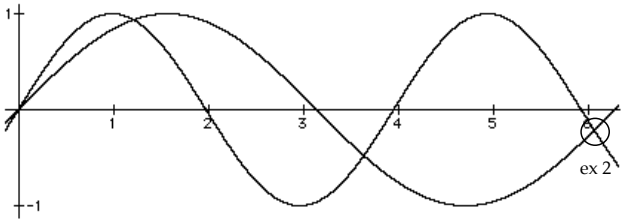
Equal Temperament divides the octave into 12 equal semitones. They are each spaced at a ratio of the 12th root of 2 (1.05946) This concept was first invented by Marin Mersenne, a French monk and mathematician in his "Harmonie Universalle" in 1636[4]. Equal temperament came into use in the late 18th century.

Our ears do not hear equal temperament as being "in tune." A justly tuned 5th will sound in tune, whereas an equally tuned 5th will sound slightly out of tune. This is because the sound wave of a justly tuned 5th looks like this:



You can see, in this example, that the sound waves cross each other on the x-axis.

The sound wave of an equally tuned 5th looks like this:



In this example, you can see that the sound waves cross each below the x-axis. This means that a greater number of beats occur. The difference is barely audible, but it is approximately 2 cents.

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[1] Scholes, Percy. The Oxford Companion to Music. 10th edition pg. 1012 "temperament"

[2] Purdam, Andrew. Comparison of Temperaments URL: http://www.pcug.org.au/~apurdam/tempers.htm

[3] distance between notes in cents

At the time that equal temperament came into use in the late 18th century, another temperament, called meantone temperament was already predominant. Many musicians in the 18th and 19th century usually tuned to meantone temperament, mainly because it sounded more in tune.

Meantone Temperament:

	C	C# / Db	D	D# / Eb	E	F	F#	G	G# / Ab	A	A#	B	C
cents	0	76 / 112	193	269 / 311	386	504	580	697	773 / 814	890	1007	1083	1200
distance[5]	76 / 112	117 / 81	75 / 118	117 / 76	118	76	117	76	117 / 117	76	117	117	76 / 117

Meantone temperament would have worked fine, except that as composers became more and more experimental, they wanted to modulate to keys other than the one that the instrument was tuned in. If they switched to the key of D#, the major 2nd would sound grossly sharp, and the relation between the major third and the major 4th would sound very flat. In addition, It was also difficult to figure out which version of "in tune" was "in tune." An example of this is as follows:

a major third above C = 386 cents = E

a major third above E = 386 cents = G#

So, the relation between C and G# would have been 772 cents. However, if you take the third below C (1200 cents - 386 cents) you get 814 cents, or Ab. Now, In equal temperament, we think of Ab and G# as being enharmonics of each other. However, in mean-tone temperament, they are 42 cents apart. This was difficult for instrument makers. It led to some keyboards being made with split black keys for playing each version, or the instrument maker deciding that one key was more important than the other.[6]

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[4] Doty states that Harmonie Universalle was written in 1639, however, Scholes claims it was finished in 1637 and Purdam claims that it was written in 1636.

[5] distance between notes in cents

[6] Purdam, Andrew. Comparison of Temperaments URL: http://www.pcug.org.au/~apurdam/tempers.htm

In meantone temperament, pure thirds were favored. Previous to meantone temperament, Pythagorean tuning was primarily used where pure 5th were favored.

Pythagorean Intonation:

	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C
cents	0	112	204	316	386	498	603	702	814	884	1018	1088	1200
distance[7]	112	92	112	70	112	105	99	112	70	134	70	112	

As you can see, this means that even fewer key modulations could occur. However, music played in the key that the instrument was tuned in sounded much more in tune. In addition to the problems with the key modulations, there were also problems with instrumental music. The majority of the music during the Middle Ages and the Renaissance was vocal music.[8] But fixed pitch fretted instruments and keyboard instruments could not be easily tuned to other temperaments. So a change had to occur. Meantone temperament was thought to be the best answer for a while. This produced 8 good major triads, 8 good minor triads, and the remaining 4 triads of each type were badly mis-tuned. But later, as music became more and more complex, and composers experimented more and more, another change occurred.

The Switch from Meantone Temperament to Equal Temperament

Musicians began to switch to equal temperament at the end of the 18th century for several reasons. One reason was the Industrial Revolution. During the Industrial Revolution, many instruments were redesigned, and standardized. The piano, harp, and organ had switched to something similar to equal temperament at an earlier point because it was difficult to re-tune those instruments. Wind instruments and brass instruments, which had previously been flexible enough to adjust pitch as the music required, were changed. "... instruments were standardized to play a chromatic scale such that the "centers" of their pitches corresponded as closely as possible to the pitches of twelve-tone equal temperament.[9]" Another reason for the switch to equal

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[7] distance between notes in cents

[8] Doty, David B. The Just Intonation Primer. "The Just Intonation Network". URL:

[9] Doty, David B. The Just Intonation Primer. "The Just Intonation Network". URL: http://www.dnai.com/~jinetwk/primer2.html (26 Apr. 1997)

temperament has to do with the end of the common practice period. Orchestras became common, and there had to be standardization between the instruments. Pianos were being used as instruments in the orchestras, as soloists, and were the predominant instrument for musical training. Since they had to have equal temperament, so did the other instruments. Musicians began to be trained in equal temperament, as opposed to meantone temperament. This meant that if composers wanted to hear there works performed, they had to expect the music to be performed in equal temperament.

The change to equal temperament happened at different times in different countries. It is thought to have first started in France in the last quarter of the 17th century in keyboard instruments.[10] Meantone Temperament was the common system in France until the mid 18th century, and England still used meantone temperament until the mid 19th century. Alexander Ellis claims in his essay "The History of Musical Pitch" that "the first organ built and tuned [in England] originally in equal temperament, by Messrs. Gray and Davison, was for Dr. Fraser's Congregational Chapel at Blackburn, in 1854 (since burned) Messrs. Walker and Mr. Willis sent out their first equally tempered organs in 1854."[11]

In the 19th century, Hermann von Helmholtz (1821-1894), surgeon, physicist, and physiologist, and father of modern scientific acoustics and psychoacoustics, began advocating Just Intonation.[12] Helmholtz felt that equal temperament had a "deplorably effect on musical practice, especially in regard to singing.[13]" Helmholtz advanced the scientific understanding of the production and perception of musical sound, and he proposed the first scientific theory of consonance and dissonance. Because of his research, there were a great number of experimental keyboards invented, for the purpose of playing in Just Intonation. However, it seems that he had little to no effect on subsequent generations of performers.

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[10] Organs are the only instrument that they can find proof of this in, but it is assumed that other keyboard instruments were tuned in Equal Temperament.

[11] Mendel, Arthur, and Alexander J. Ellis. Studies in the History of Musical Pitch. Da Capo Press, 1968

[12] Just Intonation is similar to Pythagorean Temperament

The History of Tuning

During J.S. Bach's life, (1685-1750) musicians began to feel the need for standardizing pitch. The new standard pitch that was proposed was much lower than most of the previous standards of pitch. Ellis[14] stated that the pitch of A varied[15] between 374 A, in 1700 (Church Pitch) and a high of A=567 (North Germany, no year given[16]) The concept was quickly accepted, but slowly adapted. Most organ owners (mostly churches) were not likely to change organs until the old one was no longer functional. The pitch during the 18th century is generally thought to be between A 415 to A 430. Handel's tuning fork gives the pitch of a 422.5, and Mozart's piano was tuned to 421.6.[17]

Violins made in Italy during the later half of the 18th century were also tuned much lower, which leads to an interesting problem for their current owners. In the 18th century, the strain on the strings would be approximately 63 lb. Now, in the 20th century, the strain is usually about 90 lb. This difference has been the demise of many a valuable instrument.[18]

In the 19th century, another change occurred. The London Philharmonic Society set A to be 452.5. This was an enormous leap- their previous A was set at 423.7. They soon realized that this was too high, and changed it down to 433.2, however, many other organizations had already copied them, and 452.5 became one of the accepted standards. They too, then realized that 452.5 was too high, but it wasn't until the end of

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[13] Doty, David B. The Just Intonation Primer. "The Just Intonation Network". URL: http://www.dnai.com/~jinetwk/primer2.html (26 Apr. 1997)

[14] notes about Ellis: *the History of Musical Pitch* was first published in 1877. Since then, many scholars have found many mistakes in his work. I have found no indication that these pitches are incorrect, however, I have found no other indications that they are correct

[15] Mendel, Arthur, and Alexander J. Ellis. Studies in the History of Musical Pitch. Da Capo Press, 1968

[16] pg. 23 of Ellis's article, *the History of Musical Pitch* gives the date as "very old"

[17] Scholes, Percy A. The Oxford Companion to Music. 10th edition. Oxford University Press, 1975. pg. 809 "Pitch: the period of Haydn, Mozart, and Beethoven"

[18] Scholes, Percy A. The Oxford Companion to Music. 10th edition. Oxford University Press, 1975. pg. 1083 "Violin Family: The Great Makers"

the 19th century that anyone managed to change it. The French Government proclaimed 435 to be the correct pitch for A, and Britain attempted to follow suit. They were unable to, however, because of the weather, and had to settle for A 439. (At 68 degrees Fahrenheit) This was called the *New Philharmonic Pitch.* Unfortunately, the military bands remained at the *Philharmonic Pitch* (452.5 A) making it impossible for any of their players to play in orchestras unless they possessed two instruments. Also unfortunately, the organs in England had all been changed to 452.5. Because of the possible expense of changing them to the *New Philharmonic Pitch,* they were not changed. This meant that only military bands could accompany organs.[19] In 1939, pitch was set to 440 A at an International Conference.

Conclusion

As you can see, musical tuning and temperament changed during the Classic and Romantic Period. These changes included many standardizations, both of pitch, and of temperament. Many composers are leaning towards a return to some other temperament, but it is unlikely that that will occur.

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[19]Scholes, Percy A. The Oxford Companion to Music. 10th edition. Oxford University Press, 1975. pg. 809 "Pitch: the Nineteenth Century and After."

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