

An Argument Against
the Use of Equal-Temperament
for Tonal Music

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Howard Hanson, a 20th century American composer, once said that classical music was not dead. This was in spite of Arnold Schönberg's popularization of atonality. Hanson, unlike Schönberg and the other serial composers, contended that atonality was just an alternative, not some sort of natural termination. In a way this is right and in another, it is wrong. We see that music has been developing into a yet more elaborate, intricate art form since early times. Nobody will deny that the fundamentals of composition have changed; for example, one need only compare Bach's simple chord structures to Stravinsky's polytonality, in which a piece uses more than one key. Likewise, tonality has always tried to expand by freeing itself from the confines of traditional modulations or progressions. Atonality takes this kind of motion to an extreme. It is a wholly new generation which discards some principles of music itself and adopts new ones which are ordered mathematically, not harmonically. Howard Hanson understood that tonality could go other places, and even explore its own past. Similarly, temperament also reached a sort of termination through freeing itself. This termination was a leap from rational to irrational, or a rejection of its natural principles of generation. The end result is what we call equal-temperament. This thesis argues that temperament did not have to go this route. We shall suggest alternatives which achieve the same end as equal-temperament, yet are more natural in several ways. Moreover, we will argue that due to its close connection to atonality, equal-temperament is not fit to use for most music.

The first part of this thesis will be devoted to considering the role of the intellect and the imagination in fine art. Generally, I will show that the intellect examines the

quantitative or analytical side of music, and the imagination is delighted or distressed by the music, just as the senses are the receptors of pleasure and pain.

The next part will consider the development of Western music throughout history. More specifically, it will trace the developments in tonality alongside developments in temperament. This section will then provide a basis to argue that there is a strong connection between tonality and temperament.

In the next section, I will assemble the main argument of the thesis: that is, that there is sufficient evidence from music history, as well as philosophical evidence, to deem the use of equal-temperament unsuitable for tonal music. (Now if necessary, one could dismiss the historical data, but it is still true that both atonality and equal-temperament share similar principles.) We shall find an inherent likeness between atonality and equal-temperament, and given that atonal music is unnatural and disordered, so too is equal-temperament.

After this consideration, we will briefly investigate some of the arguments which commonly are used in support of equal-temperament. Furthermore, in doing so, I will propose alternative systems which achieve the same end as equal-temperament, yet are more consistent with natural acoustic principles, and enrich the music. Anyone who believes that tonal music is superior to atonal will accept the refutations I will lay out.

Finally this thesis will show that equal-temperament is, though perhaps practical, not becoming to man. The reasons for this conclusion will come from the several different arguments in the thesis body. These arguments should convince the reader that this current system of tuning has adverse effects. I wish to show that the alternatives retain certain purities, are practical, and open before us many more

beautiful paths of composition and tonality which are untold in variety.

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Before we can address a particular art, we ought to consider fine art as a whole. Now, in this case, since all art is present both to the intellect and the imagination, we should first ask why certain works of art please us. Then we should ask what role the intellect and imagination play in and artistic object's passage into our mind.

What is the reason a certain work of art are called beautiful? It is because of the close tie between art and nature. One will not dispute that there are principles in every art form which are from nature. For example, a sculptor must consider certain aspects of shape and color of a material in order to complete his work. We also say that a well-ordered piece of art appeals to the imagination. Why, for instance, do we then say that a statue is not pleasing to the eyes? Perhaps because it is not proportional, or it is discolored, etc.. The reasons lie in nature itself and natural principles.

Now, it seems there is an order in art, namely, that it appears first to the imagination, and then the mind studies it as an object of knowledge. The fact that the first appeal of art is to imagination may cause one to place an importance on the senses above the intellect. However, as was said before, it seems that both are necessary and simultaneous. This is not in the temporal sense, but insofar as an object impressed on the viewer's imagination has an explanation as to why it is beautiful, or mediocre, or ugly.

Fine art which appears beautiful to the soul is beautiful naturally as well. This is

because the soul has a connection with the natural order of things. As Aristotle says, the "soul is in a way all existing things."¹ For in order to sense or know anything, that specific faculty must be equipped to behold the object. This is because the body and the soul are indeed part of the natural order; the body is able to sense objects which leave physical impressions of some sort, and the intellect can acquire the forms of certain things because it is disposed towards, for example, the universal.

Furthermore, "after strong stimulation of a sense we are less able to exercise it than before,"² and thus there is some proportion between the sense and the sensible.

Now, there are several extremes in the senses. For example, an ugly color, or a bright color which is blinding could both be regarded as extremes. The same occurs with sound. There are discordant sounds, and there are loud sounds. Now, with a sensible which is too powerful to sense, the defect would be in the organ or faculty. However, with a sensation which causes an unpleasant response, it is more a matter of tolerance than of capability. Everyone enjoys the more harmonious admixtures within art. Just the fact that they are more harmonious indicates some natural consistency. Thus, there is indeed a connection between the delights of the soul and the order of this or that natural entity; so, it is clear that an ordered object will resonate well with the soul.

In the particular case of music, a number of theories exist to explain (such as tonality and the root theory) why music appeals to the imagination. This faculty will perceive well-ordered compositions and it will be pleased by them. Thus, the intellect and the imagination have equal importance in their interpretation of music.

¹ Aristotle, *Physics*, 431b 20

² Aristotle, *Physics*, 429a 31

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Plato gives us some idea what music was like in his day. The *Timaeus* describes the Pythagorean scale and how we derive it. It is a generation of the scale using ascending perfect fifths, in the 3:2 ratio. What is most remarkable about this scale is its mathematical simplicity and the fact that its ratios closely resemble the overtone series. If we consider the just scale versus the Pythagorean, there are differences in the major 3rd, minor 6th, and major 7th.

We also see in Plato that music of the time was modal in character. Changing chords was a common practice, but modulating to different keys was not a question at that time. This is because the harmonies were based on the notes within a mode. Now history points to the fact that musicians favored the Ionian mode, known today as a major scale. The reasons for its acceptance are not important here, except we must remember that the just scale is commonly expressed as a major scale.

Weber writes "In the language of the Stumpf school, there was orientation around certain main tones, representing a kind of 'melodic center of gravity'."³ If this was true before widespread acceptance of the major scale, this "orientation around certain main tones" must have translated to some sort of affinity towards the "root" of this scale. So, we see it makes sense that musicians favor the "root" of a scale, also considering that it is the fundamental of the tones above it, and in a way contains them. Another reason for this is that

"the theoretical norm of melodic intonation is not one which is based on its own definite and objective laws of tonal organization, but one which we subjectively liken, for practical convenience, to some of the known forms of organized intonation, as in the case, for instance, with the Pythagorean tuning conventionally assumed as the theoretical

³ Max Weber, *The Rational and Social Foundations of Music*, p.44

norm of melodic intonation for the diatonic scale."⁴

What this is saying is that melody (and in the grand scheme, tonality) has a connection to the tuning system which we use at the time. The connection is that any melody will be an expression of the tuning system which it is played in, and tends to follow the organization of that particular system. For example, in just-intonation, certain tones lend themselves to resolve into others, simply by their relation. It is much like the painter using a certain palette of colors. Now, as tonality developed, certain innovations gradually occurred. Within tonal music, there was a gradual development into polyphony, with moving voices in various arrangements. A further step involved the transition into homophonic music, or that containing defined chords. This necessarily implied that music had a root, or some note which every part of the piece was related to. Now, as music desired to expand its boundaries, and embraced a larger variety of chords and inversions, instruments were naturally somewhat a hindrance to composition. It is difficult to say when and where this desire to expand tonally came from; but it certainly did happen, and it sought to overcome the limitations by tempering, an effect which occurs "when the distance principle is applied in such a manner that the purity of the intervals is relativized for the purpose of equalization of contradictions between different interval circles, reducing to only approximate tone purity."⁵ This means that in tempering, the musician sacrifices some interval's consonance to relieve another's dissonance. We see proof of this in the 15th century, where "mean-tone" was adopted as a viable alternative to a strict just-intonation. Edward Foote writes

"before 1700, renaissance and Baroque keyboards were tuned so that some intervals were very consonant (also called "just" intervals) and

⁴ Joseph Yasser, *Theory of Evolving Tonality*

⁵ Max Weber, *The Rational and Social Foundations of Music*, p.97

other totally unusable ("wolf" intervals). With permutations, this [meantone] tuning lasted from approximately 1400 to the early 1700's and is now known as *meantone* tuning."⁶

This allowed for a somewhat larger variety of modulations, yet it still retained an affinity towards the just scale. The musicians during Bach's time experienced another evolution in temperament. This is apparent from the historical writings regarding the "Well-Tempered Clavier", a collection of pieces using all major and minor keys almost indiscriminately. A common misconception is that Bach used equal-temperament. Even the Harvard Dictionary of Music is in doubt about this. It states

"whether Bach's famous collection of pieces in all the major and minor keys, the *Well-Tempered Clavier* (1722), or its less complete predecessor, J.K.F. Fischer's *Ariadne Musica* (c.1710), referred to equal temperament or merely to a sufficiently close approximation, is not entirely clear."⁷

Other writings say that this "well-temperament" of Bach's time is commonly called Werckmeister temperament after Andreas Werckmeister, who "published tuning rules that eliminated the restrictions of meantone."⁸ This system, and others similar to it, preserves many elements of previous systems (such as meantone), retaining some part of their purity, and it also was tuned by ear, similar to the method used in tuning just-intonation. Though it is believed that Werckmeister theorized an equal-temperament system, it was necessary to tune it according to "beats", or disparities in the frequencies of two or more tones. Still, "practicing musicians . . . tuned by ear, and they did not want to sacrifice key-coloring."⁹

Let us investigate what this "key-coloring" is. Suppose first that we have a just-intonation scale. Now, there are two possible intervals known as a minor 7th in this

⁶ Edward Foote, Notes from *Six Degrees of Tonality*, p.2

⁷ Willi Apel, *Harvard Dictionary of Music*

⁸ Edward Foote, Notes from *Six Degrees of Tonality*, p.5-6

scale, first of all, from e-d, and then from d-c. These, however, bear two different ratios. The interval e-d is represented as 5:9, and d-c is 9:16.¹⁰ Other slight differences of the sort occur in just-intonation, and when there is a combination of these intervals (especially in the manner of chords) then it is possible that certain chords which have the same name (i.e., major triad) may have difference consonance values. This is even more true in derivatives of just-intonation. These different consonances produce a variety of "key-colors" which exist relative to the key in which the instrument is tuned. There is evidence of this in the names of pieces in certain keys. Beethoven's 5th piano concerto is known as "Emperor." His 3rd symphony is called "Eroica." These are both in Eb major. His "Pastorale" symphony, on the other hand, is in F major, and so is Schumann's "Merry Farmer." It was no coincidence that Mozart wrote his Requiem Mass in D minor, considering it was one of the only minor keys he used, and it was commonly considered a mournful key. In short, we see that composers did not choose keys haphazardly, but those keys which created certain atmospheres, according to the piece.

After the Classical period, and beginning especially in Beethoven, we see that composers were drifting farther away from simple key signatures, embracing all available sharps or flats in the more complicated keys. Chopin, Tchaikovsky, Brahms, etc.. commonly used all keys, almost indiscriminately (or in some cases, according to the instrument). At the same time, temperament was approaching near equality, or symmetry. However, it was still very different from what we know as equal-temperament.

"The evolving art of modulation, the development of sonata form with its harmonic rules, and the known emotional-affective nature of

⁹ Owen Jørgensen, *The Perfection of Eighteenth-Century Temperament*, p.2

¹⁰ Molly Gustin, *Tonality*, p.17

tempering variety, all indicate the use of a commonly accepted form of well-tempered keyboards."¹¹

It ought to be remarked that "not only do well-temperaments provide tonal contrast, they also offer a higher degree of consonance than is available in equal-temperament. They can, when called upon, be far more "in tune" than today's norm."¹²

Jørgensen notes another difference between these well-tempered systems and equal-temperament. He says that there were 3 methods of tuning used before the 20th century, and of these,

"the second approach was that known as 'tuning by ear.' Today, in the late twentieth century, the term 'tuning by ear' means . . . that one is using his ears to count and compare the beat frequencies of various tempered intervals. . . During the nineteenth century and before, the term 'tuning by ear' meant the opposite; that is, one did *not* count or compare beat frequencies. In fact, one did not listen to beats at all."¹³

Tuning by beats is a method whereby the tuner deliberately measures the dissonance, not the consonance of the interval. This shift from tuning by consonance to dissonance indicates a shift in the goal of tuning. About the same time whole-tone impressionist music began to appear, and this was the only tonal system which actually required equal-temperament. This is because such music contains no difference in the tone values, since they are all whole steps. (This is, of course, opposed to diatonicism, which employs uneven steps.) Thankfully for the impressionists, equal-temperament was feasible about the same time (in the mid-late 19th century).

One method of tuning in equal-temperament was proposed by Johann Heinrich Scheibler, and it involved (as was said before) tuning according to the beats.

¹¹ Edward Foote, *Notes from Six Degrees of Tonality*, p.3-4

¹² Edward Foote, *Notes from Six Degrees of Tonality*, p.4

However, "Scheibler found, that although the ear may distinctly hear eight beats in a second, yet that for practical purposes, and in order to guard against any possible mistakes, a greater task than that of counting four beats in that space of time, should not be imposed upon the ear."¹⁴ Now this means, according to Jørgensen, that this

"was one reason why tuners through this period of history did not count and compare the beats of thirds and sixths while attempting to tune equal-temperament, but without comparing the fast beating thirds and sixths used as test intervals, equal temperament was impossible on pianos."¹⁵

From this, we may conclude (since Scheibler developed this technique before his death in 1837) that true equal-temperament was not possible before that time.

The next step in the tonal realm of music was atonality. We can say certainly that atonality is an innovation of the early 20th century, given that its inventor (Charles Ives (1874-1954)) and largest promoter and theorist (Arnold Schönberg (1874-1951)) composed mainly in that time. Thus, our historical consideration of tonality and temperament is complete, since events after this particular time are not important for our subject.

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From our brief historical review, it is obvious that tonality and temperament progressed simultaneously; and this was due to their dependence upon each other. The desire to expand tonality necessitated the expansion of temperament.

¹³ Owen Jørgensen, *The Perfection of Eighteenth-Century Temperament*, p.4

¹⁴ Johann Joseph Loehr, *An Essay on the Theory and Practice of Tuning in General, and on Scheibler's Invention of Tuning Pianofortes and Organs by the Metronome in Particular* (1853)

¹⁵ Owen Jørgensen, *The Perfection of Eighteenth-Century Temperament*, p.468

Furthermore, it is clear that, just as an artist produces art according to his medium, the tuning system available will dictate the musical (both melodic and harmonic) palette. From this, it is logical to infer that *equal-temperament is the system proper to, and only to, whole-tonality and atonality*. Jørgensen states his opinion directly, saying "equal-temperament is the only completely atonal temperament that has existed in history, and that is why it has no traces of chord shading or key-coloration. Thus, it is appropriate for the serious concert music composed during the twentieth century."¹⁶

So far, we have made our argument from history. It is not necessary, however, to support the conclusion this way alone, as Jørgensen hints in the previous quote. There is an inherent similarity between atonality and equal-temperament, and this can be shown through their principles.

It is now time for us to spell this out more fully. We will look at the principles that are similar in atonality and equal-temperament. First, we will deal with tonality. Music is tonal if "the majority of its adjacent tones, whether simultaneous or consecutive, form single-rooted sets."¹⁷ This simple account gives a reason why music which is tonal is more appealing than atonal music. Furthermore, "the hierarchy of the diatonic set was ubiquitous. It was assumed without question; so deeply embedded was it in the unconscious that it never rose to consciousness"¹⁸. This makes it entirely plausible that music has certain principles already dictated by nature, and that it took theorists some time to discover these principles. Mrs. Gustin goes to great lengths to prove her root theory and explain why music which we perceive as beautiful has order. To do this, she uses six axioms which show that tonal music is

¹⁶ Owen Jørgensen, *The Perfection of Eighteenth-Century Temperament*, p.2

¹⁷ Molly Gustin, *Tonality*, p.78

better than atonal, namely that "1. Unity is good; 2. Variety is good; 3. Order is good; 4. Consistency is good; 5. Expressive symbolism is good; and 6. Continuity is good."¹⁹ These axioms must, of course, be qualified in order to be applied to tonality; because, for example, atonality has variety. However, this variety is very limited, because in atonality there are no relationships among the notes themselves, other than simply the intervals. Similarly, atonal music is ordered. However, the order which it has is completely mathematical, not natural to music. Thus, it does not resonate with that part of the soul which receives it. Serial music, for instance, has great order and continuity, but this is only in virtue of an equation which has nothing to do with the order of melody and harmony. A serial composition may be written according to certain rules, such as "use every note only once, then, when all are exhausted you may begin again." This is an example of an imposition of certain principles on art where they do not belong. It also lacks all of the other qualities which are present in tonal music. For instance, there is no expression in atonality, no musical peaks and valleys. Furthermore, atonal music requires no skill, and no artistic talent to compose and perform. On the other hand, tonal music is not completely about equations. In order to write tonal music, one must have a good ear and understand the instruments, as well as be a critical judge of his work. Atonality requires none of that. An atonal composer may write a formula and deviations of it, and then write it on a score for as many instruments as he wishes, regardless of their timbre or playability. Atonality is a completely intellectual practice. It no longer cares about the textures of various instrumentations, or if the music is even feasible to the performers.

¹⁸ Molly Gustin, *Tonality*, p.80

¹⁹ Molly Gustin, *Tonality*, p.82

We will now look at how the same concepts may apply to equal-temperament. First, we see that it discards certain principles found in nature and adopts others which are not proper to it. Equal-temperament intervals are not related to those of the overtone series, for all (except the octave, which may as well be considered as another root) are based on 12th roots, or irrational ratios. Now, if indeed nature was such that it dictated the construction of this system, *then the tones would have no relationship to their fundamental*, much as the straight has none to the curved in the instance of $\pi:1$. Irrational numbers certainly have an order, but one which bears no likeness to a simple harmonic progression based upon some originating tone. It therefore has no hierarchy and no order in a more strict sense, in contrast to a system which uses intervals based on the fundamental.

There is, also, less variety in equal-temperament, because *all* of the keys and chords have the same consonance value. We discovered that there was a greater variety in tonal music because of the built-in hierarchy. The opposite is true in equal-temperament. There is a pseudo-hierarchy, but because of its homogeneity, there is no reason to favor certain keys to others.

Further, with a system like Werckmeister's, there will be a variety of tonal colors available, because each key will be composed of different interval values. And still further, equal-temperament disposes of the skill of the tuner, requiring only that one measure the beats between tones. No refinement of hearing is necessary; it is pure science.

Thus, an accurate summary of the previous section would be that history has shown a connection between tonality and temperament. This inference from history is borne out by the fact that tonality and temperament share similar principles, both

philosophically and artistically. However, atonality discards the principles of music which earlier musicians had accepted before it, and so does equal-temperament. Therefore, it follows that they seem proper for each other in practice, since both are completely colorless and bland.

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We shall now take a look at some arguments for equal-temperament to see why its proponents favor or accept it. One argument says "the equal-tempered scale provides a wonderful compromise, which allows us to have our cake and eat it too;"²⁰ Eating the cake means we can freely modulate without any intervals *too* dissonant, because every whole step bears the same relationship to the one before as the one after; and furthermore, this interval is very close to the one used in just-intonation and others. Is this not a brilliant idea? Yes, if you consider completely free, disorganized modulation to be a good thing. For even though the whole steps in equal-temperament are close to the just whole steps, other intervals will be a bit different from the just, and moreover, these intervals will all be homogenous. That is, any interval in equal-temperament bears the same relation to the note above as the note below. This is why it is possible in equal-temperament to change into every key indiscriminately. Now, it is true that different modulations within a piece have different colors and shadings, making one feel different emotions. However, as was pointed out earlier, non equal-tempered systems contain different colors *within the keys themselves*, so that coupled with the various effects of modulation is an even wider array of tonal capabilities, too large to even begin counting.

Another argument for equal-temperament lies in the same text, namely that "by asserting the lie that twelve fifths equal seven octaves it achieves at one and the same time enharmonic equivalence and a close approximation to the pure third, at a slight sacrifice of the purity of the fifth."²¹ Certainly this is true, according to the chart. Nobody will doubt the math. However, the chart on p.15 of *Tonality* fails to consider the relationships between sets of tones, instead of simple intervals. It shows that the equal-tempered major 3rd, for example, bears only a 1.008 discrepancy ratio with same just interval. But it is clear that the more tones there are, the more discrepancies there will be between them. Since most music is not simply two notes at a time, we are constantly exposed to this dissonance.

One might also argue that equal-temperament is so close to just-intonation that we really don't hear the difference after all. That may be true to the untrained ear; but given the nature of the ear, that it responds to the most delicate compressions in the air, it will no doubt be physically *affected* differently by something which is closer to 3:2 than something which is closer to $2^{7/12}:1$. Furthermore, the soul will also interpret the pure interval as something truer to what it wants to hear, given that the soul reflects the order in nature.

Another argument, perhaps, would be the that equal-temperament and any type of well-temperament before it are essentially similar. It is true that they both want to realize something similar, namely, the usability of all keys. They approach it differently, however. As was stated earlier, equal-temperament is based on science, not art or skill, as opposed to any other tuning system. Also, well-temperament uses an unequal distribution of dissonance, and equal-temperament does not. Well-

²⁰ Molly Gustin, *Tonality*, p.14

²¹ Molly Gustin, *Tonality*, p.14

temperament has a greater variety. De Morgan writes that

"the system of equal-temperament is to my ear the worst I know of. I believe that the tuners obtain something like it. A newly-tuned pianoforte is to me insipid and uninteresting, compared with the same instrument when some way in its progress towards being out of tune."²²

From this it is clear that he was obviously exposed to earlier systems, and saw a clear difference between the two.

Someone might also argue that these earlier systems contain similar dissonant qualities to equal-temperament, so there is no reason to prefer them. This is true, to some extent, but let us consider one particular system versus strict equal-temperament as an example. All of the major thirds in equal-temperament bear to another a ratio which is 13.7 cents (1 cent = 1/100 of an equal-tempered semitone)

from a pure just interval, or 5:4. Now a well-temperament used in Beethoven's time, the Thomas Young system, has an uneven distribution of the consonances. It begins with the C-E major 3rd being only 5 cents different than a just major 3rd, then moves in fifths, and at the middle, the interval of F#-A# is 21 cents off from just. Here is a table describing this system.

Interval	Cents Off from Just
C-E	5
G-B	8
D-F#	10
A-C#	14
E-G#	18
B-D#	19
F#-A#	21
Db-F	19
Ab-C	18
Eb-G	14
Bb-D	10
F-A	8
C-E	5

Fig. 1: The Thomas Young system

This system definitely has its limitations. However, it is clear that there is a logical progression in tempering which is by fifths. Similarly, since the dissonances are not equally spread out, certain V₇ chords, for example, will resolve very nicely into a I chord of greater consonance. This "feeling of motion" caused by the root of a root is a common characteristic of tonal music (as described in *Tonality*) and has far more

meaning in Young's system than in equal-temperament. Besides, according to Zuckerkandl, a difference of 80 cents went by unnoticed to a musical audience. This experiment determines that there is no problem tolerating some dissonance. However, it does not justify equal-temperament's equal distribution of dissonance; furthermore, this dissonance ought to support the structure of the music.

Others will say that you can never achieve a perfect ratio such as 2:1, so what determines whether the ear can perceive an irrational versus a rational interval? And more pointedly, is equal-temperament's use of irrational numbers a reason to dismiss its usage? It is true that we can never obtain a perfect consonance. Since we can never physically construct a perfect 3:2 interval, for example, it follows that even instruments in just-intonation are only just in theory, not in practice. Nor can the ear perceive the difference between a rational and irrational interval. However, as was stated earlier, the ear does hear a difference between any interval that is close to a 9:8 interval and one that is close to $2^{2/12}:1$, and it will undoubtedly (provided it has adequate experience) perceive the 9:8 interval as purer, simply because it is closer to the ideal expression in nature. Equal-temperament is an intentional deviation from the overtone series.

One might propose that the ear "corrects" the tones of a system in conformity with some pre-conception. In the case of equal-temperament, it would seem that the ear hears the dissonances, and corrects them to what it wants to hear. Well, if this is true, we should give the ear something more to work with. If you have to give it a dissonance, try to resolve it. Don't give it one chord which "resolves" into another chord of the exact same consonance value. Give it a feeling of motion. That way, there is less stress upon the ear, even if it does "correct" the pitch. Is there a way to

²² August De Morgan, *On the Beats of Imperfect Consonances*, p.142

relieve this tension on the ear? Yes, it would be a completely justly tuned system, in which every interval and every chord was pure. However, as we know, that doesn't seem possible given our 12-tone scale, and a 19-tone scale is a bit impractical. Thus, a well-tempered system such as the Thomas Young system is ideal.

This treatment of the opposing arguments should suffice for the present.

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This final section will explore the question of whether equal-temperament ought to be used or not. Given the arguments from history as well as those which consider the principles, one naturally concludes that equal-temperament coincides with atonality in time, that it shares similar principles, and that it lacks several of the qualities which Mrs. Gustin ascribes to tonal music, namely the six in her chapter on Aesthetics. Since it is so closely connected with atonality and whole-tone music, it follows that we should in no way use it, unless for these types of music (which are unnatural in themselves). One may also say that equal temperament takes the artistic side of tuning away, and replaces it with a scientific method. Surely this is not proper to good music. With equal-temperament, the tonal palette is composed of gray, undistinguishable, un-rooted tones. This is not a quality of tonal music, but of atonal. For this reason, it seems that there is no need to perform tonal music on equal-tempered instruments. In fact, it is improper. The only music which requires equal-temperament is whole-tone and atonal music. Also, since there is no hierarchy of tones in equal-temperament, the intellect has to work harder to abstract from sense perception. Therefore, the dynamics of music such as climax and resolution

are not as strong in equal-temperament as they ought to be. The listener has to, in a sense, supply the consonance. Exposure to equal-temperament over time causes unfulfilled desires and unnecessary tension. It is not hard to see why this may have adverse psychological effects on man.

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There is a solution to all of these tuning dilemmas. Well-temperament is easier and more practical today, given advances in instrument (especially piano) technology. This is the alternative to equal-temperament. Howard Hanson was right. Classical music is not dead, and neither is temperament. We ought to adopt the methods of previous centuries and tune by ear; not according to some flimsy irrational formula, but by consonances and compromises to produce a plethora of colors in the keys. This, as was stated earlier, would provide an even greater variety of tonal compositions than in equal-temperament. A temperament such as that described in figure 1 would allow tonal music to be more expressive, more unified, and in fact more tonal according to the 6 axioms; and this is just one of the many varieties of temperament available. There are many alternatives which lend themselves wonderfully to tonal music, and these have been documented and practiced previously; besides these, new tunings are constantly being developed and refined. Temperament in no way has reached its natural terminus. Rather, there is and always were a vast number of variations. Equal-temperament is equal nonsense; it has no place in tonal music nor in our lives. Since tonal music is superior to atonal, we ought to embrace well-temperament over equal-temperament. So it is clear that

equal-temperament is not some sort of "conclusion" of temperament, nor its last possible stage.

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Supplemental CD

This CD is included to expose the listener to non-equal-tempered music. There is a good amount of Baroque music in period tunings, but very little Classical and Romantic piano music. However, there is strong evidence for a revival in these performance practices.

The pianos used in the Beethoven Sonatas were tuned to period temperaments, which evidence shows Beethoven most likely used. To an untrained ear, they may sound very similar to performances in equal-temperament. However, after some careful listening and comparison, one may hear the subtle differences in the pieces. Try listening with the treble turned up slightly so the overtones are emphasized. I describe certain keys and chords as bright, metallic, throaty, clear, muddy, bell-like, and brilliant.

The Mozart Fantasia is played with a just-intonation system to demonstrate how certain intervals are usable, and others not as much. There is a distinguishable "wolf," a natural dissonance caused by the tuning. It is an intense metallic ring that is caused by tones whose partials are conflicting because they are far apart. This piece is on the CD to show it is one extreme of temperament, as opposed to equal-temperament. The tuning systems in the Beethoven Sonatas are means between these two; they, like other well-temperaments, distribute the dissonances unequally yet render all keys usable.

Michael Harrison's works utilize acoustic environments which emphasize the overtones, and create shimmering, pulsating, and glowing effects, to name a few.

Contents:

Track 1-3	<i>Sonata in Ab, Op. 110</i> in Thomas Young temperament L.V. Beethoven
Track 4	<i>Fantasia in D minor</i> in 1/4 comma meantone (uses just intervals) W.A. Mozart
Track 5-7	<i>Sonata in C, Op. 53</i> in unknown well-temperament L.V. Beethoven
Track 8	From <i>Revelation</i> in Michael Harrison's Revelation tuning Michael Harrison
Track 9	From <i>From Ancient Worlds</i> in just-intonation Michael Harrison