A COGNITIVE APPROACH TO ELECTRONIC MUSIC: THEORETICAL AND EXPERIMENT-BASED PERSPECTIVES

Anıl Çamcı
Academy for Creative and Performing Arts
Leiden University, The Netherlands
a.camci@umail.leidenuniv.nl

ABSTRACT

Meaning in music has been a topic of discussion throughout the history of the art form. Influenced chiefly by the trends in scientific methodology, perspectives on the semantics of music manifested considerable shifts in focus over time. Especially in the last century, the upsurge in cognitive research in the field of psychology has yielded a growing body of new studies that probe the processes at play during the perception of sound and music. However, research that specifically focuses on electronic music within this respect has been sparse and largely theoretical.

As both the material and the language of electronic music diverge from that of traditional musical practices, the composer's engagement with the listener's cognitive faculties is fundamentally altered. This necessitates idiosyncratic approaches towards electronic music that take into account the act of meaning attribution on both compositional and analytical levels. Stemming from the author's compositional practice, research discussed here incorporates an environmental event perception model to motivate a gesture-based approach to the study of cognitive units in electronic music. Current paper provides theoretical perspectives on this topic as well as preliminary experiment results which substantiate the proposed ideas.

1. INTRODUCTION

This paper is a product of an ongoing research project which investigates the cognitive mechanisms that operate during the experiencing of electronic music. The project takes into account both composer's (poietic) and listener's (esthesic) points of view to deal with the subject matter while utilizing perspectives and methods inherited from fields as diverse as narratology and cognitive psychology.

The paper presents current theoretical inferences and experimental findings: Section 2 offers a historical context for compositional and analytical approaches to electronic music. Section 3 provides an overview of the cognitive idiosyncrasies of electronic music in relation to instrumental practices while Section 4 discusses a gesture-based framework for electronic music informed by the discussed cognitive phenomena. Section 5 presents experimental data from listening tests to materialize the theoretical discourse.

2. HISTORICAL CONTEXT

Having now grown approximately a hundred years old, electronic music has spawned a myriad of sub-genres while benefitting greatly from the advancements in analog electronics in its earlier periods, and computer technology during the latter half of its existence. Today, studios are equipped with consumer-grade machines that can, not only handle legacy techniques of electronic music-making, but furthermore, push the borders of one's imagination in creating unique ways to process audio. The modern medium affords the composer with a plethora of technology that liberates the artistic expression to a greater extent as the translation from idea to sound becomes increasingly transparent.

Earlier periods of electronic music, however, was subjected to many technical limitations, which influenced artists on both practical and conceptual levels, thus effectively defining the aesthetic directions of the time. In contrary to the intuitiveness of the vision of "opening music to all sounds" [1] at the genesis of the genre, the technology at the time to materialize this vision was highly intricate and, therefore, accountable for artistic defenses which were often inherited from instrumental music practices. Herbert Eimert, one of the prominent figures of the Cologne studio in the 1950s, writes: "It is certain that no means of musical control could have been established over electronic material had it not been for the revolutionary thought of Anton Webern (...)" [1], referring to the Serialist Movement of the Second Viennese School, which mandates the designation of musical parameters through serial permutations.

However, this highly parametric approach practiced in certain schools of electronic music was gradually abandoned over the course of subsequent decades in favor of *composer's instincts* [3] as the arts gained control over and furthermore, started to influence technology. Zanpronha reflects that, "non-motivated" parametric procedures from the earlier periods were replaced, over time, by approaches which acknowledged the "complexity of listening and sound references" [17].

This transformation on the compositional side of the music has been paralleled by the perceptual approaches towards it as well. The emerging cognitively-oriented methods of analysis began to take into account the characteristics of the electronic music experience [5] [12][16]. Some of the ontological perspectives which surfaced as a part of this trend will be further discussed.

3. COGNITIVE IDIOSYNCRASIES OF ELECTRONIC MUSIC

In this section, electronic music will be situated in a broader context of musical practices in order to delineate the contrasting cognitive aspects between electronic and instrumental music. This will, in return, highlight the idiosyncrasies of electronic music in relation to common ideas pertinent to traditional musical practices.

3.1. Cognition of Instrumental Music

There exist intrinsic cognitive differences for both the listener and the composer, between the experiences of

instrumental and electronic music. The principal factors behind this differentiation are material and language: Instrumental music, dating back to prehistoric eras, utilizes fabricated sound sources, which have been refined to their final forms as the most widely accepted instruments for modern music. These instruments are crafted to emit sounds that do not exist in the nature [6], sometimes referred to as *harmonic* or *pure* sounds.

The language of instrumental music is also synthetic in a similar fashion: Abstract concepts like *melody, harmony* and *tonality* have been established and widely acknowledged over the course of centuries. These fabricated structures have formed a musical language that is now engraved to our deep-seated mechanisms of music perception. It is therefore that, music is understood to be a non-representational form of artistic expression [9], which breeds a self-sustaining, abstract dialect. There remains no delegation in between as *the material ascends to the affect* [4] during the experience of instrumental music. Although referentialist composers of program music might impel the dynamics of the orchestra to trigger certain imagery in concordance with an extra-musical narrative, the abstraction proposed by the musical sound opens up for the listener, a world of affects rather than representations. This is the primary reason for research on music perception to be largely focused on discovering associations between music and emotions.

3.2. Cognition of Electronic Music

However, in the case of electronic music, there is witnessed a departure from the reliance on the so-called musical sound. With the constraints of physical instruments lifted, any sound within the limits of human perception, whether it may be recorded, processed or synthesized, becomes a material for composition. Undoubtedly, this change in material mandates a change in language as well. Just as the sounds propagating in our daily environments cannot be described via the traditional musical language, sonic events harbored within electronic music display features that fall outside the vocabulary of this language. Concurrently, experience of electronic music, as well, diverges significantly from that of instrumental music: With the introduction of sounds that are not distinguished by the listener as being *musical*, the cognitive response to the genre involves a distinct process of meaning attribution that is not sufficed by the culturally embedded mechanisms of music perception. As the electronic music opens itself to all sounds, one's encounter with this music prompts a more encompassing cognitive process: The listeners' "ear-witness accounts" [13] of previously experienced daily events, or their "aural perspicacities" as Trevor Wishart refers to them [16], constitute the main reference in describing the experience of this music. Therefore, amid the material's ascent to affect which was previously described to be evident in instrumental music, we observe the emergence of a mediating layer as a new continuum from *material to meaning to affect* materializes.

This nature of electronic music yields a distinct form of communication between the composer and the listener. The listener, as well as the composer (being a listener herself), experience electronic music within a broader domain of cognitive associations to sounds:

> 'The representation of reality is now a compositional parameter that can be found at the heart of many contemporary electroacoustic approaches, be they acousmatic, soundscape/ ecological, or even musique concrète. There is no longer any need for composers or listeners to ignore the extramusical connotations of electroacoustic sounds.' [5]

However, the communication between the composer and the listener is largely yet to be explored. The concept to percept bridge is obscured by the breadth of possibilities offered by the medium. Smalley explains that the electronic music composer, therefore, faces problems as to "how to cut an aesthetic path and discover a stability in a wide-open sound world" and "how to develop appropriate sound-making methods". He further elaborates that "[the] problems of representation combined with the lack of consistent, thorough and fairly universally applicable analytical tools have undoubtedly inhibited electroacoustic music's acceptance in more intellectual, musicological circles" [12].

4. GESTURE/EVENT PERSPECTIVE

The designs of the electronic music composer are inherently connected to her knowledge of how sounds evolve over time. Objects of the *ear-witness accounts,* which construct this knowledge, are environmental sounds. Vanderveer defines an environmental sound as "(...) any possible audible acoustic event which is caused by motions in the ordinary human environment" and it is "meaningful, in the sense that [it specifies] events in the environment" [15]. Environmental sounds educate and condition us, from birth, about sound morphologies. This conditioning guides the composer in designing the surreal in contrast to the real; it is at play both within the course of *action-perception loops* [14] during a compositional process and while simply listening to a work of electronic music.

4.1. Environmental Sound Perception

Recent studies on the perception of environmental sounds have progressively shown that our categorization of aural stimuli is based on "semantic features rather than perceptual ones" [7]. While research on sound perception in the past century focused rather on the assessment of physical attributes of sounds for sorting tasks, recent experiments based on event perception underline the fact that source identification subdue psychoacoustic features of sounds in categorizing complex stimuli [11]. This denotes the fact that we utilize units of meaningful events for processing the sounds occurring in our immediate environments. Following section will discuss the parallels between this event perception model and the electronic music experience.

4.2. Gesture

While gesture composition and analysis constitute common methods for instrumental music, their applications to electronic music in light of the above explained nature of our responses to aural stimuli, imply an idiosyncratic approach to the genre and exhibit clear analogies to the perception of environmental sounds.

Hatten prefers to describe gesture, in a rather comprehensive manner, as "any energetic shaping through time that may be interpreted as significant" [8]. Coker, in his 1972 book *Music and Meaning*, refers to the term more specifically as "a recognizable formal unit (...) which signifies other purely musical objects or non-musical objects, events, and actions" [2]. Comparably, *gesture*, within the context of the current research, is described to represent "a meaningful unit of sounds in

electronic music" and operates as, both a compositional tool for the artist and a cognitive component for the listener. This functional distinction is also apparent in Zagonel's definition of mental gestures which "are closely related to the processes of composition and listening" and "are learned through experience and stored into the memory to be used as a model in composition" [10]. Gestures in electronic music are counterparts to events in nature; the semantic difference is the inherent intentionality of a gesture on the composer's part. Gestures can span from milliseconds to the entirety of a piece and co-exist in multi-layered forms, similar to temporal and textural varieties evident in our daily soundscapes. Such correspondences between sounding environmental events and gestures in electronic music will be further substantiated with the data obtained from preliminary experiments.

5. PRELIMINARY EXPERIMENTS

Subsequent to extensive studies on developing a test method which is both idiosyncratic to electronic music listening and capable of extracting a comprehensive report of this act, preliminary experiments were conducted to investigate the intercorrelations between the aforementioned theoretical framework of the gesture/event perspective and the actual experience of electronic music.

5.1. Material and Method

The piece chosen for subject group studies is titled *Birdfish*. Sound material for the piece is a white noise burst of few milliseconds, processed through several granulation algorithms and various effect chains consisting of equalizers, delays, reverbs and compressors. Compositing of the sound material was achieved via classical timeline micro-montaging. Composition of the piece was heavily driven by a premeditated narrative: Following 2011's *Nautik*, *Birdfish* is the second piece to come out of a tetralogy which explores evolutionary phenomena. Subsequent to its predecessor which studied the dynamics of the underwater, *Birdfish* engages with organic morphologies that transcend the surface of the ocean. The piece is an outcome of investigations on the characteristics of liquid and avian sounds. Constituent sound designs of the macro-level structure of the piece follow the aforementioned gesture model in which sonic actors denote events within the narrative at varying time-scales and textural formations. Gestures designed to serve foreground functions (e.g. animal vocalizations) are shorter in duration and are aimed at stimulating different parts on the cognitive continuum from abstract to representational, while ground gestures (e.g. water sounds) operate at meso-scales to set semantic and spatial contexts.

The experiments were administered a single participant at a time. Participants were not disclosed any information regarding the piece. Each participant was asked to listen to the piece, prior to being provided with any questions; this was aimed at achieving an initial listening experience that was least affected by an experiment bias. Following this first round of listening, each participant was asked to write down general impressions in free form, examples of which will be discussed in following sections.

The subsequent part involved a software-based test, during which the participants were able to listen to the piece a second time and type descriptors in real-time. An exercise session allowed each listener to hear a 30-second speech track and type in random words he or she was able to identify, in order to acquaint the participant with the interface and monitor possible software and database malfunctions. Prior to the actual experiment, it was explained that the listeners were expected to type-in their impressions as to anything they would *feel* or *imagine*, instantaneous to its occurrence within the piece.

5.2. Analysis of Data

The subject profiles display a large diversity in musical backgrounds as the group of 12 participants included composition professors, musicians, sound engineers and people with no prior training in sound or music.

12 participants input 224 descriptors in total, which average to 18.6 inputs per subject within the 4'08" duration of the piece. The responses varied from single words to up to 4-word noun phrases, although no limitations were imposed during the explanation of the experiment. The responses were later on grouped into five general categories based on whether they described sound sources, scenes (locations), emotions, concepts or perceptual descriptors. Responses that could be prepended by the phrase "sound of" were categorized as *sound sources*. Sound sources mainly consisted of sound producing objects (e.g. insect) or events (e.g. creature moving). Several responses which did not describe a source but rather implied resonant environments as in "cave" and "underwater" were categorized as *scenes*. Affectively-loaded inputs such as "anger" and "hope" were listed under *emotions* category. A relatively large set of inputs that did not exhibit direct sonic or emotional connotations but rather implied abstractions which could be attributed to a group of sounds or sounding events such as "star wars" and "language" were listed under *concepts*. Responses which described physical qualities of the sounds, such as "low" and "pan", were categorized as *perceptual descriptors*.

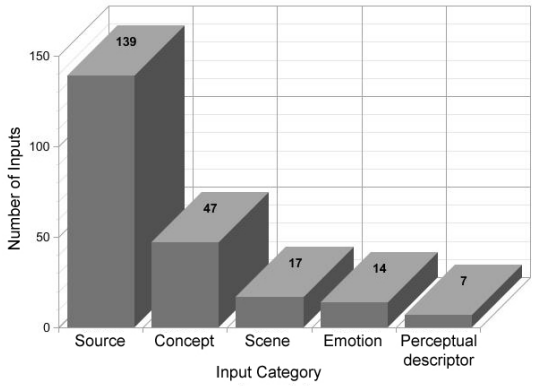

Figure 1. Real-time input distributions.

Certain responses that exhibit strong semantic similarities, albeit from different categories, were also grouped together. The highest rating semantic groups were *liquid sounds* (e.g. water, liquid, waterfall, underwater, bubbles, wet), *animal sounds* (e.g. bird, bat, mouse, amphibian creature) and *sci-fi sounds* (e.g. lightsaber, R2D2, silicon valley, electronics). Responses that displayed high inter-participant occurrences at approximate moments in the piece were "water", "birds/bats", "laser", "ice/glass", "reptiles/amphibians", "vocalization/speech", "cave" and "swarm"; these responses indicate sounds which were specifically localized by multiple participants.

5.3. Deductions and Future Work

Musical backgrounds bore little difference in terms of the responses acquired. Inputs from participants at both

ends of the musical background spectrum displayed strong similarities while the only instrumental music oriented responses were based on identification of instrument sounds (such as horns and brass), rather than musical concepts. It can be interpreted that, within the context of the piece, musical instruments were also perceived as sound sources or narrative actors rather than agents of musical language.

Comparison of results from first (i.e. general impressions), and second (i.e. real-time input) parts of the experiment per individual participant also displayed significant consistency; most of the descriptors used by a participant during the general impressions part were also observed in the subsequent real-time inputs. For the first part, while some participants chose to create lists of sound sources, feelings or actions, others preferred prose form. General impressions tended to group several ensuing real-time descriptors. For example, the real-time responses of "something stuck", "space" and "anxious", were previously phrased in general impressions section as "something stuck and shaking in space; felt anxious because of [it]" by the same participant. This denotes that, without the physical constraints of typing simultaneous to the experiencing of the piece, general impressions leaned towards situating the descriptors within the context of an event or narrative, and they reflected further affective appraisal that followed the meaning attribution.

While inter-participant occurrences of certain descriptors which indicate ground gestures (e.g. water, cave) were dispersed throughout the piece, inter-participant inputs that correspond to figure gestures (e.g. bird, reptile, dialogue) were rather localized.

The results of the preliminary experiments not only display clear correspondences between the compositional methods and the outcomes of the listening experience, but also reveals to a certain extent, the characteristics of how this music is received by the listener. These findings illustrate both the potential of electronic music to trigger recollections of extra-musical sounding events and the visceral qualities of the cognitive approach behind the gesture/event model.

Future experiments will be aimed at augmenting the data on *Birdfish* and generating new data sets on other pieces. A next series of experiments will be based on a revision of *Birdfish,* which involves variations on existing textural and spatial densities, to evaluate the effects of contextual differences on the cognition of figure gestures. Moreover, pieces which follow more abstract narratives will be utilized to monitor the level of ambiguity in descriptors. Cultivation of data from a multitude of electronic music works will also allow for the delineation of common semantic categories which might reveal general perceptual tendencies towards the genre.

6. CONCLUSION

Current paper provided theoretical perspectives on cognition of electronic music as well as reports from related experiment-based investigations. Adopting both poietic and esthesic points of view, electronic music was situated in broader domains of musical and environmental cognition. The intuitiveness of the gesture/event approach as a compositional model and an analytical tool was grounded in human cognitive faculties. With electronic music described to characteristically prompt a layer of meaning attribution amid the continuum from musical material to affective experience, this approach was utilized to reflect the parallels between the cognitions of electronic music and environmental sounds.

Preliminary experiment results were provided to materialize the above mentioned perspectives. The correspondences between compositional strategies and resulting listener experiences were highlighted. These results offered valuable insight as to how a composer's narrative concepts translated into a listener's percepts.

Further experiments will be conducted in reciprocity with compositional practice and theoretical discourse in order to explore finer details of the communication between the composer and the listener. This investigation will establish a further understanding of the cognitive nature of the genre, and will bear strategies to harness the potential of this nature to a greater extent.

7. REFERENCES

[1] Chadabe, Joel. 1996. "The Great Opening Up of Music to All Sounds" in *Electric Sound: The Past and Promise of Electronic Music,* Prentice Hall.

[2] Coker, W. 1972. *Music and Meaning: A Theoretical Introduction to Musical Aesthetics*. The Free Press, New York. p. 18.

[3] Dack, J. 1999. "Karlheinz Stockhausen's Kontakte and Narrativity", *eContact* 2.2, ix 1999.

[4] Deleuze, G., Guattari, F. 1994. "Percept, Affect and Concept" in Cazeaux C. (ed.) *The Continental Aesthetics Reader*. Routledge Publishing, New York. p. 466.

[5] Field, A. 2000. "Simulation and reality: the new sonic objects" in Emmerson, S. (ed.) *Music, Electronic Media and Culture*. Ashgate Publishing, Hampshire. pp. 7-35.

[6] Gaver, W. W. 1993. "What in the World Do We Hear? An Ecological Approach to Auditory Event Perception", *Ecological Psychology*, 5 (1): 1-29.

[7] Gustavino, C. 2007. "Categorization of Environmental Sounds", *Canadian Journal of Experimental Psychology* 2007, Vol 61. No 1, 54-63.

[8] Hatten, S. R. 2006. "A Theory of Music Gesture and its Application to Beethoven and Schubert" in Gritten, A., King. E. (eds.) *Music and Gesture*. Ashgate Publishing, Burlington, VT.

[9] Huron, D. 2006. *Sweet Anticipation, Music and the Psychology of Expectation*. The MIT Press. Cambridge, Massachusetts. p. 356.

[10] Iazzetta, F. 1997. "Meaning in Music Gesture", Proceedings of International Association for Semiotic Studies VI International Congress, July 1997, Mexico.

[11] Schubert, E. D. 1975. "The Role of Auditory Perception in Language Processing" in D. D. Duane & M. B. Rawson (Eds.) *Reading, Perception and Language*, Baltimore, MD: York Press, pp. 97-130.

[12] Smalley, D. 1997. "Spectro-morphology: explaining sounds-shapes", *Organized Sound,* 2:2. Cambridge University Press, pp. 107-126.

[13] Truax, B. 2001. *Acoustic Communication*. Ablex Publishing, Westport, USA. p. 17.

[14] Vaggione, H. 2001. "Some Ontological Remarks about Music Composition Processes", *Computer Music Journal*, March 2001. 25:1.

[15] Vanderveer, N. J. 1979. *Ecological Acoustics: Human Perception of Environmental Sounds*. Ph.D. thesis, University Of Cornell, pp 16-17.

[16] Wishart, T. 1996. *On Sonic Art*. Emmerson, S. (ed.). Overseas Publishers Association, The Netherlands. p. 149.

[17] Zanpronha, E. 2005. "Gesture in Contemporary Music: On The Edge Between Sound Materiality and Signification*", Transcultural Music Review, 9*.