University of California
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Music Expectation

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Philosophy in Music

by

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June 2024

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This dissertation is dedicated to the memory of composer and mentor William (Bill) Brunson, and the memory of guitarist and mentor Pino Russo. With all my heart, thank you.

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ABSTRACT

Music Expectation

by

Diego Ratto

Even though it took me some time to realize it, my profound interest in the topic of music expectation began when I was initially exposed to the concept of grammar familiarity in music, particularly within experimental electronic music. This captivating notion sparked a curiosity within me, leading me on a journey of exploration and discovery. I had a profound realization about something that deeply resonated with me—the significance of familiarity for listeners exposed to non-tonal, electroacoustic, and acousmatic music. As a composer myself, I became increasingly curious about how to navigate the realm of music expectation in these genres and discover the tools that can effectively engage and captivate listeners. It became evident to me that in genres like experimental computer music, the process of familiarizing oneself, building expectations, and relishing surprises demands more time and effort from the listener compared to engaging with more conventional compositions like Western classical tonal works. This realization fueled my passion to explore and unravel the intricacies of music expectation, seeking to uncover techniques and approaches that would enhance the listener's experience and foster a deeper connection with these unique and innovative musical forms.

Since that pivotal encounter, I have been engrossed in contemplating potential solutions to facilitate the process of establishing familiarity with musical content. This inquiry has

greatly influenced my recent compositions, namely *SHOMO, MEMORIA* (acousmatic) and *No Funk Allowed* (saxophone solo). Guided by this concept, I came across Leonard Meyer's enlightening book, *Music, The Arts, and Ideas: Patterns and Prediction in Twentieth-Century Culture*, which propelled me to delve further into the notion of music expectation. Driven by this newfound knowledge, I embarked on an extensive exploration, meticulously researching a multitude of bibliographic sources related to music expectation. Through this study, I immersed myself in the subject, augmenting my understanding and awareness of its intricacies, and it became evident to me that music expectation would emerge as a pivotal element in my future compositional endeavors.

This essay serves as a culmination of my investigations into the realm of music expectation. By drawing upon theoretical frameworks and my own practical experiences as a composer, I aim to unravel the nuanced dynamics at play. Within the context of acousmatic music, I endeavor to uncover effective approaches, techniques, and strategies that nurture listeners' familiarity, anticipation, and appreciation of surprises.

I aspire to contribute to the broader understanding and appreciation of music expectation, offering valuable insights to fellow composers, performers, and listeners alike. By shedding light on this intriguing phenomenon, I hope to enrich the musical landscape, paving the way for future explorations and inspirations.

INSTRUCTIONS

The focus of this essay revolves around the intriguing subject of music expectation and surprise, examined from the unique perspective of the composer. The primary objective is to explore the development of compositional tools that can be employed within unfamiliar or less conventional musical contexts, distinct from the well-established tonal framework. By delving into this exploration, the essay aims to present an analysis of the foundational concepts of music expectation put forth by eminent scholars who have contributed to the field over the past decades, primarily within the realm of traditional Western music.

However, this research goes beyond the traditional boundaries and extends these concepts to encompass repertoire that diverges from the established tonal tradition, encompassing non-tonal and acousmatic music. This essay seeks to shed light on the adaptation and application of these essential concepts within these unique musical domains.

To illustrate and contextualize the exploration of these concepts, several compositions I have crafted in recent years will be examined. Notably, instrumental pieces such as *No Funk Allowed* will be analyzed alongside acousmatic works including *MEMORIA*, *SHOMO*, *KOM*, *Echoss*, and *Mobyrei*. By examining these compositions in relation to the concepts of music expectation, this essay aims to provide an understanding of how these ideas can be applied and utilized effectively within diverse musical landscapes.

Throughout the piece some audio excerpts will be presented with the following hyperlinked icon: ⏯.

Use the following hyperlinks to listen to the works entirely:

▶️ - SHOMO

▶️ - MEMORIA

▶️ - No Funk Allowed

▶️ - KOM

▶️ - Echoss

▶️ - Mobyrei

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To provide a comprehensive understanding of music expectation, it is essential to explore the interconnected concept of meaning. According to Morris R. Cohen, meaning arises when something is connected to or indicates something beyond itself, revealing its nature through this connection (Cohen, 1944). This notion of meaning plays a crucial role in shaping the listener's expectations and is influenced by what Cohen, George Herbert, and Leonard Meyer refer to as the "triadic relationship."

The "triadic relationship" consists of three components:

1. The stimulus.

2. The entity or concept to which the stimulus refers.

3. The individual for whom the stimulus holds meaning.

Meaning can be viewed as an extramusical factor that impacts the listener's expectations. It encompasses two distinct sub-categories: *designative meaning* and *embodied meaning*, both of which are applicable to music. Designative meaning arises when music refers to external elements, evokes associations, or stirs emotions. On the other hand, embodied meaning is specific to the context of a particular musical style. During the process of listening to music, an interplay between these two types of meanings occurs. The designative aspect of a musical piece influences our expectations regarding subsequent musical events, while the embodied meaning contextualizes the experience within a specific musical style. For instance, the same musical stimulus in a Western or Eastern music context can evoke

different embodied meanings. A skip of a third in a diatonic scale holds different proportions and connotations compared to the same skip in a pentatonic scale (Meyer, 1956, 1967). By recognizing the duality of meaning in music and understanding its influence on the listener's expectations, we gain valuable insights into the intricate dynamics of music perception and the construction of musical experiences. This exploration paves the way for a deeper appreciation of the nuanced relationships between musical elements and the broader context in which they exist.

A. Probability and Expectation

Composers, performers and listeners that are familiar with a particular musical style, develop a structure of habit responses which can be also categorized as a complex system of probabilities. Out of such internalized probabilities systems arise the expectations, the tendencies upon which musical meaning is built. It is important to distinguish between active and latent expectation, but also between the fact of probability and the awareness that an individual has of alternative probabilities. The latent expectations, which we could indicate as “passive”, correspond to the norms of behavior which are taken for granted once they have become fixed habit patterns. Such expectations become “active” when our normal patterns of behavior are disturbed (deviated) and we become aware of what has been latent until that moment.

On the concept of disturbance, Meyer identifies three typologies of deviation:

1 - The normal, probable, consequent event may be delayed.

2 - The antecedent situation may be ambiguous.

3 - There may be neither delay nor ambiguity, but the consequent event may be unexpected or improbable in the particular context.

Therefore we could say that the first two types are able to trigger our active listening expectations since the antecedent-consequent relationship takes place in a defined and particular context whereas the third case would break from the particular system in which this relationship is formed by the listener expectations.

With the antecedent-consequent relationship, the factor of uncertainty also comes into play. In music expectation, uncertainty takes place when an antecedent situation, requires an estimate of the probable consequent event. For the lower the probability of a particular consequent message, the greater the uncertainty (hence the surprise) involved in the antecedent-consequent relationship (see fig. 1).

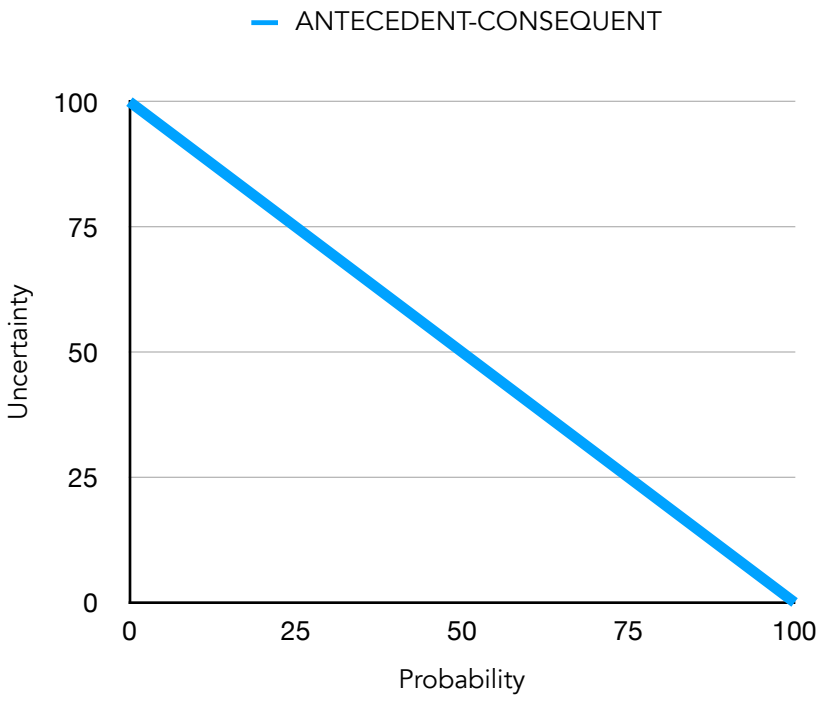

Fig. 1 - Antecedent - Consequent Graph

During the estimation process at brain level, an increase in the number of alternatives results in a necessary longer selection time (Fitts, 1953). In another way, the greater the number of decisions required of the central nervous system in a given amount of time, the slower must be the rate of information if communication is to be accurate. For example, consequently highly chromatic movements, which present the listener with a relatively large number of alternative sets of implications, require more time for the listener's brain than diatonic movements. On the other hand, when more time is given for envisioning potential outcomes, a greater number of alternatives are likely to be taken into account. As a result, in fast movements, the unexpected and irregular elements are more likely to be perceived as surprises. This can be attributed to the extended period available for listeners to mentally anticipate possible developments, allowing them to entertain a wider range of possibilities. Consequently, when an improbable or irregular event occurs within a rapid musical passage, it stands out more prominently and generates a stronger sense of surprise. The accelerated pace of the music creates a context in which deviations from expected patterns become particularly noticeable and evoke a heightened reaction from the listener. This phenomenon highlights the intricate relationship between the element of time, the cognitive process of probability assessment, and the perception of surprise in music. Therefore, considering this probabilistic approach, and the tendency of the more probable to exclude the less probable from consciousness, it is clear that the less probable becomes the unexpected, hence we interpret it as surprise.

When we hear only a single tone, a great number of different tones could follow it with equal probability. If a sequence of two tones is heard, the number of probable consequent

tones is somewhat reduced (how much depends on the tones chosen and the stylistic context). As more tones are added and consequently more relationships between tones established, the probabilities of a particular goal become increased.

> The relationships obtaining between two tones provide the listener with less basis for specific expectation than the relationships between five, six, or ten tones. Similarly, repetition or seeming repetition of a part arouses more specific expectation than the first statement of the part (Meyer 1956, p. 49).

This is the case of No Funk Allowed for sax solo. The piece begins with the reiteration of the first note[1] ⏯; given the absence of any harmonic or stylistic context, it is reasonable to assume that, for the listener, any different tone could follow the initial one with equal probability. If we consider the notes[2] in this piece as individual impulses, the first different note F (played legato) occurs after fourteen repetitions of the note E. The first F note, played with an attack, follows after an additional four tones (see fig. 2).

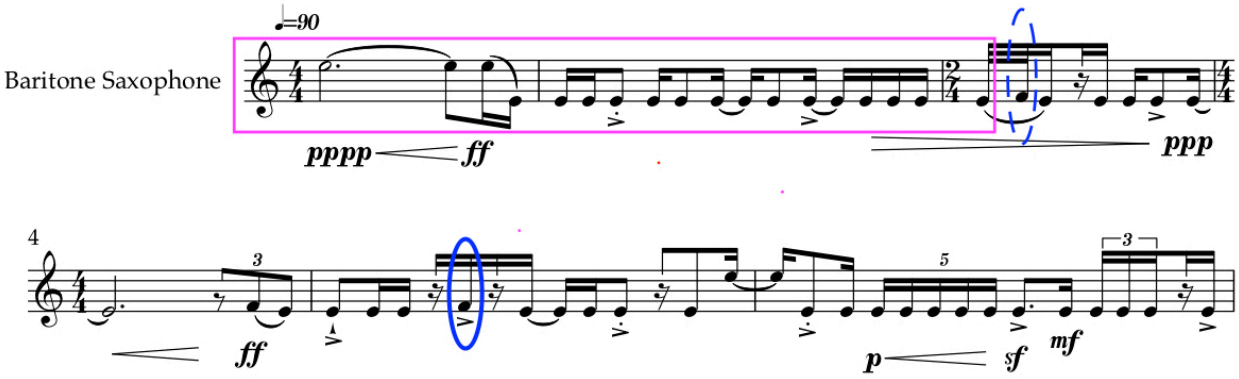

Fig. 2 - Beginning of No Funk Allowed

[1] For the purpose of this example, note is considered as absolute, regardless of the octave.

[2] In this example, a single impulse is considered when a note is played with attack. Therefore, different notes played legato are treated as one grouped legato-impulse event.

As mentioned, after introducing the first two notes, the potential range of subsequent notes is already slightly narrowed. In this particular piece, the introduction of new tones is delayed until the ninth bar. Throughout the progression of the piece, additional notes are gradually introduced, resulting in a gradual reduction of the probable subsequent tones each time. It is important to note that this piece does not rely on traditional harmony or establish a specific key. As a result, the probabilities of note relationships undergo significant changes compared to a composition within a traditional tonal context, where each new tone can be referenced and related to the key of the piece. However, due to the predominant use of the note E (primarily) and F (secondarily) throughout the composition, in comparison to other notes, a distinct “tone-center" is established. This tone-center acts as a point of reference for the listener, creating a sense of root or home, against which all other notes are perceived as deviations or departures.

It is essential to realize that unexpected, improbable events, remain in the memory and influence the listener’s later estimates of probability for the balance of the piece. Moreover, as the music unfolds in time, later events are constantly being connected to earlier ones and vice versa. The more complete the section, the higher the probability relationship between those terms already established and any future element. As Meyer states: “in music composition, the avoidance of the tendency toward maximum certainty is through the designed uncertainty introduced by the composer.” When deviation occurs, its effect increases when we are more certain about the occurrence of a specific consequence. In other words, the more the certainty and the more is the effect of an occurring deviation (see fig. 3).

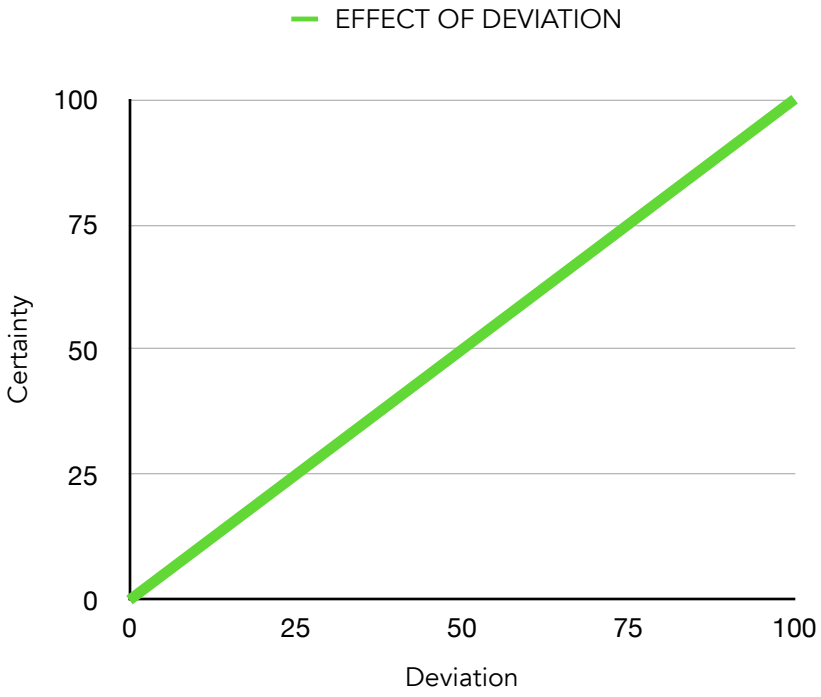

Fig. 3 - Effect of Deviation

Deviation can occur in various ways, and the extent of deviation from the norm can significantly vary depending on the nature of the piece and the composer's idea. Deviation can escalate from subtle nuances to extreme levels at times. It is worth mentioning an example in acousmatic music, such as the use of inserts. This technique involves the deliberate incorporation of completely unrelated material into the composition, inserting it at various points in time. Essentially, it entails a drastic shift in both the scenario and sound material, resulting in an abrupt and significant deviation from the norm of the piece. This technique can be highly effective as it instantaneously brings a deviation from the norm from zero to the maximum level. Instead, if we wanted to provide an example of deviation in terms of both instrumental and acousmatic works, we could mention the technique of abrupt dynamic changes, reminiscent of Beethoven's style. For example, if we were to consider a

melodic profile with a constant dynamic level, such as *p* (piano), we could incorporate a Beethoven-like technique of abrupt dynamic change. By suddenly introducing a single note or a small group of notes at *ff* (fortissimo), we would create a sharp increase in dynamic level, resulting in a significant deviation from the norm of the piece in terms of dynamics. This technique is also present in No Funk Allowed (see fig. 4) ⏯.

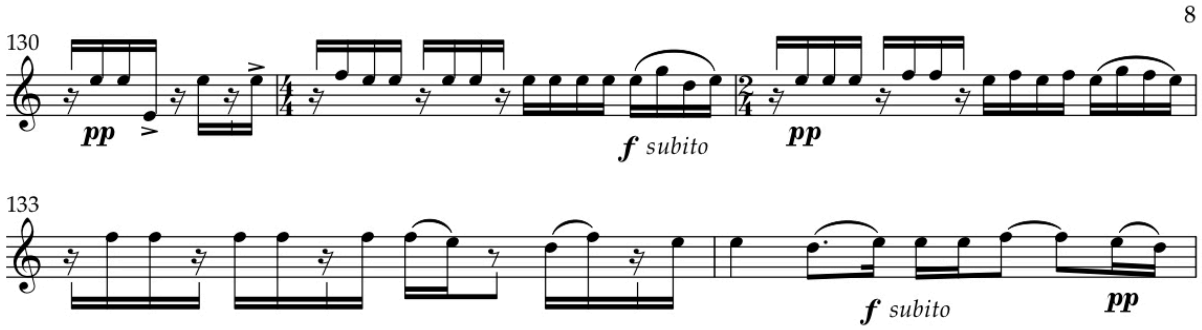

Fig. 4 - Drastic Dynamic Change in No Funk Allowed

As previously discussed regarding No Funk Allowed and the establishment of a tone-center, it is important to note that the evolution of the piece is specifically centered around the concept of deviation. As mentioned, it is worth remember that the note E has the highest occurrence (see fig. 5). Throughout the course of the piece, new tones are introduced in a progressive deviation, initially starting with tones that are closer to the "root" or tone-center, and gradually moving further away as the composition unfolds. The proportion of each deviation has been meticulously crafted to maintain the sense of a central point of reference from which to deviate, ensuring that the deviations do not become the norm.

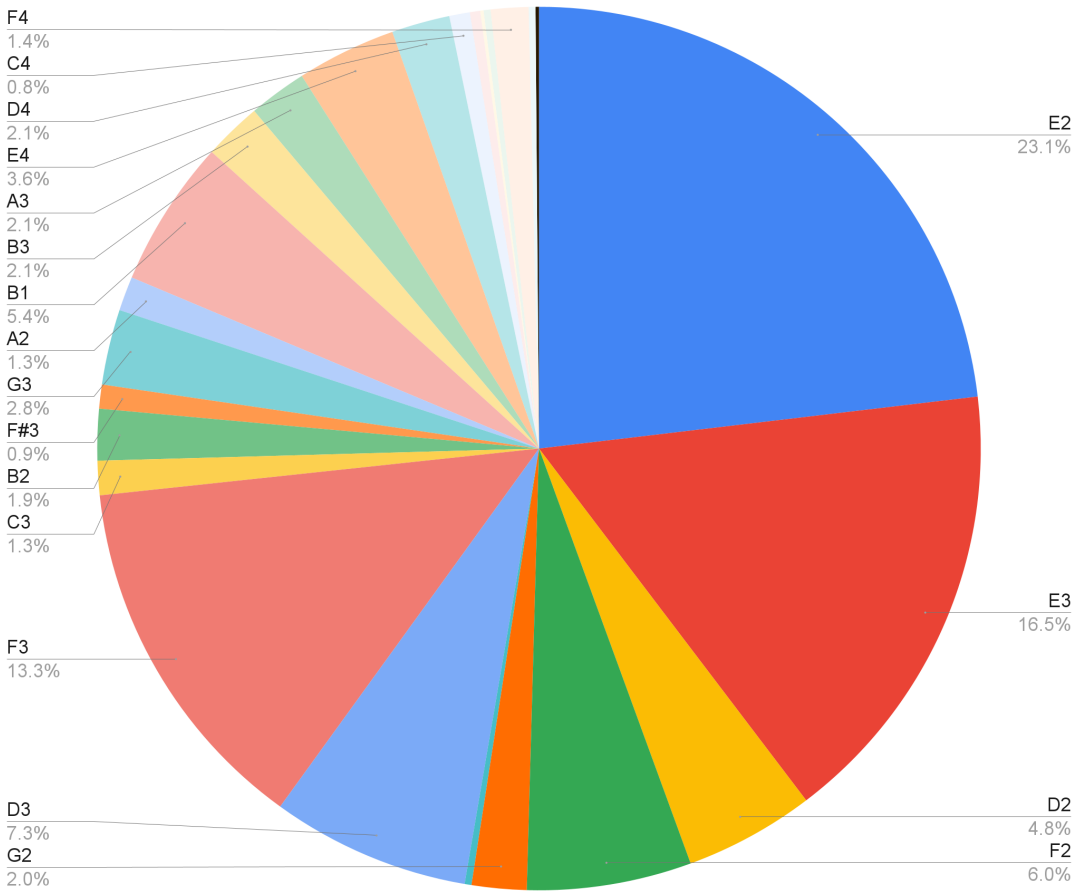

Fig. 5 - Notes Percentage in No Funk Allowed

If we also take into account the different octaves for the purpose of this new example, as the piece progresses, it expands into various registers of the instrument, corresponding to a gradual increase in deviation from the original source material, not just as mere tone but also as timbre difference (see fig. 6).

On the concept of uncertainty, Meyer differentiates between two types:

- *Desirable uncertainty* ⟹ arises within and as result of the structured probabilities of a style system in which a finite number of antecedents and consequence become mutually relevant (through habits, beliefs and attitudes of a group of listeners).

- *Undesirable uncertainty* ⟹ arises when the probabilities are not known, for example because the listeners' habit responses are not relevant to the style (see following subchapter on cultural noise).

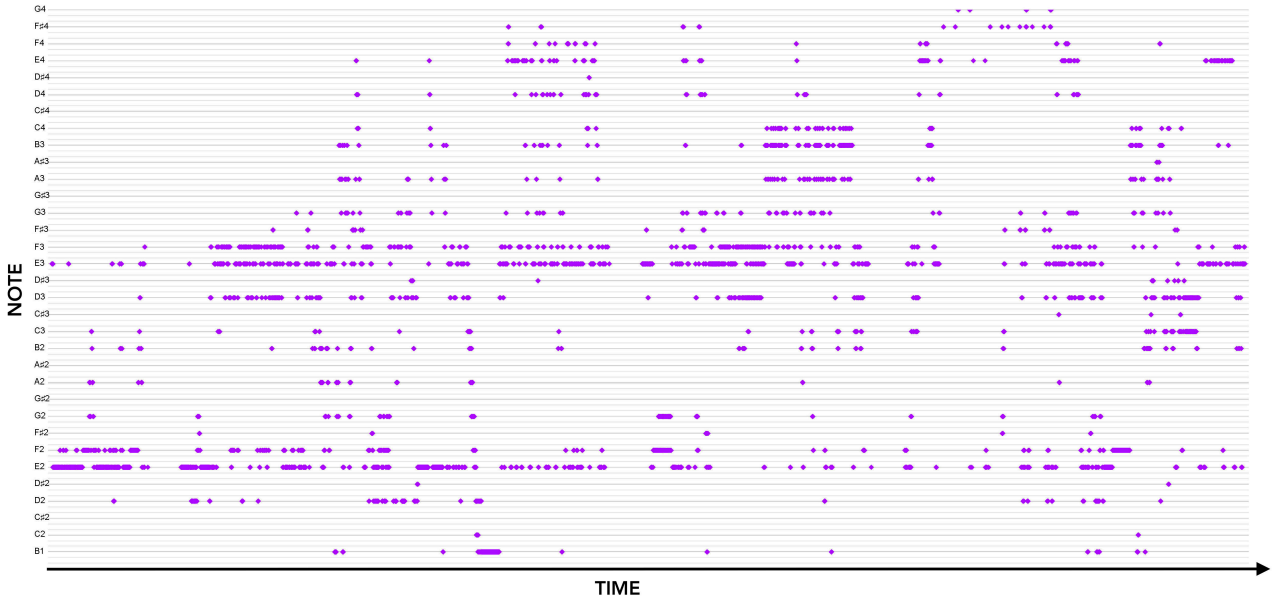

Fig. 6 - Notes Distribution in No Funk Allowed

To make a parallelism with linguistic communication, in case of desirable uncertainty, one is uncertain simply about how a sentence in a familiar language will be completed. An example of high level of desirable uncertainty in music could be found in *Tristan and Isolde* by Richard Wagner. This work pushed the boundaries of tonal music through its innovative harmonic language, continuous melody, and unresolved tension. Wagner's use of chromaticism, extended chords, and unresolved dissonances expanded the tonal system, creating ambiguity and tension. Through unresolved dissonances and delayed resolutions, Wagner built tension, leaving listeners in a state of longing and anticipation. These departures

from tonal conventions challenged the audience's expectations and created emotionally charged atmospheres. Despite its extreme innovation and pushing of limits, this work remained within the confines of tonal music. As a result, the high level of uncertainty was achieved within a familiar musical language, characterized by well-known norms and schemes that the composition frequently deviated from.

Instead, in case of undesirable uncertainty (resulting from cultural noise), one is in doubt about how a sentence in an unknown language will be completed. Here no consequent can be envisaged and none has any meaning or communicates any information when it arrives, since all seem equally probable or improbable. In this scenario, it is therefore difficult to work with expectations since the listener is not fluent in the language. Consequently, all events hold an equal likelihood of happening or not happening since there is no contextual framework to create probabilities. As a result, any expectations held by the listener will likely go unfulfilled.

In connection with any specific musical style, there are also elements that we expect to see that we notice if missing: because of the redundancy present in certain musical styles we are able to understand incomplete musical events, if what has been omitted is statistically probable. This might applying to certain more standardized musical styles and less in

contemporary, electroacoustic or acousmatic[3] music. Redundancy holds special importance as it facilitates the crucial moments in music listening where the listener's habit responses can effectively take control.

B. The Concept of Cultural Noise

The concept of cultural noise was first introduced by Meyer in 1956, it corresponds to the distinction which may exist between the habit responses required by the musical style and those which a given listener actually possesses. The more distant a culture is from our set of habit responses, the grater the amount of cultural noise involved in music communication (see fig. 7). The cultural noise factor might be higher in contemporary or acousmatic music where every composer has more freedom to play with their own set of rules which might not always be shared with a wide audience, and listeners would need to be more trained in the specific of the genre in order to reduce the cultural distance and ease the communication.

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[3] In the field of electroacoustic music, acousmatic music (also known as tape music) represents a music style per se. This genre focuses more on the spectral characteristics of sound than musical notes, more on the motion and the movements than tempo and measures and sometimes more on the transformed sounds when the source is not clear and/or hidden. This kind of music is also played in concerts in a different way than instrumental music. The piece is prerecorded on a physical support and it is reproduced nowadays with a computer and an audio system (stereo, quadrophonic, multichannel, etc.). This is in contrast with the *live performance* where the music is produced at that very moment on the stage. So, for example, we could say that to listen to an acousmatic music concert, it is like to be in a symphony concert hall, where the musicians are replaced by the loudspeakers under the supervision of the sound technician and/or the composer in person. The term *acousmatic* comes from the age of Pythagoras. At that time, students were divided in two categories: advanced students (*the mathematicians*) and new students (*the acousmatics*). The first ones were allowed to see, they used to represent figures on the sand to, for example, demonstrate theorems. The second ones instead were allowed only to listen, since they were not yet mature enough and should not have been influenced by the visual aspects and proxemics of the teacher. Accordingly, Pythagoras used to teach from behind a curtain that prevented them from seeing him (Ratto 2019, p. 7).

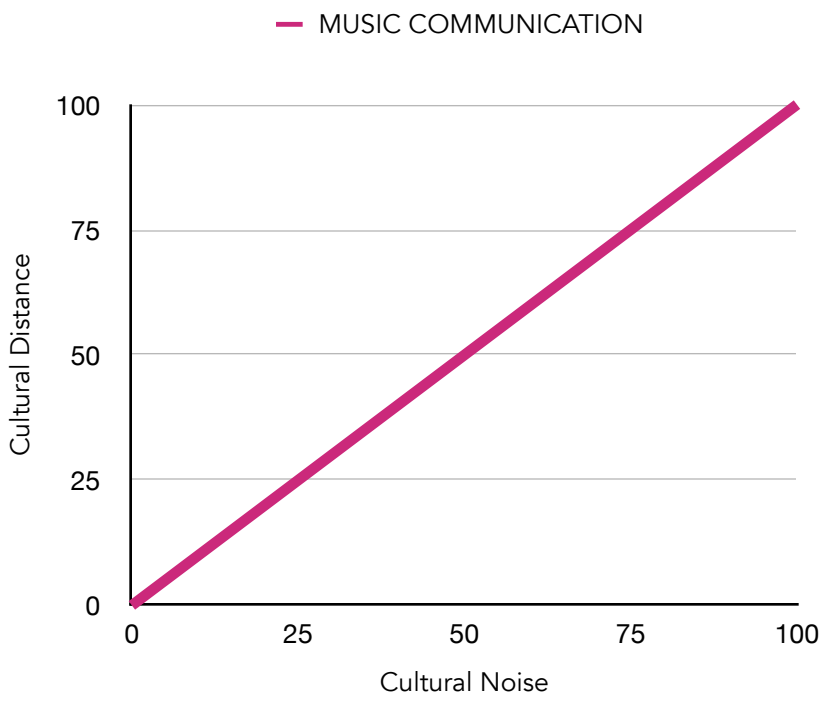

Fig. 7 - Music Communication

C. Cultural Noise in New Music

In a way we could affirm that the contemporary composer plays on purpose with the cultural noise factor as result of departure from the classical tradition.

> […] The exception to this rule is found in contemporary music. Here "noise" is the result of time-lag between the habit responses which the audience actually possesses and those which the more adventurous composer envisages for it (Meyer 1967, pp. 16-17).

An essential topic of discussion revolves around the new music that has emerged over the past few decades, particularly in relation to the perceived separation between the audience and composers. On this matter, there are some important considerations brought up by Italian pianist, philosopher and writer Alessandro Baricco who, in regards of new music, wants to remind that necessarily the listening experience is based on a dialectic of anticipation-

surprise and expectation-response. In his investigation on the subject of separation that occurred between atonal music and audience, tries to analyze it by the listener's perspective:

> Sospeso nello spazio senza coordinate della musica atonale, l'ascoltatore non può più elaborare previsioni. A una nota, a un gruppo accordale, può seguire qualsiasi nota. Cade il meccanismo di attesa e risposta che governava il piacere dell'ascolto. Subentra la realtà di una sorpresa continua e generalizzata. Ma in un sistema che non permette previsioni, lo stesso concetto di sorpresa diventa problematico. A sorprendere è l'evento che si sostituisce a un evento aspettato: ma se nulla ci si può aspettare, nulla può stupire, in senso stretto. La musica atonale, così diventa, per l'ascolto, una sequenza di eventi sonori semplicemente indecifrabili, muti, ed estranei (Baricco 1992, p. 51).[4]

On top of that, the redundancy rate of new music is at times so low to be unable to counteract the cultural noise that is constantly present in communication, this factor may be one of the difficulties which audiences encounter with modern music. "One might put this matter somewhat differently by saying that in their zeal to "pack" music full of meaning some contemporary composers have perhaps so overloaded the channel capacity of the audience that one meaning obscures another in the ensuing overflow (Meyer, 1956)." We could think about it as a "white noise" effect, resulting in an undesirable uncertainty.

> La plus grande difficulté éprouvée par un auditeur de musique contemporaine est une difficulté d'orientation. Obligé de suivre un parcours déterminé, il restera désorienté s'il ne l'a fait qu'une fois. S'il le fait une seconde fois, disons deux ans après, il sera

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[4] Translation: suspended in the space without coordinates of atonal music, the listener can no longer make predictions. To a note, to a chordal group, any other note can follow. The waiting and response mechanism that governed the pleasure of listening falls. The reality of a continuous and generalized surprise takes over. But in a system that doesn't allow predictions, the very concept of surprise becomes problematic. What surprises is the event that replaces an expected event: but if nothing can be expected, nothing can surprise, strictly speaking. Atonal music thus becomes, for listening, a sequence of simply indecipherable, mute, and extraneous sound events.

> encore désorienté parce que la pouvoir d'association a été anéanti par la distance dans le temps. […] C'est bien pourquoi les formes de la musique classique, telle la sonate, étaient, pour ceux qui les connaissaient un peu, un moyen de s'orienter dans une œuvre. Elles jouaient et jouent toujours le rôle d'aide-mémoire. (Boulez 1989, pp. 116-117).[5]

As trained listeners, as we listen to music, we are required to form archetypes based on the known repertoire. For example, listeners of acousmatic music use archetypes in order to activate the process of probabilistic expectations, although for every piece of music there will be always a certain level of freedom for each composer to create a custom grammar and set of rules and deviations. In electronic music, the amount of time required for a listener to become familiar and understand these rules varies, often as result a considerable part of the listening act focuses on the process of building a familiar structure, based on previously acquired archetypes, in order to have a system to interpret the a piece of music with its own rules and deviations.

> Traditional musical languages adhere to familiar grammars. This familiarity acts as a framework for setting up small surprises. […] In creative electronic music, where the grammar is not familiar, the surprise often consists in finding familiarity. (Roads 2015, p. 29)

[5] Translation: the greatest difficulty for those who listen to contemporary music lies in orienting themselves. Forced to follow a specific path, the listener will remain disoriented if they traverse it only once. Even if they traverse it a second time, but, for example, two years later, they will still be disoriented because the power of association has been nullified by the passage of time. [...] This is precisely why the forms of classical music, such as the sonata, were, for those who were even somewhat familiar with them, a means of orienting themselves within a work. They had, and still have, the function of a handbook.

II. Statistical Properties of Music

There are lots of stable probabilistic relationships that can be observed in music, including patterns that are unique to individual compositions and others that reflect particular styles or genres. Additionally, some probabilities seem to reflect properties of music as a whole. Experienced listeners have also general expectations about melodic sequences, Huron (2006) and colleagues have identified five patterns of statistical melodic schemas and four patterns of statistical learning in experienced listeners, some of which were previously hypothesized by Meyer (1956) and Narmour (1990).

A. Statistical Melodic Schemas

1 - Pitch Proximity

One of the most commonly observed characteristics of melodies is their use of sequences of tones that are close in pitch, as recognized by many researchers over the years. This phenomenon is believed to be based on statistical learning, as a majority of melodic intervals in actual music consist of pitches that are within a minor third of each other, leading to an expected pitch proximity in successive musical events (Dowling and Harwood, 1986).
If real melodies tend to prefer small intervals (see fig. 8[6]), what about listeners' expectations? Research has explored whether listeners expect successive melodic intervals to be small, given that real melodies tend to favor small intervals. Evidence consistent with an expectation for pitch proximity would suggest that listeners process small intervals more

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[6] Remade graph from Huron 2006. "Frequency of occurrence of melodic intervals in notated sources for folk and popular melodies from ten cultures. African sample includes Pondo, Venda, Xhosa, and Zulu works. Note that interval sizes only roughly correspond to equally tempered semitones."

quickly than large intervals, promoting event readiness. This expectation for pitch proximity is linked to Meyer's concept of probabilities in music, where anticipating certain notes creates boundaries for expectations and probabilities for the next note. In essence, accurate expectation facilitates perception, allowing for faster processing and response times to expected sounds. Therefore, it is not unreasonable to suppose that listeners might have learned to expect small intervals.

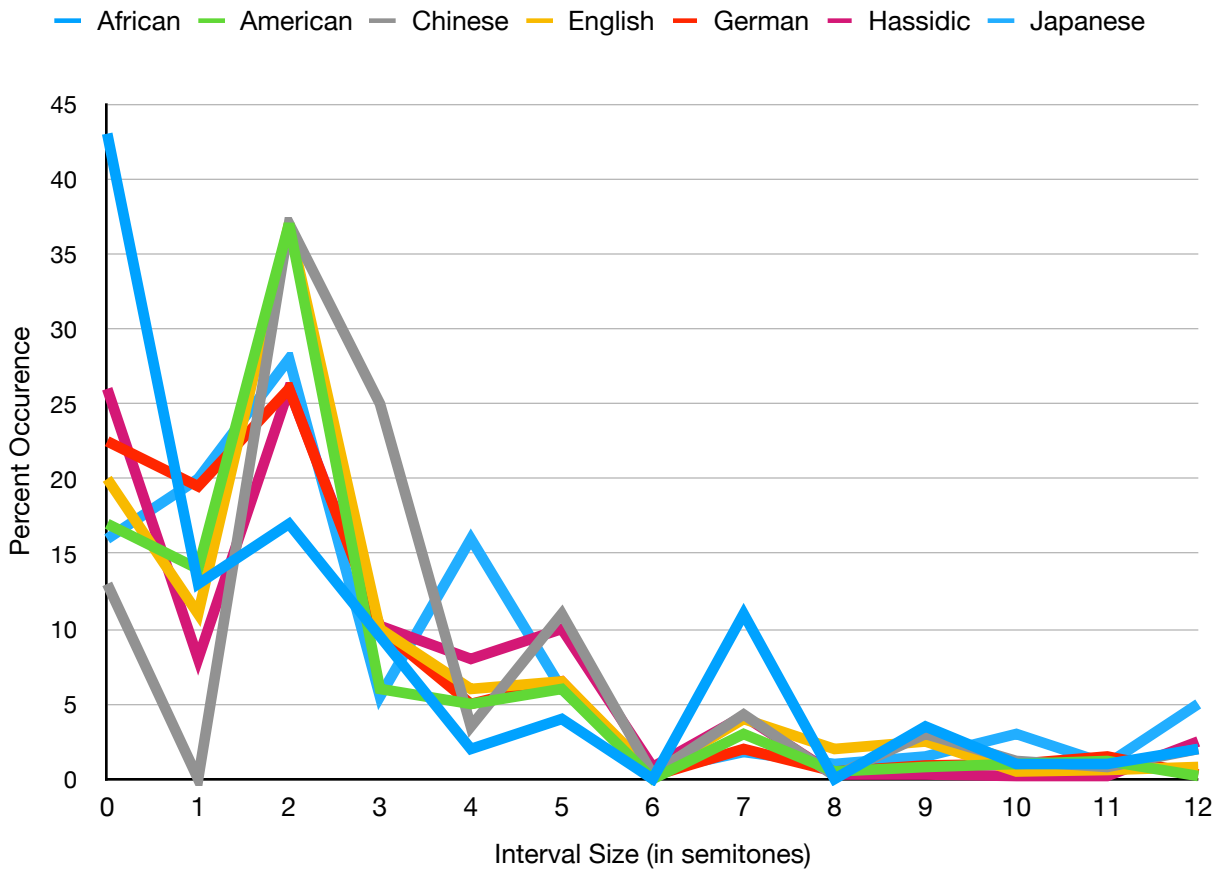


Fig. 8 - Distribution of Interval Size

2 - Step Declination

It is observed that melodies tend to move around a central pitch range, where most large intervals tend to ascend while small intervals mostly descend. As result, the majority of melodic movements are descending small intervals rather than ascending large ones.

3 - Step Inertia

Meyer suggests that small pitch intervals tend to be followed by pitches that continue in the same direction.

4 - Melodic Regression

Music theorists have noted that there is often a change in direction following the occurrence of large intervals. They have commented that large intervals tend to be followed by step motion in the opposite direction. The important part of the claim is the idea that large leaps should be followed by a change of direction (which we will refer as post-skip reversal in the statistical learning section). A wide-ranging analysis of Western music repertoire (see fig. 9[7]) supports this notion, with the majority of large intervals being succeeded by a change in direction (Huron, 2006).

[7] Remade Chart from Huron 2006. "Watt's (1924) analysis of intervals in Schubert Lieder. Larger intervals are more likely to be followed by a change of melodic direction than small intervals. No data point corresponds to eleven semitone intervals because of the absence of such intervals in Watt's sample. From von Hippel and Huron 2000."

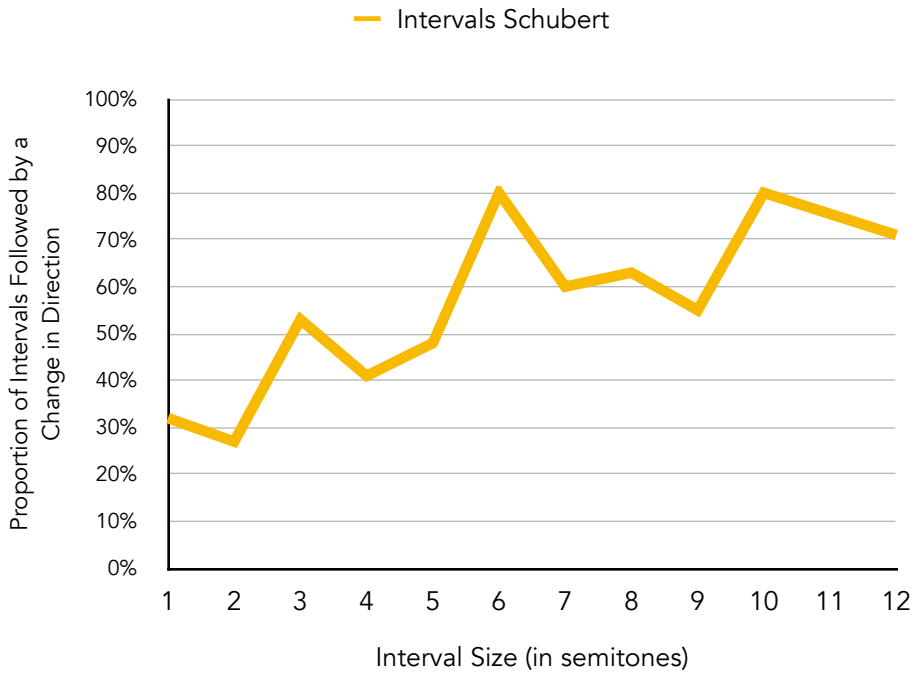


Fig. 9 - Watt's (1924) Analysis of Intervals in Schubert Lieder

Huron expands it further by introducing the concept of melodic regression to the mean (see fig. 10[8]):

> In general, most large intervals tend to take the melody toward the extremes of the melody's range. For example, a large ascending leap has a good probability of placing the melody in the upper region of the tessitura or range. Having landed near the upper boundary, a melody has little choice but to go down. […] Regression to the mean is simply a numerical artifact—a necessary consequence of the fact that most values lie near the center of some distribution. […] The most frequently occurring pitches in a melody lie near the center of the melody's range. Pitches near the extremes of the range occur less commonly. This makes melodies a candidate for regression to the mean (Huron 2006, p. 81).

[8] Remade Chart from Huron 2006. "Number of instances of various melodic leaps found in a cross-cultural sample of melodies. Most large intervals that approach the median pitch continue in the same melodic direction. Large intervals that land on the median pitch are as likely to continue in the same direction as to reverse direction. Results support the phenomenon of melodic regression and fail to support post-leap reversal. From von Hippel and Huron 2000."

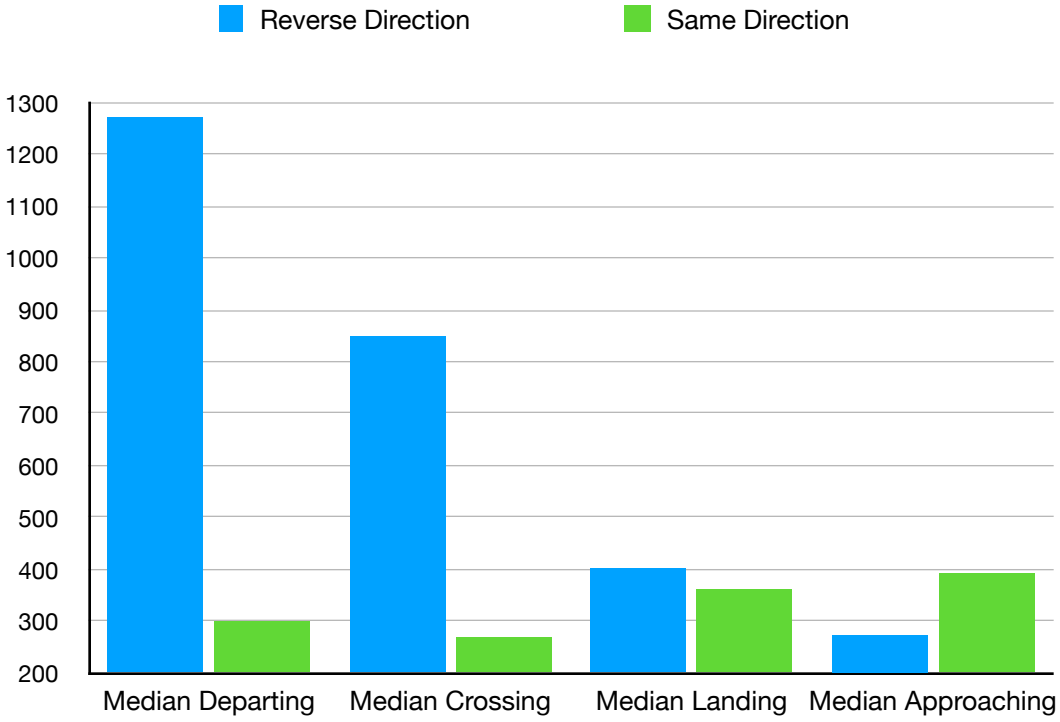
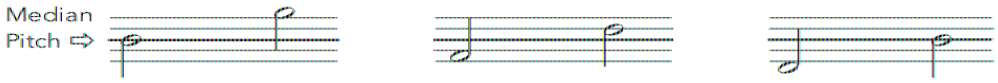


Fig. 10 - Melodic Regression to the Mean



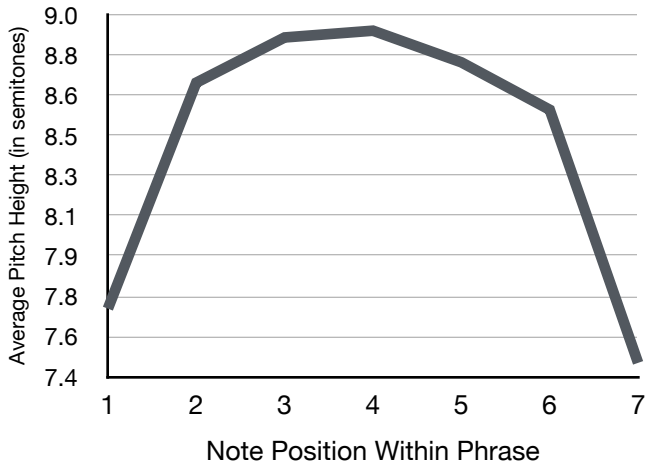


Fig. 11a - Average Contour A

5 - Melodic Arch

The commonly known melodic pattern is referred to as the arch-shaped contour, which has been noted by music experts for centuries. It's observed that phrases tend to ascend and subsequently descend in pitch, creating the arch shape (see fig. 11a[9] - 11b[10]). This pattern is not exclusive to Western music (Huron, 2006).

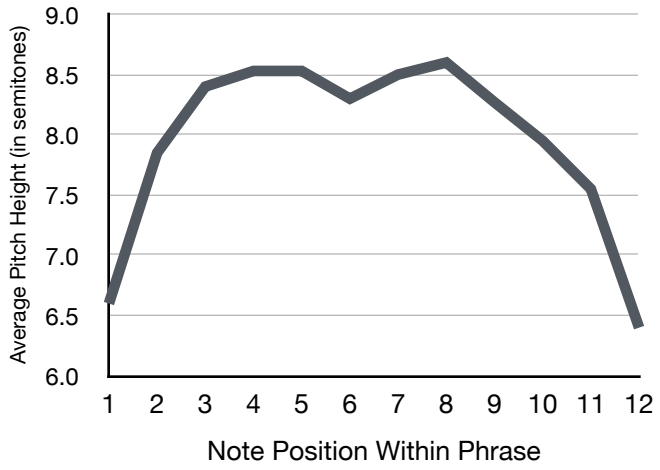


Fig. 11b - Average Contour B

[9] Remade chart from Huron 2006. "Average contour for 6,364 seven-note phrases taken from *The Essen Folksong Collection* (Schaffrath 1995). The graph shows the average pitch height (measured in semitones above middle C) according to serial position in the phrase. This arch shape contour is present for 5-note, 6-note, 7-note, 8-note, 9-note, 10-note, and 11-note phrases. From Huron 1996."

[10] Remade chart from Huron 2006. "Average contour for 1,600 twelve-note phrases taken from *The Essen Folksong Collection*. The graph shows the average pitch height (measured in semitones above middle C) according to serial position in the phrase. The dip in the middle of the arch ("McDonald's effect") is evident in 12-note, 13-note, 14-note, and 15-note phrases and suggests possible subphrase structures. From Huron 1996."

B. Statistical Learning in Experienced Listeners

Trained listeners have some very general schematic expectations about types of sequences of melodic events. Huron and his colleagues have described four patterns of statistical learning in experienced listeners (Snyder, 2008).

1 - Pitch Proximity.

Expecting a pitched musical event to be followed by an event relatively close to it in pitch. This is thought to be statistical learning based on the fact that the majority of melodic intervals in actual music consist of pitches that are close (within a m3) together (Dowling and Harwood, 1986).

2 - Post-Skip Reversal.

The expectation that after a large melodic interval, there will be a change of direction of melodic motion, usually by stepwise motion (Meyer 1956, Narmour 1990, Snyder 2008).

3 - Step Inertia.

Musician listeners expect step inertia, a tendency for a small pitch interval to be followed by another small pitch interval in the same direction (Meyer 1956, Narmour 1990, Snyder 2008).

4 - Pitch Declination.

Listeners expect that a phrase will move down melodically at the end. Objectively, melodic phrases tend on average to have an arch like shape, with a rise in pitch at the beginning and a fall at the end.

C. Statistical Aspects and Counterpoint

Through the examination of musical repertoire, it becomes apparent that statistical melodic patterns and learning share numerous similarities. Musicians and composers acquire certain melodic tendencies through their study of music, which then become predictable expectations in the listening experience. These melodic schemas have been valuable tools for classical composers and a possible point of reference and departure when composing new music. In addition, many of these mentioned melodic configurations align particularly with some principles of counterpoint that are commonly taught in academic coursework. Specifically, counterpoint rules govern how to shape melodic lines and develop them over time. Some of these rules have a strong correlation with the aforementioned statistical points:

- After a leap bigger than a third, it is indicated to proceed in the opposite direction by step wise motion if possible (this can be connected to the concept of step-wise reversal).

- Melodic lines in counterpoint should have a climax and a general curve shape like (this can be connected to the concept of pitch declination and melodic arch).

- Lines should always be inside an octave or 10th (this can be connected to the concept of regression to the mean).

- Usually lines in counterpoint move with small intervals, often stepwise and should avoid too many leaps (this can be connected to the concept of pitch proximity).

Throughout the centuries, trained musicians and composers have developed and formalized various schemas and rules, which are crucial in creating music. As a result, these rules have become deeply ingrained in their learning processes, and have shaped their music expectations. This symbiotic relationship has had a profound impact on the evolution of music. For instance, these established expectations guide composers in creating works that adhere to traditional structures, or seek to deviate from them in interesting and innovative ways. Therefore, it can be argued that the study of music has contributed greatly to the development of our music expectations.

D. Familiarity

As previously mentioned, individuals listening to creative electronic music often spend time in seeking familiarity with a particular piece. It is intriguing to delve into the process of establishing a sense of familiarity and understand how it influences one's appreciation of music. An effective method for attaining familiarity is through repeated exposure. This paradigm has been used broadly in laboratory studies of aesthetic preferences. Especially R. B. Zajonc who named it the *exposure effect*, has used it in investigations of his hypothesis that there exists a positive relationship between the "mere exposure" of stimuli and subjects' liking for them (Zajonc 1968, Hargreaves 1984). Among all studies, there are two interesting experiments conducted on this subject, the first one by Max Meyer in 1903 and the second by Helen K. Mull in 1957.

Max Meyer conducted a basic music study, where he created a collection of piano pieces that were styled as "orientalesque". He requested a group of individuals to listen to his compositions and provide feedback on their preferences. Max Meyer repeated each piece several times, asking his audience to rate their enjoyment level with repeated hearings. The composer extended the study to include twelve performances of each piano piece. Through his research, Max Meyer concluded that the more he played his works, the more likable his listeners found them to be.

Mull's interest in this investigation came from her dislike of certain types of serious contemporary music and from some people saying she needed to be more familiar with the music before passing judgment. The study uses examples of Schoenberg and Hindemith's work[11], which depart from traditional composition. The purpose was to determine if repeated listening would bring out the music's charms, and which parts would have liked or disliked and why. The investigation involved 16 observers who were music students at Sweet Briar College between 19 and 22 years old. Over the course of two weeks, they played each selection one at a time for two separate sessions lasting one hour each. During the first hour, they played each selection three times in a row, while during the second hour, they played each selection twice in a row. The purpose was to provide familiarity without overindulging. Upon analyzing the results, they found that 8 students liked Schoenberg in the last hearing compared to 4 in the first, while 10 students liked Hindemith in the last hearing compared to 3 in the first. Furthermore, 5 students changed from an initial dislike to a final liking. The

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[11] Schoenberg's String Quartet 111, Op. 31, first movement, played by the Kolisch String Quartet. Hindemith's String Quartet IV, Op. 32, second movement, played by the Guilet String Quartet.

experiment showed also that some sections of the presented works were preferred in comparison to others. The following are the conclusions of the experiment as reported by Mull:

1. Familiarity with the serious modern music here investigated usually increases enjoyment of it.
2. An initial dislike of this music may, with repeated hearing, become a liking for it.
3. There is some general agreement as to what areas are preferred.
4. There is considerable consistency of preference on the part of the individual Os[12], indicating the validity of the preference.
5. The generally popular areas are relatively simple and melodious in the classic sense, the outstanding example being the almost universally and consistently preferred long solo melody in Hindemith.
6. Melody and less dissonance are frequently alleged as reasons for preference. The music scores show that these qualities are actually characteristic of the popular areas.
7. Absence of degree-wise melody and of consonant harmony may in these instances account largely for inconsistencies of preference, other aspects of dissonant polyphonic music simultaneously present compelling attention less forcefully, and therefore competing among themselves on terms of approximate equality, with a consequent variety of results, and a resulting inconstancy of preference.
8. Neither of the compositions studied was generally much liked, even at the end of the familiarizing process.

Understanding how familiarity affects listening is crucial. Points 3-4-5 in Mull's conclusions are particularly noteworthy, revealing that beyond mere preference, familiarity is a key factor in a listener's actions. This familiarity stems from archetypes, based on the listener's experience and training, and plays a significant role in how the listener engages with the repertoire. We could also argue that a sense of familiarity can result in an unconscious understanding, allowing the listener to feel at ease and relaxed in a familiar musical context, which, in turn, enables them to appreciate surprises and fully engage with the composition.

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[12] Observers / students.

E. Familiarity and Acousmatic

The concept of familiarity can be particularly relevant to acousmatic music. For example, if we analyze the acousmatic piece MEMORIA ⏯, the use of voices, both female and male robotic ones, could be interpreted as a leitmotif. In this sense, their presence as upfront and impactful sounds, inherently human in nature, establishes a strong connection with the listener, representing a recurring element throughout the piece. Although each usage undergoes different transformations, their distinctiveness from the rest of the material leaves a lasting impression on the listener's mind. Therefore, we can contemplate how the concept of familiarity holds varying significance in the context of an acousmatic piece, influenced by both the intrinsic qualities of the sound itself, its usage, and its perception by the audience.

MEMORIA also draws upon numerous samples from everyday objects used in the 90s, such as Walkmans, CD players, cassette players, and others. These sounds, by their very familiarity, may evoke a stronger connection for listeners who experienced childhood during that era, evoking nostalgia and emotional resonance that extends beyond the piece, despite the transformation and processing of these sounds potentially making their sources less recognizable.

Another element contributing to the sense of familiarity in MEMORIA is the recurring slide projector sound. This sound, present in different moments and sections from start to finish, acts as a leitmotif tied to the piece's concept of capturing snapshots of the past—a recollection of memories (hence the title, MEMORIA)—through diapositives. Moreover, the "click sound" of the diapositives ends the piece as a little unexpected surprise. The recurrence of this element too, enhances the overall sense of coherence and familiarity for the listener.

Based on the concept of familiarity of sounds, one could discern two levels of familiarity associated with the sonic characteristics within an acousmatic piece in general. The first level encompasses sounds presented in the piece and utilized as leitmotifs, where familiarity develops through repeated use, gradually embedding these sounds into the listener's memory. The second level pertains to the recognizability of sounds drawn from everyday life or familiar to the listener prior to encountering the piece.

Therefore, both as a composer and a listener, one can appreciate the expanded potential of an acousmatic piece compared to an instrumental composition. While an instrumental piece relies on creating familiarity primarily through the repetition of familiar musical motifs (first level), the acousmatic genre offers an additional layer of familiarity through its ability to incorporate sounds connected to the outside world (second level).

III. Time and Expectation

In the realm of music expectation, time assumes a central role. Time serves as the canvas upon which musical events unfold, allowing composers to manipulate its passage to create tension, release, and resolution. Our perception of time in music is not simply a linear progression; it is elastic, malleable, and subject to manipulation by skilled composers and performers. To comprehend the significance of time in shaping music expectation, it is essential to consider the underlying psychological and cognitive processes at play. The human mind naturally seeks patterns, predictability, and coherence, and this propensity extends to our experience of music. As listeners, we develop a set of expectations based on our exposure to various musical styles, genres, and conventions. We anticipate certain melodic contours, harmonic progressions, and rhythmic patterns based on our familiarity with the musical language. However, composers and performers often exploit these expectations, skillfully manipulating the passage of time to defy or subvert them, leading to moments of surprise, tension, and resolution. Moreover, the concept of musical time goes beyond the immediate temporal experience. It extends to larger structural elements such as musical form and the relationship between sections within a composition.

In anticipating future events, listeners also form expectations about when events may occur. That is, successful anticipation will reduce unnecessary vigilance and arousal leading up to the anticipated event. In her theory of *rhythmic attending*, Mari Riess Jones notes that the listener's attention is most acute at strong metric positions. This suggests that the organization of time in music, particularly through the establishment of a rhythmic framework, plays a crucial role in shaping our expectations and focusing our attention. By

accentuating strong metric positions, composers and performers guide our anticipation, allowing us to engage with the music more actively and enhancing our overall listening experience. In music, beats are usually arranged into patterns that exhibit a hierarchical structure. Experienced listeners possess the ability to leverage these patterns to successfully predict the probable temporal placement of future tone onsets. It is reasonable to assume that listeners anticipate tone onsets to occur precisely at the strongest metric positions (see fig.12[13]).

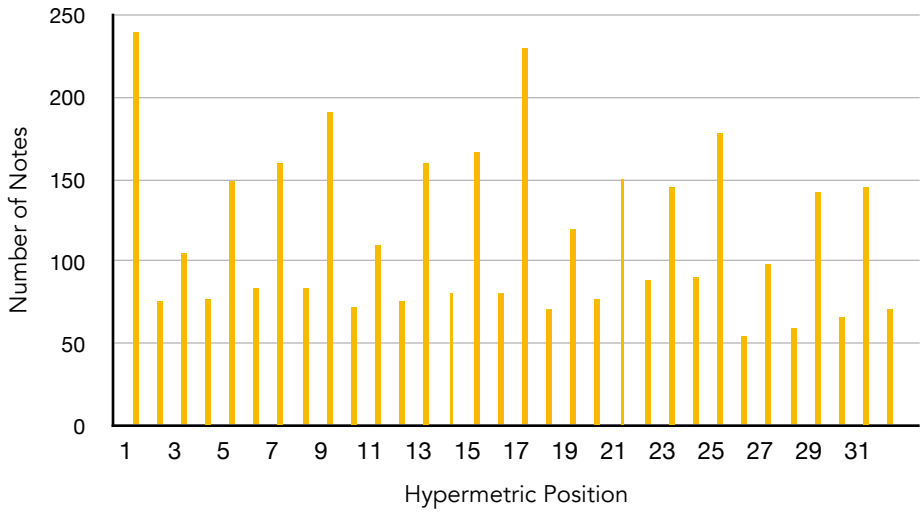

Fig. 12 - Hypermetric Position

> Much music, in addition to being organized around a regular pulse, is also organized at a higher time level into regular cycles of more, and less, accented beats. This type of cyclical organization is referred to as *metre*; metrical organization is schematic, and generates expectations not only about when, but also what, kind of events will happen

[13] Remade chart from Huron 2006. "Four-measure hypermetric organization in Joseph Haydn's String Quartet, op. 54, no. 1, fourth movement. The movement is written in 2/4 meter; the graph plots the number of note onsets for all four instruments in sixteenth durations. Positions 1, 9, 17, and 25 coincide with the downbeats for the first, second, third, and fourth measures in the four-measure hypermetric unit. These positions exhibit the strong–weak–medium–weak structure commonly seen within a single measure of 4/4."

> at what points in time. Like pulse, it is a cognitive structure that is inferred from actual events in music (Snyder 2008, p. 111).

One of the most important points of this pattern is certainly the downbeat. The downbeat in music is not just a moment when events are likely to occur, it also sounds pleasant. It's one of the simple joys of listening to music, as events on the downbeat bring a positive response due to the expected timing. This effect extends beyond the downbeat, as certain beats and sub-beats are more likely and evoke varying degrees of pleasure through prediction. There's a clear parallel between the pleasure felt when hearing a downbeat and the pleasure experienced by culturally attuned listeners when hearing an expected tonic (Huron, 2006). How does the interplay of time and expectation function in music genres that typically lack specific meter-based structures? Take acousmatic music, for instance, where rhythmic patterns organized by a specific meter are often absent. In such cases, are there alternative elements that can serve as substitutes for temporal expectations and the notion of a downbeat? Indeed, certain gestures within acousmatic music have a propensity to generate temporal expectations. For instance, the fluctuations in energy levels among sound elements often create anticipation, and there is a recurring association between tension and resolution. These dynamics contribute to the formation of temporal expectations within the context of acousmatic music, despite the absence of traditional rhythmic frameworks. While periodicity in music aids listeners in developing temporal expectations, it is not an indispensable requirement for their formation. What truly matters is the listener's familiarity with the temporal structure and the presence of predictable elements within the temporal pattern. Non-periodic temporal expectations can still be effectively established as long as the listener has sufficient experience with the underlying temporal framework and can discern certain

recurring elements or patterns. This suggests that while periodicity contributes to the formation of temporal expectations, it is not the sole determinant, highlighting the significance of familiarity and predictability in the temporal domain of music perception. On the idea of non-periodic temporal expectations, Huron (2006) presents a clear schematic representation (see fig. 13) that portrays the occurrence of and accelerating onset, which is a distinctive characteristic of a sound produced by bouncing objects.

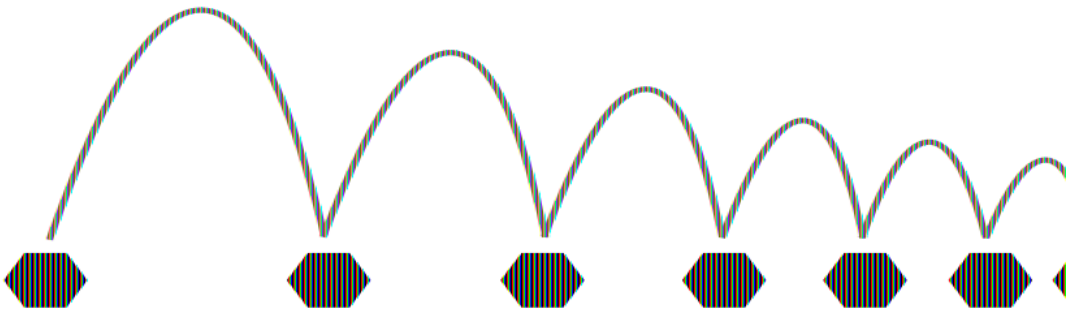

Fig. 13 - Accelerating Onset

Despite the absence of metric regularity in this pattern, it still exhibits predictability. The predictable nature of the pattern arises from the consistent acceleration of the onset, allowing listeners to anticipate and foresee the temporal progression of subsequent sounds. This phenomenon demonstrates that even in non-metrically regular contexts such as acousmatic music, the human perceptual system is capable of extracting underlying temporal regularities and using them to form expectations. The predictability inherent in the accelerating onset pattern highlights the remarkable ability of listeners to perceive and anticipate temporal dynamics beyond strict metric structures. For instance, this type of predictability can be observed in two distinct sections of the acousmatic compositions Echoss and KOM. In the

composition called Echoss, there is a brief series of increasing impulses ⏯. These impulses are designed to create a sense of acceleration and, along with a logarithmic increase in volume and movement from a distant position towards the listener, they also serve as a gesture to drive the following sound element forward. In the piece KOM instead there is a more spread and subtle gesture of impulses deceleration which also represents a pattern that is predicable even though not metrically regular ⏯. Indeed, the predictability observed in this example can be attributed not only to the properties of the sound itself (mass, timbre, etc.), but also to the spatial context in which they are presented. The interaction between the qualities of the sound and the virtual space[14] in which it unfolds, contribute to the overall predictability and perceived pattern within the composition. The sound is progressively moved to a greater depth layer, increasing the distance between each impulse. This spatial manipulation amplifies the sense of predictability as the sound object appears to recede into the distance, creating an anticipation of its eventual disappearance. The combination of the decelerating pattern and the spatial expansion adds to the overall predictability and reinforces the listener's perception of the objects' trajectory within the virtual space of the piece.

[14] Virtual space (defined as the *inner* space of the piece) is the space created by the composer inside the piece itself, no matter the physical place of the execution. The best way to understand the characteristics of this space is by listening the piece in a location lacking of acoustic space. It is not possible to create virtual space without digital plugins during the creating and mixing step of a work. So, from the loudspeaker both the primary (direct sounds) and the secondary (indirect sounds) are played. With the information brought by the latter, our auditory system is able to recreate the space where the sounds are virtually placed and moved inside a composition (Ratto 2019, p. 20).

A. Repetition

Repetition in music serves as a powerful tool that not only captivates the listener's attention but also plays a fundamental role in shaping their expectations. By incorporating repetitive elements, composers and performers can establish familiar patterns, structures, and motifs that guide the listener's anticipation of what comes next. These repetitive elements create a sense of expectation, as the listener subconsciously anticipates the recurrence or variation of familiar musical ideas. Understanding the relationship between music repetition and expectation provides valuable insights into how composers manipulate these elements to evoke emotional responses and engage listeners on a cognitive level.

Returning to the piece No Funk Allowed, the concept of repetition is not only present in terms of notes but also in terms of rhythmic gestures, making it a fundamental element of the composition. By incorporating specific repeated patterns and rhythmic figures, the composition prompts the listener to rely on their expectations to anticipate the musical progression. These recurring patterns create a sense of familiarity and establish a framework for the listener to follow, enhancing their ability to predict and anticipate the unfolding of the music. However, relying solely on the repetition of the same material can quickly lead to a decrease in uncertainty regarding the anticipation of subsequent events. When patterns become too predictable or repetitive, the listener's sense of surprise or novelty diminishes, potentially resulting in a less engaging musical experience. To maintain interest and prevent the system from reaching a state of low uncertainty, it is crucial to introduce variations, deviations, or unexpected elements within the repetitive structure of the piece. Indeed, in order to maintain a balance between expectation and uncertainty, No Funk Allowed has been

meticulously crafted, particularly in terms of the repetition of rhythmic figures. In example A (see fig. 14), the consistent pattern of sixteenth note triplets with a rest on the downbeat is altered at two specific points ⏯.

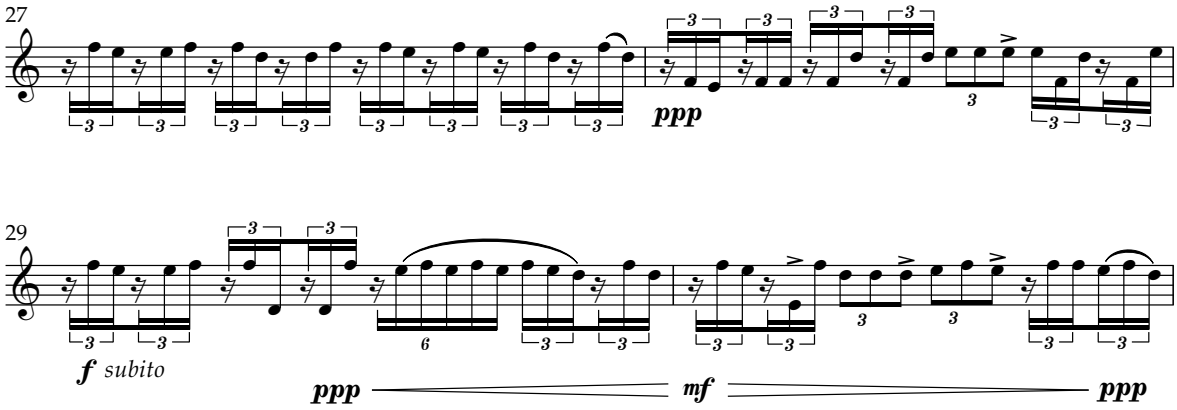

Fig. 14 - Pattern Interruption A

Firstly, on the third beat of bar 28, the pattern is interrupted. Secondly, on the second to third beat of bar 30, the alteration occurs again. At these points, the regular sixteenth note triplets are replaced by eight note triplets that begin directly on the beat, without any rest. In Example B (see fig. 15), the rhythmic structure is characterized by a "swung" staccato pattern featuring dotted eighth and sixteenth notes. However, this pattern is intentionally interrupted, as exemplified for example by the introduction of a legato phrase using thirty-second notes at bar 85. Despite this interruption, the overall rhythmic framework is meticulously constructed to evoke a pronounced swing feel, resembling a well-oiled "machine." Nevertheless, this sense of fluidity is momentarily disrupted at bar 86, akin to a malfunctioning gear within the aforementioned “machine” ⏯.

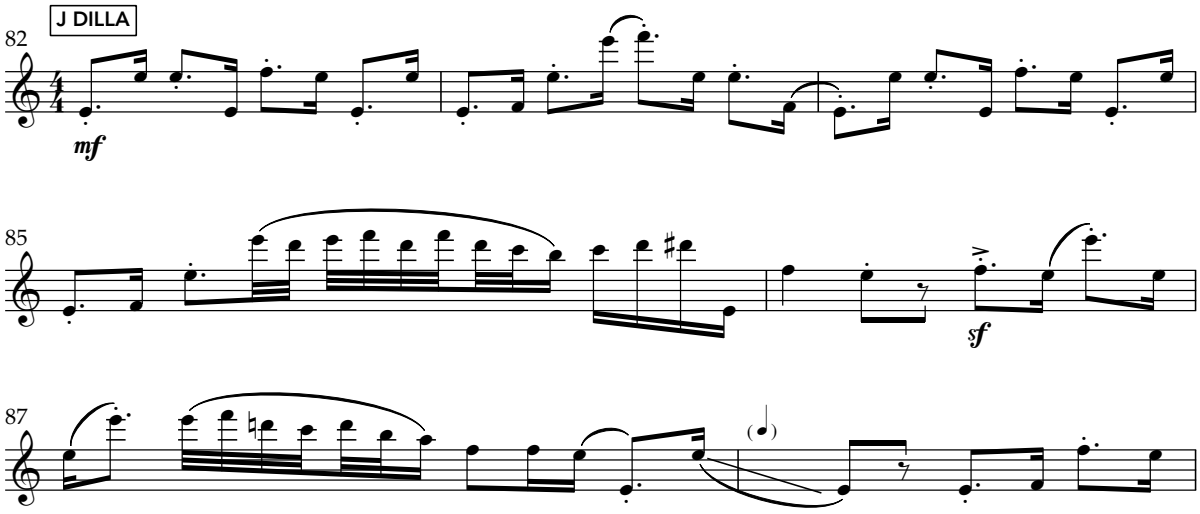

Fig. 15 - Pattern Interruption B

By deliberately introducing a percentage of deviation within the repetitive structure, the piece ensures that there is always an element of surprise or unpredictability. This careful balance allows the listener to engage with the music, keeping their anticipation active while also providing moments of unexpected variation to sustain their interest.

Consider the seemingly straightforward concept of repetition and its implications, one perspective, put forth by Meyer, suggests that repetition engenders an expectation for change. However, Narmour offers an alternative viewpoint, asserting that repetition fosters an expectation for further repetition. As Margulis (2014) affirms, this divergence between two theorists, particularly noteworthy since Narmour was a student of Meyer, sheds light on an intriguing aspect. It becomes apparent that reducing the concept of repetition to either continuation or change is overly simplistic. The interpretation of repetition depends on various factors, including the specific type of expectation being considered, the contextual

framework in which the repetition occurs, and the nature of the element being repeated. To fully grasp the multifaceted nature of repetition and its impact, a nuanced understanding of the intricacies involved is required.

An intriguing aspect of repetition is its versatility across different mediums and musical styles, ranging from classical compositions to popular music and even within the realm of acousmatic music. Despite acousmatic music being known for its exploratory and unconventional nature, repetition still finds a place within its sonic tapestry. In the context of acousmatic music, repetition takes on a distinct character and purpose, often diverging from the traditional notions found in other genres. In acousmatic music, repetition serves as a captivating tool for manipulating auditory perception and engaging the listener in a unique manner. The repetitive elements in acousmatic compositions can be highly abstract and experimental, challenging traditional notions of melodic or rhythmic repetition found in more conventional genres. Repetition in acousmatic music often manifests through the recurrence of sound fragments, sonic textures, or gestural motifs. These repeated elements can be transformed, fragmented, or altered over time, creating intricate sonic narratives and evoking a sense of sonic journey. Moreover, in lack of a specific system of harmony and melody, repetition in acousmatic music not only can act as a structural device but also plays a pivotal role in shaping the listener's expectations. The repetition of certain sonic elements establishes familiarity and invites the listener to actively engage with the composition, discerning subtle variations or transformations that occur within the repetitive framework.

For example, in the acousmatic piece SHOMO, repetition is utilized as a device to manipulate the listener's expectations and induce predictability. Two distinct musical

elements contribute to this effect, with one being the textural drone-like layer that establishes the foundation of the composition. This layer provides a familiar backdrop against which the listener can easily find a sense of familiarity and stability. Despite the evolving nature of this sonic layer over time, its changes are subtle and stretched out, allowing the listener to rely on it as a highly predictable and familiar element. The gradual transformations within the layer maintain a sense of continuity and reinforce the listener's expectation of its presence, further contributing to the overall predictability of the composition. The second repeated element in SHOMO is characterized by digital/glitch-like regular impulses that emerge immediately after the initial portion of the extensive fade-in at the beginning of the piece ⏯. The repetitive and regular rhythmic element strongly encourages the listener to engage with their expectations and anticipation. Its constant and consistent repetition establishes a sense of familiarity and reduces uncertainty, leading the listener to anticipate its continuation throughout the composition. This predictable nature of the rhythmic gesture creates a framework for the listener's interpretation and involvement, while also setting the stage for potential variations and deviations that may arise later in the piece. When this rhythmic pattern undergoes a sudden and brief change, it disrupts the previously established low uncertainty and high predictability. This unexpected alteration creates a strong deviation effect, resulting in a moment of surprising and unforeseen musical impact. The listener's anticipation is momentarily shattered, leading to a heightened sense of surprise and intrigue within the composition. This interplay between repetition and variation stimulates the listener's cognitive processes, encouraging them to delve deeper into the sonic landscape and discover new nuances with each recurrence.

> […] Novel musical events are less predictable than repeated ones. This suggests that, beyond any stylistic and contextual considerations, musical novelty is more unexpected than musical repetition (Taher 2016, p. 316).

If we consider the piece MEMORIA instead, the low ostinato rhythmic pulse creates a form of repetition, establishing the musical pace of the piece in the first section from 00:29 to 04:20 ⏯. This repetition typically instills an expectation for its continuation, serving as a strong identifier of the piece. However, it brings forth two main challenges. Firstly, how to sustain interest while utilizing this repetition for not losing momentum. And secondly, what occurs when this element is removed, resulting in a significant contrast akin to a pronounced shift in the piece. In addressing the first challenge specific to MEMORIA, the rhythmic ostinato has been subtly manipulated multiple times to maintain a sense of momentum for the listener, while avoiding mere copy-paste repetition that may lead to very high predictability and boredom. Additionally, strategic moments have been crafted where this element is either removed or lowered for a sufficient duration, introducing interesting variations without risking a loss of momentum. The rhythmic ostinato establishes a sense of familiarity from the outset, and the first section revolves entirely around this sonic environment. The compositional challenge lay in playing with this element while continually introducing new variations of it. This balancing act ensured that while the piece maintained its familiarity, it also remained fresh and engaging by integrating constant new elements. The ostinato groove introduced at the beginning resurfaces later at the end of the piece, providing closure by returning to something familiar, similarly to the diapositive sound previously mentioned.

B. Habituation

Habituation is widely recognized as one of the fundamental and most basic forms of learning. It can be formally described as the gradual reduction in responsiveness that occurs as a consequence of repeated exposure to a particular stimulus (Huron, 2006). This phenomenon can be observed across various sensory modalities, but for the purpose of this discussion, we will focus on auditory habituation. When an eliciting stimulus, such as a specific sound or sound pattern, is repeatedly presented to a listener, a fascinating process unfolds. Initially, the listener responds to the stimulus with full attention and sensitivity. However, as the stimulus is repeated over time, the listener's level of responsiveness gradually diminishes. This decrement in response can be attributed to the process of habituation. The underlying mechanism of habituation involves the brain's ability to recognize and categorize incoming stimuli. Initially, the novel stimulus captures the listener's attention, and the brain devotes significant cognitive resources to process and analyze it. However, as the stimulus is encountered repeatedly, the brain recognizes its familiarity and assigns it a lower priority. Consequently, the listener's attention wanes, resulting in reduced responsiveness. This process of habituation plays a crucial role in our daily lives. It enables us to filter out irrelevant or repetitive information, allowing us to focus on novel or significant stimuli. Imagine the constant barrage of sounds we encounter throughout the day, from the hum of appliances to the background chatter in a crowded environment. Without habituation, our cognitive resources would be overwhelmed, hindering our ability to discern important sounds from the mundane.

Another influential factor in the process of habituation is the predictability of the stimulus. But, when a listener becomes accustomed to a series of identical stimuli, the introduction of a singular novel stimulus, symbolically represented as A A A A A A A B, has a tendency to capture the listener's attention once again. Furthermore, the presence of this novel stimulus can disrupt the listener's habituation to the initial stimulus. As a result, if the listener is subsequently exposed to the original stimulus again, their response is likely to resemble that of someone who had not yet habituated to it. This intriguing phenomenon is known as *dishabituation*, and the novel stimulus responsible for disrupting the habituation process is referred to as a *dishabituating stimulus* (Huron, 2013).

Another interesting aspect of habituation lies in its versatility as a compositional tool, transcending the boundaries of medium-specific composition. Whether one is composing for traditional instruments, delving into the realm of electroacoustic music, or exploring the possibilities of acousmatic compositions, habituation can be harnessed to create captivating sonic experiences. When employed as a compositional technique, habituation offers composers a means to manipulate the listeners' perceptual responses. By carefully structuring the presentation of stimuli and their subsequent repetitions, composers can shape the way listeners engage with the musical material. Through repeated exposure to specific musical elements, the listeners' responsiveness gradually diminishes, allowing the composer to guide their attention towards other aspects of the composition. In the realm of acousmatic music, habituation can be employed in a myriad of ways. For example, through the strategic repetition and manipulation of sound impulses, composers can gradually reduce the listeners' responsiveness to specific sonic elements. As listeners become habituated to these elements,

the composer can introduce new sonic material or variations, effectively reorienting the listeners' attention and creating a sense of dynamic progression within the composition. By carefully designing the presentation and repetition of sound events in space, composers can guide listeners through immersive sonic journeys. Through the skillful interplay of familiar and unfamiliar sounds, composers can disrupt habitual expectations, prompting listeners to reevaluate their sonic perceptions and engage with the composition on deeper levels. On the idea of habituation and stimuli in space, Huron presents an experimental method tested in his research, the study is called “Head-Turning Paradigm”.

> When we hear an unexpected sound, we will often turn our head in the direction of the sound. This basic reflex is referred to as the orienting response. If a stimulus is repeated, after a while an individual will habituate to the stimulus and fail to orient to it. If a change is then made to the stimulus, and if the change is sufficiently novel, then a listener might reorient to the sound. This reorienting to a modified stimulus is called dishabituation (Huron 2006, p. 49).

Taking from Huron's research on habituation and dishabituation, we can revisit the piece SHOMO and its repeated rhythmic element as an illustrative example. The initial exposure to the repetitive rhythmic pattern in the piece may induce habituation, where the listener becomes accustomed to the familiar and predictable nature of the pattern. However, through intentional variations or disruptions introduced within the composition, a state of dishabituation can be achieved. These unexpected changes serve to capture the listener's attention, breaking the established pattern and re-engaging their interest and anticipation. By employing the principles of habituation and dishabituation, SHOMO effectively plays with the listener's expectations, creating moments of surprise and maintaining their engagement throughout the piece. As previously mentioned, the repetition pattern in SHOMO is

periodically and abruptly interrupted, resulting in a powerful deviation. These sudden breaks in the established pattern serve as moments of significant contrast and surprise within the composition. By intentionally introducing these deviations, the piece challenges the listener's expectations and creates a heightened sense of unpredictability. In the context of the acousmatic medium, the sudden change in SHOMO not only manifests as a shift in the musical figure but also extends to the virtual space of the composition. This means that the alteration in the sonic elements is not limited to a mere change in musical patterns but is also reflected in the spatial positioning and movement of the sounds within the virtual environment. The sudden shift in the inner space enhances the impact of the deviation, creating a multidimensional experience for the listener. When a change in the steady left-right stereophonic pattern occurs in SHOMO, it is accompanied by impulses that create different trajectories within the virtual space of the composition ⏯. These spatial variations not only impact the overall sonic experience but also influence the listener's orienting response. Whether the piece is being listened to through a pair of loudspeakers or headphones, the altered trajectories and spatial movements of the sound sources contribute to the listener's sense of immersion and engagement. Indeed, in an acousmonium setup within a

concert hall, where the listener is physically immersed in the electroacoustic space[15], the concept of the head-turning paradigm can be expanded. The spatial distribution of the loudspeakers array allows for a more dynamic and interactive experience, as the listener actively reorients themselves to the sounds and their positions within the electroacoustic/ acoustic space. The listener's head-turning movements and engagement with the spatialized sound sources contribute to their perception and understanding of the composition. This heightened level of physical immersion and interaction adds another layer of complexity and engagement to the listening experience, as the listener actively navigates and explores music expectation enhanced through the use of space.

[15] The electroacoustic space (defined as the *external space* of the piece) expands the acoustic space by using electronic devices. Here the loudspeakers become the new sound source. It is important to remember that a loudspeaker can not be compared to a traditional instrument, since it tends to be a neutral source, not identifiable with a specific timbre (although every loudspeaker has its own technical properties, its proper shape and its own material), with a wide frequency range and reproducer of all type of sounds (concrete, synthetic, instrument recorded, etc.). Furthermore, through the loudspeakers it is possible to: divide the space from the sound source, focus more sounds in the same spot, distribute the same sound source in different places at the same time or break up a sound by placing its components in different spots (Ratto 2019, p. 19).

IV. Predictability and Surprise

A. Schemas

Huron argues that when individuals form expectations about the world, they often tend to generalize based on past experiences. This tendency can be attributed to the existence of schemas, which are encapsulated models of behavior or perception specific to particular situations or contexts. In the realm of music, various environmental cues, both auditory and non-auditory, play a crucial role in distinguishing different musical genres. For example, as explored also in topic theory[16], instrumentation, particular meters, melodies, etc., can serve as one such cue. When trained listeners approach any piece of music, they have certain schemas of expectation:

> […] Western-enculturated listeners have a tendency to start by assuming a major mode. Western-enculturated listeners have a tendency to assume a binary meter. Even before the first sound is heard, listeners are prepared to invoke several musically pertinent "default" expectations. […] Listeners are remarkably adept at classifying the type of music in just 250 milliseconds. experienced listeners can activate a schema appropriate for the genre of music they are hearing in a very short period of time (Huron 2006, p. 217).

Building upon the concept of schemas, it becomes intriguing to explore the specific schema expectations that trained and non-trained listeners of acousmatic music activate when encountering a new composition. As we have mentioned before, listeners of electroacoustic

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[16] Topic theory in music refers to a conceptual framework that explores the association between musical elements and extramusical concepts, such as emotions, characters, or cultural references. It suggests that certain musical features, such as melodic patterns, harmonic progressions, or rhythmic structures, can evoke specific associations or "topics" in listeners' minds. These topics can be culturally defined and can vary across different historical periods and musical genres. Topic theory provides a way to analyze and understand how music communicates and expresses meaning beyond its purely sonic qualities, offering insights into the relationship between music and other forms of human experience.

or acousmatic music develop certain archetypes through their exposure to a repertoire, which in turn shapes their expectations. However, when it comes to generalized schemas, similar to how traditional music listeners tend to assume a binary meter and a major mode when approaching a composition, it would be fascinating to investigate if there are other commonly shared schemas present in the realm of new music repertoire. This leads us to the question of whether there are additional prevailing schemas that influence how listeners perceive and anticipate new musical works for example in the acousmatic genre. Unraveling this inquiry would require future studies that employ experiments and tests involving a diverse range of listeners. By conducting such investigations, valuable insights can be gained to shed light on the presence and activation of common schemas within the ever-evolving landscape of acousmatic music. These endeavors hold the potential to provide meaningful answers and further enrich our understanding of the perceptual dynamics at play in the acousmatic realm.

B. Creating Predictability

From the composer perspective, it becomes captivating to explore the process of creating patterns of predictability, particularly in the context of new music that doesn't rely on pre-established schemas, as discussed earlier. In genres like acousmatic music, where composers have the freedom to devise novel schemas and grammatical structures for each piece, an intriguing question arises: are there strategies to assist listeners in grasping these unique schemas and grammatical frameworks from the outset, enabling them to navigate the composition without expending time and effort in search of familiarity? As composers embark on the creation of new music, they face the challenge of striking a balance between novelty and comprehensibility. While the absence of preexisting schemas may grant

composers greater creative freedom, it also presents an opportunity to introduce fresh and unconventional musical elements. However, without some degree of predictability, listeners may struggle to comprehend or engage with the composition effectively. By strategically incorporating recognizable elements, composers can create a sense of continuity and structure, enabling listeners to develop a mental framework that aids in comprehending and following the musical progression. Additionally, composers can employ progressive development techniques to gradually introduce and expand upon their unique schemas and grammar throughout the composition. By structuring the piece in a way that allows listeners to gradually familiarize themselves with new musical elements, composers enhance the listener's ability to form expectation. This progressive unveiling of unfamiliar musical language might help listeners establish a cognitive foothold within the composition, enabling them to navigate the evolving sonic landscape with greater ease.

Based on this concept, SHOMO and No Funk Allowed aim to introduce diverse listeners to a fresh and personal grammar of music. They accomplish this by providing explicit rules from the beginning, equipping listeners with the necessary tools to interpret and embrace the inherent surprises. Both pieces were meticulously crafted also with the intention of delving into the parameters of music expectation explored in this research. These compositions serve as artistic experiments, actively engaging the listener's anticipation and perception through the careful manipulation of musical elements. In SHOMO, the repetitive rhythmic patterns and their periodic interruptions create a dynamic interplay between familiarity and surprise. The composition plays with the listener's expectations, employing repetition as a foundation and then introducing unexpected deviations that challenge and captivate their attention.

Similarly, No Funk Allowed utilizes tone-center, repetition, variation, and rhythmic gestures to shape the listener's musical experience. Both compositions exemplify the intent to actively manipulate music expectation. Through their distinct approaches, hopefully SHOMO and No Funk Allowed demonstrate some of the creative possibilities that arise when composers consciously explore the boundaries of music expectation in their artistic works.

C. Types of Predictability

As previously mentioned, listeners develop a range of schematic expectations through repeated exposure to the statistical relationships between different elements in music. Manipulating these expectations can have a profound impact on the emotional experience of music. In his works between 1987-1994 Bharucha presented two types of expectations: schematic and veridical. Schematic expectations arise from familiarity with typical practice, but veridical expectations arise from familiarity with what happens in a specific piece.

> A piece of music in a familiar genre generates expectations based on implicit knowledge about common features of the genre […] Schematic expectation are automatic, culturally generic, and develop from assimilation of the music of a genre over years of experience. Veridical expectations refer to the actual next event in a familiar piece even though the event may be schematically unexpected […] (Stevens, Byron 2008, p. 18).

In his work, Huron develops the concept further, presenting four types of predictability. We'll present the four categories as follows.

1. Schematic Predictability: in this approach, the music is deliberately crafted to align with the preexisting schemas that listeners naturally bring to their listening experience. By

conforming to these familiar schemas, the music resonates with the listener's expectations and provides a sense of familiarity.

2. Dynamic Predictability: with dynamic predictability, the music is constructed to evoke accurate and specific expectations unique to the composition itself. Various techniques can be employed to enhance predictability, such as thematic and motivic repetition, the use of ostinato, and the creation of sequences. However, one of the simplest and most effective techniques is the strategic repetition of substantial musical segments within the composition.

3. Veridical Familiarity: a straightforward method to increase predictability is to encourage listeners to engage with the music repeatedly. By promoting repeated exposure, listeners become more familiar with the musical material, which in turn enhances their ability to anticipate and predict upcoming events within the composition.

4. Conscious Predictability: in the realm of conscious predictability, the music is organized in a manner that allows perceptive and knowledgeable listeners to consciously infer future musical events as the composition unfolds. Through attentive listening and cognitive processing, these listeners are able to anticipate musical developments based on their understanding of the underlying musical structure and elements.

There is a piece that includes all four of these categories: Ravel’s Bolero. The rhythm would have a schematic predictability for those with Spanish culture who would recognize the rhythm as one of the dances familiar to them, thus giving them a sense of schematic predictability. The bolero itself creates dynamic predictability through repetition, as the new

listener quickly grasps the rhythmic pattern that repeats infinitely. Furthermore, since this piece is famous and potentially listened to many times by listeners, it also gains veridical familiarity. Lastly, the piece is design so that gains conscious predictability too. But at the same time, despite this piece adopting a rhythmic motif of a Spanish dance, and even with the title, it still manages to make this theme its own and unique to Ravel's composition. In other words, for many listeners, that is Ravel's Bolero, not just any bolero.

To illustrate the concept of dynamic predictability in an acousmatic piece, we can discuss Mobyrei. The composition is divided into three sections, the middle section is characterized by the presence of an ostinato sequence that persists throughout the entire duration of the section ⏯. In fact, this ostinato sequence forms the core and essence of the section itself. In Mobyrei, the repetitive rhythmic pattern of the ostinato is obsessively reiterated throughout the section. The entire narrative of this section revolves around the ostinato, which originates as a small point in the distant depths of the virtual space. Gradually, it moves closer and closer to the listener's perspective, accompanied by a constant and steady crescendo in amplitude. This progression builds up to a climactic moment, where the sound is at its closest and loudest point to the listener. Subsequently, the process reverses, and the sound gradually recedes, becoming softer and receding further away. Indeed, the construction of this section in Mobyrei is deliberately designed to evoke precise and distinct expectations that are specific to the composition. Because of the repetitive nature of the ostinato, the listener becomes accustomed to its pattern and anticipates its development. This establishes a particular set of expectations that are unique to this piece, as the ostinato's trajectory towards and away from the listener's perspective creates a sense of spatial and dynamic movement.

Certainly, during the initial listening experience of Mobyrei, the listener can readily discern the underlying structural framework of the middle section. This discernment allows for the quick development of a strong sense of predictability. In this particular composition, the narrative quality of the musical gestures further enhances this predictability. As the ostinato sequence unfolds and progresses in its repetitive pattern, the listener can anticipate its development and trajectory, thereby reinforcing the sense of predictability. This interplay between the construction schema, the listener's perception, and the narrative attitude of the musical gestures contributes to the overall immersive and engaging nature of the piece.
By employing the four different approaches to predictability, composers can manipulate the listener's expectations and create engaging musical experiences that balance elements of familiarity and novelty. Each approach offers unique strategies to guide the listener's anticipation and enhance their overall comprehension and enjoyment of the music.

D. Creating Surprise

Starting from the four categories for creating predictability, Huron presents techniques of surprise that can be extracted for the same categories.

1. Schematic surprise: in this case, the music is intentionally structured in a way that defies the established schemas that listeners have developed through their previous listening experiences.

A commonly encountered form of schematic surprise is exemplified by the deceptive cadence, characterized by the V-vi progression in a major key. In this progression, the expected resolution of the dominant V to the tonic I is subverted, instead leading to other chords, often the submediant vi. Despite the long-standing familiarity with the deceptive

cadence, it continues to evoke a sense of schematic surprise. One reason for this is that the V-I cadence, in addition to being a perfect cadence with the same attraction as the downbeat previously discussed, is also statistically more prevalent in music, establishing it as a normative schema from which the deceptive cadence deviates.

2. Dynamic surprise: in this case, the music is crafted in a manner that creates specific expectations within the composition itself, only to then deliberately subvert those expectations.

As previously mentioned, the use of Beethoven-like abrupt change of dynamic can be an effective dynamic surprise. Building upon this concept, Huron offers another analogous example: in Haydn's Surprise Symphony (no. 94), one notable instance of dynamic surprise is found in the quiet second movement. The movement, marked piano throughout, establishes a serene atmosphere typical of slow symphonic movements. After presenting the main theme in its entirety, the surprise version emerges in the second statement, featuring a fortissimo dominant chord on the second beat. To differentiate from the “what-related” violation of dynamic expectation in Haydn’s, Huron explores another example on “when-related” violation by mentioning a particular time anticipation of the extremely famous principal theme of Beethoven’s Ode to Joy. The surprise element emerges through a single syncopated moment in Beethoven's composition, precisely when the fourth phrase initiates a quarter-note before the downbeat. This unforeseen occurrence transpires after Beethoven has already presented the phrase in its unsurprising form, with each of the preceding three phrases commencing on a downbeat. For a listener encountering the piece for the first time, the

anticipated expectation is that the fourth phrase will commence on the downbeat of the subsequent measure (see fig. 16).

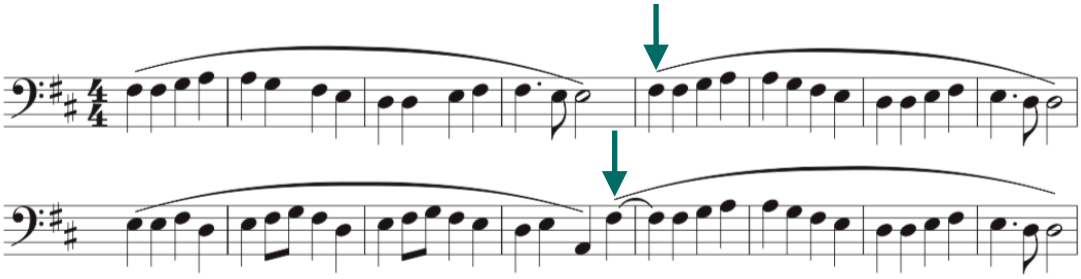

Fig. 16 - Ode to Joy Theme

3. Veridical surprise: surprises can also arise by challenging the listener's existing understanding of a particular musical work. These surprises may occur through performance errors, misquotations, or intentional parodies, for instance.

Veridical surprise can also arise from unfamiliar interpretive nuances that introduce unexpected elements into familiar works. One notable example is the fusion of Bach's compositions with swing, where classical chamber ensembles start by playing a recognizable Bach piece and then abruptly shift the rhythm from an even-eight pulse to a swinging tempo. Similarly, in the realm of jazz, many musicians explore well known tunes from the pop-rock repertoire, incorporating intriguing harmonies and experimenting with variations in tempo, feel, and chord substitutions. An excellent illustration of this is jazz pianist Brad Mehldau, who has covered songs by Radiohead and The Beatles, infusing them with his unique jazz style.

4. Conscious surprise: in this case, the music guides a knowledgeable listener to consciously anticipate a forthcoming event, only to intentionally undermine or defy that expectation.

Specifically talking about repetition and surprise, Taher (2016) states that “each reiteration of a musical pattern increases the listener's ability to predict it”, interrupting repetitive patterns can create surprise. Consequently, this not only allows the composer to avoid habituation but also enhances the expressiveness of their work.

> Repetition and novelty are complementary concepts that have occupied a central place in the literature on musical expectation. Each reiteration of a musical pattern increases the listener’s ability to predict it, especially when the repeated fragment is short […] (Taher 2016, p. 316).

In regards to surprise, Taher also adds that novel musical events are inherently less predictable compared to repeated ones. This suggests that, regardless of stylistic and contextual factors, musical novelty brings about a higher level of unexpectedness than musical repetition.

V. Conclusions

Throughout this essay, we have delved into the intriguing realm of music expectation and its implications for composers and listeners. By exploring various perspectives and theories, we have gained valuable insights into the role of familiarity, surprise, and compositional tools in shaping musical experiences.

One key realization is the significance of the composer's perspective in navigating music expectation within unfamiliar grammar and creating meaningful surprises. Moreover, we have attempted to extend the fundamental concepts of music expectation, which were originally proposed in the realm of traditional Western music, to repertoire that differs from the traditional tonal framework. This expansion has hopefully opened up new ways for composers to think about non-tonal and acousmatic music. Drawing upon the concepts explored, we have also examined compositions such as No Funk Allowed, SHOMO, and MEMORIA as practical examples of applying these ideas.

Looking ahead, this research on music expectation hopefully opens the way for future possibilities and research. By continuing to explore and develop innovative approaches in composition, we can further enhance the listener's engagement and appreciation of non-tonal and acousmatic genres. May this research inspire further investigations and artistic endeavors, propelling the exploration of music expectation into exciting and uncharted territories.

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