Music perception of avant garde: Musical structure and time

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Abstract: The practice of new music composition and the education in the Darmstadt courses have served as a model for the development of new music, attempted to create anational style of music to which no false meaning could possibly be attached. Karlheinz Stockhausen, György Ligeti and Iannis Xenakis – for instance – found a new way to think and work in their music to organize a musical structures. Intuition is necessary in the musical creation, but it is not the base for artistic freedom or creative innovation. Therefore, a wide range of different compositional strategies can be inspired by modern tools of scientific areas or directed solely intuitive approach. Avant-garde composers have used the mathematical and symbolic pre-compositional principles, which were the starting point and the foundation of the created musical structures. These musical structures are often not the same as the listener experiences. This article aims to examine selected compositional strategies manifested in speeches and writings of composers and their creative exemplifications of selected works, and finally, the reference of these findings to the conditions of music perception. Application strategies based on modern scientific tools and/or intuition isn't mutually exclusive. Achievements in the various areas of science - mathematics, psychoacoustics and cognitive psychology, based on the role of expectations in the perception - are used in comparative considerations. Comparisons and observations should show whether and how the strategies of composers affect the perception of music.

The musical avant-garde since 1950 is often considered to be representative of heterogeneous currents built around the ideas of innovation. Darmstadt New Music Summer School – from late 1950s/early 1960s called Darmstadt School – has stereotypically been linked with serialism and/or strict formalism. This led to the use of the phrase Darmstadt School as a pejorative term, implying rule-based music. But recent research supports more diverse understanding of the Darmstadt avant-garde. The practice of new music composition and the education in the Darmstadt courses have served as a model for the development of new music, attempted to create anational style of music to which no false meaning could possibly be attached.
Among the many distinguished lecturers to have appeared are Karlheinz Stockhausen ('father of the Darmstadt School'), György Ligeti ('second generation' of Darmstadt composers) and Iannis Xenakis (invited to Darmstadt only in 1972). The extensive theoretical writings and musical works each of them indicate a wide range of different compositional strategies. They found a new way to think and work on their music to organize a musical structures.

Composers' approaches

As indicates David Huron, in opinion of many composers, 'it is intuition rather than knowledge that provides the foundation for artistic creation' (Huron 2006, ix). Intuition is necessary in the musical creation, but it is not the base for artistic freedom or creative innovation. Most composers uses knowledge of the predecessors about the techniques. A wide range of different compositional strategies can be inspired by modern tools of scientific areas or directed solely intuitive approach. This does not mean, however, that both approaches are mutually exclusive. The difference relies on the importance and the place of intuition in the compositional strategies, and also in the type of knowledge which the composer uses. On this basis, and through intuition, they create musical structures. The vision of the sound of the musical structures that arise during composing takes shape in the imagination of the composer. Other composers, guided by intuition, are looking for new tools borrowed from

scientific areas. In this case, the role of intuition is limited to the selection of specific tools and procedures, and after their use, it is formed the image of musical structures.

Karlheinz Stockhausen

Throughout his career Stockhausen has dealt with the most diverse musical problems by the most varied methods. A characteristic which he has never ceased placing at the center of his thought and works, it was the quest for a new balance founded upon an acute connection between speculation and intuition. Among other things the composer explained many important ideas. Stockhausen said:

"Use all the components of any given number of elements, don't leave out individual elements, use them all with equal importance and try to find an equidistant scale so that certain steps are no larger than others. It's a spiritual and democratic attitude toward the world."(Cott 1973, 101)

The specificity of the relation to serial technique relies on the pointillistic conception of writing. The individual note was taken as the largest unit to be shaped. The high degree of change from note to note stood in the way of the formation of sensory units. Therefore the predominant characteristics of a group of notes were fixed with the aid of series. By incorporating silence he constituted an empty space between two sound events characterized by a specific sound profile. *Gruppenkomposition* stressed the acoustical quality of fragmented serial complexes. The isolated sounds moved about according to combinatorial rules. Stockhausen laid out the theoretical basis for the confluence of serial thought and a crucial domain in his experiment: time. He explained all musical parameters – proportions of duration, aspects of rhythm, as well as pitch, timbre, and dynamics – as *Zeitproportionen.*

Music consists of order-relationships in time; this presupposes that one has a conception of such time. We hear alterations in an acoustic field: silence-sound-silence, or sound-sound; and between the alterations we can distinguish time-intervals of varying magnitude. These time-intervals may be called *phases…*
Our sense-perception divides acoustically-perceptible phases into two groups; we speak of *duration* and *pitches* (Stockhausen 1959, 10)

So, duration and pitch are essentially related to each other. They only belong to two different "temporal realms" – *Zeithereiche.* All of the musical domains – pitches, durations, timbres – fall solely under the domain of time: the difference between them is not one of nature, but only of degree, of speed of vibration and of acoustic spectra.

The another artistic goal was the transition from serial composition to composition with *formulas.*

The formula is more than a leitmotif or a psychological profile, more than a theme that can be developed further or a generative series: the FORMULA is the matrix and plan of the micro- and macro-form, while, at the same time, it is the psychic shape and the image of the vibrations of a supra-mental manifestation (Stockhausen 1989, 667)

A formula's profile incorporates several parameters, one could say that it embraces different segments, comparable to the different limbs of the human body. The initial formulas contain all the properties of the work which they generate, and also their superposition and their summation. In the domain of formula composition, fidelity to serial thought is unchanged, but the main principle is pluridirectionality (with groups of central notes). The formula is a melodic-rhythmic structure from which the principal characteristics of the work are derived. It has to be simple enough to be singable, and sufficiently rich in internal relationships to generate coherent and musically interesting larger structures. Each of the work's levels of organization must be an expansion of the formula – the expansion of two autonomous types; simple (development) and complex (imbrication).

György Ligeti

Ligeti was almost totally ignorant of recent developments in style and technique.

In my music, one finds neither that which one might call the 'scientific' nor the 'mathematical'; but rather a unification of construction with poetic, emotional imagination (Ligeti 1988, 4)

His aural imagination was extraordinarily acute, displaying a unique attention to the smallest detail, the structures always maintaining a wonderful luminosity, however complex or intricate.

If I identify the dream described above as the foundation for some of my composition, I do not mean that it serves as their "content." Nothing could be further from my intention than to create illustrative or wholly programmatic art. The content of the dream was many times transformed, layered over with other ideas and compositional processes, and was manifested in the end only in certain formal/technical aspects as well as in the general character of the corresponding work (Ligeti 1993, 165)

He never believed that music could be explained and structured in a pseudo-mathematical way. Ligeti used techniques, but he forgot them after writing and he had no overall scheme or permanent procedures.

I detest both absolute geometrical precision and total openness. I want a certain order, but an order slightly disorganized … I love irregularities. My artistic credo is, truly: I want to be free, individualistic, do as I please, and I refuse to subject myself to a certain rule. But I cannot compose without a set of rules adequate to the idea. Music comes first: *prima la musica, dopo la regola* (Michel 1985, 180)

But his openness to influences exposes Ligeti's penchant for symmetrical constructions and his fondness of formal proportional relationships, and of his use of the golden section at the formal level. Ligeti thought of form as a process of temporal transformation, while shunning developmental, hierarchical formal models. The main types of form which he has identified were the "balanced, or static form"; the "dynamic, restless, fragmented forms" (also called "interlocked" or "split"); the forms "like a precision mechanism"; and the "kaleidoscopic" type, made up of "separate and contrasted musical shapes" (Ligeti 1983, 134-135). One of the most striking general features of Ligeti's descriptions of his music, which he has displayed both in his articles and in his interviews, is his frequent recourse to his conception about the form-creating interval signals and about his net-structure micropolyphony. Ligeti has introduced distinctive harmonic processes based on intervallic units and their constant transformation. The harmonic crystallization inside the sonorities results from linear (canonic or contrapuntal) procedures. The harmonic 'constellations of pitches' are superimposed on one another, and are constantly and gradually transformed, one note at a time, by means of stepwise voice-leading. As Ligeti has stated about the intervals that make up the signals

are divided by blurred areas, so that you hear an interval [or signal] that gets gradually blurred and in the ensuing mist another interval appears, it becomes clearer and clearer until the surrounding mist completely clears and you hear the new interval [or signal] all by itself …. 'Mistiness' usually means a contrapuntal texture, a micropolyphonic cobweb technique; the perfect interval appears in the texture first as a hint and then gradually becomes the dominant feature (Ligeti 1983, 60)

Generally speaking, the net-structure is the effect of Ligeti's observations that "composition consists principally of injecting a system of links into naïve musical ideas" in order to create a "musically consistent and linked network" (Ligeti 1983, 124). The net-structures (*Netzstrukturen*) can be based on chromatic fluctuation of microstructures, on expansion and contraction of intervallic constellations, and also they can be generated by constant chromatic transformation of triadic units or built on complex overlapping rhythmic relationships. In the compositions based on the net-structures the harmonic, intervallic, and rhythmic metamorphoses become the main structural functions of the form-generating textures. He has also introduced the other term "net-formations" (*Netzgebilden*) – micropolyphonic webs – with no distinctive harmonic processes, as opposed to the harmonic net-structures. Finally, Ligeti

frequently has employed the term "meccanico", but "meccanico" and net-structure passages differ in texture, sound, harmonic processes and designs.

Iannis Xenakis

The need for structural universalism and abstraction led Xenakis to the use of scientific concepts and tools. But he said:

> Scientific thought is only a means with which to realize my ideas, which are not of scientific origin. These ideas are born of intuition, some kind of vision (Varga 1996, 47)

In Xenakis's music the probability/stochastic laws form the macrostructure and the distribution of notes. Other factors, such as – for example - mathematical set theory and the arborescence method, or sieve theory are joined with golden proportion to determine the actual deployment of notes, the occurrence of phrases, and durations. Xenakis expressed himself as "a user of mathematics" (Bourgeois 1969, 34). In his historical book, he noted that:

> It is not so much the inevitable use of mathematics that characterizes the attitude of these experiments, as the overriding need to consider sound and music as a vast potential reservoir in which a knowledge of the laws of thought and the structured creations of thought may find a completely new medium of materialization, i.e., of communication (Xenakis 1992, ix).

According to Xenakis, the compositional process is subdivided into three stages, which he related to mathematical practice: the outside-time algebra refers to elements that decided without consideration of sequence, temporal algebra to sequential organization of elements excluding actual events, and in-time algebra to the application of outside-time elements to temporal sequence. From the structure to the distribution of notes in the structure, the probability laws are the primary determinant for making decision. The probability of a certain outcome ranges from zero to one; zero when an expected result does not happen at all, and one when the performance brings about the expected result.

> In 1954, I introduced probability theory and calculus in musical composition in order to control sound masses both in their invention and in their evolution. This inaugurated an entirely new path in music, more global than polyphony, serialism or, in general, "discrete" music […] But the laws of probability that I use are often nested and vary with time which creates a stochastic dynamics which is aesthetically interesting (Xenakis 1992, 255-256)

Stochastic composition treats the various aspects of musical sound (pitch, time point, dynamic level, and timbre) separately and uses probability distributions to organize them. After the different aspects are manipulated individually, the results are reintegrated in order to form a musical texture. By choosing an appropriate distribution for each aspect, it is possible to generate randomly chosen intervals that may be used compositionally. Whereas "stochastic music" relies on indeterminism, group structures organize predetermined elements according to specific order. In Xenakis's music, the theory of groups serves mainly to structure sets of permutated elements, which could be pitches, durations, ways of playing, registers, etc. The structural level and pitch constructions were fashioned with the aid of the mathematical set theory, Boolean algebra (Benson 2006). Some parallel algebraic properties of the Boolean operations expanded Xenakis's theory from set to group structure, as in mathematics. Elements of each set are applicable to the four properties, and therefore a set has a group structure: closed binary rules, associative property, identity/neutral element and an inverse. With his "sieve theory" – the ultimate derivation of his personal use of group theory – Xenakis tried to achieve the structural universalism. For the composer, "sieve theory" enables one to reconstruct all existing scales to invent new ones. This theory is essentially a method of creating a series of pitches or rhythms through the application of a formula, which acts as sort of filter, creating symmetrical structures.

In music, the question of symmetries (spatial identities) or of periodicities (identities in time) plays a fundamental role at all levels: from a sample in sound synthesis by computers, to the architecture of a piece. It is thus necessary to formulate a theory permitting the construction of symmetries which are as complex as one might want, and inversely, to retrieve from a given series of events or objects in space or time the symmetries that constitute the series. We shall call these series "sieves" (Xenakis 1992, 268)

Should also be noted that, Xenakis has introduced the idea of arborescence, to create a compositional method related to causality, repetition and consequent variation and to keep the music from losing continuity. He has believed that any given curvy line may reproduce itself so it becomes a bush or a tree shape [arborescence], and the tree or bush shape is placed on pitch versus time space. The initial arborescence might be transformed, through rotation (for example, the rotation can be made at any angle), inversion, retrograde, or their combination, in music (Varga 1996, 88-89).

Some examples of the implementation

The following are examples of the ways in which the creative ideas were used by the composers in their music.

Karlheinz Stockhausen

About his *Kontra-Punkte* (1952-53) for 10 instruments Stockhausen wrote:

The work is in one movement. Six different timbres are employed: flute-bassoon, clarinet-bass clarinet, trumpet-trombone, piano, harp, violin-violoncello (three characteristically differing types of wind instrument, in pairs, and three types of stringed instrument with struck, plucked, and bowed strings respectively). These six timbres are resolved into one, that of the piano (struck strings). One by one the trumpet, trombone, bassoon, violin, bass clarinet, harp, cello, and flute drop out. Six different loudness levels (ppp-sfz) likewise reduce one by one to pp. Great differences between very short and long durations are gradually eliminated, leaving closely related middle values (semiquaver, triplet semiquaver, dotted semiquaver, quint semiquaver, etc.). Out of the opposition between vertical and horizontal tone-relationships emerges a two-voice, monochrome counterpoint (Stockhausen 1964, 20-21)

This piece represents a transformation of "punctual" material into "groups", a transition from an abstract, conceptual order that is essentially static, to an audibly organized dynamic continuum. One can discern sections of more or less dissociated "points" alternate with sections of a more assertive melodic counterpoint. They are defined by variations in tempo, a fundamental pulsation of MM=120, with which the more cohesive elements of the music are associated, alternating with six other tempi, which together make up an incomplete tempo scale. Stockhausen has applied bar-unit of dotted crotchet, suited to serial compositions, suggesting the possibility of subdivision from one to one-twelfth of a bar. In the piece one can find the serial relationships of pitch, metre, and duration.

In *Gruppen* (1955-57) for three orchestras space and time stand together in the structural constitution of the piece as musical dimensions in an unbroken, palpable continuum. A synchronous realization of up to three different temporal layers running at different speeds is enabling by three nearly equally scored orchestras, which are placed around the audience. As Stockhausen explained:

Each sound-source is now in a position to let its own time-space be experienced, and the listener finds himself in the midst of several time-spaces which in turn create a new, common time-space (Stockhausen 1964, 71)

Almost all elements of the serial method of organization are in a coherent relationship to the time structure. A twelve-section duration series are characterized by the same properties as

the twelve semitones of the chromatic scale. This is the starting point and the foundation of the entire serial process of organization. *Gruppen* consists of a groups of sounds, noises and sound-noises which are completely independent units and each of them moves within its temporal space. There are short, characteristic figures whose constant recurrence forms a bond between the musical passages. Because of the irregular rhythms and the lack of a stable basic tempo, one can not indicate consistent pulse throughout the work. The spatial separation of the groups results from the superimposition of several time layers having different tempi. This distribution of the groups facilitates the great freedom in the way the groups interact with each other. Consequently, the groups can follow each other, overlap with each other, accumulate above each other. Stockhausen emphasized, that they can absorb each other, play with or obliterate each other, repulse or cling to each other, or merge. The specific rhythm/tempo-related structure determines the tension, which, in turn, enhances the bond between the musical passages. Tempo and counting value, rhythmic make-up, length, density, pitch range, and direction of movement are fixed for each individual group. The timbral species of the individual groups are organized in according to four different criteria: mixed, mixed and long sustained tones, monochrome, and alternating monochrome. Finally, all the groups (174) are used by the composer in four large sections of the piece, which, in turn, are divided into thirteen subsections. In *Gruppen* there are also the three "inserts," which are independent of serial predetermination.

Inori (1973-74), a work for one or two soloists (mime-dancers) and orchestra, is based on the conception of formula. In introduction to the score of the piece one can read:

> The ur-gestalt – the formula – of INORI is, at the same time, the form scheme of the large form," and, "all measurements and relationships in the large form are a projection of the ur-gestalt (Stockhausen 1983, xx)

The whole piece evolves from the formula, which in its original form lasts about one minute and is divided into five segments. Its projection encompasses a little over an hour of music. Within the *Inori* formula are thirteen different pitches - besides two pitches which are repeated at the end - and each of them has got its own tempo, a specific intensity, a sound color, and a prayer gesture. The dancer-mime performs gestures of prayer synchronous with the music of the orchestra. The formula not only constitutes a melodic form on a small scale, it also provides the musical parameters for the large scale form of the entire work. One of the main feature of the piece is the presence of an organic process of growing, with the formula driving this process, although *Inori* consists of five parts. The process of unfolding is a single one from beginning to end, and there are no pauses between sections. Each of the five parts develops specific element of musical work (rhythm, intensity, melody, harmony, and polyphony). Each measure of the formula corresponds to one or two subdivisions of the "large form", thus yielding twenty-one subdivisions. The composer has also fixed the principle of the proportion. This means, that one quarter note of the formula equals one minute of the "large form." But this calculated duration is exceeded by about ten minutes as a result of the ritardandos, the fermatas, and the unmeasured parts which also appear in *Inori* course.

György Ligeti

Apparitions (1958-59) for orchestra, as Ligeti has explained, one can treat as an example "of the process of transformation to which the web was subjected" (Ligeti 1993, 165). The piece was composed by chromatically filled spaces of maximized density. Consequently, the individual intervals within the sonic structures lost their identity. The transformations pass from one sound group to the next. As the composer suggested:

The states are broken up by suddenly emerging events and are transformed under their influence, and vice versa: the altered states also have a certain effect upon the type of events, for these must be of over new character, in order to be able further to transform the transformed state. In this way arises an unceasing development: states and events, once they have occurred, reciprocally exclude their repetition, thus are irretrievable (Ligeti 1967, 169)

Ligeti's own remarks about *Apparitions* have indicated two types of musical material. First, something between sound and noise, consists of several voices stratified and interwoven in semitones. Many resultant complexes "vary in quality according to their registral placement, the type and density of their interweaving, and the nature of their constituent, individual voices" (Ligeti 1993, 165). Second type consists of fixed groups of sounds which "populate the noise-labyrinth" arising from the first type. All used intervals have been employed to indirect or oblique statement, successive lower or upper boundaries of clusters, or space between clusters or composite space filled chromatically, simultaneous statement filled chromatically, incorporation as segment into larger cluster.

Ligeti's *Atmosphères* (1961) for orchestra is described as his *klangfarben* piece. *Atmosphères* and *Apparitions* have got many common features deriving from "micropolyphony" idea. Nevertheless *Atmosphères* also differs considerably at both the local and global levels. In the piece the idea of a *repertory* – of durations or intervals – has been discarded. Ligeti also stressed that, "modification of timbre and dynamics are obviously very significant but the patterns emerging from them are even more important" (Ligeti 1983, 39). This composition itself characterizes the absorption of individual shapes into static planes and total elimination of rhythm. In *Atmosphères* one can find the various static planes and movements from one plane to the next. A main feature of this piece and also further works is the organization of volumes of sound of varying density. Consequently, Ligeti has used schemas based upon vertical span and symmetrical considerations.

In *Ramifications* (1968-69) for string orchestra or twelve solo strings players Ligeti linked the pattern-meccanico techniques and microcanon. The small and large-scale structures result from the repetitive patterns. The distinctive feature of the piece is the division of orchestra into two groups tuned a quarter tone apart, however sometimes the first of groups sounds around a quarter tone lower than the second (the case when the canonic patterns of the first group are notated a semitone lower than those of the second), but other times the first of groups sounds a quarter tone higher than the second one (the both groups are notated the same). The number of repetitions of a pattern before a pattern shift and the brief durations assigned the pitches vary from instrument to instrument. The patterns (repeated small melodic fragments) are partitioned by changes of range or directions. They consist of segments that look like fragments of "scales" or like arpeggiations of chords. The melodic lines consisting of these patterns are differentiated from each other by contrasting instrumentals timbres. In the pattern-meccanico composition, scalar patterns function as creators of compound melody, with stepwise linear connections from each pattern to the next. Another feature of *Ramifications* is the presence of the extensive sections of pattern-canon, which encompass most of the eight-and-a-half minutes of this piece. In each of them, the individual melodic lines enter simultaneously and continue without pause to the end of the section. All lines must be independent and balanced in volume and articulation. Finally, a microcanon refers to compositions in which a melodic line is set against itself in strict canon in many voices at short time intervals to form musical structure.

These and another complex interaction of various elements at several levels of structure are the factors which create the perceptive shape of Ligeti's works.

Iannis Xenakis

The piano solo piece *Herma* (1961) is an example of "symbolic music" in which the symbolic logic is applied to pitch sets and their transformation. Xenakis has adopted as a universal pitch set, the set of all 88 keys on the standard piano keyboard. Then he selected three subsets. They are set up initially and they are subjected to follow certain mathematical functions (Benson 2006). There are set algebraic operations (i.e., intersection, union, complementation), relationships between sets (e.g., equality), and rules of logic (e.g., implication). Boolean algebra was used to set up outside-time materials and inside-time elements. But the temporal element set of the piece was not derived by way of set theory for this theory is totally non-temporal. In *Herma,* a pitch set is articulated in-time as a sequence of pitch drawn from the set. Individual pitches are drawn at random without registral preference and each of them is associated with an attack randomly placed in time. As Xenakis indicated, "The whole piece is to be played without accents, the bar-lines serving merely as division in time" (Xenakis 1967, preface). The stochastic procedures is introduced to avoid melodic or harmonic pattern. The sets of pitch for the piece follow the two equation as given on the last page of the score. The basic formal plan of *Herma* is based on distribution of the sets on two planes and each plane represents the above-mentioned equation and is subdivided into two distinctive dynamic levels.

In *Evryali* from 1973 the first time Xenakis used the arborescence method. This piece consists of up to eight individual voices that often reach the highest and lowest register of the piano keyboard. They are spread in four staves at times, based on their polyphonic voice leading rather than their chordal motions. In *Evryali* one can discern four significantly different materials: arborescence, wave, block, scattered sound and silence. The concept of arborescence was introduced to composition for the purpose of creating continuity from the moment of conception. Some sections of *Evryali* include longer, denser and more complicated arborescence, and others include shorter and simpler ones. While the waves occur when all voices move in the same directions. There are also only static chords, stopping the flowing motion of arborescences or waves abruptly. Blocks are created both from chords that are comprised of voices with irregular and omission notes and of chords that are fixed in terms of notes but change rhythm. Scattered sound are the phrases which are fairly short or where the individual voices and overall texture do not form specific one of the above. And finally, silence designates obvious long pauses, indicated as "silence" by Xenakis with their durations in seconds. One have to note, that this piece combines the arborescence method with percussive rhythmic patterns. The rhythmic value is mostly sixteenth and, when other value are used together, they keep 1:2 ratios throughout (for example quarter notes to eight notes).

Mists (1980), also for the piano solo, is based on a scale that Xenakis created specifically for this work. The full length of the scale is two semitones larger than the range of the instrument. It means, that only twenty-nine of the scale's thirty pitches appeared in the published score. Therefore, most of the pitch material in the piece is an imperfect realization of the scale originally conceived by Xenakis. As Squibbs has indicated, the discrepancy may be linked with theory of sives. Consequently, scales of any length, based on units of any size, may be constructed by performing standard set-theoretic operations on interval cycles (Squibbs 2002, 92). In *Mists* the composer has used cycles of two, five, and nine semitones. The full length of the scale is equivalent to the lowest common multiple of its constituent interval cycles. In this case ninety is the period of this scale. Moreover, Xenakis has used additional scales, also based on sieve theory. They were derived by cyclic transposition. The scales may be fully or partially and in ordered successions – ascending or descending "stepwise" motion – or in unordered, randomized successions presented. These differences in presentation determine whether the scales constitute a feature of the musical surface or whether they serve as a basis for harmony of a given passage of music.

The mathematical and symbolic pre-compositional principles do not seem immediately related to music. But, they are basis for intellectual construction of these pieces and indicate inevitable associations with music.

Cognitive implications

In contact between the musical work and the "universal listener", knowledge of the work concerns solely forms of cognition, which are, in turn, conditioned by the particular structure of our minds, since a mental representation of a musical work is the result of the action of the nervous system, in particular the brain, of which the mind is a function. Music is a highly complex cognitive object, in which perception is possible thanks to the isolation and organizing of data provided by the sensory system. Moreover, listener's expectation appears to shape many aspects of musical organization. In opinion of Huron:

> The capacity to form expectations relies on the brain's ability to create mental structures that emulate environmental structures […] Expectations are automatic, ubiquitous, and (mostly) unconscious. We cannot turn off the mind's tendency to anticipate events and we are usually unaware of the mind's disposition to make predictions. Expect when we are surprised, or when the outcomes are important, we may not be cognizant of the specific predictions our minds make (Huron 2006, 358)

The importance of expectation while perceiving music is that, "accurate expectations improve perception by anticipating the *what, when,* and *where* of likely stimuli" (Huron 2006, 357). However avant-garde composers have used the mathematical and symbolic pre-compositional principles, which were the starting point and the foundation of the created musical structures. These musical structures are often not the same as the listener experiences. One can find many of structures and structural devices in music. They range in scale from the minuscule to the monumental. In a studies of music one can frequently to talk about function, origin, or purpose of structures. Nevertheless, there isn't a one-to-one relationship between the physical sound and the mental experience of music, and also, between the notated structure and the experienced structure, or, between musical structure and function. Exploring music of Western common-practice - mainly - Temperlay (2001, 292) has assumed that if certain mental representations - preference rule systems, which are models of the perception of music - are present in the minds of listeners, it is likely that they are also present in the minds of composers. Not all the structures evident in music can be related to, for instance, perceptual goals, especially in the avant-garde music. The mental mechanisms involved in musical expectations on the one hand are linked to biological adaptation (are innate), on the other hand are linked to culture context (are acquired, learned).

Research into the perceptual phenomenon in listening and certain constant relations have led to the formulation of many principles and concepts. Albert Bregman (Bregman, 1990) has developed a theory in which he suggests that these principles are heuristics or best guesses that listeners employ in parsing or marking sense of their auditory environment. He refers to the processes whereby listeners make sense of the world of sounds as Auditory Scene Analysis, a non-conscious process of guessing about "what's making the mental representation of experienced music", but guessing in a way that fits consistently with the facts of the musical world. In *Ramifications* music scene analysis – in the sense of perceptual sound organization - refers to recognition of one or more independent streams, perception dynamic progressions, transformation the seemingly amorphous "mechanical" sequences into a new structure. But an auditory stream can be thought as a cluster of acoustical energy formed in our auditory processes. A perceptual sound is a symbol which corresponds to an acoustic entity and its essential property is its hierarchical structure.

Expectations are the result of a process of induction, in which generalizations are formed from a finite number of specific experiences. However, inductive inference is known to be fallible. Also therefore, the principles underlying musical expectations are likely to be imperfect approximations of the actual principles that shape the music. As one can see from a broad

sample of melodies, several simple principles appear to underlie the objective organization of certain types of music. In the realm of melody, there are principles, such as – for instance - the tendency for successive pitches to be relatively close, or melodic phrases in Western music tend to exhibit an arch-shaped contour. Nevertheless, experienced listener, who uses of learned schemas, doesn't always appear to form an appropriate expectations. Consequently, he really forms expectation for pitch proximity, but, in turn, he expects 'post-skip reversal' – an approximation of melodic regression to the mean, or, for example, 'late phrase-declination' – the tendency for pitches to descend in the latter half of phrases (Aarden 2003). In *Herma* – for instance – sieves are constructed with the aid of standard set-algebraic operations applied to pitch sets, but these primitive sets display definite regularities. Thus the products of these operations can be made more easily apprehensible and discriminable to listeners. But in the piece one can observe contradiction between the technical approach of Xenakis and musical structure. Conception of *Herma* - as a temporal blackboard upon which is inscribed a set-theoretic argument demonstrating the equivalence of two different expressions for the target set - is impenetrable to the listener. Even experienced listener cannot grasp large, harmonically amorphous pitch set which are subjected to merely stochastic expositions.

Listeners use also inductive strategy to expect the most frequent past event (statistical learning). As Huron has noted, "The simple frequency of isolated events ("zeroth-order probability") appears to provide the foundation for unconsciously learned expectations" (Huron 2006, 360). However, in measuring the perceived uncertainty or complexity of musical structures, there is no reason to assume that the probability distribution in the listener's mind is identical to the actual distribution in the structures. In *Gruppen* the distribution of groups in the work and their distribution in the listener's mind aren't the same, because of the most complex compositional principles. Entropy indicates the complexity of a structures as an isolated, self-contained system; but this is not of much relevance to perception, unless it can be argued that the structures truly represents the musical experience of the listener (Temperley 2007). Listener learn the contextual or contingent probabilities of neighboring or co-occurring events. Contingent probabilities can be influenced by the number of prior events that combine to influence a particular ensuing event. 'Pointillistc' athematic serial music of *Kontra-Punkte* is not a perceptual problem for the listener. The contextual and contingent probabilities, just here, are being the foundations of perceptual organization. The most straightforward way of creating predictable events is to follow existing musical conventions, but the avant-garde music, in general, is slightly difficult to predict, because it isn't based on traditional scales, meters, timbres, harmonies, genres, or styles.

In a process of music perception, one can observe that there is tendency to prefer frequently occurring events, although this preference is a result of predictability rather than frequency. Therefore, for instance, once a metrical context is established, listener tend to experience events that occur at the most expected moments to be more pleasant. Moreover, in music, using repeated figures, ostinatos, motives, themes, and rhythmic patterns will increase the likelihood of predictive success for listener. But events can be more predictable within works by creating musical structures that are similar. In contrast to repetition, similarity allows to introduce elements of novelty. Variation techniques such as the ground bass, the sequence, modal and tonal transposition, reharmonization, dynamic contrast, and other techniques can preserve dynamic predictability. For example, from the beginning of *Atmosphères,* reduction in density, taking place as it does against a backdrop of chromatically filled space in the strings, cases the winds almost to disappear, as if their plane had merged with that of the strings. Subsequently, all previous structures are superseded, and then, one can noted the succession of dynamic emergences that creates the symmetrical design. Finally, despite the time lag between entrances of parts enforced by the canonic plan, one can perceive the general outline that emerges as a resultant of the canon. Moreover, the internal details are slightly askew, but the external dimensions stand out clearly. In the case of highly predictable structures, listener can reduce his attention and his arousal. Contrary, more energetic sounds can evoke increase

arousal. While listening to the avant-garde music, one can experience a surprise. Surprise might involve unexpected pitches, chords, chord progressions, event timing (such as syncopations), sonorities (such as suspensions), dynamics, and other.

In turn, one cannot forget that a memory is very important in perception of all kinds of music. A memory influences four type of expectations. As Huron states:

> Schematic expectations represent generalizations learned from a lifetime of exposure. Veridical expectations represent invariant sequences learned from frequent exposure to a particular stimulus. Dynamic expectations arise from the immediately preceding experience. Conscious expectation arise from conscious reflection or thought (Huron 2006, 363).

Consequently, for instance, motives are veridically coded whereas figures are coded schematically or dynamically. Principal feature of *Inori* is reconciling the progress of a discourse with a logic of perception, while permitting the free unfolding of models which have resulted from the formula. In such case memory must recompose the events in a constant dialectic between stringing together and interlocking. Long silences between each new stage allow the memory each time to reconsider the immediately preceding experience and to make its synthesis with the work from the very outset. Consequently, the density of information considerably increases from one part to the next without perception ever being disoriented. Apart from the different types of memory, divergent predictions might also arise from different mental representations. It is a result that listeners may differ in the accuracy of their predictive heuristics.

Contrast is also a huge influence on music perception. One can induce it by various means. For *Evryali,* awareness of each polyphonic line is crucial. Perception of one voice thoroughly and then another, and eventually adding one voice on top of another is important, for Xenakis's polyphonic texture isn't pianistically considered but mathematically built. The repeated notes within blocked chords in the piece also don't have regular organization that could be perceived by musical intuition but are mathematically constructed. The delaying of an expected event has the effect of extending the period of tension. This can be achieved through simple pauses, using slower tempos, or using a progressive slowing. When the event finally appears, the resulting contrastive valence often increases the sense of pleasure. Such extending the period of tension often is feature of the compositional technique or style. This technique tend to produce its greatest effect when the passage is highly stereotypical or cliché. In turn, repetitions lead to the prediction effect, but also can lead to (unconscious) habituation and to (conscious) boredom, while violations of expectation lead to contrastive valence, but also can lead to annoyance. If the violation is especially large, listeners are apt to experience the music as "weird". Listeners may come to expect the unexpected.

Conclusion

As Huron has noted:

> Each new style builds a distinctive schematic context that provides new opportunities for both thwarting expectations and confirming expectations. Musicians have the freedom to create new styles, but the listener's penchant for predictability restrains the speed with which new styles can be spawned. Musicians create musical culture, but not just as they please (Huron 2006, 368)

This statement is the best conclusion to the foregoing. In it lies at the heart of avant-garde music perceptual difficulties.

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