

## Reviews & Insights

### **A proposal for a new technology instrumental practice of bowed strings - Analysing Sonic "Afterimages"**

by Kalodiki Georgia

With this project, an aesthetic transformation of afterimage is proposed as a means for the electronic processing of sound structures produced by strings. The results of this processing create energetic 'imprints' within the temporal evolution of a musical event. According to Shimojo, Kamitani, and Nishida,<sup>1</sup> afterimage belongs to the category of after-sensations. The function of cinema is based on a defect related to the physiology of the human eye, a phenomenon called "afterimage". In afterimage, a momentary visual presence remains in the sense of vision after the external stimulus. In other words, the reflection formed on the retina from an object does not vanish immediately, but remains in the visual system even after its disappearance. The idea of afterimage can be aesthetically transferred to the art of sounds as an 'after-effect.' If we define energy as the profile of a sound according to its spectro-morphological properties (see *Research*), here an assumption is made as a working hypothesis, according to which the energy imprint of a sonic event, namely the after-effect, coexists and/or follows in time the initial sonic gesture by definition and constitutes a possible processed version of it, just as in afterimage the stimulus remains in the sensory medium of perception, for the perceptual mechanism to take place through processing. In an attempt to create sound stimuli that are subsequently used as material for electronic processing with continuous phase differences, a sequence of overlapping sound events is created, which function as after-effects. My work *Afterimage* for strings and electronics will be used as a reference.

#### *Introduction*

This research field is based on recordings of techniques produced by string instruments with mixed harmonic spectra and varying degrees of harmonicity, leading to noisy textures. Thus, *sffz* phrases on the violin, viola, and cello, which are followed by sonic afterimages, that is electronically processed echoes, aiming at the creation and shaping of mixed harmonic spectra.

---

<sup>1</sup> SHIMOJO S., KAMITANI Y. & NISHIDA S., Afterimage of perceptually filled-in surface, «Science», 293(5535), 2001, pp. 1677-1680, doi: 10.1126/science.1060161.



This work is distributed under a Creative Commons Attribution - Share alike 4.0 International License.

The methodology and the way of conception and construction of the 'afterimages' as gestures and structural processes in the work constitutes the main material of musical thought through the visualization of sound and its return to the musical space as a means of sound projection of images. Modern string playing techniques (see *Methodology*) functioned in the work as afterimages that provided ideas for electronic processing. Through the above methodology, ways of merging the two sources were explored both in terms of spectrum and in terms of redistributing the sonic information.

#### *Theoretical background. History*

The phenomenon of afterimage served as an example of how sensory perception can interact with empirical reality and often mislead it. If indeed the fact that the perception of an event by our senses occurs after the moment it happened is real, then afterimage raises philosophical questions about which of the two perceptions is the real one.<sup>2</sup> It is very interesting how this approach can be extended to the creation of sound images, which in turn create phase differences between sound forms, resulting in interesting contrasts between noise and pure tone.

The exploration of the possibilities of instruments through modern sound production techniques, combined with the significant progress of music technology in the 20th century, influenced the way composers handle musical material, breaking the boundaries between pure tonal pitch and noise. The central idea of the process of sound liberation, which was first articulated by Edgar Varese during the 1920s and 1930s as the 'opening of music to sounds'<sup>3</sup> leads to the possibility of producing new timbres through the use of noise.<sup>4</sup>

Henry Cowell with the technique of semitonal consonances-clusters (1916), and the Futurists' conceptualization of noise, expanded the path for exploring the possibilities of instruments through modern sound production techniques, according to Cage.<sup>5</sup>

Generally, the use of contemporary performance techniques often lead to non-harmonic noisy spectra, extending the timbral boundaries of the instrument. In the article 'Making Noise: Extended Techniques after Experimentalism', Burtner states that contemporary techniques require the performer to use the instrument beyond the limits of conventional sound production.<sup>6</sup>

---

<sup>2</sup> For Parmenides (Eleatic philosopher of the cosmological period) every change we see in things is deceptive, and this apparent impression is due to the deception of the senses.

<sup>3</sup> CHADABE, J., *The History of Electronic Music as a Reflection of Structural Paradigms*, «Leonardo Music Journal», VI, 1996, pp. 3-7.

<sup>4</sup> VARESE E. & WEN-CHUNG C., 'The Liberation of Sound', *Perspectives of New Music*, V, 1, 1996, pp. 11-19.

<sup>5</sup> 'Whereas in the past, the point of disagreement has been between dissonance and consonance, it will be, in the immediate future, between noise and so-called musical sound'.

<sup>6</sup> 'The use of unorthodox techniques in playing is the fundamental justification for exploring the resultant morphologies, principally if the goal is to enhance technical control of sound for player and composer.'

In the repertory for strings and electronics, an important work is *Synchronisms No 9* by Mario Davidovsky for violin and electronics (1988), which creates a holistic sound continuum between organic sound and electronics through the continuous merging of the material presented by both mediums. In the work *Time and Motion II* by Bryan Ferneyhough, two different musical materials in different phases interact by the use of two tape delays. Cello is distorted through the technique of ring modulation extending its timbre.

### *Hypothesis*

As a working hypothesis in the project *Afterimage*, a parallel was drawn between the visual experience - in terms of the perceptual mechanism - and the acoustic experience, drawing a parallel by the concept of space and rhythm. The transposition of music into a three-dimensional imaginary space influenced many architects to create programs translating music into architectural constructions. The afterimage could be presented as a temporary pause of the organism in relation to its harmonization with the environment.

Immediate experience arises from interaction and interrelation with nature. In the work *Afterimage*, echoes of sound material originated from strings, subjected to processing, and consequently distorted on a spectral and macroscopic level.

### *Methodology*

In the project *Afterimage*, *sffz* percussive sounds on the violin, viola, and cello, are followed by sonic afterimages of mixed harmonic spectra visualizing the sound and connecting the two senses, vision and hearing by the correlation between the duality pure tone/noise.

*Glissandi*, non-harmonic textures such as scratch tones, playing behind and above the bridge of the strings, bow strikes on the frets, *pizzicato*, as well as *jete* and seagull effect attacks are some of the noisy after-effects of the strings that functioned as resonances for electronic processing. Granular texture, frequency shifting and signal modulation techniques create prolonged noise of varied texture. Afterimage sound fields are created by the performer's timbral changes from pure tone to noise through changes in the position and/or mechanical pressure of the bow. These techniques create various levels of noise along with the pitch in varying ratios (Image 1).



Image 1



Image 2

*Suggestions on the investigation of the relationship between pure tone and noise as a variable structural component of the morphological evolution*

The noise production techniques and non-harmonic sound structures in string instruments and their spectral processing by filters interacted with emerging harmonic intervals which were used for the structural reorganization of the work and the creation of points of tension and relaxation through *tenutes* that defined a rolling path of changing tonal centers. These were related to harmonic spectra with varying degrees of noisy textures. The percentages of harmonicity of the resonances in this work were structured based on the relationship between percussive sound and harmonic material (often with a 'blurred' ambiguous pitch) produced by the strings or the electronics.

One could categorize the performance techniques in this work into two types. Regarding noise production, a first large group of techniques related to *sfz* sounds was recorded and produced through striking, as in the first measures of the work (Image 1) with the technique *col legno battuto* (striking the wood of the bow on the string), and a second large group of techniques in which the pressure of the bow was such that a prolonged noise of varying texture was produced, for example in bar 119 on the cello. In this second category, micro-structures were produced that simulated the granular texture technique, leading to electroacoustic texture, as in bar 120 (Image 2).

### Research

This research is part of my PhD thesis concerning electroacoustic composition, based on the spectral analysis and signal processing of instrumental noisy sound spectrums. More specifically, this research includes the hierarchical taxonomy of spectrally complex sounds based on the nature of their inharmonic content.

As a result, this project is based on the creation, collection, documentation, and categorization of a series of unconventional sounds and noises that can be produced by the strings, based on their typology and their spectro-morphological characteristics.<sup>7</sup> The processing of the sound characteristics (pitch, dynamics, phase relationships, articulation, etc.) and then the creative search for rich spectral acoustic events through the utilization of their qualitative characteristics was constructed using techniques related to the shaping of the sound environment and the morphology of the acoustic signal (*FFT, time stretch, phasing, flanger, vocoder, etc.*).

The sounds were initially selected based on the ratio of harmonic to non-harmonic spectrum they contain, and then their extending timbral possibilities were explored through electronic processing.

This process leads to a series of spectro-morphological researching process concerning the transformation of the acoustic signal and the development of innovating ways to construct new sounds deriving from the initial sound material (noisy instrumental spectrums).

The instruments chosen to be approached through the logic of the relationship that arises from a mixed harmony (the coexistence of pitch and noise) are the strings, which are treated as a unified spectral environment. The alternation of vertical and horizontal actions is constructed by using the strings as percussion and creating the *sfz* phrases right before the immediate entry of *glissandi* from the *tenuti*, applying the idea of afterimage.

Thus, the relationship between vertical and horizontal action is rooted in an emerging relationship between noise and pure tone, shaping the morphological structure through the creation of mixed tonal centers. The relationship between harmonic and non-harmonic spectra is complementary just like afterimage is connected to the initial visual stimulus. In this composition, the practice of creating non-harmonic spectra in string instruments and the electronic reorganization of the spectral profile of audio files, lead in exploring ways of transition from harmonic sound to noise and vice versa.

### *Conclusions*

Through the use of the afterimage concept, vision and hearing are treated as related senses concerning the notion of space. In an effort to create sound stimuli which were subsequently used as material for electronic processing with continuous phase differences, a new way of structuring the duality of 'tone-noise' (harmonic and non-harmonic sound) was created through a sequence of overlapping sound events.

In the present research, noise is expanded as a concept beyond its spectral dimension and is approached in terms of perception not only spectrally but also holistically as a large volume of information. The alternation between noise and pitch constitutes a morphological condition serving the idea of afterimage. The artificial sense of sliding and

---

<sup>7</sup> SMALLEY D., *Spectromorphology and structuring processes*, in S. EMMERSON (ed.), *The language of Electroacoustic Music*, MacMillan Press, Basingstoke 1985, pp. 61-93.

oscillation through the use of *glissando* and *tremolo* provide direction and coherence to the work. Recordings of *sfz* attacks, and sounds of varying bow pressure led to prolonged noise of varied texture. Sonic afterimages visualize and re-transform the musical space through instrumental effects via electronic processing.

## REFERENCES

- ARNHEIM R., *New Essays on the Psychology of Art*, University of California Press, Berkley 1986.
- CHADABE J., *The History of Electronic Music as a Reflection of Structural Paradigms*, «Leonardo Music Journal», VI, 1996, pp. 3-7.
- DESSOIR M., *Aesthetics and the Theory of Art*, Wayne State University Press, Detroit 1970.
- SHIMOJO S., KAMITANI Y. & NISHIDA S., *Afterimage of perceptually filled-in surface*, «Science», 293(5535), 2001, pp. 1677-1680, doi: 10.1126/science.1060161.
- SMALLEY D., *Spectromorphology and structuring processes*, in S. EMMERSON (ed.), *The language of Electroacoustic Music*, MacMillan Press, Basingstoke 1985, pp. 61-93.
- VARESE E. & WEN-CHUNG C., *The Liberation of Sound*, «Perspectives of New Music», V, 1, 1996, pp. 11-19.

### *Music sources*

- BOULEZ PIERRE (1997), *Anthèmes II* for violin and electronics.
- CRUMB GEORGE (1971), *Vox Balaenae* for amplified flute, cello and piano.
- DAVIDOVSKY MARIO (1963-2006), *12 Synchronisms* for instruments and electronics.
- FERNEYHOUGH BRYAN (1973-1976), *Time and Motion Study II* for cello and electronics.
- SAARIAHO KAIJA (1982-1984), *Verblendungen* for orchestra and electronics.
- SMALLEY ROGER (1978), *Echo III* for cello and delay.



This work is distributed under a Creative Commons Attribution - Share alike 4.0 International License.