Influence of “indeterminate music” on visual art: 
a phenomenological, semiotic and fractal exploration

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Abstract. Indeterminacy in music, a well known neo-avant-garde approach of composing sound where some features of a musical work are left open to chance or to the interpreter's free choice, became noticeable among some American music composers such as John Cage, Earle Brown, Morton Feldman and Christian Wolff in the mid 20th century. Simultaneously, a group of artists from the West created “abstract expressionism” in visual arts, which showed a strong resemblance with this “indeterminate music”, both using two kinds of abstract languages. The commonality among these two art forms is the free improvisation of creative activity. The correspondence between the indeterminate music induced emotions and the depicted emotional contents in paintings is a relevant area which is still scientifically unexplored. To investigate the same, we conducted a case study where a visual artist listened to four music clips composed by the above mentioned musicians and created four paintings. The visual artist is strongly inspired by the abstract expressionist methods and these methods lend well to inspirational work based on listening to indeterminate music. To understand the nature of intermediality, if any, that exists between “indeterminate music” and visual imagery, the artist’s phenomenological interpretations of the process was compared with detailed semiotic analysis of specific musical and visual elements and the nature of their relatedness. Fractal analysis in the form of Detrended Fluctuation Analysis (DFA) was also done on both the acoustic waveforms of the chosen music clips and the corresponding paintings to explore possible correlations. Some unique findings yielded from the analysis, which hint toward strong correlation between the prominent musical features of indeterminate music and the prominent visual features of the paintings inspired by them. This novel study has the potential to offer both new methodology as well as better understanding the features of intermediality between “indeterminate music” and visual art.

Keywords: Fractal analysis, Semiotic analysis, Indeterminate Music, Intermedial relationship, Visual arts

1. Introduction

In context of aesthetic sensation, the category of ‘sound’ is often divided in two: ‘noise’, which is chaotic, offensive, and strange; and ‘music’, which is harmonious, resonant, and divine. These opposing concepts are brought together in the occurrence of experimental Noise Music which is “indeterminate” in construction [1]. Often such experimental music is characterized by harsh frequencies and high volume. Many people would agree that the genre can be harsh, discordant, and unlistenable. Such music presents a ‘symbolic inversion’ [2] of traditional musical language by being chaotic and inharmonic. But the important aspects are that, what kind of emotions are evoked, how meaning-making takes place by such “indeterminate music” and what are the relationships between “indeterminate music” and visual imagery? To investigate these questions, we focused on: (a) the musical indeterminacy which has profound connection with Heisenberg’s Uncertainty principal of
quantum physics, (b) interpretation of the indeterminate music which involves Husserl’s *Phenomenological Reduction* technique of the listener, and (c) the intermedial relationship between musical features and visual imagery.

1.1. Indeterminacy in music

What is indeterminacy in music is a fundamental question. The possible answers of this question could be analyzed from three different perspectives such as (i) subjective auditory indeterminacy (ii) indeterminacy from the point of view of performance and (iii) indeterminacy in musical composition. In this context we must mention *The Gabor Matrix* which was named after its inventor, Dennis Gabor, who began his revolutionary investigation of “subjective acoustics” by focusing on an apparent deficiency in the standard account of hearing [3]. In contrast to the observations earlier done by Georg Ohm and Hermann von Helmholtz (that the ear performs a Fourier analysis of sounds by calculating the relative intensities of different spectral frequency components, which are then recombined in the human brain) Gabor argued that the spectral components under Fourier analysis are perfectly sinusoidal and infinite in duration, which make them fundamentally incapable of accounting for the inherently temporal dimension of auditory experience [4]. As a solution he proposed a granular theory, in which individual sounds could be viewed as functions of “elementary signals,” each of which is describable by an “effective duration” and an “effective bandwidth,” which are equivalent to the mean square deviations of the corresponding energy distributions from the average values of time and frequency, respectively [5]. He also suggested that the effective duration and effective bandwidth of an elementary signal are inversely proportional to each other [3], thereby importing a degree of inherent “uncertainty” into the foundations of psychoacoustics [4]. This approach was highly influenced by contemporary mathematical formulation of quantum mechanics, and in particular on Werner Heisenberg’s time-energy uncertainty principle [4,5] which is also referred to as the “principle of indeterminacy,” [4, 6-10].

Though it is believed that quantum mechanics stimulated new music among young European composers in the 1950s, in reality, the formative uses of the term “indeterminacy” began to emerge most prominently in America, beginning with the writings of Christian Wolff. While analyzing some of his contemporary composed works by various American and European composers Wolff characterized them as containing “a gamut of degrees of indeterminacy that are left to the performer’s choice,” [11] and he believed that John Cage’s Music for Piano series involve “large areas of indeterminacy in respect both to composition and performance”[3]. Following Heisenberg’s ideas Wolff connected the term “indeterminacy” with quantum physics. Wolff used a common term to make distinction between indeterminacy in respect to composition and indeterminacy in respect to performance which hinted towards an underlying similarity that unites these two types [12].

1.2. Phenomenology of music and visual arts

The term Phenomenology came from two Greek words – (i) “Phainomenon” which means appearance and (ii) “logos” which means study or reason. Simply, how things or phenomena appear to our awareness (in terms of our subjective experience) is known as Phenomenology. As per the opinion of the pioneer of Phenomenology Edmund Husserl, through Phenomenological reduction we are able to know and understand the essence or meaning of things as they appear to us [13]. From the standpoint of a phenomenological attitude, the nature of music or understanding of music depends upon how an individual experiences music. Husserl added significant new knowledge into the consciousness of a listener during perception of sounds and sequences of rhythms. Analysing the perception of a single sound and a sequence of sounds within a melody Husserl [14] exemplified or need to rethink the perception of musical time and rhythms in particular. Boenn [15] demonstrated the contribution of Husserl’s phenomenology on music analysis and composition by scientifically exploring how musical perception is based on the conscious reduction of acoustic and spatiotemporal diversity into unity as well as On the other hand, in the field of visual arts, a few researchers have attempted to understand
visual arts through phenomenological perspectives. Dahl [16] attempted to develop some phenomenological reflections on the abstractions in abstract expressionist painters’ artworks, and tried to shed light on the mimetic relation between artwork and world. Another painter-philosopher Nigel Wentworth [17] significantly contributed in enriching the context of phenomenology of painting as he found that most philosophers have failed to grasp the vital steps to the creation and experience of paintings; he tried to change the situation and started practicing painting as the painter actually experiences it.

1.3. Connection between indeterminate music and abstract expressionism

The connection between indeterminate music and abstract expressionism is significant area to understand the present study where the term “free improvisation” connects these two domains. “Free improvisation” is a term which has often been used in context of a form of music-making that first emerged in the 1960s among the U.K. composers and groups such as the Spontaneous Music Ensemble, Cardew, Bailey, and AMM. In an article, Sansom [18] defined “free improvisation” analytically. Sansom’s article explored “free improvisation” as corresponding with Abstract Expressionist art movement. He mentioned that the development of modern abstract art in the west provides certain noticeable and strong parallels with the musical issues already considered.

In the book *The New York schools of music and the visual arts*, edited by Johnson [19], has a clear indication that music and visual of New York during the mid 20th century had a reciprocal relationship. In a group of musical pieces known collectively as *Folio* (1952-53), Earle Brown started a landmark sequence of explorations in graphic notation of music. The musical composition entitled 1953 features a kind of “time notation” in which the physical length of the music-note heads correspond to their intended durations in musical time. It demonstrates Brown’s interest in integration sight with sound. Another music piece in the *Folio* set, December 1952, takes a far more revolutionary step in this path. The score consists exclusively of straight vertical and horizontal lines, drawn with slightly different thicknesses, which Brown distributed arbitrarily onto a single white page. The improvisational element of December, of course, connects this music composition directly to many abstract expressionist painters who embraced spontaneity, freedom and accident in their art work. Visually, Earle Brown’s this graphic notation itself most strongly resembles early artworks of Piet Mondrian that feature similarly abstract arrangements of horizontal and vertical lines.

1.4. Overview of this work

Based on the commonalities mentioned above and combining them with artistic freedom, if someone allows a spontaneous, free-flowing response to such indeterminate music, will that art show tangible marks of influence/resemblance, or will it not indicate any such pattern? The present study attempts to search for the possible correlations (if any) between four self chosen indeterminate music pieces (performed by four legendary composers of this genre – John Cage, Morton Feldman, Earle Brown and Christian Wolff) and the four paintings created by a professional visual artist who created these paintings while listening to these music pieces (these music pieces were self chosen by the visual artist himself).

Figure 1: Sample waveform of a part of “Durations 1-5” music clip by Morton Feldman.

It is expected that the emotional expression of a particular indeterminate music clip will highly influence the corresponding painting’s theme as well as related visual features. The nature of intermediality between music (especially of indeterminate genre) and the paintings inspired by
them is still a scientifically unexplored domain. To investigate the same, we took a three way approach – first we did a phenomenological study where the visual artist listened to the self chosen four music clips and the artist’s phenomenological interpretations of the music pieces as well as the process of translating the emotional or imagery experiences to visual representations were recorded/noted down. Secondly, the details obtained from the phenomenology study were compared with detailed semiotic analysis of specific musical (for the chosen four music pieces) and visual (for the corresponding paintings) elements and their relatedness. Music has a very complex nature as the different musical components are always intertwined at every instant, more so in case of indeterminate music where sudden fluctuations of pitch, intensity, timbre, and tempo make the whole acoustic waveform extremely complex and impossible to analyze using only linear and deterministic approaches. These properties resemble to that of a chaotic, self similar nonlinear system. Within a painting too, different visual elements like line patterns, colors, textures, shapes, orientations exist in an entangled manner and thus, the painting inherently possesses a certain degree of complexity. Similar to the music, the analysis of the paintings using only the linear/deterministic approaches make us lose a lot of vital information and latest state of the art chaos based nonlinear tools must be used to study the complete information of the music pieces and the paintings. Fractal analysis here assumes much significance as it can quantitatively measure the symmetry scaling present in the embedded geometry of the music and the paintings. So, in the third and final step, Detrended Fluctuation Analysis (DFA) was done on both the acoustic waveforms of the chosen music clips and the corresponding paintings to explore possible correlations between their symmetry scaling. Some unique findings yielded from the analysis.

2. Details of the experimental music and painting

An experimental phenomenological study was conducted for four music clips which are namely - Music clip (1) Early Brown’s “Novara”, Music clip (2) John Cage’s “Water walk”, Music clip (3) Morton Feldman – “Durations 1-5” and Music clip (4) Christian Wolff - Electric spring 2. In this study, the first author of this paper (Pinaki Gayen) himself is a professional visual artist who created four different paintings during listening to the above mentioned music clips. The visual artist is strongly inspired by the abstract expressionist methods of painting and believes that listening to indeterminate music can help him to create inspirational artworks based on these methods. The four paintings corresponding to the four music pieces are titled as “Wound”, “Rain in brain”, “Pandemic” and “Abandoned” respectively.

3. Detailed phenomenological study

In the phenomenological study we recorded the professional visual artist’s interpretation of these four music clips, i.e., how he experienced the indeterminate musical features and attempted to translate the resultant emotions and visual imageries into meaningful paintings. The reason for this phenomenological study is to explore the subjective interpretation of indeterminate music and whether any intermedial connection exists between indeterminate music features and the corresponding visual content depiction. His interpretations of each music clip and the corresponding painting are as follow:

3.1. Music 1: Early Brown – “Novara”

“In this music clip there are some features which are creating an unknown multidimensional space and it is in darkness. I am experiencing the dimensions and directions of the space while some new unknown sounds are appearing suddenly.”

“I played this music clip in a computer (with good quality sound system) in my room (studio). During listening to this music clip I switched off the light. During listening to this music I noticed that some sad, anger, painful and fearful memories were coming into my mind with different imageries. Some memories related to a tree stump and a lonely dog came into my mind with empathetic feelings. After these evocations of negative memories and emotions, I switched on the...
light of my room. I had a ready blank canvas (size 16 feet x 6 feet) on the wall of my room (studio) and the canvas was black. Gradually I started depicting human body (closure view) which look like skeleton on the canvas. Then I depicted a tree stump, a lonely dog, a gun, an eye and depicted wounds all over the canvas with red bold brush strokes. I did not have any previously planned idea about the depiction. Finally I gave a title of the painting which is “wound” (Figure 2).”

3.2. **Music 2: John Cage – “Water walk”**

“In this music clip there are some features that gradually increase tension. The sound appears like a huge cloud and sudden high pitch sound acts like thunder-sound. As a whole it creates an imagery of collision between two clouds, thunderstorm, lightning, and light rain. Altogether it evokes some ambiguous feeling, tension, fear and nervousness.”

3.3. **Music 3: Morton Feldman – “Durations 1-5”**

“The musical features of this music clip sounds like smooth, slow tempo and low pitch. I experienced vast emptiness through this music, because there is not much sudden high pitch sound, and there is obviously some indication of loneliness, sadness and fear. I visualized a vast death-valley where no sign of life – only skeletons all around. I mainly depicted broken, distorted, fragmented skeletons all over the canvas with some downward, curve, zigzag fragmented red brush strokes to convey the negative emotional experiences (Figure 4). I gave a title to this painting which is “Pandemic” (7 feet x 30 feet).”
3.4. Music 4: Christian Wolff - Electric spring 2

"In this music clip there are some sudden high pitch sounds, loud, fragmented, sometimes sudden silence and sometimes completely unfamiliar sounds attracted my attention. This music clip evoked an unknown fear and kind of suffocative feeling which psychologically and physiologically affected me.

Figure 5: Painting 4 related to Christian Wolff’s “Electric spring 2” (music 4) Painting by Pinaki Gayen.

This music evoked an imagery of a closed interior space where in every turn some objects appeared suddenly and the imaginary space gave a feeling of abandon. I depicted an abandoned toilet space from top view and depicted a broken skeleton, a dead cat, a urinal with red, black, sap green and yellow ochre color. I gave a title of the painting which is “Abandoned”.

4. Methodology

4.1. Pre-processing of music clips

For the acoustic analysis, the visual artist chose 5 parts (each of duration ~ 12 seconds) from each of the above mentioned four indeterminate music pieces. The shorter 5 excerpts from each piece were chosen in such a way that they contain the signature essence of that piece as well as are sufficient to communicate strong emotions. Each of the clips were then normalized to 0dB and digitized at a rate of 44.1 kHz at mono channel 16 bit format. The pitch and intensity contours for each clip was calculated and drawn using Praat [20] software.

4.2. Detrended Fluctuation Analysis (DFA) technique for analysing music clips and paintings

All the sound clips were analysed using the one-dimensional Detrended Fluctuation Analysis (DFA) technique which measures the scale of self symmetry embedded in the audio time series. This is conventionally done following the algorithm of Peng et.al [21]. For each clip DFA yields a parameter called scaling exponent ($\alpha$) which is a unique quantitative measure of the long range temporal correlations present in the auditory time series. The value of $\alpha$ is nearly 0.5 for all uncorrelated sequences, $0<\alpha<0.5$ for anti-correlated sequences, $0.5<\alpha<1$ for long range temporal correlations and $\alpha>1$ for strong correlations that are not of power law form. In this work, we applied the same DFA technique for extracting the scaling exponent corresponding to different paintings. Novel 2D-DFA algorithm is applied for this purpose following the algorithm as given in Nag et al [22]:

4.2.1. 2D-Detrended Fluctuation Analysis

This section describes the steps for computing Hurst Exponent using the two-dimensional DFA algorithm for an image $I$. The steps are as follows:

1) The profile $x_{i,j}$ is computed using:

$$x_{i,j} = \sum_{m=1}^{M} \sum_{n=1}^{N} (I_{i,j} - \bar{I})$$  \hspace{1cm} (1)

where $m = 1, 2, \cdots, M$, $n = 1, 2, \cdots, N$, $I_{i,m} = 0, 1, \cdots, 255$ is the brightness of the pixel at the coordinates $(m, n)$ of the image and $\bar{I}$ represents the mean value of $I_{i,m}$.

2) $x_{i,j}$ is divided into small regions of size $s 	imes s$, where $s$ is set as:

$$s_{\text{min}} = 5 \leq s \leq s_{\text{max}} = \min(M, N)/4$$  \hspace{1cm} (2)

$$x_{i,j} = \sum_{m=1}^{M} \sum_{n=1}^{N} (I_{i,j} - \bar{I})$$
3) An interpolating curve is computed of \( x_{ij} \) using:
\[
G_{ij}(l,s) = a_i l + b_j + c_l
\]
in the \( l^{th} \) small square region of size \( s \times s \), which can be given by using a multiple regression procedure.

4) The variance in the \( l^{th} \) small square region is computed for \( s = s_{\text{min}}, s_{\text{min}} + 1, \cdots, s_{\text{max}} \), which is given by:
\[
F_{ij}^2(l,s) = \frac{1}{s^2} \sum_{m=1}^{s+m} \sum_{n=1}^{l+n}(x_{ij} - G_{ij}(l,s))^2
\]

5) The root mean square \( F(s) \) is computed as:
\[
F(s) = \left( \frac{1}{L_s} \sum_{l=1}^{L_s} F_{ij}^2(l,s) \right)^{1/2}
\]
where \( L_s \) denotes the number of the small square regions of size \( s \times s \).

6) If \( x_{ij} \) has a long-range power-law correlation characteristic, then the fluctuation function \( F(s) \) is observed as follows:
\[
F(s) \propto s^\alpha
\]
where \( \alpha \) is the two-dimensional scaling exponent, a self-affinity parameter representing the long-range power-law correlation characteristics of the surface. \( \alpha \) has been computed for Red/Blue/Green color coordinates. Similar to the 1D DFA scaling exponent, in case of 2D surfaces also, the measurements are almost similar, i.e. when the 2D series is completely uncorrelated (Gaussian or non-Gaussian probability distribution), the calculation of the scaling exponent results 0.5, also called white noise. For anti-correlated data \( \alpha<0.5 \), and if \( \alpha>0.5 \), the data is long-range correlated.

5. Results and Discussion

5.1. Summary of phenomenology and Semiotic analysis

On the basis of the above mentioned phenomenological interpretation of the music clips and the depicted imageries in the paintings, we found some interesting correlations between music clips and the corresponding paintings. From the descriptive phenomenological interpretation given by the artist we picked up the significant musical features for each music clip and the visual features for their corresponding paintings. Thus the summary of the phenomenology as well as the detailed semiotic analysis of the music clips and corresponding paintings are reported in the Table 1.

For the music clip1 we found features like sudden fluctuation between low pitch and high pitch, fragmented and slow tempo sound which evoked mainly anger, sadness and fear. On the other hand, we noticed thick, curve, wavy, downward and fragmented lines in the painting 1 where the negative emotional contents have been depicted with yellow ocher, red, gray and black. Such dark color usage for negative emotional expressions in the painting 1 is consistent with the findings of some previous studies [23, 24]. The semiotic analysis between music clip 1 and painting 1 revealed that the musical experiences and evoked visual imageries have been represented as indexical representation to a great extent in the painting 1 as we came to know from the above mentioned artist’s interpretation that during listening to the music clip 1 some memories related to a tree stump, a lonely dog and some wounded human body came into his mind and he tried to depict the same in the painting 1. Here we get a significant amount of indexical representational content between artist’s visual imagery and the depicted painting. As we know that Tempo is one of the significant musical features and it has a major impact on emotional experience [25]. Previously some experimental studies have found that listeners have a tendency to associate faster tempo and major modes with happiness, and slower tempo and minor modes with sadness [26]. For the music clip 2 we found chaotic, loud, sudden high pitch, fragmented music features which evoked wonder, surprise, tension, fear, nervousness in the artist’s mind and he translated these feelings into painting 2 which has been depicted with wavy, curve, zigzag and fragmented lines and with deep blue, white, black color. The semiotic analysis between music clip 2 and painting 2 revealed that the musical experiences and evoked visual imageries have been depicted in the painting 2 mostly as
indexical representation and to some extent symbolic representation as the imagery of cloud, rain and thunder have been triggered by the different musical features and juxtaposed with the symbolic drawing of cerebrum and with some dialogues. It is actually mixture of indexical and symbolic representations. The contrast white and deep blue color has been used here as a symbol of wonder.

Table 1: Significant musical features of the indeterminate music pieces, associated emotions and important visual features of the paintings influenced by those music pieces.

| Musical stimuli | Emotions | Visual depiction |
|-----------------|----------|------------------|
| **Music 1**      |          |                  |
| **Sudden fluctuation** |          | Closure view of human body (male) with projected ribs; front view, profile view, back view of human body; standing and laying figures; gun; tree stump; human eye; dog; human legs; dustbin; water; scratched textures of wound. |
| pitch, fragmented, slow tempo | anger, disgust, sad, fear | Figurative elements |
| **Music 2**      |          |                  |
| **Chaotic, sudden high pitch, loud, extremely unusual fragmented sounds (not using musical instruments)** | Wonder, surprise, tension, fear, nervousness | Cerebrum of human brain; clouds; rain drops; lightning; English alphabets, words and sentences; numbers; question marks. |
| **Music 3**      |          |                  |
| **Smooth, slow tempo, low pitch, single short notes suddenly playing over the continuous background of sustained notes** | loneliness, sadness and fear | Closure view of a toilet from top; urinal; two bricks for standing in front of urinal; broken human skeleton; dead cat; cross symbol; color spots; typography. |
| **Music 4**      |          |                  |
| **Suddenly appearing high pitch, sound and continuous pitch bending towards low pitch, sudden silence, loud, fragmented suffocation** | Slowly building, cross, hazy, red, yellow | View of a toilet from top; urinal; two bricks for standing in front of urinal; broken human skeleton; dead cat; cross symbol; color spots; typography. |

In the music clip 3 we found smooth, slow tempo, low pitch, fragmented music features which evoked loneliness, sadness and fear in the artist’s mind and the painting (painting 3) for the music clip 3 shows dominating pattern of fragmented, curve, downward, zigzag lines and light blue, red, gray colors. The depicted emotional visual content has similarity with the evoked emotions by the music clip 3. The semiotic analysis between music clip 3 and painting 3 revealed that the musical
experiences and visual imageries have been represented mostly as indexical representation in the painting 3, because the artist described in the phenomenological experiences that he visualized vast emptiness, human skeletons and a death-valley while he listened to different unusual music futures. The musical evoked certain imageries and made him depict the same. It helps us to recognize the painting 3 as an indexical representational approach of his musical experiences. The artist has also depicted the musical fragmentations and musical pitch through fragmented upward and downward lines. In case of music clip 4 we found sudden single high pitch sound, sudden silence, loud, and fragmented features in the foreground of a continuous gliding from low pitch to high pitch, which evoked suspense, anxiety, fear and suffocative feelings. The corresponding painting of the music clip 4 shows dominating use of cross, hazy, fragmented, dotted lines and dominating use of red, black, yellow ocher and sap green colors. The depicted content in the painting 4 shows negative emotional expression. The semiotic analysis between music clip 4 and painting 4 reveals that the artist has depicted his musical experiences through mostly indexical and symbolic representations. Because, the artist mentioned in the phenomenological interpretations that he visualized a closed toilet space and some objects namely human skeleton, dead cat and a urinal in that space due to the sudden appearance of unusual music features. The artist depicted the imageries which evoked by the music clip 4. At the same time, the red color has been dominantly used as a symbol of fear and anxiety in the painting and the two crosses have been used as a symbol of closed space or suffocative feeling. Here we get both indexical and symbolic representational approach. However, the fragmented/isolated sound patterns were common to all four music pieces and the analysis of the four paintings revealed that fragmented line patterns were present in all the four paintings, which indicates an iconic representation of the most prominent musical feature of indeterminate music into the paintings inspired by them.

5.2. Acoustic signal analysis of the four indeterminate music clips
To compare with the artist’s phenomenological interpretations and detailed semiotic analysis, both the pitch contours and intensity contours for different parts of the four indeterminate music pieces were drawn using Praat software. In Figure 5 (a-d) the pitch contours for part 1 (red lines), part 2 (green lines), part 3 (blue lines), part 4 (yellow lines), part 5 (teal lines) of each clip are shown. Similarly, the intensity contours for the same are given in Figure 6 (a-d).

Figure 5 (a-d): Pitch contours of the chosen four indeterminate music clips.
Comparing the pitch contours for the four music clips we can see that the Music 1 (Figure 5a) features the highest and most frequent fluctuations between high pitch and low pitch ranges in all 5 parts chosen from the entire clip. In case of Music 2 (Figure 5b) the pitch contours are extremely fragmented and in most parts of the 5 excerpts chosen from this clip we find undefined pitch contours as many unusual sounds (created using various non-musical objects) accumulate to build up the entire composition. Compared to the other three pieces Music 3 (Figure 5c) features more presence of sustained pitches as evident from the pitch contours of the 5 parts taken from this piece. In the background of these sustained notes, the presence of suddenly occurring single notes is also observed. In case of Music 4 (Figure 5d) the pitch contours of the chosen 5 parts are highly different from one another (unlike the other 3 pieces), though, in 2-3 parts continuous oscillation between two adjacent notes are observed in the pitch contours as a result of the continuous pitch bending parts present in the musical piece. In other parts presence of both suddenly appearing single notes as well as small sustained notes are observed. These findings support the visual artist’s description of the musical features in his phenomenological interpretations of the four music pieces.

A comparative look at the intensity contours of the 4 music clip reveals that as per the chosen 5 parts, Music 1 (Figure 6a) features the largest and most frequent intensity fluctuations among the four experimental indeterminate music pieces, whereas Music 3 (Figure 6c) features the lowest variation in the intensity among the chosen 5 parts. Music 2 (Figure 6b) features sharp spikes and dips in the intensity contours of the 5 excerpts, again pointing towards the extremely unusual soundscape of the piece created by different musical and non-musical objects. Similar to the case of pitch contours, Music 4 (Figure 6d) also features wide variations in the intensity contours of the chosen 5 parts, where long periods of continued intensity are observed in some parts whereas the other parts fluctuations between low pitch and high pitch regions are observed. This again supports the visual artist’s viewpoint about the music pieces.

5.3. Fractal analysis of music and comparison with semiotic and phenomenological analysis
To understand the complete nature of self similarity present in these 4 music pieces, Detrended Fluctuation Analysis (DFA) technique was applied on the 5 excerpts taken from each clip. The DFA
Scaling exponent values corresponding to each musical piece was then achieved by averaging over the 5 parts chosen from that particular piece of music. Figure 7 represents the average DFA scaling exponent values for the 4 music pieces.

From Figure 7 we can clearly observe that Music 3 features highest DFA scaling exponent value among the chosen 4 indeterminate music pieces and Music 1 features the lowest DFA scaling exponent. Now, we had observed previously that, Music 3 also featured highest presence of sustained pitches and lowest variation of intensity among the 4 pieces, whereas Music 1, on the contrary, featured highest degree of fluctuations between the low pitch and high pitch regions and the also the largest amount of intensity fluctuations. On the other hand, the DFA scaling exponent value is lesser than Music 3 but greater than the other two pieces in case of Music 4 which featured an equivalent share of continuous pitch bending and suddenly appearing single notes as well as a balanced distribution of continuous and fluctuating intensity contours. Music 2, which featured an extremely fragmented and undefined pitch contour as well as sharp fluctuations in the intensity contour, yielded a DFA scaling exponent value greater than Music 1 but lesser than the other two. So, in terms of the long range temporal correlation present in the acoustical waveform the 4 music pieces can be arranged in the following order: Music 3 > Music 4 > Music 2 > Music 1

Thus, it can be clearly inferred from the above observations that the two perceivable musical features – pitch and intensity have prominent influence on the long range temporal correlation present in the acoustical waveform of an indeterminate music piece. Going into more details, we see that continuity or sustenance in the pitch and intensity level of the audio signal can be correlated with greater degree of long range temporal correlation compared to the music clips with sudden and frequent fluctuations in the pitch and intensity contours.

Also, comparing with the phenomenological interpretations of the visual artist we see that Music 3, which featured the highest scaling exponent value, evoked the expression of loneliness or a persistent sadness and fear which can be easily associated with the musical structure of the piece where infrequent single notes are appearing in the foreground of a sustained pitch and intensity level. Music 4, with the continuous pitch bending and wide variance in intensity level, evoked a sense of slowly building up suspense, anxiety and fear in the artist’s mind and had a lower degree of long range temporal correlation than the sadness evoking Music 3. With the usage of unusual non-musical objects and extremely fragmented pitch contours as well as sharply fluctuating intensity contours Music 2 was mostly associated with emotions like wonder, surprise, fear, nervousness and featured a much lower degree of long range temporal correlations compared to the previous two music pieces. Music 1, having the highest fluctuations both in the pitch and intensity levels among the chosen 4 pieces, primarily evoked emotions like anger, disgust followed by sadness and fear and also had lowest long range temporal correlations among the 4 music pieces. So, in terms of association between different emotions and the degree of acoustical long range temporal correlations of the corresponding music pieces, we observe that the correlation decreased in the following order: Sadness > Anxiety > Wonder > Anger
5.4 Fractal analysis of paintings and comparison with semiotic and phenomenological analysis
The same Detrended Fluctuation Analysis (DFA) technique was applied on the 4 paintings influenced by the 4 music clips to study the intermediality between them in terms of symmetry scaling. The only difference is that in case of music we used 1D DFA and the Scaling exponent obtained from the analysis measures the long range temporal correlations present in the time series whereas in case of paintings, we used 2D DFA and the Scaling exponent obtained from this analysis is the two-dimensional scaling exponent, a self-affinity parameter representing the long-range power-law correlation characteristics of the surface. For the 4 paintings, scaling exponent has been computed for Red/ Green/ Blue color coordinates. **Figure 8 (a-d)** represents the variation in Red, Green and Blue DFA scaling exponents for the 4 paintings.

![Figure 8a](image1)

**Figure 8a**

![Figure 8b](image2)

**Figure 8b**

![Figure 8c](image3)

**Figure 8c**

![Figure 8d](image4)

**Figure 8d**

**Figure 8 (a-d):** Variation in 2D DFA scaling exponent in the Red, Green, Blue color coordinates of the 4 paintings

Analysis of the above figures revealed that in case of Painting 1 (**Figure 8a**) (influenced by Music 1), highest degree of correlation is observed for red colour and the scaling exponent values gradually featured a significant decrement in the order: Red > Green > Blue. In case of Painting 2 (**Figure 8b**) also, we observed the same trend in the variation of scaling exponent along red, green, blue color coordinates, but in this case the rate of decrement in the DFA scaling exponent from red to green to blue was much lesser compared to that of Painting 1. In case of Painting 3 (**Figure 8c**), we observe the complete opposite trend where the DFA scaling exponent gradually decreased in the order Blue > Green > Red and the rate of change in the scaling exponent value from red to green to blue was highest among all 4 paintings. This trend is again observed for Painting 4 (**Figure 8d**), but the rate of increment in the scaling exponent from red to green to blue is not as pronounced as in case of Painting 3. Here, it is important to mention that the dominance of presence of a particular color proportion in a painting must not be confused with the degree of long range correlation along that particular color coordinate in the painting.

Comparing these observations with the semiotic analysis of music, we find that, the paintings which were influenced by music having higher proportion of sustained pitch and steady intensity level, feature a higher long range correlation along the blue color coordinate, whereas the paintings which were influenced by music pieces containing high degree of pitch and intensity fluctuations showed a higher degree of long range correlation along the red color coordinate. Music 3 had the
most prominent presence of steady pitch and intensity level among the 4 pieces and Painting 3 featured the largest increment in the blue color scaling exponent among the 4 paintings. On the other hand in case of Music 1, we observed the highest presence of frequently fluctuating pitch and intensity levels and Painting 1 featured the highest DFA scaling exponent values along the red color coordinate. Similar to Music 1, Music 2 also featured highly fragmented pitch contours along with sharp spikes in the intensity contour. In the corresponding Painting 2, following the trend of Painting 1, we observed that red color featured a higher degree of long range correlation than green and blue. Music 4 had some proportion of steady intensity level as well as continued pitch bended structure and in Painting 4, following the trend of Painting 3 the blue color featured highest scaling exponent value among the three basic colors, though in this case the rate of change is not that pronounced. Probably the equivalent presence of suddenly appearing single notes in Music 4 influenced the shift in the 2D long range correlation from blue to green to red.

Comparing the results of the fractal analysis of music pieces and the corresponding paintings, we observed that music pieces having higher long range temporal correlation influences a higher degree of 2D long range correlation along the blue color coordinate. As the temporal correlation gradually decreases in the music pieces, we found a switchover in the dominance of 2D correlation in the direction of red color coordinate. The music with highest DFA scaling exponent value (Music 3) inspired the highest proportion of long range correlation along blue color coordinate (in Painting 3) whereas the music with lowest DFA scaling exponent inspired highest degree correlation along the red color coordinate (in Painting 1).

6. Conclusion
In the present study we wanted to see whether any intermediality or correlation exists between the indeterminate music pieces and their corresponding paintings and if the emotions as well as visual imageries evoked by a particular indeterminate music clip act as the mediators which then get translated into the depicted visual contents in the painting created during listening to the same music clip. We attempted to explore the answers to this research question from three approaches, namely – Phenomenological analysis, Semiotic analysis and Fractal analysis. The phenomenological exploration revealed that the musical emotions and visual imageries evoked by the particular indeterminate music clips have highly subjective experiential aspect, although the semiotic analysis of the music pieces and the corresponding paintings revealed that the phenomenological interpretation and visual content depiction by the artist through different visual elements in painting had significant amounts of indexical relationship with the music pieces. The acts of interpretations are neither arbitrary nor unstructured. This paper suggests that emotional impressions and identified features play a key role in triggering responses. When direct correspondence is found between the structural components of the two mediums, such representations are iconic, where as when responses are not found to be identifiable correlated, such responses are symbolic. On the other hand, when responses trigger memories and emotions, often they result in indexical interpretations. The fragmented nature of pitch and intensity contour is present in all indeterminate music pieces and the emotions like fear and uncertainty is very commonly evoked as a result of listening to these pieces. This fragmented nature of music is directly reflected as the fragmented line patterns in all of the four paintings, indicating an iconic representation of the musical features into the paintings. However, despite of the dominance of fragmented patterns some variations in the musical structure can generate other emotions also in the listener’s mind. We observed that strong presence of long steady pitch and intensity contours in the backdrop of distant fragmented notes primarily communicated emotions like loneliness, sadness, suspense, anxiety whereas the music pieces with only larger fluctuations of pitch and intensity mostly communicated emotions like anger, disgust, wonder, surprise etc. The visual artist then translated these emotions and the related visual imageries into his paintings through different basic visual elements (line patterns, colors, shapes etc) – most of the paintings used dark colors like red, yellow ochre, black, deep blue, gray, all of which are mostly associated with negative emotions. Apart from fragmented lines thick, dark, zigzag, cross, hazy line patterns are used to depict emotions like anger,
fear, anxiety; whereas wavy, curved, downward line patterns were used more commonly to depict sadness, loneliness and wonder. Overall, indexical and iconic representations are prevalently observed in all paintings and in some cases, a mixture of indexical, iconic and symbolic representations of different musical elements are also found in the corresponding paintings. The validation of these findings got confirmed by the Fractal analysis of the music pieces as well as the paintings using the same Detrended Fluctuation analysis technique. The main findings of the study can be summarized as:

i. The music pieces featuring higher presence of chaotic, loud, fragmented sounds, sudden fluctuations in the pitch and intensity level, in general, yielded a lower degree of long range temporal correlations in their acoustical waveform (as evident from the lower DFA scaling exponent values) compared to the music pieces which featured larger proportion of continuous and steady notes and lesser intensity fluctuations.

ii. Although fear is the dominant emotion evoked by the indeterminate music clips, an association is also found between the emotional attributes of the music and the long range temporal correlations in the acoustic waveform of that audio. Higher degree of long range correlation in the acoustical waveform of music was found to evoke emotions like sadness, loneliness, anxiety whereas lower degree of long range correlation was usually associated with emotions like anger, surprise etc.

iii. Another correlation was also observed between the long range correlation of the music pieces and the corresponding paintings. Music having higher degree of temporal correlations were found to be associated a higher value of scaling exponent along the blue color coordinate compared to that of green and red, whereas the paintings which were inspired by music pieces with lower temporal correlations featured a higher value of DFA scaling exponent along the red color coordinate compared to its blue and green counterparts.

This study offers both new methodology as well as some significant new knowledge in the domain of both quantitative and qualitative assessment of intermediality between the unique genre of indeterminate music and the paintings inspired by them. In this study all the analysis were done after the visual artist created the paintings, and hence we could not address the correlation between the temporal and spatial features of the two mediums – music and visuals. To overcome this limitation exploration of the sequence of painting related to unfolding of music will be done in future.

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