CAN HARMONY BE NON-LINEAR? ISSUES IN MICROTONAL COMPOSITION AND PERCEPTION

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ABSTRACT

Can harmony be non-linear? This is the question which New York composer Glenn Branca has posed in relation to the potential for new developments in the role of harmony in contemporary music. The question will be investigated in relation to a discussion of the characteristics of more traditional conceptions of harmony. The discussion will first focus on aspects which could be considered to be 'linear' along with a brief survey of changing approaches to harmony in Western music history. This will be followed by a survey of possibilities for the construction of harmony based on principles of non-linearity in terms of temporal, textural and pitch elements. These possibilities will be discussed with reference to experimental compositions and compositional approaches.

1. INTRODUCTION

In April 2007 New York composer Glenn Branca published an article on the *New York Times* website in which he posed a series of questions for contemporary art-music and its associated culture. (This move was inspired by mathematician David Hilbert's 'Paris Problems' of 1900, which referred to problems which he hoped to see solved in the new century.) One of these questions will be focused upon here: 'Can harmony be non-linear?' [1]

A consideration of this question will lead to an investigation of the possibility of avant-garde developments in harmony based upon more ambitious expectations of the perception of auditory structures. Speculative accounts by Tenney [14], [15] and Snyder [13] will be used as the starting points for this investigation, with some of Snyder's discussions of musical structures being extended into the realm of harmony.

2. TRADITIONAL 'LINEAR' HARMONY

2.1 Linearity of Chord Progressions and Cadences

A definition of the 'linear' characteristics of Western harmony will first be attempted. *Grove* defines harmony as:

> 'The combining of notes simultaneously, to produce chords, and *successively, to produce chord progressions*. The term is used descriptively to denote notes and chords so combined, and also prescriptively to denote a system of structural principles governing their combination.' (*italics mine*) [3]

The focus here is on both the simultaneous properties of the chords and, more crucially for the question at hand, directed chord progressions. In this view, harmony is a system which is based upon codified sets of progressions which imply or evoke a strong impression of causality. As Snyder puts it, 'linearity is a way of constructing music so that events in a sequence seem connected to and grow out of each other' [13:63]. Furthermore, there is an element of binary opposition in the way in which the chordal structures progress from dissonance to consonance. In the dominant view (to be found in accounts from Rameau [9] to Schenker [10] and Lehrdahl & Jackedoff [6]), harmony is a process of tension and release leading from dissonance to consconance. This conception of harmony in effect derives its strong directional imperatives and linearity from this axis of tension and release.

2.2 Development of Linear Harmony and Challenges to its Primacy

McClary has stated that '[w]e can now look back to the 1800s […] and recognise that [symphonic pieces of that period…] all shared an investment in dynamic narratives of subjective struggle towards triumph.' [8:291]. Whilst some of McClary's conclusions about the ethos of 'struggle towards triumph' in the symphonic repertoire are by no means uncontroversial, the important element in the quote for the present discussion is the focus on 'dynamic narratives' being an attribute of pieces *in that particular era*.

Tenney [14] has noted dramatic changes in the conception of harmony in Western Music as illustrated by the changing definitions of the terms 'consonance' and 'dissonance' in Western music.

The initial conception (which is termed 'consonance/dissonance-concept-1' or CDC-1) is based upon ease of tuning between successive notes, later becoming 'relations between notes' [14:9-16]. CDC-2 (the early polyphonic period) is related to tonal fusion [14:17-31]. CDC-3 brings in questions of counterpoint and clarity of voices as a result of registral spacing, interval and well-proportioned contours from voice-leading [14:39-58]. CDC-4 (Classical/Romantic conception) sees 'consonance as a product of the perceptual stability of a triadic component' [14:65-86].

This is the conception which is most to the fore in our current mainstream definition of harmony. Overlaid upon this is the post-Helmholz view (CDC-5) of consonance as related to lack of sensory dissonance due to the critical band response of the basilar membrane [14:87-94].

The implications of this list are twofold. In the first instance, the concept of harmony has changed considerably over the history of Western music. As a result, rather than any of these definitions of harmony being 'incorrect' or 'less advanced', it is possibly more correct to view 'harmony' as a catch-all term and a multi-dimensional phenomenon. Secondly, the necessity of temporal linearity and syntactical functionalism in the dominant (CDC-4) conception of structure is perhaps also open to question.

In relation to the genesis of the tension/release element of CDC-4, Tenney notes that:

> '[I]n CDC-4, dissonance is no longer the "result" of melodic motion, but one of its primary *causes*. In addition, this association of dissonance with motion gradually begins to reflect back on the consonance/dissonance concept […] if a note is judged to have a strong tendency towards motion—for whatever reason —it may therefore come to be called "dissonant".' (*italics Tenney*) [13:78]

Thus musical practice and theory of the CDC-4 period has produced a conception of musical grammar and structure based upon a tension/release axis. In relation to the alternative concept of continuum, Snyder relates linearity to continuity as 'incremental, directional, and often regular changes' [13:229]. It is argued that microtonal composition, with its greater number of intervals intervals drawn from the pitch continuum, offers even greater possibilities for linear (and, as will be seen below, non-linear) progressions.

3. THE POSSIBILITIES AND PROBLEMS OF NON-LINEAR HARMONY

3.1 Possibilities for Non-Linear Harmony—Temporal Order

As was noted above with reference to Snyder [13], linear construction highlights or implies causality. Furthermore, this causality highlights a unified structure and identity for a piece of music. In terms of the view of 'harmony' as related to 'unity', does a certain apparent acausality necessarily negate this unity?

In the absence of 'traditional syntactically-derived goal patterns' [13:232] goals are still established by other structural cues such as the repetition of significant patterns in certain key locations (reinforcing an impression of a larger-scale structures or schemata).

More crucially for the present purposes, pieces may be structured on an 'associative' basis, without clear or 'deep' hierarchical structure but with similar materials in various locations marking non-causal structural points. The effect would thus be of a 'web-like' structure of interconnections rather than a single structural line through the piece [13:234]. Microtonality, with its greater possibilities for interconnections between intervals (based on adjacency or modulation) could aid in the creation of such associative structures. The dramatically increased number of possible progressions makes a fixed linear (and apparently causal) ordering of material less important.

However, in the case of microtonality which uses a more familiar overall schema such as the harmonic series, there is the potential to evoke an 'associative' response based on the overall schema (for more on such structures see [2]) of the series. Thus, while the listener might be unsure of the direction or goal until the next section is reached, there is a certain sense of familiarity about all of the material. The directions taken are not necessarily 'obvious' ones, but progressions are obviously not made 'at random', and reflect aspects of the overall structure, even if the specific choices of progression appear surprising or unexpected and do not follow on from the previous elements in a perceptually 'linear' manner.

This type of conception of harmony and syntax is echoed in Tenney citation of Cage's views of what might be conceived of as a 'wider harmony', in which 'harmony' is defined as:

> 'an interpenetration and non-obstruction of sounds… a composer at this moment…renounces harmony and its effect of fusing sounds in a fixed relationship.' [15:17]

Such 'associative' connections can draw heavily from long-term memory [13:226] and pieces with such a structural articulation are probably less subject to short-term memory constraints, though with the trade-off of less focus on ordering of events. Both of these views relate well to Branca's comments in a conversation with the author on the subject of non-linear harmony, which he relates metaphorically to the Cagean use of collage, simultaneity and interpenetration of disparate elements.

3.2 Perception of Pitch Materials—Towards Perceptual Non-linearity

Pitch has been defined as :

> 'that attribute of auditory sensation in terms of which sounds may be ordered on a scale from high to low. Pitch mainly depends on the frequency content of the sound stimulus, but it also depends on the sound pressure and the waveform of the stimulus.' (ANSI definition, cited in [5:283])

In pure tone cases with equal amplitude in the presentation material, perceived pitch relates to input frequency in a roughly exponential manner. [11:149-150]. The further up in pitch one proceeds in octave intervals, the greater the frequency change required will be, in a relation which is roughly exponential. Looked at another way, the sizes of pitch intervals will become smaller as a tone proceeds upwards in a series of equal

frequency steps. If we construct a scale which is physically linear (such as one based upon the harmonic series of a given fundamental), we will obtain a scale which is non-linear in perception. As the possible intervals will be increased in number, a greater range of permutation and combination/connection possibilities would open up. Therefore, non-linear pitch materials can also reinforce non-linear temporal structures.

3.3 Microtonality and Perception

Microtonality has been criticised on a number of perceptual grounds. Snyder notes that the well-established Just Noticeable Difference for adjacent presentations of pitch is so small because it works with echoic memory [13:127] and discusses the problems of categorical perception of small intervals (an issue also noted by McAdams [7]). Snyder notes that including intervening tones will make matters more difficult as a result of an increase in the use of memory [13:128]. He thus distinguishes between discriminations in perceptual and conceptual categories, with the former relating more to echoic memory [13:127] and the latter relating to short term/long term memory [13:128],

However, although conceptual categories of pitch may not be quite so accommodating of nuance, microtonal variations in pitches *in simultaneous presentation* can result in more than just a change in melodic/intervallic nuance. A change in interval in a microtonal range may have quite a considerable effect on the overall sound mass/timbral structure in the case of a chord, cluster or dyad in terms of auditory segregation or grouping effects based upon the beating (or lack thereof) of component partials [2]. In the case of certain intervals with pure tuning, a quasi-timbral impression can be created which may be related to tonal fusion. As such, an interval such as a 7/4 or seventh harmonic (which is frequently heard in the music of La Monte Young) will produce a very different sonority (and timbral effect) to a tempered minor seventh when presented as part of a dyad or chord, even if it is perhaps harder to distinguish between these two in a non-adjacent sequential contexts. Though Snyder cites the work of Sethares [12] and states that 'pitch and timbre are not entirely separate parameters' [13:199], he does not explicitly make the connection between timbre and the discrimination of small pitch intervals. Snyder categorises pitch as a 'primary' parameter of musical structure and timbre as a 'secondary' parameter (on the basis of pitch's 'relatively fixed proportional relationship' and timbre's lack of such a scale) [13:195]. He notes that such secondary parameters may reinforce primary parameters [13:197]. If this is the case, then this type of combined pitch/timbre aggregate memory may aid in the perception of microtonal intervals.

3.4 Possibilities for Non-Linear Harmony—Pitch Materials and Sound Structure

In addition microtonal interval which is recognisably part of the harmonic series can have a perceptual clarity of relation to the larger structure of this 'overall' schema.

The series is an example of a primitive schema [2:397] based upon one of the main principles of environmental regularity behind the auditory perception system, and offers strong possibilities as both an element implying simultaneous grouping (quasi-tonal fusion) and sequential grouping (melodic contour based upon a recognition of elements of the series). Thus, the harmonic series is one common structural rationale behind microtonal music. In terms of harmony as 'sonority', it can clearly evokes an element of chordal fusion which is similar to tonal fusion. (Chapter 2 of Erickson [4] deals extensively with just such a phenomenon.)

The overall structural archetype, along with a use of pure tunings—without too much vibrato or irregular beating effects in the constituent tones—can cause chords to fuse in this context. Even less 'holistic' evocations of the harmonic series such as those found in the chords of La Monte Young's *Well-Tuned Piano* can appear to be strongly fused in a pitch-like tonal complex due to their pure tunings, resulting in chords which the author and others have perceived as being 'bell-like'.

The use of the harmonic series as perceptual framework for a resulting harmony which is more non-linear can take two contrasting approaches.

One approach is to present a large number of elements of the series as possible at the one time. A process-based approach has been followed by James Tenney in his *Spectral Canon for Conlon Nancarrow*, in which the various elements of the harmonic series enter in turn with different temporal offsets of decreasing interval. Irregularities in performed pitch and other changing conditions over long durations in La Monte Young's *Composition 1960 #7* foreground and segregate elements of the series from the spectra of the component instrumental tones due to processes of grouping and segregation and, in particular, the 'old-plus-new heuristic' [2:220-224]. The small pitch variations and long glissandi in the drone works of Phil Niblock engender a similar effect. In the classic approach of the French Spectral School, the spectral analyses of harmonic timbres are orchestrated with various temporal features of the spectrum evoked in an apparently a-causal 'associative' manner which nonetheless relates back to the overall structure of the harmonic series.

Another approach—one which has been explored by Branca in his early symphonies—is to use the harmonic series as a tuning system, scale and structure, but to present more a version which is sparser in its simultaneous presentation. This type of approach lends itself towards the consideration of the possible combinations of the more isolated elements from the harmonic series framework. In cases like this, there is a certain familiarity with the intervallic materials, though the range of options in terms of progression and sonority makes for an unpredictable range of progressions (which nonetheless appear to be logical progressions within the context of the structure of the series).

The 'complete-schema' and 'occluded schema' approaches to harmonic series seem to offer potential form non-linear/causal structures in different ways. The 'complete-schema' case of Tenney et al. and the Spectralist approach offers a very obvious associative form. The 'occluded schema' approach by Branca offers a less obvious associative form because it does not present the harmonic series in as simultaneous a fashion, but nevertheless the connection to this root structure seems to remain. However, the complexity of the potential connections afforded by this associative 'web' perhaps affords so many possibilities that a greater number of syntactical possibilities are admitted. Therefore strict temporal ordering of syntactical elements becomes less necessary.

Within this context, even dissonant intervals or complexes are not as 'cognitive-structurally' dissonant in terms of a conception of demanding resolution. Microtonal intervals which are dissonant in sensory term (relating to the critical band response) may also be considered 'consonant' at another level due to their periodicity (from pure tuning, even in cases of small intervals being within a critical band) and also from the reinforcement of perceptually 'detached' harmonic partials from due to the factors of auditory scene analysis mentioned above.

The different views of the potential for microtonal harmony above allow for more structural possibilities of harmony which are not necessarily constrained by clear, well-travelled, linear paths.

4. CONCLUSION

To conclude this discussion, it has been suggested that non-linearity in the temporal structure of music can lead to a structure which is more 'associative' and is less subject to the structural constraints of short-term memory. Such a form can potentially be aided by the use of microtonal pitch materials from the harmonic series. Not only does the resulting increase in range of possibilities facilitate less predetermined syntaxes of combination, but the familiar schema of the harmonic series aids in this overall association. Such microtonal materials, whilst potentially difficult to categorise purely in terms of the pitch dimension may be additionally categorised by a cross-reference with the timbre/sonority of the chords produced. In this respect, microtonal composers working with such non-linear harmony may have much in common with those focused upon timbre-based and electroacoustic composition. In relation to Branca's original question, the author believes that not only is non-linear harmony possible, but that some composers (including Branca) are already doing it.

5. REFERENCES

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