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Koan, by James Tenney

By Chris Lortie[1] and Yuval Adler[2]

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In 1971, American composer James Tenney wrote the solo violin piece *Koan* as part of his *Postal Pieces*. The score is contained entirely on a postcard consisting of only seven measures. A string quartet arrangement of *Koan*, written by Tenney in 1984, retains the original violin line but adds a further harmonic context in the remaining three instruments.

Tenney provides the following explanation in his program notes:

> "In 1971, I wrote a piece called *Koan* for solo violin which was concerned with the perceptual effects of an absolutely linear and predictable formal process — involving a bowed tremolo progressing through a series of microtonal intervals on progressively higher pairs of strings. The first violin part in this *Koan* for string quartet is essentially the same as that earlier piece, but here the other instruments of the quartet are used to provide a harmonic context — and thus a harmonic "meaning" — for each of those microtonal intervals, within a fairly complex, just tuning system. The resultant sonorities might be conceived as a complex "chord progression" on various different roots or fundamentals. Some of these sonorities will be quite familiar to the Western ear; others are rather more "exotic." But they are all derived by a simple extrapolation from traditional harmonic relationships."

These harmonic relationships are composed in accordance with frequency ratios; more specifically, frequency ratios between difference tones. A difference tone is a psychoacoustic phenomenon where a tone is perceived which is not originally present, and whose frequency is experienced as the difference in frequencies of two existing tones. (The general class of these tones is called combination tones, which has two subclasses: difference tones and sum tones.)

The table below shows the use of this concept over the form of the string quartet version (f_1 and f_2 are the frequencies of the two tones played in the original violin part):

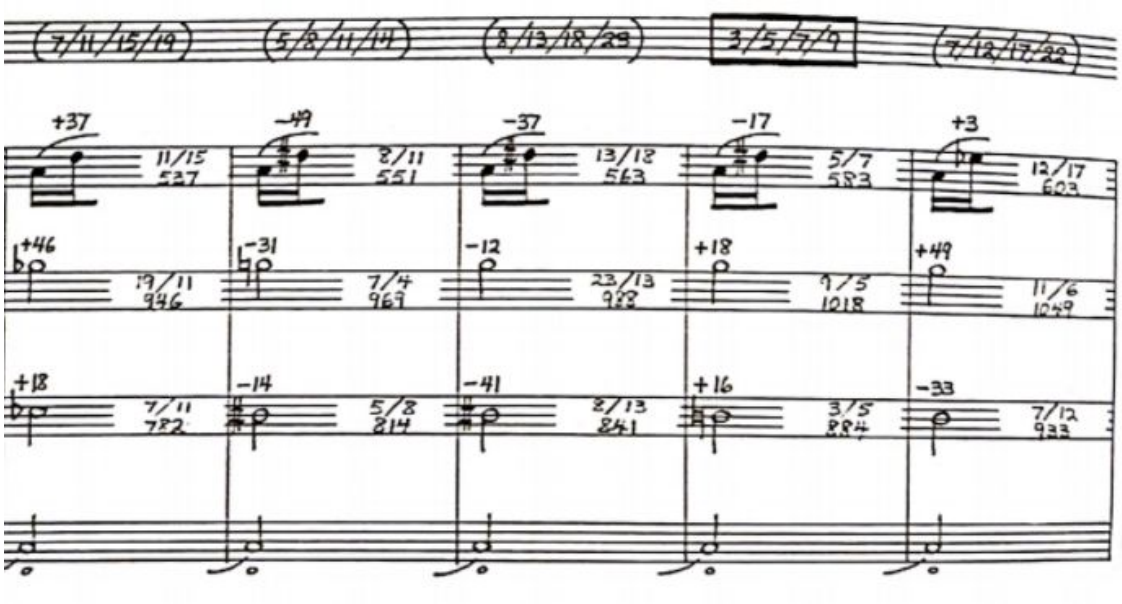
	m. 1 [A]	m. 44 [B]	m. 87 [C]	m. 130 [D]	m. 173 [E]	m. 216 [F]	m. 259 [G]
Vl. I	f_1 and f_2						f_1 and f_2
Vl. II				$2f_2 - f_1$		$3f_2 - 2f_1$	$3f_2 - 2f_1$
Viola		$2f_1 - f_2$					$2f_1 - f_2$
Cello	f_2					$3f_1 - 2f_2$	$3f_2 - 2f_1$

Formal diagram of difference tones used in the string quartet arrangement of *Koan*

Tenney's harmonizations represent an amplification of natural byproducts of the inner ear. The approach towards the added instrumentation seems similar to Gérard Grisey's "instrumental synthesis", where Grisey uses frequency partials of some source sound, derived from an acoustic analysis of a recording, to generate pitch material for orchestration. But unlike Grisey, for the added instrumentation in the string quartet version of *Koan*, Tenney does not use spectral components present in the original acoustic sound of the violin part as they would propagate in the room. Instead, Tenney uses frequency components only present within the listener at the moment of audiation. This goes beyond relying on mainly acoustic properties of a sound in composition and orchestration to include mainly *psycho*-acoustic properties of a sound.

By expanding upon the violin line in this way, Tenney gives a clue towards the latent intentions of the original piece: *Koan* is an artistic byproduct of Tenney's acoustical research questions. Tenney's research into temporal Gestalt formation, consonance/dissonance discourse, and his landmark *Meta-Hodos* each point to a vested interest in the phenomenological experience of music. While these secondary sources will not be discussed explicitly here, their existence nevertheless informs an analytical reading of *Koan* as a perceptual experiment.

The use of mathematical ratios as they occur in natural phenomena (and assigning them the qualifier of "context" or "meaning") informs the structure for this psychoacoustic drama. The perception of these ratios, while plausible in the solo version, is augmented further to the point of exaggeration in the quartet version, as if to erase any doubt of their existence. Tenney provides a helpful label of these ratios in each measure to aid the performers in their intonation:



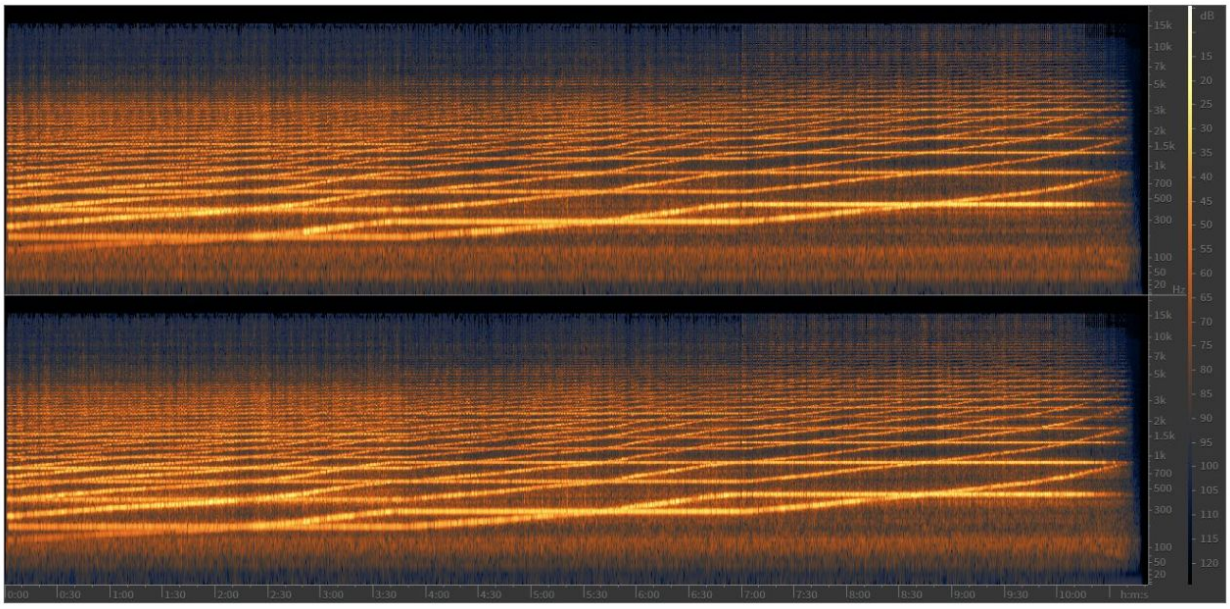
James Tenney, *Koan: for string quartet* (Maryland: Smith Publications, 1986).

Ratios that include numbers with small proportions — and therefore more harmonic consonance — are enclosed in rectangular boxes. These correspond with moments of timbral **smoothness** (as opposed to **roughness**), i.e. the degree of harmonicity perceived in a sound as a result of acoustic beating. Incidentally, these moments of harmonicity are spaced at irregular intervals. The perceptual experience of approaching and receding from these consonances creates for the listener a timeline of arbitrary spikes or valleys in spectral tension. To borrow a term from chemistry, these "islands of stability" hold no consistency in their spacing; only general probabilities can be discerned. Even so, these alignments of simple harmonic ratios can be predicted to an extent by the listener. One may experience the converging of multiple instruments towards these consonances through the progression of beating patterns leading towards them. The formulation of expectation therefore happens on an immediate perceptual level, not a cognitive one; large-scale patterns of harmonicity cannot be discerned easily, while measure-to-measure resolutions of these dissonances can be anticipated to a degree.

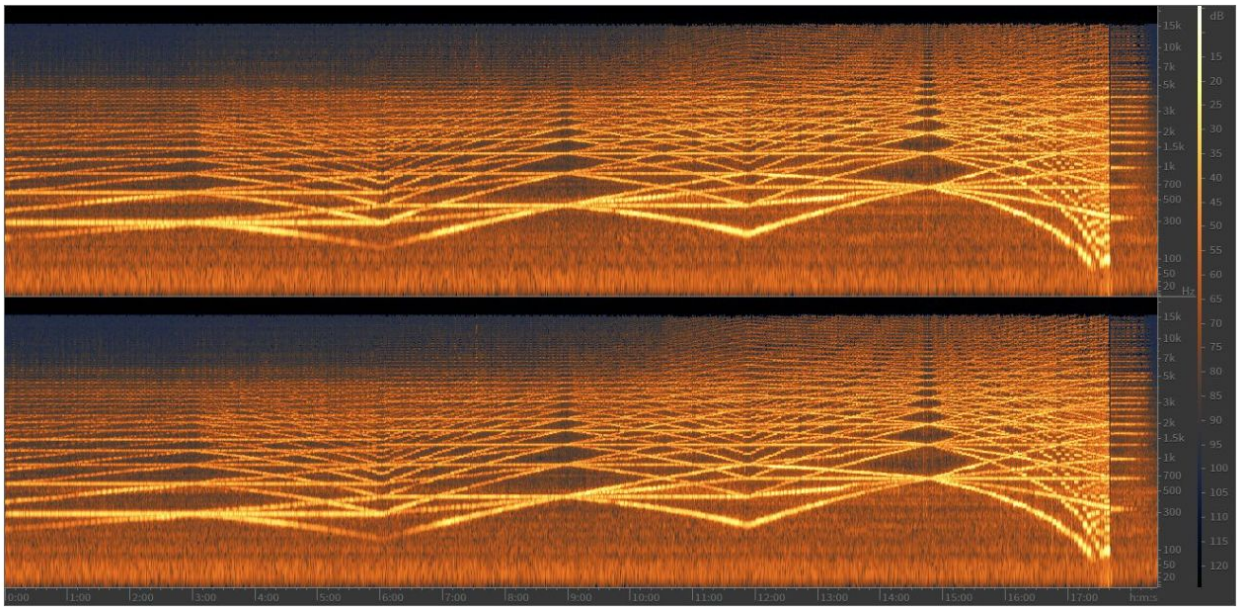
What started as a psychoacoustic phenomenon of emergent tones, which could be heard as spectral elements of the original violin piece, is written out in the quartet version into a constantly shifting harmonic landscape, where our perceptions of the ensemble's instantaneous timbre is our only guide through moments of tension and release.

Below are two spectrograms that offer an acoustical perspective to complement the perceptual, psychoacoustic approach taken above. Instead of focusing on the heard experience, they illustrate the mathematical construction and beauty of *Koan* in both its versions. The quartet version's spectrogram contains within it the same diamond-shaped lattice from the original version, with additional branches of these diamonds appearing above and below (these represent the simulated difference tones played by the Violin II, Viola, and later, the Cello). The lowest voice (Cello) appears to slope off sharply downward towards the end of the piece; this can be explained by the logarithmic nature of pitch. As the Violin II climbs steadily upward, the logarithmic difference of

the two highest pitches forces the Cello line to descend rapidly (the perceptual effect, however, remains consistent with what precedes it). The quartet version is then bookended by a 12-measure coda on an E-major chord, hence the horizontal lines at the end of the second spectrogram.



Spectrogram of solo viola version in its entirety as performed by Elisabeth Smalt, which can be heard here: https://www.youtube.com/watch?v=5iE6CP7D84Y



Spectrogram of string quartet version in its entirety as performed by Quatuor Bozzini on their 2008 album *Arbor Vitae*, which can be found here: https://quatuorbozzini.ca/en/discographie/1679

Finally, a video of Quatuor Bozzini's performance of the piece, recorded live in Montreal at the Sala Rossa during the Festival Suoni Per Il Popolo in 2016.

https://www.youtube.com/watch?v=8Tpo2tCH-6I