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CHAPTER 3

COGNITIVE FOUNDATIONS OF ELECTRONIC MUSIC

COGNITION OF MUSIC

Before going into a discussion of the experiential characteristics of electronic music, I will provide an analysis of music cognition in general. A significant amount of research into this matter has been conducted over the past decades. Furthermore, musicologists, music theorists and philosophers have been placing immense scrutiny on the mechanisms underlying music appreciation for as long as their fields have existed. We therefore have a relatively large body of knowledge on the cognition of music. The overview below will function as a frame of reference for when I describe the cognitive idiosyncrasies of electronic music in the following section.

An overwhelming majority of research on music cognition focuses on Western musical practices (Cross 2010: 4). While this causes my frame of reference to be skewed towards Western music, the discourse on music cognition nevertheless takes cultural orientations into account. I should also note that my focus throughout this section will be on instrumental music. Text-driven vocal music, although utilizing similar devices as instrumental music, communicates meaning through spoken language. Since such a language is a communication system that relies on its own semantic conventions, a study of verbally communicated meaning falls outside the scope of the current discussion.

Development of Musical Behavior

A complex web of perceptual and cognitive processes determines the nature of a musical experience. The gestalt of this experience is a mysterious transduction of changes in air pressure into affective appraisal. I will now go over some of the facts and hypotheses which address this mystery.

Since music predates recorded history, we only have theories regarding its origin. Throughout its existence, music has been associated with various functions ranging from communication to ritual. It is therefore impossible to delineate a single instigator for musical activity in humans. The author and soundscape artist Bernard Krause, for example, breaks the history of musical sound into several evolutionary stages (2012). In his taxonomy, *geophony* represents sounds produced by the earth: wind, thunder and earthquakes are examples of geophonic sound sources. On the other hand, *biophonic* sounds are produced by living organisms, particularly by animal species which predate the evolution of humans. Krause suggests that biophony has its roots in geophony, because animals might have initially imitated the sounds of the earth. Going further ahead in the evolutionary chain, Krause describe *anthrophony* as sounds produced by humans. He hypothesizes that humans were originally inspired by geophonic and biophonic sounds when establishing a vocabulary of vocalizations. In his book *The Great Animal Orchestra* (2012), Krause provides several examples of biophonic sounds which made their way from biophony to the musical vocabulary of humans. However, even research in the relatively modern field of biomusicology would admit, for instance, that the connection between music and animal song is ambivalent (Brown et al. 2001: 8). Several other theories indicate that music could have originated from, or at least co-evolved with speech and language (Richman 2001: 301; Marler 2001: 45; Mithens 2005: 6).

The ongoing discussion on the evolutionary origins of music is extensive. A different point of focus in this area is the development of musical behavior in humans from birth. Since the sense of hearing is primarily a survival tool for human beings, the auditory system functions in a multi-sensory context. There are many studies on the perception and semiotics of sounds which focus on the correlations between auditory and other sensory information (e.g. visual and kinetic stimuli) (Warren et al. 1987; Merer et al. 2007; Özcan and van Egmond 2009; Vines et al. 2011). Music as an auditory phenomenon inevitably inherits multimodal characteristics. In relation to this biological disposition, several studies indicate that certain features of music and the affective appraisal of musical experience have evolved similarly across cultures. In their experiment-based investigation of the correlations between the dynamic structures of music and movement, Sievers et al. (2013) found that certain structural features like rate, direction and dissonance prompted similar emotions when evaluated separately within music and animations. Furthermore, the reactions to structural similarities across music and movement were consistent amongst participants from the US and Cambodia, implying cross-cultural roots to this behavior.

In another study on how low-level variables in music, such as changes in pitch, dynamics and rhythm are mapped in the non-auditory domains of space and motion, Eitan and Granot collected data that corroborate certain widely shared assumptions on the matter (e.g. a decrease in pitch corresponding to a downward motion). However, they also found that these cognitive mappings were multifaceted and much more complex than previously assumed: "[m]usical space seems to be skewed in many different ways, rather than composed of neatly arranged, symmetrical parametric scales and intervals" (2006, p, 242).

While music shares similarities with speech in terms of communication of emotions, the evolutionary origins of the associations between pitch patterns and emotional states are not clear: these associations may have arbitrarily emerged and evolved over time into a "formal communicative code", or they might have formed based on the physiological characteristics of the human auditory system (Curtis 2010: 12). Accordingly, Brown et al. underline a middle ground for the discussions on the origins of music perception mechanisms: while ethnomusicologists are mostly skeptical towards *musical universals*, which imply biological determinism, modern biocultural studies on social behavior motivates "a balance between genetic constraints on the one hand, and historical contingencies on the other" (Brown et al. 2001: 13). Evidence suggested as a preview to a universal music theory addresses several aspects of a musical structure:

> [O]ctaves are perceived as equivalent in almost all cultures, that virtually all scales of the world consist of seven or fewer pitches (per octave), that most of the world's rhythmic patterns are based on divisive patterns of twos and threes, and that emotional excitement in music is universally expressed through loud, fast, accelerating, and high-registered sound patterns. (14)

Trehub corroborates this view by enumerating other universals such as the prevalent emphasis on global structure in music, preference of small-integer frequency ratios between pitches and the ubiquity of unequal steps in scales (Trehub 2001: 427). The universality of these characteristics implies biological roots to music. Yet "most of these features are low-level structural properties" (Sievers 2012: 1).

From Biology to Culture

When we look at Western music history, we can observe that music has evolved into a much more complex artifact than individual variations in low level properties such as pitch, timbre and rhythm. Furthermore, certain seemingly instinctual behaviors that are genetically transferred may be rooted in a naturally selected ability to learn. This theory, called *The Baldwin Effect*, points to a cultural inheritance of learned behavior across generations (Depew 2003: 3). In his book *How Musical is Man?*, the ethnomusicologist John Blacking describes a common understanding of music as "a system of ordering sound in which a cumulative set of rules and an increasing range of permissible sound patterns" (1973: x). He later explains that while biology does have an impact on musical abilities, social factors play a much more important role in their development (46).

In short, there are qualities of music we enjoy due to our physiological disposition, but beyond that is an experiential complexity that originates in culture. A multi-disciplinary investigation of this complexity is necessary in order to form a comprehensive understanding of how and why we engage in musical activities. For instance, in a perception study conducted with infants, researchers observed a preference for consonant intervals between pitches (Trainor et al.: 187). While this implies a physiological origin for musical consonance, it also reveals that the aesthetic appeal of the so-called dissonant intervals is a cultural phenomenon (Curtis 2010: 346). Several other studies conducted with young children highlight a corroborating idea that musical expectancy depends heavily on cultural learning (Juslin and Västfjäll 2008: 568) and does not develop fully until sometime between the ages 5 and 11 (569). In other words, we learn to appreciate many characteristics of music. From a different research perspective, neuroscientific evidence supports that music is an acquired taste. In a recent fMRI-based experiment conducted to investigate the neural processes related to reward in previously unheard music, Salimpoor et al. observed significant effects of sociocultural factors, experience and memory:

> [O]ur appreciation of new music is likely related to (i) highly individualized accumulation of auditory cortical stores based on previous listening experiences, (ii) the corresponding temporal expectations that stem from implicit understanding of the rules of music structure and probabilities of the occurrence of temporal and tonal events, and (iii) the positive prediction errors that result from these expectations. (2013: 218)

These findings suggest that musical taste is based on the accumulation of our listening experiences. Whatever music we have heard thus far will contribute to our appreciation of the music we will listen to in the future.

Music and Emotion

Music, despite lacking immediate survival value, activates brain mechanisms associated with pleasure and reward. The neurobiology of music may be "incompletely understood" but there is scientific evidence that listening to music activates "brain areas involved in the formation of learned associations and representation of value in stimuli" (Omar et al. 2011:

1814). Correspondingly, experienced listeners have been observed to exhibit increased neural responses related to emotion when compared to inexperienced listeners (Chapin et al. 2010: 8).

> The journey from listening to feeling involves a dynamic interplay between several neural systems (…) It is from this complex interaction of auditory, attentional, motor, emotion, and cognitive networks that feeling takes form and sound becomes music. (11, 13)

The combined sensory and cognitive experience of a musical piece influences the listener's affective state (Salimpoor et al. 2013: 218). In a study on the induction of emotions in music, the psychologists Juslin and Västfjäll refer to existing research which indicate that "people value music primarily because of the emotions it evokes" (2008: 559) and emphasize a need to investigate the mechanisms underlying the affective appraisal of music. They argue that evocation of emotions in music is based on processes that are not exclusive to music. As a result, they enumerate six mechanisms which they have observed to contribute to this phenomenon: *brain stem reflexes*, *evaluative conditioning*, *emotional contagion*, *visual imagery*, *episodic memory*, and *musical expectancy*. These mechanisms do not function in a mutually exclusive manner but rather assume complementary roles when processing emotions. Our emotional experience of music is the outcome of complex interactions across these mechanisms (572). Below are several of the said mechanisms that pertain to the current discussion:

Brain stem reflex deals with the previously described low-level structural and cross-cultural characteristics of the musical experience. Brain stem reflexes are hard-wired and are connected with the early stages of auditory processing. Sounds that are "sudden, loud, dissonant, or feature fast temporal patterns" signal the brain stem about potentially important events and induce arousal. According to Juslin and Västfjäll, this arousal reflects the impact of auditory sensations, "music as *sound* in the most basic sense" (564).

Visual imagery is a mental process which resembles perceptual experience but occurs in the absence of relevant stimuli. Several studies have shown that music is highly capable of stimulating such processes. Whether visual imagery involves "pictorial" representations or it reflects "propositional" representations of events in mind is an ongoing ontological debate. However:

> [L]isteners seem to conceptualize the musical structure through a metaphorical nonverbal mapping between the music and so-called image-schemata grounded in bodily experience. (566).

Musics which accompany certain life events are stored in e*pisodic memory* and represent a point of reference for pleasantness of a musical experience. Episodic memory is therefore a "subjectively important source of emotion in music" (567).

Musical expectancy pertains to the induction of emotions through the violation of a listener's expectations. This, however, should not be confused with simple forms of unexpectedness, such as the sudden onset of a loud tone, which would instead trigger a brain stem reflex. the development of musical expectancy involves the cultural learning of syntactical relationships across the components of a musical structure (568).

In their open peer commentary on Juslin and Västfjäll's theories, Fritz and Koelsch suggest the addition of *semantic association* to the mechanisms that underlie music perception (2008: 580). They give the examples of drum figures in the musics of African cultures and national anthems as musical forms which could evoke semantic associations. Since the semantic concepts attached to these musics exhibit emotional connotations, decoding of these associations can induce emotional responses (580). The composer and philosopher Leonard B. Meyer refers to musical structures which elicit semantic associations as *connotative symbols*. A connotative symbol can designate a specific emotional state and be indicative of "a specific idea, concept, or individual" (Meyer 1956: 260).

Leonard B. Meyer's comprehensive analysis of meaning in music constructs and consecutively deconstructs a dichotomy between absolute and referential meanings in music. The absolutist approach claims that music communicates only musical meaning, which is *abstract* and *intellectual*, and musical material refers to nothing but itself. Conversely the referentialists contend that music is capable of communicating meanings that refer to the "extramusical world of concepts, actions, emotional states, and character" (1). Meyer's position on this matter is that music can indeed convey referential meanings but the two camps are not mutually exclusive: these two types of meaning "can and do coexist in one and the same piece of music, just as they do in a poem or a painting". More importantly, both types of meaning "depend upon learning" (2). The communicated meaning of either flavor can be both intellectual and emotional at the same time (39). Meyer's opinion as a music philosopher is in agreement with the scientific studies on emotion in music as discussed above.

Material and Language of Instrumental Music

The material of music is fabricated. The musical instrument is a sound source manufactured to produce *pure sounds*: most instrumental sounds are harmonic and display a smooth temporal evolution when compared to the sounds of daily life (Gaver 1993a: 2). Although modern performance practices explore further timbral possibilities of acoustic instruments, the instruments were originally designed to articulate proportional tonal relationships. The language through which an instrument speaks is therefore fabricated in a similar fashion. A musical language is based on "codes of a convention consolidated over the centuries" (Boulez 1986: 4).

> [T]he listener qualifies sounds as musical, because s/he hears certain characteristics that lead him/her to believe that s/he is hearing music. These sounds more or less comply with the musical precedents s/he is familiar with, and therefore s/he calls these musical sounds. This results in the listener assuming a listening stance that differs from everyday listening. As soon as s/he has decided to regard a series of sounds as music, other conventions, criteria, and precedents are used while listening to it. (Meelberg 2006: 15)

The constituent structures of a musical language, such as melodies and harmonies, are abstract concepts that have been gradually established and acknowledged over time. In that sense, music had managed to reverse the traditional development of semiosis, as the sign (i.e. the abstract components of a musical language) has come to synthesize the referent (i.e. affective appraisal). We have constructed a plethora of clichés to facilitate musical communication (Huron 2006: 2) and the fabricated structures of music have been engraved in our deep-seated mechanisms of music perception. The sociocultural environments we are born into provide us with an initial context of conventions, and as we become exposed to new music, our musical vocabularies expand. Although certain musical affects such as frisson, have their roots in biology (34), we primarily *learn* how to feel about music. Our culturally-idiosyncratic musical languages mediate our appreciation of music.

While, from various ontological perspectives, music can be described to serve other goals, I will align myself with the scientific evidence above and contend that musical experience is ultimately one of emotions. This emotion can be the satisfaction gained from the systematic resolution of a purely formalist program, or it could be the overtly clichéd sadness of a minor chord. By arguing thus, I do not intend to motivate an opposition against divergent views on what is to be experienced in music but rather to situate emotion, of various kinds and degrees, as the inevitable outcome of musical experience. The language of instrumental music can therefore be considered to translate musical material into human emotions.

Affect in Music

This translation of material into emotion is a multifaceted process which involves a host of mechanisms. Therefore the affective appraisal of music comprises successive stages which utilize different but interconnected perceptual resources. A particular component of this spectrum, which will contribute to further discussion in the next chapters, is the experience of affect. The previous references to affective appraisal in this section pertained to the use of the term in psychology. But the concept of affect has been applied to many studies of experience in a variety of domains ranging from virtual reality (Bertelsen and Murphie 2010) and painting (Deleuze 2003) to politics (Massumi 2010) and sports (Ekkekakis 2012). This concept is not only adopted by a large array of disciplines but it is also subjected to a miscellany of interpretations. On the far end of the spectrum, Lim et al. (2008: 118) and Shouse (2005) point to uses of affect as a synonym for emotion. While this approach begs the question of why affect would need to be demarcated as a separate concept, it nevertheless provides an insight regarding the context within which the concept is situated. The particular interpretation of affect that I find constructive for the current discussion is offered by the philosophers Deleuze and Guattari:

> We paint, sculpt, compose, and write with sensations. We paint, sculpt, compose, and write sensations. As percepts, sensations are not perceptions referring to an object (reference): if they resemble something it is with a resemblance produced with their own methods; and the smile on the canvas is made solely with colors, lines, shadow, and light. If resemblance haunts the work of art, it is because sensation refers only to its material: it is the percept or affect of the material itself, the smile of oil, the gesture of fired clay, the thrust of metal, the crouch of Romanesque stone, and the ascent of Gothic stone. The material is so varied in each case (canvas support, paintbrush or equivalent agent, color in the tube) that it is difficult to say where in fact the material ends and sensation begins; preparation of the canvas, the track of the brush's hair, and many other things besides are obviously part of the sensation. How could the sensation be preserved without a material capable of lasting? And however short the time it lasts, this time is considered as a duration. We will see how the plane of the material ascends irresistibly and invades the plane of composition of the sensations themselves to the point of being part of them or indiscernible from them. (2000: 466)

The use of affect in philosophy dates back to Spinoza's *Ethics.* Spinoza identifies affect as an affection of the body by which "the body's power of acting is increased or diminished" (1994: 154). In his introduction to Deleuze and Guattari's *A Thousand Plateaus*, the philosopher Brian Massumi offers a related description of affect as a "prepersonal intensity corresponding to the passage from one experiential state of the body to another" (in Deleuze and Guattari 1987: xvi). Emotion on the other hand is personal according to Massumi:

> Emotion is qualified intensity, the conventional, consensual point of insertion of intensity into semantically and semiotically formed progressions, into narrativizable action-reaction circuits, into function and meaning. (2002: 28)

The music philosopher Vincent Meelberg, offers a comparatively demystified interpretation of affect based on Massumi's definition. In his analysis of expressive qualities in music, Meelberg proposes a differentiation between musical gestures and *sonic strokes*. A sonic stroke is an acoustic phenomenon that induces musical affect upon impacting the listener's body (Meelberg 2009: 325). A consequence of this impact is emotion, which emerges once the affect is reflected upon (i.e. a sonic stroke is registered as a musical gesture).

Connecting this philosophical approach with the scientific studies discussed earlier, affect can be considered to engage with brain stem reflex. Due to its attachment to the early stages of auditory processing, brain stem reflex is highly correlated with physiology and the so-called universals (i.e. the low-level structural properties) of musical experience. A functional coherence between affect and the brain stem reflex is highlighted by their intrinsic reliance on the spectrotemporal and dynamic properties of musical sound. While affect represents the corporeal segment of the affective appraisal of music, it cannot be dissociated from an ensuing emotion. This is mainly due to the aforementioned interplay between the mechanisms underlying music cognition. The musicologist Marc Leman points to seminal neuroscientific studies, such as those by Antonio Damasio, Marc Jeannerod and Wolf Singer, that motivate a departure from the Cartesian view of mind and matter as separate entities; it is understood that the so-called subjective world of mental representations stems from our embodied interactions with the physical environment (Leman 2008: 13).

> [T]he conceptual system is grounded in sensorimotor simulation. It is becoming increasingly difficult to argue that the conceptual system is completely modular and amodal. To the contrary, the conceptual system appears to share many mechanisms with perception and action, thereby making it non-modular and modal. (Pecher et al. 2003: 129)

This view brings us back to the understanding of music cognition grounded in the indivisible union of body and mind; biology and culture. From a phenomenological perspective, the mechanism of anticipation can be considered to mediate our everyday experiences (Schutz 1967:58), musical or not. *It is no surprise*, then, when the music cognition researcher David Huron congruently characterizes musical expectancy as being interwoven with both biology and culture (2005: 3).

COGNITIVE IDIOSYNCRASIES OF ELECTRONIC MUSIC

Now let us look at how electronic music differs from instrumental music in terms of the listening experience. There are two standpoints to be noted here that are fundamental to the research discussed here and my practice in general: Firstly, when I refer to *listening*, I do not seek a separation between the composer and the listener. As briefly touched upon in Chapter 1, listening will be considered the primal activity of electronic music composition with regards to the particular characteristics of cognition that are being scrutinized in this book. Secondly, although it may initially appear that I intend to impose a dichotomy between instrumental and electronic musics, this is in fact not so. The following comparison between the two will act as a gateway to a discussion of the cognitive idiosyncrasies of electronic music. Eventually, I will argue that the experiential differences between the two, merely represent poles in a continuum; their juxtaposition reveals more of an *amalgamation* than a *shift* in languages.

The electronic medium affords myriads of techniques to compose music. I have described a number of these in Chapter 1 when I also stated that, from a listener's perspective, pieces created with drastically different techniques could be experienced similarly. This also implies that the actions through which a composer materializes an idea may be perceived by the listener differently. For instance, a participant of my experiment expressed in his general impressions that *Element Yon* might be a generative piece although the piece was composed almost entirely by performing with various devices and later montaging the results. Conversely, some participants have associated the algorithmically generated sections of *Diegese* with choreographed narratives. Later in the chapter, I will adopt a semiological model to overcome a communicational hierarchy between the composer and the listener and to put the emphasis on the complexity of listening instead.

The composer who is also a listener

> The composer as a listener is the correlate of the composer as a producer: in order to produce music, an act of hearing is necessary, whether it be the "inner hearing" (the silent writing situation) of pure instrumental music composition, or the "concrete hearing" of electroacoustic music composition. These situations involve variants (there are many others) of an "action/perception feedback loop" which can be defined as an instance of validation proper to musical processes. (Vaggione 2001: 60)

The composer Horacio Vaggione's distinction between modes of hearing articulates some essential characteristics of electronic music composition. For the composer working in the electronic medium, both inner and concrete modes of hearing become vital activities. While the interplay between these actions will be unique to each instance of composition, they will nevertheless coexist.

Undoubtedly, the gamut of compositional strategies in electronic music is extremely wide but a common scenario for me, and perhaps other artists, is as follows: I *imagine* or *recall* a sound. This sound may have been conjured up as a component of a premeditated structure, or it might act as a starting point at a more exploratory stage of composition. I might have *listened* to this sound previously or I might be making this sound up from scratch, but a pool of possibilities had already been defined through what I am physiologically capable of hearing and what I had previously heard. On certain occasions, I prefer to draw this sound on paper[8]. This drawing might represent the temporal unfolding of an envelope (i.e. a waveform) or the spatial movement of a sound object. Such drawings display similarities to how I would animate sound events with hand gestures if I were to talk about my music. So far no sound has been produced in the physical domain. The sound has been imagined and may have been represented in different modalities. All these actions are guided only by my inner hearing.

The process up until this point is not intrinsically different for a composer of instrumental music. The possible pool of sounds is defined by the *material* of instrumental music, as discussed in the previous section, and what is recalled would be expressed in the *language* which the instruments are designed to speak. In the case of instrumental music, the act of creating visual representations of musical ideas would correspond to the writing of the score. The difference for the instrumental music composer is that this process remains the sole activity until the work is interpreted by a performer. The back and forth between creating and evaluating the work transpires within a loop between the composer's inner hearing and the score on paper. The composer is capable of auditioning chunks of music by playing it with an instrument or via software, the latter being a fairly modern artifact, but the results would still be mere representations of the actual work. Of course, a work can be a solo piece which the composer herself can perfectly imagine and recreate on an instrument, but in this case either the inner hearing lends itself to concrete hearing where the writing becomes no longer silent in an improvisational manner, or the composer assumes consecutive identities, writing music through inner hearing as a composer and later interpreting as a performer.

Electronic music blurs this distinction by affording the coexistence of hearing modes. To illustrate this, let me continue describing my experience as an electronic music composer from where I left off: the sound has been imagined through inner hearing, yet no sound has been produced. At this point, I proceed actually to design this sound. There are several strategies to achieve this: If the sound in mind is referential (e.g. the sound of a wind blowing, the sound of shattering glass), I might (a) record this sound from an actual source, (b) record sounds that create an illusion of the reference (similar to foley in filmmaking) or, (c) generate sounds that create an illusion of the reference. In the latter method, I would investigate the physical characteristics of the sound in mind: What are the temporal and spectral constituents of this sound? How does it resonate and become attenuated in a space? Which synthesis method would work best to recreate the sonic characteristics of this sound? If recordings of this sound were available, I would go through them and analyze their physical invariants. Based on such inspections, I might use various oscillators, noise generators and filters to *sculpt* the sound in a similar fashion to *subtractive synthesis*, or if the sound is a product of complex processes, I might build software that can recreate the unfolding of the sound.

[8] Research findings show that when we imagine a sound, the process is a multimodal experience during which our faculties of visual perception are also activated (Bradley 2000: 213). Gygi et al., in an attempt to explain the strong correlation between the perceptual spaces of sounds and multimodal events, hypothesize that listeners may be unable to judge sounds and events independently (2007: 853). Research on embodied music cognition similarly emphasize the multimodal nature of musical experience (Godøy 2006: 149).

On the other hand, if the sound in mind is purely speculative without a clear reference (as in Schaeffer's *sound objects*), I would first evaluate the complexity of the sound. Would it be easier to generate this sound, or should I micromontage it into existence from chunks of recordings? Although the sound itself is not referential, what could be a reference *to* this sound? What is the sound of that reference, and how does it relate to my speculative imagination? Then the strategies listed above come into play: I would record or generate sounds, either manually or via algorithms, and try to materialize the sound in mind.

The above steps taken as a result of my inner hearing will have immediate sonic consequences which will instigate my concrete hearing. The results of these actions will not be representations of the musical material but will make up the actual work itself, without a need for a mediating performance. I can therefore imagine the work and experience it at the same time. Morton Subotnick describes this idiosyncrasy of electronic music as his primary reason for deciding to compose for the electronic medium in the 1960s:

> I thought what I saw was the possibility one day of having a studio in your home and to create a whole new music, where you would be where music could become a sound. A studio art, where I could have an idea and try it out. Instead of putting it on paper and having musicians play it, I could actually try it out directly, listen to it and redo it, just like a painter would (…) I would be the composer and the performer and the listener, then send it off, and other people could listen to it. (quoted in Rosenbloom 2011)

The painting analogy expressed here is particularly effective in delineating the concurrency of imagining to the formation of the work. The electronic music composition emerges from an immediate interplay between the composer's actions and their audible outcomes. Vaggione describes this phenomenon as an "action/perception feedback loop" (2001: 60). To obtain a better understanding of this concept let's imagine a scenario in which I am designing a sound which does not have a clear reference. Upon the first step I take to produce this sound, my inner hearing is instantaneously supplemented by my concrete hearing. As I proceed to develop this sound, my initial imagination begins to evolve. This is the result of a complex negotiation which will be unique to every sound I design for every piece that I compose. The imagined sound of my inner hearing can take total precedence and steer the design process. Conversely, the sound that I bring into physicality through various methods can begin to overpower the imagined sound by offering new possibilities previously unimagined. I, as the listening composer, discover the physical characteristics of my quiet speculation. Every action I take will trigger new perceptions, which, in return, will *immediately* influence my next step.

> In a manner similar to a child's cognitive development, active manipulation of the "object" leads to its functional and conceptual understanding, and therefore, similar to its role in childhood, play is an important activity to stimulate that learning. Playing with a sound involves both memory and imagination, the "what if" question, and the sense of discovery. (Truax 1996: 60)

Parameters to Instincts: A Priori to Experiential

A particular competence granted by the electronic medium is the ability to achieve a superhuman degree of accuracy. With modern computers, the level of time-domain precision is unrestrained within the limits of human perception. Many digital processes which would be deemed ordinary by the contemporary electronic music composer, such as zooming in, stretching, duplicating and reversing an audio file, are relatively recent implementations. Yet these processes are now inextricable from modern composition routines, and they bring an unprecedented level of elasticity to the sonic material.

Such elasticity was not at the artist's disposal up until the late 1980s when the first digital audio workstations were introduced. Even then, hardware constraints significantly hindered the capabilities of audio applications. As someone who was born into the age of personal computers, even I am able to retrospectively discern remarkable leaps in efficiency of my compositional workflow within time spans as brief as a couple of years. These leaps have especially become apparent in the quality of resource-demanding processes such as reverberation and frequency-domain transformations. The number of such processes that can be applied to an audio track, and the number of effect-laden audio tracks which can be played back in real-time without disruptive CPU overloading have considerably increased. Audio programmers today are supplied with a surplus of hardware capacity. The implications of such processing power go beyond a feat of numbers. The technical gap between a composer's concept and its perceivable outcome is continuously shrinking: the ever-expanding arsenal of audio processing tools makes it progressively easier for a composer to materialize sounds faithful to the fantasies of inner hearing. This is the reason why the electronic music composer Curtis Roads refers to the present day as "the golden age of electronic music" (quoted in Robindoré 2005: 11).

A historical overview of such interplay between technology and the composer paints a clear picture of certain emergent characteristics of electronic music. The promise of the electronic medium was not entirely decoupled from preceding views on what should be deemed musical material. But it did nevertheless bring about a musical paradigm shift:

> The new sound material has come upon unsuspected possibilities, by no means purely by chance but at least by guided extrapolation, and has tended to proliferate on its own; so rich in possibilities is it that sometimes mental categories have yet to be created in order to use them. (Boulez 1986: 9)

As briefly touched upon in Section 1 of Chapter 1, the early theoretical perspectives towards electronic music guided the composers through their initial encounters with the electronic medium in the 1950s. One of the most significant examples of this was the adoption of *serialism* from the *Second Viennese School* as a philosophical direction for the electronic music studio at the Westdeutscher Rundfunk in Cologne. One of the founders of this studio, Herbert Eimert wrote: "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" (Chadabe 1997: 37). Webern was the most influential exponent of serialism in the domain of instrumental music. *Total serialism*, which extends the application of serial techniques beyond pitch configurations to further compositional parameters such as duration and dynamics, was exercised by the composers of the Cologne studio such as Boulez and Stockhausen.

There was indeed a natural marriage between total serialism and the electronic medium. On the one hand it was a composition technique which demanded meticulous control over each parameter of music including pitch, rhythm, dynamics and timbre. An ideal exhibition of the finely pointillistic essence of this style required super-human performance. On the other hand it constituted a brand-new compositional paradigm which afforded an unprecedented mathematical precision in the control over sonic parameters via industrial-grade electronic devices. Most composers, however, did not possess preconceived ideas as to how these devices could be utilized within the context of music. The studio technician had a primary role in bridging the gap between the artist and the medium. Most composers, therefore, were not in absolute control of the creative process. Furthermore, technical challenges were coupled with a lack of aesthetic precedent. An "irrational necessity" to overcome the stagnation in the world of musical instruments came before aesthetic reflection, which was all but relinquished in favor of free development (Boulez 1986: 9):

> To musicians accustomed to a precise demarcation, a controlled hierarchy and the codes of a convention consolidated over the centuries, the new material has proposed a mass of unclassified solutions, and offered us every kind of structure without any perspective, so affording us a glimpse of its immense potential without guidance as to which methods we should follow. (4)

The inherent compatibility of the electronic medium with the parametric nature of serialism, and the existing affiliation of the Cologne composers with this style in the instrumental domain represented natural gateways to electronic music. When we view Eimert's earlier statement in this context, it could be argued that serialism functioned as an initial comfort zone for the composers facing the unknowns of the electronic medium for the first time.

The strictly deterministic reliance on serial permutations exercised during the early years of the Cologne studio was criticized by the members of the Paris studio. Conversely, the stylistic direction of the Paris studio, which relied heavily on exploration and play, was condemned by the adamant practitioners of serialism for not having any deterministic basis. A few years later, Luciano Berio and Bruno Maderna established the *Studio di Fonologia Musicale* in Milan and instated a mix between serialism and musique concrète as the studio's stylistic orientation. They referred to their output as *radiophonic art*, which relied on the said styles only to the extents deemed necessary by the artist.

The composer Luigi Nono, who succeeded Berio as the head of the studio, criticized any artistic dependence on mathematical relationships without interrogative contemplation as a "tendency to seek refuge" (1960: 1). He also described the delegation of artistic determinism to randomness at the opposite end, as a sign of inability on the composer's part to make decisions. Nono's arguments emphasize the significance of artistic initiative and the conscious translation from artistic instincts to actions. To Nono, neither pure determinism nor pure randomness should overpower intuition and logic (3). It should be noted that deterministic procedures governed a significant portion of Nono's early work; the artist merely opposed lending too much authority to such methods[9]. Pierre Boulez, who was a prominent practitioner of serialism in the early 1950s, similarly emphasized a need for a middle ground:

> [M]usical invention must bring about the creation of the musical material it needs; by its efforts, it will provide the necessary impulse for technology to respond functionally to its desires and imagination. This process will need to be flexible enough to avoid the extreme rigidity and impoverishment of an excessive determinism and to encompass the accidental or unforeseen,

[9] Nono's *Liebeslied*, for chorus and instruments, utilizes a revised serial method which incorporates "less automatic procedures" (Zampronha 2005: 3).

> which it must be ready later to integrate into a larger and richer conception. (Boulez 1986: 11)

The ability to think through the electronic medium developed in parallel with the artist's comprehension of technology. The composer's concept at some point needs to converge with the medium because "when either the material or the idea develops independently, unconcerned whether or not they coincide, a serious imbalance develops, to the detriment of the work" (Boulez 1986: 6). Karlheinz Stockhausen has produced arguably the most prominent works of electronic music to come out of the Cologne studio. In 1963, Stockhausen succeeded Eimert as the artistic director of the studio and remained at the helm until 1977[10]. Stockhausen's oeuvre of electronic music constitutes an illuminating timeline of both the stylistic evolutions in early electronic music and the artists' internalization of the electronic medium.

Stockhausen's early electronic works at the WDR were serial studies in accordance with the artistic direction of the studio. In 1956, four years after the studio was established, Stockhausen completed *Gesang der Jünglinge*. This seminal work marked a departure from a strict adherence to the technique (Holmes 2008: 66). His electronic epic from another three years later, *Kontakte*, is described to rely on serial proportions only at a "broad formal level" (Toop 1981: 189). While the realization of this piece employed serial methods to a certain degree, Stockhausen had gained enough artistic liberty over the electronic medium to override them when he felt it necessary. As the researcher John Dack expressed in his 1999 article, *Karlheinz Stockhausen's Kontakte and Narrativity*, the composer did not allow "any rationalistic method to take precedence over musical instinct". In a 1997 interview, Stockhausen recounts an instance where he ended up recomposing an entire section of *Kontakte*:

> [If] one has a construction planned [for the piece], if it is based on relationships between the individual durations–and in my music that has always been the case–then you go on and trust that it will sound organic. But then when you splice all the parts together in the end, all the different sections, then you hear for the first time how it sounds in a run, in continuity. (Stockhausen quoted in Paul 1997)

Stockhausen's theoretical work accompanying his artistic output reinforces his role as a pioneering figure. His concept of *Unity in Electronic Music*[11] relies heavily on the physics of sound and the characteristics of auditory perception. In order to implement the requirements of this concept, Stockhausen amassed a significant amount of research rooted in scientific principles. The outcome of these endeavors in the form of artistic works represents an evolution in the relationship between the electronic medium and the composer.

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[10] Stockhausen continued to act as the permanent artistic advisor of the electronic music studio at the Westdeutscher Rundfunk from 1977 until 1990. The studio was decommissioned by the radio in 2000. In later interviews, Stockhausen expressed his hopes to procure the equipment for a new establishment. Unfortunately, this plan never materialized.

[11] *The Concept of Unity in Electronic Music* is a proposal "to bring all the spheres of electronic music under a unified musical time, and to find one general set of laws to govern every sphere of musical time itself" (Stockhausen 1962: 48). The main premise of this approach is that every structure in electronic music, from a pulse to a composition, is a result of the temporal orderings in continuous time-spheres (e.g. frequency duration, rhythm duration and form duration).

Complexity of Listening

As composers tightened their grasp on the new medium, what is *heard* in electronic music started to take precedence over what had been *parametrized*. By the early 1960s, composers began to acknowledge that a listener would "perceive a sound-event as a homogeneous phenomenon" (Stockhausen 1962: 40) rather than a manipulation of individual properties. During the ensuing decades, the mutual influence between parameters and the "complexity of listening" (Zampronha 2005) gained even further prominence in electronic music practices. The musicologist Joanna Demers refers to this period as the *post-Schaefferian era* (2010: 14) mainly because of declining interest at the time in practicing Schaeffer's *reduced listening*[12]. Working with external associations, a practice which goes against the mandates of this mode of listening, progressively became an integral aspect of electronic music (14). The composer Ambrose Field asserts that, today, neither composers nor listeners foster a need to disregard the extramusical connotations in electronic music (2000: 37). Demers states that this evolution is, above all, practical, since both empirical evidence and common sense affirm recognition as an intrinsic aspect of listening (2010: 84).

The composer Trevor Wishart, while on the one hand denying the premise of reduced listening, agrees with Schaeffer on the possibility of maintaining control over the listening experience (Demers 2010: 30). Wishart contends that a set of *metaphoric primitives* would be necessary to establish a complex metaphoric network between the composer and the listener. Metaphoric primitives are "symbols which are reasonably unambiguous to a large number of people" (Wishart 1986: 55). This definition reminds the concept of *connotations* described by Meyer as conscious image processes common to individuals within a culture (1956: 257). Image processes, as referred to here, are memory functions triggered by musical stimuli, and act as mediators through which music arouses affect. Connotations are based upon similarities between our experience of musical material and the "non-musical world of concepts, images, objects, qualities, and states of mind" (260). The recognition of such connotations necessitates habituation and automatism, which are established over time and after "repeated encounters with a given association" (260). It should be noted that Meyer proposes this concept within the paradigm of instrumental music and points to the difficulty of particularizing connotations aroused by musical material. According to Meyer, connotative meaning in instrumental music is therefore a problematic topic to theorize upon (264). This is why Meyer views extrinsic (or designative) meaning in instrumental music of lesser prominence when compared to embodied meaning in which music refers to *itself* (35).

However, connotations, and more generally processes of meaning attribution, gain new facets when viewed in light of the material of electronic music. What is *itself* to electronic music (i.e. its material and therefore its language) is redefined. Technologies of sound generation and reproduction unlock for the artist an entirely new and virtually unlimited vocabulary of sounds. Unsurprisingly, the extent of this sonic material far exceeds the vocabulary of a traditional musical language and "pitches music into a no-man's-land" (Demers 2010: 13). Electronic music is therefore characterized as "the first musical genre ever to place under the composer's control an acoustic palette as wide as that of the environment itself" (Emmerson 1986: 18). Metaphorical systems which play "a central role in defining our everyday realities" (Lakoff and Johnson 2003: 3) extend into the communication of meaning in electronic music.

[12] Reduced listening is a listening mode that "focuses on the traits of the sound itself, independent of its cause and of its meaning" (Chion 1994: 29).

The medium through which musical material comes into being also has implications in terms of semantics. In a study of the communication of expression in instrumental music, Vines et al. found that being able to see the performer has an impact upon our emotional experience (2010: 157). Even in the absence of a performer, we mentally simulate physical gestures: the perception of instrumental music incorporates what the musicologist Rolf Inge Godøy refers to as a *motormimetic component*, in which the listener mentally re-enacts the articulatory gestures of a performer (2006: 155). This motormimetic component relies on the listener's mental repertoire of action/gesture consequences (Leman 2012: 5). The physical activities relating to sound making in instrumental music is therefore interwoven with how the resulting sounds would be perceived. This relationship, however, disappears in electronic music since the immediate corporeal link between the performer (i.e. the composer) and the material is broken. Producing a sound in the electronic medium is "rarely the result of a single, quasi-instrumental, real-time, physical gesture" (Smalley 1997: 109). A single gesture in electronic music can encompass many gestures performed at different times and layered together in a way that obscures the perception of the individual gestures.

The new material, brought into the composer's vocabulary by the electronic medium, necessitates a new language. The culturally embedded language of instrumental music is unidiomatic and insufficient to address the structural complexity this new material makes available for artistic expression. When music is opened up to all sounds, discovering a path through the "bewildering sonic array" of electronic music becomes a challenge both for the listener and the composer (107). As Smalley denotes, the electronic music listener rarely has preconceived notions as to what to expect from a new piece as "everything remains to be revealed by the composer and discovered by the listener" (1996: 101). If anticipation underlies our appraisal mechanisms (Huron 2006: 7), musical expectancy plays a significant role in how we experience a particular piece. But if any sound within the threshold of our hearing is to be expected in electronic music, how can the composer construct the unexpected?

> [S]urprise requires an expected outcome; and an expected outcome requires an internalized norm. Composers must activate either normative schemas (such as styles) or commonplace clichés in their listeners if their violations of expectation are to have the desired effect. (36)

As Field states, a common ground is necessary for the composer and the listener to communicate (2000: 40). This sentiment aligns with the conceptualizations of metaphoric primitives and connotations. Establishing a framework of anticipation for the experience of electronic music necessitates a shared point of reference across the agents of this experience. Such a normative function exists in our survival instincts and the formation of our sensory mechanisms. We are hardwired to perform what the composer Michel Chion refers to as "causal listening" (1994: 26), during which one can identify a precise cause or recognize a category upon hearing a sound. This is because the act of listening in humans has evolved to locate and identify events (Gibson 1966: 96). From this evolutionary perspective, all sounds can be considered signs: the perception of a sound indicates something beyond the sound itself and a sound can never exist as a pure abstraction (Demers 2010: 37) since a sign is "in a conjoint relation to the thing denoted and to the mind" (Peirce 1885: 180). Accordingly, the sound world of electronic music encourages the imagination of extrinsic connections (Smalley 1997: 110). Even in the absence of adequate information, "the perceptual system hunts" and "tries to find meaning to make sense from what little information it can get" (Gibson 1966: 303). This has various implications in terms of the listening experience of electronic music on both ends of the communication.

Esthesis-Poiesis Model of Semiology

To delineate these implications, I will split the discussion into two threads of listening imagination. Instead of merely contrasting the composer with the listener, I will adopt Jean-Jacques Nattiez's theory of musical semiology and describe these two threads through *poiesis* and *esthesis*. Nattiez characterizes the three dimensions of symbolic phenomenon as:

1. *The poietic dimension* is the *sender*'s *process of creation*,
2. *The esthesic dimension* is the *receiver*'s *construction* of a meaning from the poietic,
3. *The trace* is the physical and material embodiment of the symbolic form, accessible to senses. (Nattiez 1990: 12)

This model is based on the semiologist Jean Molino's theory which restructures the classic schema of communication from "Producer –> Message –> Receiver" into "Producer –> Trace <– Receiver", implying, in effect, that:

(a) a symbolic form (a poem, a film, a symphony) is not some "intermediary" in a process of communication that transmits the meaning intended by the author to an audience;

(b) it is instead the result of a complex *process* of creation (the poietic process) that has to do with the forms as well as the content of the work;

(c) it is also the point of departure for a complex process of reception (the esthesic process) that *reconstructs* a "message" (Nattiez: 17).

In other words, poiesis is the transduction of meaning (or concept) into material, while esthesis is the construction of meaning (or percept) from the material (the trace). But *meaning as concept* and *meaning as percept*, attached to the same material, are not preordained to match. There are several reasons for me to adopt Nattiez's approach instead of a simple collation of the composer and the listener. Firstly, I find a semiological perspective to be appropriate for discussing the communication of meaning in electronic music. More importantly, Nattiez's ternary model bears a distinct compatibility with the unique form of action/perception feedback loops inherent to electronic music composition as discussed above. Poiesis and esthesis can easily, and to the most part accurately, be regarded as acts of the composer and the listener respectively. However, since electronic music composition enables the coexistence of inner hearing and concrete hearing, it can be formulated as a complex interplay between poiesis and esthesis. This approach resonates with the previously highlighted understanding of *the composer as a listener*. The momentary acts of composition can therefore be schematized as:

Action —>	Trace	<— Perception
Poiesis		Esthesis

The idea of trace not only contributes to a unified understanding of listening but at the same time liberates the percept from the concept. This liberation can manifest itself during the composition process as illustrated in the above schema, or it can transpire between composer and listener. For the composer, a concept to be materialized and the perception of the resulting material can contradict each other. This is an internal conflict between poiesis and esthesis. Conscious or unconscious resolutions of such conflicts guide the nonlinear progression of a composition at various scales ranging from gesture to form. Communication of meaning between the composer and the listener is also fertile with such conflicts. I will further analyze these conflicts in the next chapter under a discussion of gestural intentionality.

The Esthesic Thread

The human mind processes sensory input on the basis of what has already been experienced (Demers 2010: 50). The auditory system is "constantly ready for new information about the environment and compares it to stored experience" (Truax 1984: 26). Our knowledge of likely sequences of sounds significantly aids auditory recognition (Gygi 2004: 1262) since the memory of a sound shares a highly correlated perceptual space with the actual experience of this sound (Gygi et al. 2007: 853). The structured environments which we co-evolve with establishes a context for our auditory experiences (Windsor 2000: 20) and our past experiences impact our appraisal of future encounters (Tajadura-Jiménez and Västfjäll 2008: 68).

We develop cognitive representations of acoustic phenomena as part of meaningful events occurring in our daily environments; these representations are collective in terms of their relevance to the observer's membership to a community of experiences (Dubois et al. 2006: 869). This aspect of cognitive representations has a similarity to the connotations described by Meyer, and offers an insight into how connotations can be easier to particularize in the context of electronic music. When listeners are enculturated into a particular auditory environment, learned schemas establish the ground for prediction and *surprise* (Huron 2006: 36). When our mental catalogue of musical experiences fails to guide us through a piece of electronic music, the mind resorts to a more general catalogue of experiences: a lack of musical reference conjures up a profusion of other kinds of references. The esthesic complexity of electronic music matches that of environmental sounds, which "can hardly be reduced to a set of physical parameters" (Dubois 2000: 49). The experience of meaning in electronic music "is in essential harmony with that in everyday life" (Kendall 2010: 73).

Even the synthesized sounds of electronic music can trigger references in the listener's mind (Emmerson 1986, p. 26; Windsor 2000: 17) since synthesized sound events too convey environmental information (Gaver 1993b: 290). A real source is not necessary for the listener to speculate a physical cause (Windsor 2000: 15). The tendency of a listener to make sense of a sound in relation to the environment (21) expands beyond the recognition of featural similarities between sounds inside and outside electronic music, and facilitate the attribution of contextual meaning to stimuli. The disposition of a sound objects can maintain a sense of reality contextually (Wishart 1996: 146). The mind is capable of situating abstract sound sources within a "real-space" (146) and retaining associations to past experiences.

Smalley refers to this reflex of the human mind as *source bonding*, which "can occur in what might be considered the most abstract of works" since bonding play "is an inherent perceptual activity" (Smalley 1997: 110). He further describes this phenomenon as "the natural tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins" (110). Smalley utilizes this concept to discuss the links between the intrinsic (the musical work) and the extrinsic (the sounding world outside)[13].

The Poietic Thread

In his *Aesthetic Theory*, Theodor Adorno describes art as the language of wanting the other: "The elements of this other are present in reality and they require only the most minute displacement into a new constellation to find their right position" (Adorno 1997, 132). An artwork is a demonstration of this displacement in reality. In Demers' interpretation of Adorno, it is impossible to create an entirely new type of material from nothing, so artistic material can either imitate empirical reality or mediate it by alienating the familiar through technology (Demers 2010: 50).

Our encounters with environmental phenomena establish a frame of reference for our esthesic activities. This has self-evident implications for the poietic acts of the composer who is also a listener. My knowledge of sounds come from my daily environments. When I design a sound, the possible outcome is above all bounded by the physiological constraints of my auditory mechanisms. Once the physical characteristics of the changes in air pressure fall within the thresholds of my perception, my cognitive faculties come into play. My ideas as to how to design a sound will be shaped by how the sounds I have encountered thus far have come to pass, since actual sounds and imagined sounds occupy highly correlated perceptual spaces (Gygi et al. 2007: 853). This does not necessarily point to a normalizing function of my mental catalogue of sounds. But I can design the abstract only in reference to the concrete; the unreal *becomes* through the real. In this vein, Adorno describes the role of material in going beyond the material itself:

> The choice of the material, its use, and the limitations of that use, are an essential element of production. Even innovative expansion of the material into the unknown, going beyond the material's given condition, is to a large extent a function of the material and its critique, which is defined by the material itself (…) If [the composer] turns critically against tradition through the use of an autonomous material, one completely purged of concepts such as consonance, dissonance, triad, and diatonicism, the negated is nevertheless retained in the negation. Such works speak by virtue of the taboos they radiate. (Adorno 1997: 148)

While this statement can be viewed as a conceptualization of breaking away from musical (and otherwise artistic) tradition, it can also be applied to the relation between abstractness and representationality in artistic material. In an abstract work, physical reality becomes the negated; the negation commissions the negated in both poiesis and esthesis. This principle applies to representations of reality (or the lack thereof) in electronic music as well. For instance, acousmatic music, in similar fashion to Meyer's prioritization of embodied meaning in instrumental music, focuses on the qualities of sounds in themselves. Even in the early years of the Paris studio where this style originated, a common technique for producing abstract sounds was the exhaustive investigation of sound recordings which were clearly indicative of their sources. By studying those attributes of a sound that attach it to its source event, composers discovered what exactly they had to deform to sever this tie. Such practices

[13] This binary approach to signification is apparent in numerous studies on meaning in instrumental music as well (Meyer 1969, Jakobson 1970, Coker 1972, Nattiez 1990).

demonstrate that an extensive understanding of reality facilitates its abstraction. In electronic music, the reality to be embraced or negated is the entirety of our auditory vocabulary.

But how does one meaningfully deal with such a large corpus? Exploration and experimentation are undoubtedly inextricable components of electronic music composition at any level of artistic expertise. However, as one furthers his or her involvement with the electronic medium, methods to materialize a sonic imagination become increasingly more innate for the composer. As a teacher of electronic music composition, I find that the novice composer is often inclined to *play* with sounds or sound generating devices until they arrive at a base material which they find interesting or pleasing. This process, at times, deviates from the "guided extrapolation" Boulez describes, and suffers an absence of artistic initiative. When I described a composition scenario earlier in this section, I stressed the prominence of the unimagined in the action/perception feedback loops. Exploring a sound material for poietic leads is an unquestionably valid form of composition. However, the composer should not easily surrender to the immediate *artifacts*[14] *of the medium*.

> [Material] is the sum of all that is available to [the artists], including words, colors, sounds, associations of every sort and every technique ever developed. To this extent, forms too can become material; it is everything that artists encounter about which they must make a decision. The idea, widespread among unreflective artists, of the open eligibility of any and all material is problematic in that it ignores the constraint inherent in technical procedures and the progress of material, which is imposed by various materials as well as by the necessity to employ specific materials. (Adorno 1997: 148)

In my opinion, this correlates to the confusion of non-motivated openness with artistic initiative. In the former, one loses track of artistic inclination and obliviously gives in to the constraints or the self-assertions of the medium. Falling into this poietic trap engenders an artistic inertia disguised in unrestricted exploration. On the other hand, constraints, different from rules, "act as "reflecting walls" inside which a tissue of specific relationships is spun" (Vaggione 2001: 57). The articulation of artistic initiative through constraints becomes of particular importance in the open sound world of electronic music.

Amalgamation of Musical Languages

The material of electronic music, and the language this material motivates, undoubtedly set the genre apart from its predecessors. The cognitive Psychologist William W. Gaver's distinction between everyday listening and musical listening is naively insulated from the immutable debate on what music is. For Gaver, in everyday listening we would hear "a single-engine propeller plane flying past"; musical listening on the other hand involves an experiencing of the sound itself (Gaver 1993b: 286). This, to say the least, would be a crude segregation in the context of the current discussion. However, it also affords an external perspective that reveals two poles of the semantic play in electronic music. The language of instrumental music is not discarded but augmented by that of electronic music. The cognitive continuum from abstract to representational becomes an instrument for the electronic music composer. All of the pieces associated with the current study makes use of this continuum to

[14] "Something observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure" (Oxford Dictionary of English).

varying degrees. The amalgamation, for instance, can serve a formal function: in my piece *Do You Remember Rob Nolasco?,* two movements imitate each other's narrative arcs by making use of separate musical languages[15]. In *Christmas 2013*, one musical language is situated within the other in the form of a diegetic actor at a gesture level. In *Birdfish,* adhering to the work's evolutionary theme, the amalgamation is transformative as an amphibian mutates into a bird, which mutates into a leitmotif.

The culturally encoded "material-to-emotion" pathway relevant to the appraisal of instrumental music is intercepted in electronic music by acts of meaning attribution instigated by the musical material. This, however, does not invalidate the affective outcome of music which was described earlier as an ultimate goal for artistic experience. In their experimental study on auditory-induced emotion, Tajadura-Jiménez and Västfjäll concluded that the meaning attributed to a sound by the listener is as important as the physical properties of the sound in inducing affective response (2008: 63).

Amorphous sequences, in the cognitive scientist Danièle Dubois' terminology, yield a categorization on the basis of acoustic parameters such as intensity or pitch. An example of these are background noises "in which no specific event could be isolated" (Dubois 2000: 48). In other words, when the listener fails to identify a source for it, the auditory stimulus is processed as an abstract phenomenon rather than a part of a meaningful event (49). This finding is in agreement with the results of the experiments conducted by Guastavino et al. which revealed that in describing *ambient noises* participants commonly used simple adjectives relating to physical attributes of the acoustic signal instead of source descriptors, "suggesting a more abstracted conceptualization of a sound in itself" (2007: 55). Similarly, Özcan and van Egmond state that in the absence of identification during a sound recognition process, featural aspects of the sound are analyzed (2007: 199). In summation, upon hearing a sound, a series of perceptual mechanisms are activated. If the heard sound is abstract, we focus on its featural aspects (i.e. we evaluate it in itself). If, on the other hand, the heard sound is representational, we focus on its semantic associations.

However, these two processes are not necessarily mutually exclusive. The acoustic engineer Pedro Novo describes three models for the design of acoustic virtual environments, namely authentic, plausible and creational approaches (2005: 278). The plausible approach evokes auditory events which will be perceived as having happened in a real environment. The authentic approach aims at reproducing existing real environments, while the creational approach attempts to evoke neither authentic, nor plausible auditory events. This mainly self-evident tripartite taxonomy is reminiscent of Wishart's couplings of objects and spaces that are real and unreal. Interestingly, although such actor and setting pairs would amount to four combinations, Wishart's *landscape* model is also three-part: (1) unreal-objects/real-space, (2) real-objects/unreal-space, (3) real-objects/real-spaces (1996: 146-147). Simon Emmerson, the editor of Wishart's *On Sonic Art*, points to this reduction in footnotes and offers the possibility of an unreal-object/unreal-space scenario (147). However, Wishart's omission of this option could be due to the listener's instinctive imposition of reality on the auditory experience.

Wishart's dichotomy of *real* versus *unreal* on an object-space plane is comparable to Emmerson's language grid as seen in Table 3.1. Between a mimetic discourse, which evokes images external to the musical material, and an aural discourse based on sound objects which are free of such associations, Emmerson sees a "continuum of possibilities" (19). In pieces where a balance of both is found, although the sound sources are recognizable, "the

[15] For a more detailed compositional report, please refer to Section 2 of Chapter 1.

impressions are welded together in other ways than those based on associative image" (Emmerson 1986: 20). The axes of the grid are discourse (representing the degree to which mimetic references are used) and syntax (either abstracted from the material or constructed independently from it). In devising this grid, Emmerson's actual goal is to address the divide between *elektronische Musik* and *musique concrète*, with the former relying upon an abstract syntax while the latter focuses on abstracting syntax from material. Each number in the language grid corresponds to a combination of discourse and syntax, which Emmerson exemplifies with various pieces of electronic music. Having constructed the language grid, Emmerson notes that the outermost boundaries of the discourse-syntax plane are "ideal states which are probably unobtainable" (25). I wish to interpret this distinction as Emmerson's pre-emptive affirmation of the lack of an unreal-object/unreal-space scenario in Wishart's model.

Abstract syntax	1	4	7
Combination of abstract and abstracted syntax	2	5	8
Abstracted syntax	3	6	9
	I: Aural discourse dominant	II: Combination of aural and mimetic discourse	III: Mimetic discourse dominant
		MUSICAL DISCOURSE	

Table 3.1: Language Grid (Emmerson 1986: 24)

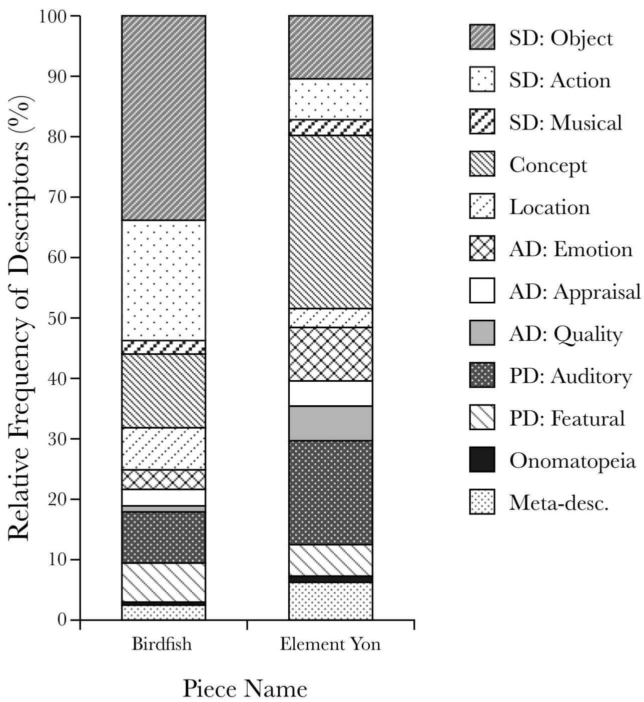
The current discussion focuses on language as a whole rather than as a construct of discourse and syntax. I have regarded musical language as being in a constant and causal duality with material in both instrumental and electronic domains. The conventions as to the organization of the material (i.e. the language) emerges from the material. From an esthesic perspective material and language are symbiotic. Therefore, the aforementioned cognitive continuum crosses the language grid diagonally from *abstract* at *field 1* (exemplified by Emmerson with serialist *elektronische Musik*), to *representational* at *field 9* (exemplified with Ferrari's *Presque Rien*).

As a display of the poles of the cognitive continuum, the data from the listening experiments conducted with *Birdfish* and *Element Yon* reveal a stark contrast between listener responses. In Chapter 1, I described these two pieces as having been composed concurrently using similar structural and gestural formations, but with synthesized materials which diverge significantly in terms of representational intentions. Revisiting the data presented earlier, Table 3.2 shows the significant difference in the number of descriptors per piece.

	Birdfish	Element Yon
Piece Duration	4'40"	3'45"
Total Number of RTD	334	170
Average Number of RTD per Minute	6.05	3.77

Table 3.2: Real-time descriptor (RTD) numbers for Birdfish *and* Element Yon

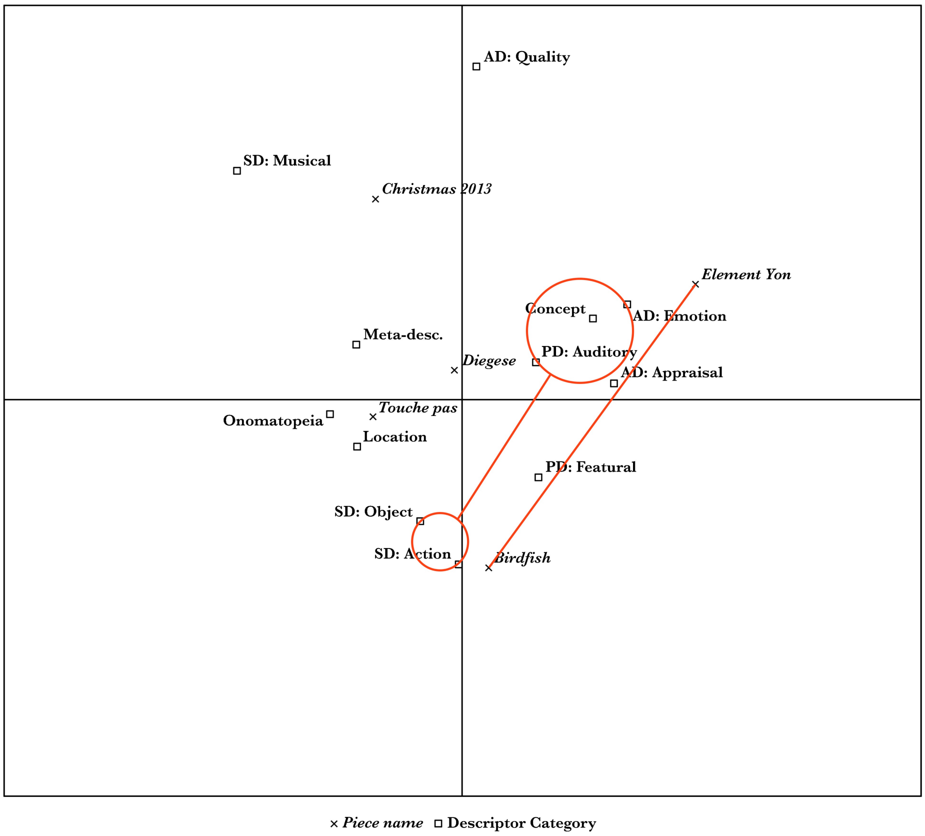
Looking at Graph 3.1, the most salient descriptor category for *Birdfish* is observed to be *object source descriptors* (SD: Object), covering 33.83% of all submissions. When weighted with *action* and *musical source descriptors*, the representational sound world of *Birdfish* appears to have instigated a dominance of source descriptors accounting for 55.96% of all descriptors. For *Element Yon*, *concept descriptors*, which represent 28.64% of all entries submitted for this piece, were the most common. Given the abstract content of this piece, this result conforms to prior expectations. Graph 3.2 revisits the correspondence analysis from the previous chapter with the regions relevant to these two pieces highlighted.



Graph 3.1: Categorical Distributions for Birdfish *and* Element Yon

Another significant difference between the two is observable in the *auditory descriptors* category (8.45% for *Birdfish* versus 17.18% for *Element Yon*). With *Element Yon,* listeners were much more inclined to describe those perceptual characteristics of sound which pertain to frequency spectrum and dynamics. This is in agreement with the results of previous experimental studies which described that in the absence of source identification more abstract conceptualizations of sounds grounded in physical attributes emerge.

Categories of lesser salience also reveal insights when reviewed comparatively. Given that the two pieces were designed with similar spatial characteristics, the relative difference in the percentages of location descriptors, (6.96% for *Birdfish* and 3.12% for *Element Yon*) can be explained by contextual evaluation of spatial cues. While spatial components in *Birdfish* were marked with *location* and *action descriptors* such as “cave”, “dungeon”, “underwater”, “flying” and “running”, such components in *Element Yon* were referred to with *concept*, *auditory* and *meta-descriptors* such as “surrounded”, “panning”, “stereo” and “reverb”.



Graph 3.2: Correspondence analysis highlighting Birdfish *and* Element Yon

Furthermore, *Element Yon* produced a notably higher percentage of *affective descriptors* (AD) with *emotion descriptors* as the most salient subcategory (18.75% for *Element Yon* and 6.95% for *Birdfish*). This can be explained by the dominance of representational imagery in *Birdfish*, so that the spontaneous responses related more to the descriptions of objects and actions. With *Element Yon* on the other hand, the participants, besides having *less* to say as evidenced in Table 3.2, were more inclined to reflect about their affective experience. These results suggest that, despite the syntactical congruences across these pieces, the sheer difference in how the source materials were perceived mediated the appraisal of the works.

General impressions submitted by the participants who listened to *Element Yon* were mostly concerned with the physical characteristics of sounds such as spectral characteristics, concepts such as “flow”, “hollowness”, “contrast” and “heaviness”, and affective appraisals such as “exciting”, “curious”, “calm” and “annoyed”. Impressions relating to objects or environments were also highly conceptual, such as “big magnets”, “gravity”, “circus-like”, “a dark metro station”. One participant expressed that “no images came to [her] mind”. In Chapter 5, I will further interpret such general impressions in relation to the *awareness of the physical self*. The general impressions of *Birdfish* were either in the form of word or sentence lists enumerating imagined sound sources, or visually-oriented narratives that recounted a story involving sound sources. One participant sketched the drawing seen in Figure 3.1 as his general impression of this piece.

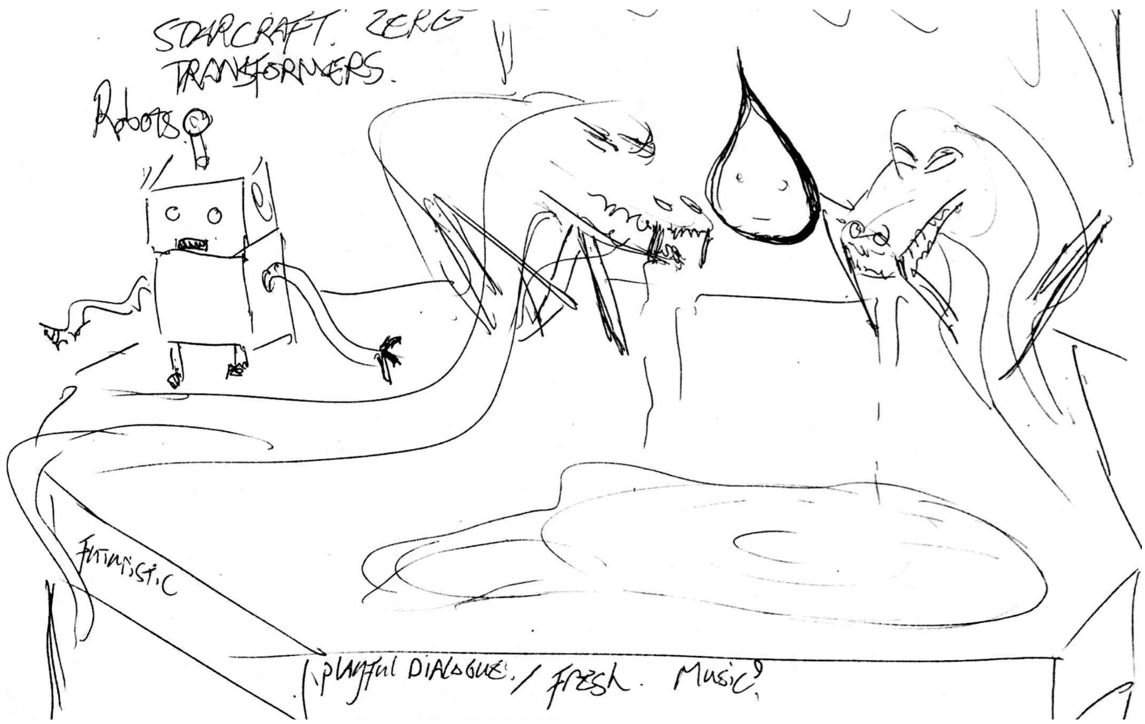


Figure 3.1: A participant's general impression of Birdfish *in the form of a drawing*

As may be observed from the data collected with only these two works, electronic music can induce a variety of experiences from representational to abstract, conceptual to perceptual and semantic to affective. In the beginning of this section, I noted that although the current discourse might appear to impose a dichotomy between instrumental and electronic musics, the ultimate point to be made would be that the language of electronic music does not replace that of instrumental music, but rather expands it. This sentiment, which I have characterized above as an amalgamation of musical languages, is probably best expressed by the pioneering composer of electronic music Edgard Varèse:

> My fight for the liberation of sound and for my right to make music with any sound and all sounds has sometimes been construed as a desire to disparage and even to discard the great music of the past. But that is where my roots are. No matter how original, how different a composer may seem, he has only grafted a little bit of himself on the old plant. But this should be allowed to do without being accused of wanting to kill the plant. He only wants to produce a new flower. It does not matter if at first it seems to some people more like a cactus than a rose. (Varèse and Wen-chung 1966: 14)