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ORÍ ODÁRA: RESEARCH ON THE COMPOSITIONAL MATERIALS OF THE WORK AND THE DUALITY BETWEEN RHYTHMS AND PITCHES

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Abstract: This article aims to present, as a self-ethnographic work, the materials chosen for the Orí Odára music, which is based on the application of acoustic principles to rhythm. Despite being an unfinished piece, the objective is to show ways to expand the role attributed to rhythm as a basic element of the discursive structure of music, in order to bring this sound parameter closer to the heights in question.
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INTRODUCTION

Western music was developed mainly through the use of notes and scales, making (high) frequencies the main sound parameter to base listening to and structuring musical works. However, even the high frequencies that underlie the music of this tradition, perceived as notes, are exactly the same acoustic phenomenon as rhythms, which are nothing more than low frequencies perceived in another way. In other words, the low threshold of hearing (approximately 20Hz) separates the way of perceiving vibrations such as notes and rhythms[1].

Understanding the relationship of high and low frequencies is not something new in acoustic terms, but an idea that only began to be thought about musically during the 20th century. Consecrated composers such as Henry Cowell and Karlheinz Stockhausen theorized and composed about the duality between rhythms and pitches between the 30s and 60s of the last century. Recently, works such as Júlio Herrlein's thesis on the Theory of Rhythmic Sets are examples of works that move away from the duality of the physical phenomenon between rhythms and pitches in themselves, but which also lead to a greater importance of rhythm for the formal and material elaboration of the pieces.

The piece *Orí Odára,* object of brief appreciation, uses the references traced by the aforementioned authors, especially Stockhausen and Cowell, in a variety of ways to obtain their compositional materials. Likewise, the choices of materials directly influence the formal planning of the piece, since all the durations contained therein come from the same algorithm as the notes used in the piece.

The development of a musical composition that treats the pitch component in a similar way to the durations is motivated not only by the compositional and auditory exploration of abstractions referring to the isomorphism between the two sound parameters. It is also intended to explore compositional tools that allow the insertion of musical elements and extra-musical ideas that do not belong to common western practice. Anyway, the way such ideas appear in *Orí Odára* are not part of this study, only the demonstration of how their materials were conceived.

THEORETICAL REFERENCE

The main theoretical references used for the abstraction of the techniques used are the texts New Music Resourses by Henry Cowell (COWELL, 1996) and How Time Passes By by Karlheinz Stockhausen (STOCKHAUSEN, 1959). Both composers take the harmonic series as the basis of their own techniques and practices, however quite differently from each other. However, before relating the harmonic series to rhythms, it is necessary to clarify how rhythms and notes can be interpreted as an isomorphic phenomenon.

If a note like A 3 (440Hz) is taken as an example, it is nothing more than a mechanical wave that takes 1/440 second to complete its full cycle. However, the human ear is not capable of perceiving just one cycle of this wave, since 1/440 second is a very short

1 See TEPFER, (2012).

duration. Thus, this sound wave must remain vibrating longer, so that it can be perceived.

However, if this note is held for longer, for a duration of one second, for example, what one hears is not the second divided into 440 parts, but a continuum in the form of a musical note played by an instrument. On the contrary, if a one-second vibration, 60bpm/1Hz, is repeated, what is perceived are several isolated pulses, as in a metronome. Between the perception of isolated pulses and a continuous sound there are transition frequencies, in the range of 20 Hz.

From this fact two conclusions are possible: the phenomenon that we perceive as rhythms and durations is exactly the same that makes us perceive notes, just as essentially a metronome does the same thing as a musical instrument in a much "lower" range; what an instrument does when playing a note is, according to Stockhausen (STOCKHAUSEN, 1959), shape proportions of time, since the durations of the high frequency of the note are carried during the duration of the note's playing. With this point clarified, it is appropriate to approach the relationships of rhythms and harmonic series found by Cowell and Stockhausen.

Henry Cowell in 1930 in his *New Music Resources* (COWELL, 1996) observes how the harmonic series could be reproduced in a rhythmic way, from the use of tuplets, since the series is the result of subdividing a frequency into whole numbers. In other words, if a sound were slowed down to the sub-20Hz range, what was previously heard as harmonics will be heard as a polyrhythmic texture of several tuplets.

Based on this observation, the musician suggested in his theoretical work forms of temporal notation that would represent harmonic partials of the duration of a semibreve, so that it would be possible to note rhythmic subdivisions different from those used in simple and compound measures without the use of triplets. Thus, it would be possible to reproduce in a simple way the same observable relationships in the harmonic series of notes in the rhythms.

Even so, other subdivisions and sets of proportions could be deduced as "fundamental", making it possible to relate several durations and their respective "harmonics". A quarter note at 60 bpm, for example, would be the fourth harmonic of a semibreve lasting 4 seconds. From this semibreve, other durations would form his "harmonic series", dividing its duration of 4 seconds into five, six, seven and so many countless parts.

Much of what Cowell portrays in his book on rhythmic propositions is related to the possible reproduction of harmonic intervals in the rhythmic plane, through the polyrhythm of voices. The author explains that the intervals can be abstracted from the harmonic series and, therefore, from a mathematical relationship between the sound waves that constitute the interval. A major third interval, for example, is perceived in the harmonic series at harmonics 4 and 5, so a 4 versus 5 polyrhythm is a transposition below the 20Hz threshold of the interval.

The composer even asked Leon Theremin to build the Rythmicon, an instrument capable of reproducing rhythmically, that is, at low frequencies, the relationships present in diatonic scales, now polyrhythmic. in compositions, the *Rythmicana* work for solo piano (1938) is an example of Henry Cowell's use of rhythmic speculations.

On the other hand, Stockhausen in 1957 would approach the theme in his text in order to theorize a possible "translation" of a series of notes for their respective durations in the plane of frequencies below 20Hz, expanding the conceptions of integral serialism.

The first approach would be to take a common minimum unit, a sixteenth note, for

example, and add a unit at each step. What results is the opposite of Cowell's proposition in which a fundamental undergoes subdivisions, a unit that is multiplied. In other words, what results is an inverted harmonic series, capable of representing a twelve-tone series or even a series composed of other values in the n harmonics derived from it.

In another case, the notes of a predetermined series would be transposed down countless octaves, until the pulses of that note could be perceived individually, that is, as rhythm. The result is a series of durations with numerical ratios similar to those present in the chromatic scale, which finds it difficult to accurately perform intervals with complex subdivisions such as the tritone (ratio 32:45).

Similarly, Stockhausen proposes that the same mathematical relationship that constitutes the chromatic scale ($12\sqrt{2}$) be used as a basis for multiplying durations, in order to establish a rhythmic chromatic scale. In the text, Stockhausen uses as an example the duration of one second (1Hz or even 60 bpm) to determine other metronomic marks within the same chromatic relationship. Thus, a scale that had 60 bpm as a base would have the following metronomic marks: 60; 63.6; 67.4; 71.4; 75.6; 80.1; 89.9; 95.2; 100.9; 106.6;113.3; 120 bpm. The other metronomic markings would be just "octave" of the markings determined by the equation, just as 120 bpm, double 60, is the "octave" of the frequency taken as a reference.

At the end of *How Time Passes By* (STOCKHAUSEN, 1959) the author also suggests the construction of an instrument capable only of playing precisely individualized durations according to their corresponding note in octaves or to the chromatic scale ratio. His plays *Zeitmasse* (1955-56), Gruppen *für drei Orchester* (1955-57) and *Klavierstück* XI (1955) contain such applied principles.

Obviously, the conclusions of both composers are not restricted only to the durations relative to the pulse and its subdivisions, but also to aspects of meter and other major temporal constructions. Even phrases, periods and even sections of the works can be treated more specifically, depending on the rhythmic material used.

In the song *Orí Odára* the compositional materials have their main source in the harmonic series, as well as the works of Cowell and Stockhausen that approach the question of rhythm and notes in a parallel way. However, the treatment is slightly different from those proposed by the aforementioned authors. In short, the work is based on the successive multiplication of a long duration by specific harmonics, which will determine all the materials of the piece, from rhythms to notes. The details of the process of extracting the musical materials from this piece will be discussed below.

EXTRACTION OF MATERIALS FROM THE PIECE ORÍ ODÁRA

The piece *Orí Odára* for solo piano, as stated earlier, derives its materials from the application in the rhythmic domain of the acoustic principles found in the harmonic series. In any case, the way in which the relationships between materials are achieved differs from those given by Henry Cowell and Karlheinz Stockhausen.

In the piece in question, the total duration foreseen for the work, 8 minutes, is taken as the fundamental of a hypothetical harmonic series. Compositional materials are derived from the constant division of this "fundamental" frequency by the sets of numerals 3, 6, 12, 15 (set α) and 3, 6, 8, 10,11 and 14 (set β) and 16[2]. These numerals act as harmonics of the 8 minute fundamental and also as harmonics of the previous divisions.

2 The values of duration, rhythmic frequencies and corrected notes for the tempered system are found in topic 5.

When entering the frequencies corresponding to the vibration of the piano strings, it was decided to maintain the tuning in the standard tempered piano system. The same type of adaptation occurs with approximate results between the multiplications of different numerals that are treated as a single result.

All compositional materials, whether session durations, periods, phrases, bars, pulses, individual attacks, even the notes are included in the division of the fundamental 8 minutes by the numerals of the two sets. Durations not covered in this table are derived from dividing or multiplying the results of this table. Thus, the duration of 10 seconds, for example, can be reached within these limits either by dividing 30"[3] by the numeral 3, contained in the set α and β, or by multiplying the same numeral by 3.33...", result from the successive division of the fundamental by the numeral 12.

Another detail in relation to the derivation and use of the materials lies in the sets called α and β. They will determine the possible "harmony" within each session of the song, based on a certain set of rules.

The α set will be exclusive in the first part of the song along with the division in 16, up to 150" from the beginning. This way, only the materials coming from the division of 3, 6, 12 and 15 and the derivations of the results divided by this set appear in this section of the song. The appearance of any element of β is further resolved by any relation arising from the numbers of α.

From 150" from the beginning to 300", in the second section of the song, the results of both sets, α, β and the numeral 16, along with their derivations can be used. No form of resolution is required during this session of the song.

Finally, the last 180", from 300" to 480", the set β (3, 6, 8, 10, 11 and 14) and the number 16 are the division and multiplication factors present in the session, obeying the same form resolution of materials provided for in the first session.

It is observed that the numbers 3, 6 and 16 always appear in the music as possible division factors; the first is so because it affects both sets, α and β, while the second manifests itself as an arbitrary choice of subdivision.

In order to present an example in this work, a short analysis of the first minute of the second session of the song (from 150" to 210") is presented. This excerpt objectively exemplifies all the procedures adopted for the composition of the work, with a relatively simple musical result.

Initially, in the structural plan of this section, it was decided to derive the metronome marking 162 bpm, part of the subdivisions of the fundamental 8 minutes[4], increasing its duration by 3 times, obtaining the marking of 54 bpm.

Due to the proximity of the markings obtained by the subdivisions of 6 and 11 (162 bpm and 166 bpm, according to item 5), this passage is composed of a counterpoint between these two numerals: the upper voice in cycles of 11 eighth notes and the lower voice in cycles of 6 eighth notes.

To get the exact 1 minute duration for the passage, the duration of the 54bpm metronome markings (1.111...second) would have to be repeated 54 times, resulting in 9 cycles of 6 eighth notes of the lower voice (6x9=54) and 5 incomplete cycles of 11 eighth notes of the upper voice (11x5=55). The notes attacked in second 210, beginning of bar 65, are the first of a so-called lower voice cycle and the last note of the fifth cycle of 11 eighth notes of the upper voice.

Regarding the choice of pitches in this section, similar procedures were adopted, however, as it is an example, only the notes of

3 8' divided by 16, i.e. 30" as the 16th harmonic of the fundamental 8'

4 See item 5.1.2.

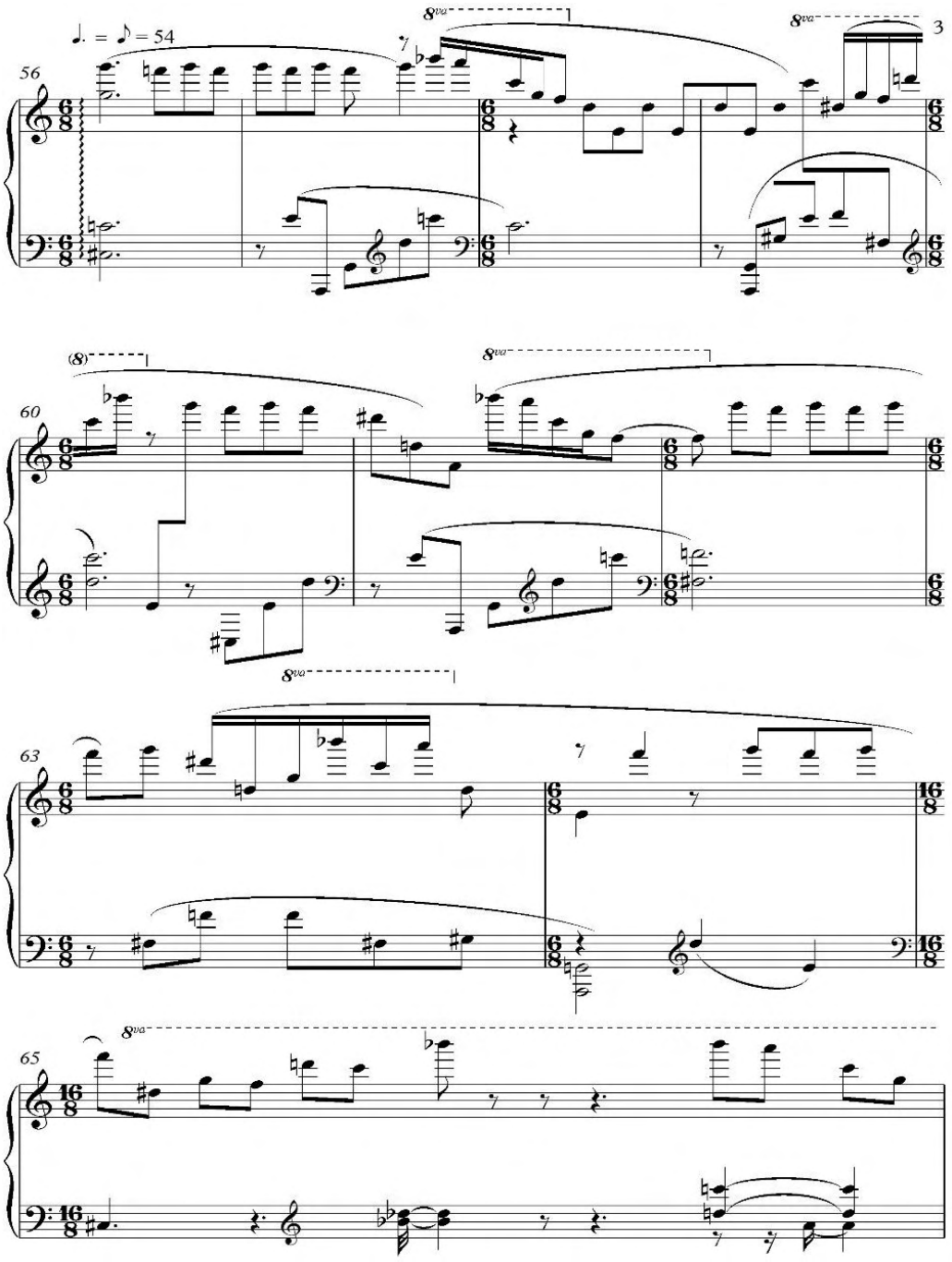

Fig.1. Start of the second session of *Orí Odára.*

bar 56 will be addressed.

The bar 56 chord is derived from operations on the note C#2, present in the bass. The first step is to multiply the frequency of this note by the numeral 11, obtaining the note G5; from the high note, the frequency value is divided by 6, obtaining the note C3; finally, this last frequency is multiplied by 3, obtaining the note G4. The F5 present in this bar is the tenth harmonic of the note C#2, that is, the value of this frequency multiplied by the numeral 10.

Finally, it is noteworthy that the note C#2 plays a role not only harmonic, but also structural in the music, given that it only occurs every 30 seconds (1/16 of the duration of the piece) as a secondary parameter of perception. music time. In the excerpt from fig.1, here exemplified, the note occurs exactly at the beginning, in the middle and at the end of its duration, which is not repeated in other excerpts and sessions.

CONCLUSIONS

This article has succinctly presented the way in which music materials *Orí Odára* were extracted and how all the abstracted durations are used in the body of the music in order to standardize, to a certain extent, the use of notes and rhythms.

The approach of interpreting sound material as durations with distinct forms of perception above and below the 20Hz threshold is nothing new. As is well known, the sound phenomenon is already approached this way and composers such as Cowell, Stockhausen and many others have theorized and composed taking this approach into account. However, the rhythmic aspect is still little used in Western music as a fundamental foundation for the formal and material structuring of the works.

It is also concluded that this use of durations in a homogeneous way between notes and rhythms can be approached in many different ways, containing an infinity of sound possibilities, different from those that have developed among other composers. The protagonism of rhythm can also help musical constructions that dialogue with musical or extra-musical aspects not typical of Western language, but present in other cultural manifestations contained in different contexts.

Finally, the musical elements of *Orí Odára* direct the understanding of time, both in composition and in listening, to other levels than those explored by the common practice of music, in such a way as to also explore the forms of musical discourse in a different way.

MUSIC MATERIALS "*ORÍ ODÁRA*"

Base duration: 8 minutes (480 seconds).

Multiplication bases: α (3, 6, 12, 15) and β (3, 6, 8, 10, 11, 14) and 16.

TABLE

The table will show in parentheses the numeral by which the previous duration will be divided followed by the result of the operation. The first division of each specific numeral will always be carried out with respect to the fundamental 8', the second division of each numeral will be done from the result of the first and so on. No derivation will be presented in the table, only the divisions that always occur by the same numeral from the fundamental 8'. Durations appear in descending order.

LONG DURATIONS

8'=480"
(3) 160"
(6) 80"
(8) 60"
(3) 53,3..."
(10) 48"
(11) 43,633..."

(12) 40”
(14) 34,28”
(15) 32”
(16) 30”
(3) 17,7...”
(6) 13,3...”
(8) 7,5”
(3) 5,925”
(10) 4,8”
(11) 3,966”
(12) 3,3...”
(14) 2,44”
(6) 2,2...”
(15) 2,13”
(3) 1,975” = 30 Bpm
(16) 1,875” = 32 Bpm

METRONOME MARKINGS

(8) 64 Bpm
(3) 91 Bpm
(10) 125 Bpm
(6) 162 Bpm
166 Bpm
216 Bpm
(3) 273 Bpm
343 Bpm
421 Bpm

RHYTHMIC TRANSITION

(8, 16) 8,53...Hz // 512 Bpm
(3) 13,66 Hz // 820 Bpm
(6) 16,2 Hz // 972 Bpm

HEIGHTS

(10) 20,83...” Hz = E -1
(11) 30,50 Hz = B -1
(12) 43,2 Hz = F 0
(3) 41,006 Hz = E 0
(8) 68,26 Hz = C# 1
(14) 80,0466 Hz = D# 1
(6) 97,2 Hz = G 1
(15) 105,46875 Hz = A 1
(3) 123,01875 Hz = B 1
(16) 136,53...Hz = C# 2
(10) 208, 3...” Hz = G# 2
(11) 335,582 Hz = E 3
(3) 369,05625 Hz = F# 3
(12) 518,4113 Hz = C 4
(8) 546, 13... Hz = C# 4
(6) 583,2 Hz = D 4
(3) 1107,16875 Hz = C# 5
(14) 1120,6334 Hz = C# 5
(15) 1582,03125 Hz = G 5
(10) 2083,3... Hz = C 6
(3) 3321,50625 Hz = G# 6
(6) 3499,2 Hz = A 6
(11) 3691,506 = A# 6
(8) 4369,0666 Hz = C# 7
(12) 6220,8 Hz = G 7

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