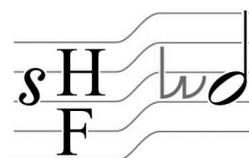


THIRTY-ONE
THE JOURNAL OF THE HUYGENS-FOKKER FOUNDATION



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Thirty-One
Estd 2009
ISSN 1877-6949

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www.thirty-one.eu

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SOME THOUGHTS ON LINEAR MICROTONALITY

Frank Denyer

The growing use of microtonal intervals in composition has influenced and been influenced by diverse forms of pitch analyses. This has, by and large, concentrated on aspects of the harmonic series, often advocating its authority as the most 'rational' or 'scientific' foundation for understanding musical scales. In such work musical intervals have been described as 'true' when they conformed to mathematical ratios that demonstrated their precise place and derivation in the model. This has opened up new areas of enquiry but has also led such work to be unusually susceptible to academic pedantry. The harmonic series, because it is 'harmonic', is made up of intervals that are most acutely appreciated when their component notes are heard as simultaneities.

In my own work I have approached microtonal issues from a different viewpoint, focusing primarily on the perception of *linear* microtonal relationships. For reasons that will become apparent, the two perspectives do not have many points of convergence. The fact is that our human perception of micro-intervals is considerably altered when we hear the constituent notes linearly (i.e. one after the other) rather than simultaneously, a fact that can be easily verified in the studio.

The linear investigation I advocate is not based on an extracted set of mathematical relationships but on the observations of our perceptual intelligence allied to the unaided capacities of the human ear and the interpretation of its data by the brain. So much of our hearing is interdependent with other mental functions that we must take the whole skein together, and there can be no excuse for excluding awkward aspects of listening – such as the inherent capacity to privilege certain aural information, or the propensity for misperception and aural illusion due to the natural limitations of the sensory organs and the associated processing. Neither should we devalue the ability of such a complex web to trigger responses in far flung neural networks of the brain, because that is exactly what gives sound its unrivalled suggestibility and essentially its capacity to become music.

Let us first consider one tiny piece of actual perceptual evidence. Laboratory data shows that even primary intervals from the harmonic series, such as the octave or fifth, when heard linearly, are usually judged by musicians as being 'completely in tune' only after their harmonic identity has been slightly modified, most often by making them a few cents narrower than that produced by the pure ratios. In a test I conducted at Wesleyan University in 1977, two tunable oscillators were set up in such a way that when either one was sounding the other was switched off. Thirty-five musicians attended individually and each was asked to tune one oscillator to a perfect fifth or an octave above the other, but they could never hear both notes simultaneously. However, they were free to go back and forth between the oscillators any number of times, and no time limit was imposed. Interestingly, the resulting (melodic) intervals were, on average, tuned flatter than their harmonic counterparts.

This appeared to demonstrate two different ways of being '*in tune*'. The question is: *being in tune with what?* Historically there have been, and may still be, many different but equally legitimate answers to this question. I also cannot fail to notice that my own temperament leads me to feel comfortable when I recognise an inner point of ultimate reference, with the power to at least modify the rigid application of externally imposed rules (much as the

individual conscience is a significant factor to judgments of guilt or innocence in modern legal systems; when laws are absolute and their advocates cannot imagine circumstances where they might be modified, the result is tyranny).

Being *in tune*. Whatever it is we wish to be *in tune* with – whether an internal or external reality, the Indian atman or the Chinese huang chung (yellow bell), the voice of God, lay lines, the basic laws of the physical environment or merely our own inner nature –whatever it is, humankind has periodically become convinced that a superior form of music could be realisable, and one with unique revelatory potential, if only sufficiently rigorous efforts were made to re-establish pitch as music's deepest underlying fundamental. We seem to have carried this perennial desire to purify music so that it might better reflect a more perfect existence, perhaps even transmit knowledge of the divine itself or allow us to experience the sounds from a remote heavenly sphere, or just the essence of a bygone golden age, or at least intimations of a life more perfect than the one we now experience. Sadly, the holy grail remains elusive and as with many religious or political aspirations, the results never seem to succeed as potently as had been hoped. The quest, like that of the grail, partially fails. For some this inevitably triggers demands for the application of even more rigorous tuning theories. For others, such perfection remains to be found only in the dream of an unheard, silent or unstruck music, perfect because unrealised. Numerous world traditions are littered with tragic memorials that celebrate both sides of this divide.

In our own fragmented, individualistic and uncertain times perhaps we must be content with music that is just in tune with itself (oh, those wonderful unisons), but even then all is not health and fitness, for it still remains for us to find some practical accommodation between the *tuned* and the *out of tune*. In other societies the latter has frequently been treated with extreme caution and special roles devised even for its marginal inclusion. Not only roles but rules, their precise nature and scope being almost as diverse as humanity itself. In some form these have been formulated on every continent in almost every era. Incorporating notes that are *in tune* with others which are *out of tune* has implications that reach far beyond music, suggesting parallels with social definitions of 'belonging' and 'not belonging', the sacred and the secular, the insider and the foreigner, the civilized and the primitive, the professional and the amateur, the true and the false, or even the role of comfort and discomfort in a particular life-view.

In practice, this interface between the *tuned* and *untuned* may be extended from a sharp but crude division between good and evil to the addition of a more ambiguous but fertile no-man's land between them, or even to a complete gradation of values with the poles only as small rarified points on either end. In such circumstances the practical musician finds that being *in tune* or *out of tune* is not a mathematically fixed issue, but one that requires the negotiation of a subtle path between the physical capabilities of musical instruments and the limitations of the human ear while still remaining susceptible to wider aesthetic imperatives. This relates to many aspects of music making and not merely performance itself. Here is one very specific case: comparing a piano that has been tuned with an electronic tuner to one tuned by ear, it is clear that the exact type and degree of variation between these two methods remains an issue for musical discussion and personal judgment.

The first vague glimpse of this matrix of interconnections started to float into my mind in the early seventies. I had noticed that open-holed woodwind instruments, whether from Europe or Asia, could create remarkably fluid and organic melodic continuities, but that these features were diminished when the player performed the same phrases, with similar articulation, on the standard silver flute, even though paradoxically the latter had the capacity to produce notes that were said to be more *in tune*. Open-holed instruments allowed a rounding of certain intervals precisely because the intonation was more malleable and it was clear that an experienced player took full advantage of this. I concluded that late 19th/ early 20th century European woodwind instruments, with their greater uniformity of bore, accuracy in the location and size of finger-holes, precision key mechanisms, not to mention developments of mouth plates and reeds, might be less responsive to my particular aspirations as a composer, searching as I already was for a melodic line inherently softer, flexible and more fluid than any I had yet come across.

Therefore, when writing my piece *After the Rain* (1983) and trying to envisage a suitable ensemble that might support a solo shakuhachi and solo violin, I chose three ocarinas and percussion, partly because the ocarina had a particularly large number of variables that affected pitch, and this unpredictability tended to create a soft edged intonation. This was further reinforced by the instrument's soft attack and overall dynamic level. It could have been argued that this tactic would merely produce a certain randomness of intonation, but I considered that this uncertainty might already go some way towards modifying the hard-edged pitch-tyranny with which I was surrounded and from which I was trying to liberate myself.

Such experiences were indeed liberating and soon I was able to grasp some more focused specifics. For example, I found that in a linear context, flattening an harmonic interval by a few cents would soften its outline and when melodic intervals like octaves, fifths and fourths were treated in this way, there was also a greater propensity for the two notes to bind themselves together as a unit, an important factor when attempting to make coherent melodic wholes.

The opposite tendency occurred when a primary interval was slightly widened. The sharpening of an interval increased its outward movement and it appeared brighter and more energetic than it would otherwise. Here there was a tendency for the notes to separate and the linear bonds that link them to weaken. (In a real musical context there may be other factors that nullify both considerations. It is well to remember that harmonic content is particularly potent in this respect.)

If narrowing were to be compared to a visual artist rounding off the corners of a square, rectangle or triangle, then randomly mixing, narrowing and widening would be more like drawing geometrical shapes 'by hand'. Neither affects the fundamental identity of the shapes themselves, but compared with the hard, precisely delineated figures drawn with ruler and compass, they appear less rigid, more inherently flexible, and so more 'humane' perhaps.

Such adjustments of intonation all occur at the micro-level. But it is precisely at this level where another facet becomes inter-connected. In a linear context, the very tiniest changes of frequency (less than five or six cents) appear not as pitch alterations at all, but are heard as changes of timbre. In the other direction it follows that a particular timbre change might have an impact on our linear pitch perception. This suggests that instrumentation may actively affect intonation judgments.

At this point we might pause to consider the distinction between 'pitch' and 'note'. When the Berlin Philharmonic decides to raise its standard pitch very slightly (which they do periodically), clearly the musicians themselves continue to play the same notes as before. If the pitch of an unaccompanied singer gradually becomes sharper during the course of a piece, the actual notes remain the same although their individual frequencies may be increasing. While working in Kenya's Kerio Valley I noticed that lyre players could consider two strings to have an octave relationship and be acceptably *in tune* even when one of them was more than a hundred cents away from the 2:1 harmonic ratio. This is probably because they employ a gamut of just five notes, somewhat casually spread out between the octave, so the identity of adjacent notes is never compromised, and the essential pitch relationships remain the same, making them indeed *in tune*. In all three cases outlined above, the musical context has maintained the structural function of the notes and they are not considered as having been altered.

Thus arises an interesting question which has long fascinated me. What particular musical conditions might I create that would allow a very slight frequency change to be perceived as a distinctly *different* note rather than a variant of the same note; and how, on the other hand, could I make a significant frequency change of perhaps more than a hundred cents seem like the *same* note? The following example from *Tentative Thoughts, Silenced Voices* (2002-3) illustrates how I have dealt with this and other related issues in practice (Figure 1). (A key to the accidentals I use for microtones is given in Figure 2.)

Figure 1: Denyer, *Tentative Thoughts, Silenced Voices* page 4, bars 1-9; © 2003, Frank Denyer

The play between the semitone sharp $f1$ in the viola and the last note of the two male singers (a sixth-tone flat $g1$) is first heard as two versions of the same note, although it is certainly wide enough to be perceived as a pitch change and not a timbre change. The voice note is disguised by first appearing merely as the end of a small glissando. Subsequently (bar 2) these notes are repeated in alternation between the viola (sharp $f1$) and the first male voice

(sixth-tone flat $g1$), and then in bar 3 between the viola and the concertina reed, and finally spread out over the whole of bars 4 and 5. During these four bars (bars 2-5) perception has been gradually changing from what appears to be two versions of the same note, to two quite separate notes in opposition. The upper one is then taken up by the violin an octave higher (sixth-tone flat $g2$) as the starting point for the next musical paragraph, which moves off with a more confident melodic intent through the interval of a falling perfect fifth, albeit narrowed by a sixth-tone. The violin adds the next five notes that are purely diatonic (bar 6) but accompanied by the santur with quarter-tone shifts. The latter do not appear as variants of each other as one might expect, or as triadic blurring, but as a definite *stepwise* movement, partly because the santur is muted to reduce its echo-like resonance. The main melody is transferred to the viola (bar 7), creating a subtle timbre change, and immediately thereafter a quarter-tone vibrato-like ornament is heard that is obviously a single note despite its pitch alterations. The addition of the rubbed clothboard to this particular viola note also helps smudge the variations in frequency.

	sharp	flat
a shade (12-25 cents)	Δ	▽
sixth tone	†	‡
quarter tone	†	‡
third tone	†	‡
half tone	#	b
two-thirds tone	##	bb
three-quarters tone	###	bbb

Figure 2: accidentals for microtones used in scores by Frank Denyer

Over the years I have accumulated a collection of simple pitched and non-pitched percussion instruments whose sounds are produced by friction. (Friction percussion is somewhat undeveloped in the western instrumentarium, so there are gaps that need filling and scope for experiment.) As in the musical example above, non-pitched friction percussion instruments can act as useful adjuncts to pitched instruments, as well as having their own inherent character. A flute, for instance, with its almost sine-wave purity may be easily modified by noise elements from the player's voice or breath, but friction percussion instruments allow this process to be considerably intensified.

As a more subtle example of linear microtonal thinking I would like to turn to the opening of my piece *Ghosts Again* (2005) (Figure 3).

ghosts again

Frank Denyer

The image shows a handwritten musical score for the piece "ghosts again" by Frank Denyer, covering pages 1 to 5. The score is written for four instruments: Violin, Flute, Clarinet (in C), and Percussion. The Violin part begins with a melodic arc, marked with "PARALLEL MUTE" and a tempo of ♩ = 38-40. The Flute and Clarinet parts have specific fingerings and dynamics like "pppp". The Percussion part includes a "SMALL BAMBOO SWITCH". The score is annotated with circled numbers 1 through 5, corresponding to the bars mentioned in the caption. The title "ghosts again" is written in the center, and the composer's name "Frank Denyer" is in the top right.

Figure 3: Denyer, *Ghosts Again* page 1, bars 1- 5; © 2005, Frank Denyer

The piece starts with a melodic arc that can be thought of as an elaborate anacrusis leading the ear forward to the note d3 (bar 2) which, as in the previous example, is first introduced only as the end of a glissando, but which is then more firmly established by being repeated. The main purpose of this anacrusis is to imbue d3, when it arrives, with a floating, un-rooted and somewhat strange character difficult to describe. I'll try to outline how this happens. The clarinet opens with an upward legato minor third that is flattened by one-sixth of a tone. This flattening softens and constrains the interval but at the same time gives it an inner tendency to expand outwards, which it does after it has been taken up by the violin (expanding from a sixth-tone sharp c1 to a two-thirds flat d1). From there it sweeps upwards in a long and unexpected curve that is tonally disorienting, especially as it comes to rest on a strange two-thirds sharp a2 that is immediately 'corrected' by a very slightly sharpened version of this same note (a quarter-flat b2). At this juncture the ear is naturally confused, but the perfect fourth leap up to the first beat of the following bar helps put firm tonal ground beneath our feet, despite the fact that the fourth is slightly widened by approximately 16 cents (from quarter-tone flat b2 to a sixth-tone flat e3). However, this sharpening pulls us back to a truer perfect fourth (quarter-tone flat e3), although any security gained is quite fleeting because the note continues to slide until it finally arrives on the all important d3. The latter now seems strange because, since the opening, the ear has been made to readjust its basic tonal orientation microtonally and this point of arrival is unrelated to any of the events immediately preceding it (but closely related to where we originally began with the first clarinet note). And so the pitch appears in all its oddness. This is crucial for what follows as the next few minutes are entirely taken up with its further adventures that evolve out of that uncertainty.

Although in this paper it is only possible to touch briefly on some simple aspects of this terrain, I would nevertheless like to add some thoughts about training and preparation. For me, unusual intervals are only viable after they have been completely internalised by the performer. This means more than merely being able to mimic them and implies that they have been absorbed into the substrata of the artist's subconscious. Is this asking too much? If not, how can it be achieved?

A culturally shared collection of musical pitch relationships is already an inner part of each individual's life from very early childhood. As such they act as a foundation for the later assimilation of musical experiences. This pitch repertoire slowly expands as the child matures but for those that are active as musicians, this development is faster and much more extensive. All intervals have the potential to accrue variants or modifications that can become deeply embedded by reference to familiar musical contexts and it is not uncommon for modified intervals to be used as a measure of stylistic authenticity. (The precise pitching of blue notes in jazz would be one obvious case but all genres are riddled with them; indeed at a more refined level it may be that the majority of notes fall into this category.) To give another

example: performers of Hindusthani classical music will have certain absolute intervals (the primary harmonic ratios of the octave and fifth) both in their sub-conscious and represented externally by the ever present drone, but they will be able to utilise the other degrees of the scale, whose position is a little more subtle, having absorbed a feeling for their exact intonation through the aural tradition. There is a third category of notes whose precise pitch is contentious because even more variable and open to individual taste. The flattened 3rd in raga Jaijaianti is one such note, its placing dependent on individual experience and always something to be argued over by cognoscenti. A dhrupad singer cannot sing Jaijaianti without employing this peculiarly flattened third which must be used very sparingly and with care, like a rare spice. It must also be approached and followed via the step below and never lingered over. An experienced musician can sometimes cleverly give the illusion of this note by subtle microtonal inflections of the second degree of the scale not directly touching the third at all. This aural slight-of-hand is heard in many performances by true masters of the form.

In music of all types musicians internalise different variants of particular intervals. Whatever comprises the musician's primary internal repertoire, it is of course perceived by them as 'the norm' and acts as their fundamental reference for any later expansion. However, in adult life the ability to add new and unfamiliar intervals usually slows down. This is the problem.

Nevertheless, I have found that for the preparation of my work, preliminary pitch training still pays considerable benefits. For example, performers can quite easily learn to reproduce a melodic relationship of 10-20 cents and not confuse this with an interval of 28-35 cents or one of 39-46. These distances soon become distinct and stable. It then becomes easier to progress to the introduction of larger new intervals such as +/- 240 cents, +/- 942 cents, or +/- 1041 cents. Each of these has a characteristic flavour that is also soon recognised. (I give these as simple examples but in reality the task is related to the particular demands of the composition being prepared.)

Practising equidistant heptatonic scales from various starting points can be a useful way to break out from the ever-ready western chromatic reference and the diatonic scales it supports. Then try alternating this scale with an equidistant octatonic scale on the same fundamental. In itself the octatonic scale is easier to navigate simply because alternate notes are a comfortable minor third apart (each interval is a three-quarter tone). When both feel comfortable, alter one degree of each scale by a sixth-tone. Then repeat the scale altering the same degree by a quarter-tone. Following this, alter two degrees of each scale by one of the microtonal intervals practised initially, i.e. 28-33 cents or 40-45 cents. Go on to alter one degree in one way and another by a different one. Such exercises can be extended as required. The technical limitations of unmodified equidistant scales derive from their rigid symmetry, a consequence of being comprised of identical intervals. Each transposition or tonic shift can therefore only produce a clone of the same scale.

In more recent years I have come to use more elaborate methods and to give an idea of them I would like to take an example from *Unnamed* of 1998 (Figure 4). This is a long solo composition for shakuhachi. It is helpful to keep in mind that here 'a note' is often a 'pitch-field' rather than a discrete frequency. These fields are not uniform in scope. In passages that use, or partly use, the equidistant heptatonic scale, I have attempted to give each note its own particular set of characteristics within its individually sized pitch-field. One degree might have variant alternatives that result in very slight shifts in its pitch position almost each time it occurs; another has satellite notes that tend to blur or colour it like ornamental moons and it will never be heard in isolation; then there are others that always appear in movement, traversing their field, while still others that have narrow fields and remain stable and unadorned. In addition to this now complex scale the piece as a whole contains several other note sources with quite different derivations but which simultaneously share the musical territory. First, there are the four strongest notes of the shakuhachi (foundation tone, fifth, octave, twelfth and fifteenth), then the pentatonic scale produced by the open holes of the instrument (not at all equal-tempered pitches), then some more complex notes produced through the shakuhachi's characteristic *meri* technique, and finally sections of the western chromatic scale (with the addition of some quarter-tone passing notes). All together, these make a very complex matrix of pitch material, an extremely fine but quite asymmetric grid or

galaxy. For the player it would be impossible to internalise so many micro-pitches if they were all presented as equal dots in the firmament. However, by understanding the derivation of each note, the whole can be internalised by reference to a few simple subsets. I did this in the notation by indicating each of the principal subsets with a different colour. From a compositional point of view this unevenly distributed galaxy allowed a flexibility of line to emerge, as well as the possibility to rest in various tonalities along the way.

G = equiheptatonic scale from G[#] (Green)
 B = satellite pitches to equiheptatonic notes (Blue)
 Y = primary and strongest shakuhachi pitches (Yellow)
 The remaining unmarked notes are from the standard chromatic scale (black)

Figure 4: Denyer, *Unnamed* page 8, bars 6-14; © 1998, Frank Denyer

Such systems do not have any value in themselves and are of no concern to the listener; indeed the last thing I want is for the listener to be preoccupied with microtonality. They are used only as a compositional tool in order to make possible the kind of melodic structures I am interested in.

To some extent I can now find my way around such spaces instinctively. But even at its most prescribed, this terrain essentially remains an open one because it has to be forever susceptible to the subconscious aesthetic instincts of musicians. It is principally this factor that informs the linearity and allows for the exploration of those mysterious and ambiguous areas that form the borderline between conscious and sub-conscious perception.

December 2008

Note

Tentative Thoughts, *Silenced Voices* and *Ghosts Again* are recorded on *Frank Denyer: Silenced Voices*, Mode 198 (2008). *Unnamed*, performed by Yoshikazu Iwamoto, is recorded on *Frank Denyer: Music for Shakuhachi*, Another Timbre AT03 (2007). For more information: www.frankdenyer.eu.