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"The Bass moves into the middle: this is our musical revolution. [...] Why is it important or interesting for this to happen? Why was it important for painting to grow beyond earth/sky gravitational systems and liberate space?" [1]

Jonathan Harvey

Introduction

This study intends to investigate the relationship between spectral space in electroacoustic music and the more culturally prominent notion of pitch-space as an aspect of pre-acousmatic music. The question posed here is whether there are any parallels between listening expectations developed through the use of pitch space in instrumental music, and those formed in conjunction with exploitation of spectral space within the genre of acousmatic music.

Terminology

Spectral space is defined as *the available range, occupied by the frequency components of sonic phenomena.* The concept of spectral space can be used to discuss the temporal evolution of sounds within the frequency continuum. In acousmatic music where source-bonding and note-based or rhythmic musical structures are weakened, spectral space becomes the focus of our listening experience, yielding direct listening expectations that inform our perception of musical form.

Pitch space refers to *the deployment of pitches between the lowest and highest available pitches to the composer* (this is naturally dictated by the instrumental ranges). Note that the perception of pitch and intervallic relationships is crucial for the existence of pitch space. Pitch space can be viewed as a subcategory of spectral space as it refers to a particular manner in which spectral space is revealed and deployed. For instance individual pitches or notes are clearly defined, dividing the spectrum into grids or steps (see Wishart's concept of *lattice*[2]).

Expectation

In *Emotion and Meaning in Music*, Leonard Meyer states that "Embodied musical meaning is, in short, a product of expectation" and goes on to demonstrate that an emotional reaction to a musical passage is triggered when a particular expectation is implied but not satisfied.[3] Thus it follows that in order to understand the creation of musical *meaning* through the deployment of spectral space, we need to study and classify listening expectations that are created with regard to attributes of spectral space.

Listening expectations in music are created on at least two levels: firstly, on the level of intrinsic structures of auditory stimuli and secondly, through extra-auditory implications of auditory stimuli.

Intrinsic structures

Experiments in the field of music perception and psychology have established that musical expectation is largely learnt through cultural exposure, a process David Huron refers to as "statistical learning". In other words, listeners are "sensitive to the frequencies of occurrence of different auditory events", and it is precisely this occurrence frequency that shapes our listening habits and expectations.[4] Huron's research demonstrates that our listening expectations regarding melodic motion in pitch space are created due to cultural exposure to reoccurring motion-patterns and arrangements of pitches within pitch space.[5]

Adapting ideas from the gestalt school of psychology, Meyer mentions that musical prediction and expectation is to a large extent governed by our mind's preference to organise stimuli into intrinsically complete and closed structures.[6] In this sense discontinuity of motion leads to discontinuity within a mind-process that in turn creates psychological dissatisfaction and arouses strong emotional tension. Meyer describes such discontinuities as structural gaps, which imply subsequent closure or completion.[7]

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[1] Jonathan Harvey, 'Reflection after Composing' Tempo, New Ser., No. 140 (Mar., 1982), p. 2.

[2] Trevor Wishart, 'On Sonic Art', London: Taylor & Francis Group, 2002, pp. 23-43.

[3] Leonard B. Meyer, *Emotion and Meaning in Music,* (The University of Chicago Press, London: 1961), pp.33-34.

[4] David Huron, *Sweet Anticipation: Music and the Psychology of Expectation.* (London: The MIT Press: 2006), pp. 60-71.

[5] Ibid., pp. 91-94.

[6] Ibid., pp. 83-93.

[7] Ibid., p. 88.

Extra-auditory Implications

In addition to intrinsic auditory relationships, musical expectations are created through references to other sensory experiences. The mind links auditory stimuli to mental representations drawn from other sensory experiences (e.g. visual, kinetic, etc…) in order to form a complete impression of the perceptual reality of the perceived stimuli in relation to the body.

The concept of pitch or frequency range, as spatial height is undeniably rooted in our collective cultural consciousness and cannot be disregarded as mere fiction: we experience spectral space as an aspect of the musically represented space. For instance consider Baudelaire's description of his experience of a performance of Wagner's *Lohengrin* Prelude which clearly connects spectral height with the concept of spatial height.

"I remember that from the very first bars I suffered one of those happy impressions that almost all imaginative men have known, through dreams, in sleep. I felt myself released from the *bonds of gravity,* and I rediscovered in memory that extraordinary *thrill of pleasure* which dwells in *high places*." [8]

Baudelaire goes on to say "no musician excels as Wagner does in *painting* space and depth, both material and spiritual".[9]

The images of weightlessness and height are self explanatory in the above quote. It is clear that Baudelair's allegories of spatial dimensions reflect certain aspects of the spectral design of this passage. For instance the lightness of the violin timbre and the presence of high-pitched textures without any supporting root (of which I will say more later).

Relationship Between Spectral Space and Pitch Space

In order to evaluate listening expectations regarding spectral space, we need to investigate and classify the notions of motion continuity, recurrence of patterns, motion types or morphological behaviour within spectral space, in addition to possible extra-auditory links. It would be highly unlikely that our expectations regarding motion through spectral space in electroacoustic music are arbitrarily created, and not habituated through cultural exposure. Furthermore it seems probable that listening expectations and attitudes towards spectral space are closely related to, and partly habituated as a result of cultural exposure to pitch space in the context of pre-acousmatic music.

Spectral Space: Motion Implications and Attributes

Taking into consideration what was previously discussed with regard to musical expectation, let us start with the basic assumption that our expectations concerning motion within spectral space are informed on two levels (see figure 1).

	Intrinsic attributes (auditory)	Transmodal (extra-auditory)
	Planes	Rootedness
	Diagonal Forces	Weight/Demensions
Figure 1		Gravity

Planes and Diagonal Forces

Smalley describes planes as the implication of focal points or strata within spectral space. Planes may also be implied through motion that seems to gravitate towards an imaginary spectral region. The opposite of a plane is a diagonal force or the implication of material to diagonally move across the spectral space.[10]

In electroacoustic music spectral motion-continuity and diagonal forces may be implied through many different means, depending on the morphological behaviour or characteristics of material used. Diagonal forces may be created through mixing and sequencing of discretely spaced elements in spectral space or by the use of continuous glissando motion.

Rootedness

Rootedness refers to the implication that a texture is rooted or anchored within a lower plane. Root is expected to occupy the lower region of spectral space as the supporting ground above which other textural materials exist. A texture may or may not be rooted: higher textural elements that elevate without a supporting ground imply a lack of root-orientation. Rootedness is conventionally understood in terms of harmonic interdependency of pitches with the bass (root positioned triads). But harmony is not the only factor responsible for the formation or lack of rooted textures. For instance, in the previously mentioned Wagner example the texture elevates even though triads are mostly root positioned. Here elevation is produced as the result of high tessitura and the lightness or thin quality of the violin timbre.

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[8] Charles Baudelair, *The Painter of Modern Life and Other Essays,* (Phaidon Press Limited: 1995), p. 116.

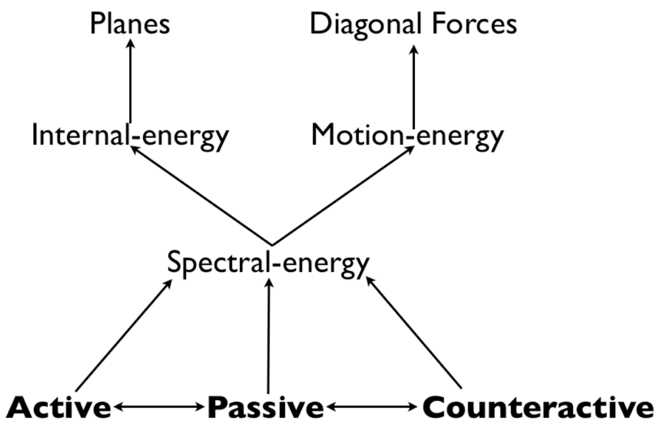
[9] Ibid., p. 116.

[10] Ibid., pp. 45-46.

Weight/Dimension
In acousmatic music, the sensation of **weight** relates to the physical dimensions of imagined sources of sounds. Lower frequencies are often perceived as being larger in **dimensions** (and therefore heavier), and higher sounds as smaller and lighter. Lighter spectromorphologies tend to float or elevate readily, whereas heavier spectromorphologies allude to an earthbound gravitational force.

Behavioural Tendencies and Spectral-Energy
Often, diagonal forces create motion behaviours that inform our conception of *weight* and *gravity*. For instance textural elements may give-in to the gravitational pull of the root thus becoming heavier. Whereas lighter spectromorphologies ascend or elevate easily, heavier materials may push their way upwards through concentrated *motion-energy*. It therefore follows that diagonal forces can be **passive**, **active** or **counteractive**. Passive are those elements that behave seemingly naturally in relation to their perceived weight/size and the gravitational tendency of the root. Active forces are those that need high levels of motion-energy or internal-energy to negate the expected gravitational tendency. An active diagonal force creates motion-continuity, which can be disturbed through counteractive motion, creating tension that implies subsequent resolution by regression towards the active course. In Mayer's terminology this deviation from a process-continuity is defined as "process reversal".
Figure 2 demonstrates the relationship between spectral energy and the creation of behavioural functions or tendencies (i.e. active, passive and counteractive). Starting from the top, planes and diagonal forces exist within a spatial setting predefined by our notion of gravity and weight.

Figure 2

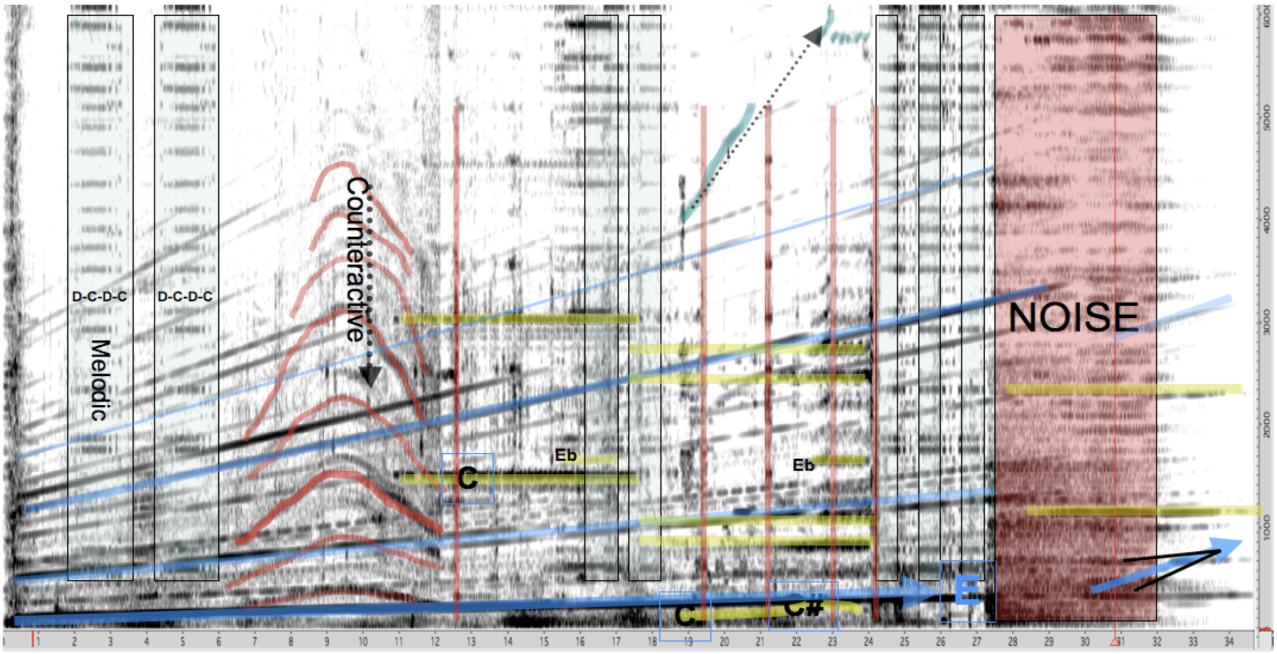


If planes are physically present, their internal spectral-energy informs us about their behavioural-function in relation to gravity and their weight: do they need high levels of energy to **actively** maintain themselves or are they behaving **passively** in relation to external diagonal forces, the gravitation pull and their weight?
Diagonal forces imply behavioural-function through the amount of motion-energy they project: is their energy **actively** resisting the gravitational pull of the root or behaving seemingly **passively** in relation to its weigh and the root's gravity?
Finally, in more complex situations, both planes and diagonal forces can contain **counteractive** energy if their behavioural or energy tendencies run against **actively** present planes and/or diagonal forces. There may exist any number of counteracting elements that are intertwined within a complex field.
An excerpt from my piece Circular Ruins can serve to demonstrate such activities within electroacoustic music. In the section starting at 4'.33", an ascending glissando motion is employed to create a strongly active diagonal force (see Figure 3). The glissando implies a higher plane towards which it moves with a high amount of motion-energy, suggesting a subsequent resolution (note that the plane is not physically present here). The different elements in this passage interact with the glissando, either supporting or counteracting the global elevation. The repeating melodic pattern (D-C-D-C) creates a kind of plane (that is the tonal centre established around the note C) whilst the upward motion of the glissando is from time to time stabilised through the emergence of insistently sustained pitches. The noisier materials also outline counteractive diagonal forces that forcefully pull downwards through swelling motions. At the end of this section our expectation of a resolution is left unsatisfied as the glissando becomes lighter in weight and disappears upwards (thus an active process becomes passive).

Final Remarks
The above notions are taken from real-world analogies but I have also tried to reiterate that spectral space is deployed within music to paint space in a far more liberated manner than experienced in real life. For instance remember Baudelaire's dream-like vision of spatial relationships in *Lohengrin* (e.g. loss of gravity). Indeed Jonathan Harvey highlights the significance of the progressive liberation from the harmonic or textural *root* through the advance of atonality in Western Art Music (harmonies radiating outwards from the centre, rather than implying earth-bound rootedness):

"The original connection of serialism with heaven, or transcendental consciousness of some sort, will strike many as grotesque - especially those who find serial music turgid and negative, expressive of pain and conflict [...]. But my ear suspects that in such music the bass is still struggling at the bottom, alienated and bearing an enormous tension of dislocated dissonance, trying to be a root under somewhat unfavourable and stressed conditions. Music which floats, in which it is unattractive and implausible for consciousness to read a bass at the bottom, is a different matter." [11]
A thorough classification of different listening implications in relation to textural behaviour within spectral space is needed in order to open the way for a better understanding of the attributes, which influence the formation of meaning in electroacoustic music. Furthermore, the creation of a unified vocabulary for describing similarly experienced textural relationships in both acousmatic and instrumental music sanctions the establishment of a historical trail, thus expanding our knowledge of the perceptual procedures that influence the composition and audition of musically represented space.

Figure 3 - Annotated sonogram from *Circular Ruins*, starting at 4'.33"



Glissando from 4'.35"

Bibliography
BAUDELAIRE, Charles. *The Painter of Modern Life and Other Essays.* Phaidon Press Limited, 1995.

HARVEY, Jonathan. 'Reflection after Composing', in Tempo, New Ser., No. 140 (Mar., 1982), pp. 2-4.

HURON, David. *Sweet Anticipation: music and the psychology of expectation.* London: The MIT Press, 2006.

MEYER, Leonard B. *Emotion and Meanning in Music.* London: The University of Chicago Press, 1956.

SMALLEY, Denis (1997). 'Spectromorphology: Explaining Sound-shapes', in Organised Sound Vol. 2, Part 2 (Cambridge University Press), pp. 107-26.

SMALLEY, Denis (2007). 'Space-form and the Acousmatic Image', in Organised Sound Vol. 12, Part 1 (Cambridge University Press), pp. 35-58.

WISHART, Trevor. *On Sonic Art.* London: Taylor & Francis Group, 2002.

[11] Jonathan Harvey, 'Reflection after Composing' Tempo, New Ser., No. 140 (Mar., 1982), p. 3.