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The Hierarchical and Combinatorial Nature
of the Rhythmic Structure of Brazilian *Choro*

1. Introduction

This paper integrates a broad research project whose central objective is to elaborate analytical and compositional systematic approaches based on the principles of developing variation and *Grundgestalt*, both created by Arnold Schoenberg. The research has yielded several studies distributed over some distinct branches.[1] The present paper is associated to the most recent of them, which is essentially concerned to investigate the processes of variation in the *choro*, a typical Brazilian musical popular genre.[2]

Emerged in the second half of the 19th century in Rio de Janeiro – then, the capital of the Brazilian Empire – the *choro* owes its origins to some stylized European dances (especially the polka) that became very popular in the city at that epoch. The name of the incipient genre was associated to the typical instrumental groups (formed by flute, two guitars and *cavaquinho*,[3] and also called "*choro*") that used to perform those pieces with a special native swing. Soon, Brazilian composers were stimulated to write original polkas (and mazurkas, schottischs, waltzes, habaneras, etc.), which finished to be generically labeled as *choros*, at the first decades of 20th century.[4] Since then one of the most remarkable characteristic of *choro* has been the fact that its performers (commonly named "*chorões*") use to substitute improvisations (or, more accurately, melodic variations) for literal part repetitions.

The principal motivation for this new line of research is precisely to study the process of creation of idiomatic variations in *choros*, and to investigate if they can be systematically reproduced (and, maybe, taught and learned).

For this purpose, it will be created a computer program for algorithmic composition of *choro* idiomatic variations, able to operate according to a set of rules for music construction, formalized from a modeled abstraction of a *choro*. Such a model is currently being constructed with the data obtained from a detailed statistical analysis of 78 selected pieces[5] written by Alfredo "Pixinguinha" Viana Filho (1887–1973), notoriously the greatest *choro* composer of all times.[6]

The statistical analysis has covered four main structural aspects: form, harmony, melody, and rhythm. It is of special importance the fact that not only all of these elements present separately hierarchical, and stratified organization, but they also are strongly, and mutually connected. For this reason, in spite the *choro*'s rhythmic structure is in the focus of this paper, its adequate understanding depends on a brief exam of the correlate elements, as it is presented in the following sections.

2. Form

The lowest formal level (encompassing the complete *choro*) corresponds to a simple rondo form: AA-BB-A-CC-A. The second level displays the isolated parts (A, B, C). Each one of them has an extension of 16 bars (in binary metric, usually, 2/4) and, in general, a configuration similar to the practice form of the *period*, subdivided into two segments: the antecedent (mm. 1–8) and the consequent (mm. 9–16), concluding with, respectively, dominant and authentic cadences.[7] In the third layer (that can be properly named as "sentence level"), both segments are also subdivided, resulting in a structure formed by four 4-bar phrases, with clearly defined functions, as following (the three-levels formal structure is summarized in Figure 1):

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[1] See, for instance, Almada (2011; 2012; 2013a; 2013b; 2013c).

[2] For initial studies on this subject, see Almada (2012b) and Almada (in press).

[3] A small four-string instrument (tunning: D-B-G-D) very similar to the Hawaiian ukulele (both instruments are originated in Portugal).

[4] More precisely, the process of transformation of the polka (or *polca*, in its nationalized version) into the *choro* was intermediated by two quite fashioned genres: the *maxixe* and the so-called *Brazilian tango*, popularized by composers like Ernesto Nazareth and Chiquinha Gonzaga, as about at the last decades of 19th century. These genres have already most of the principal structural characteristics present in the modern *choro*, and can be considered its more near and legitimate ascendants.

[5] This number represents the total of parts of *choros* (counted as separate pieces). Since a standard *choro* has normally three parts, that total corresponds to 26 *choros*. The selected scores were extracted from Pixinguinha (1997).

[6] The first stage of the statistical investigation, recently concluded, was realized with the help of two of my students: Alexandre Avellar and Pedro Zisels.

[7] For more information about the period practice form, see Schoenberg (1967: 25–31).

- Phrase 1 (mm. 1–4): presents the thematic/motivic enunciation with the principal "genetic" melodic material of the current part.
- Phrase 2 (mm. 5–8): functions as a providential contrast to Phrase 1, from both motivic and harmonic perspectives.
- Phrase 3 (mm. 9–12): in the most of the cases, it recapitulates the material of Phrase 1 (in general, only its initial two bars, with a different continuation, both melodically and harmonically).
- Phrase 4 (mm. 13–16): concludes the "narrative" of the part, what is reinforced not only by an authentic cadence, but also by a proper rhythmic intensification.
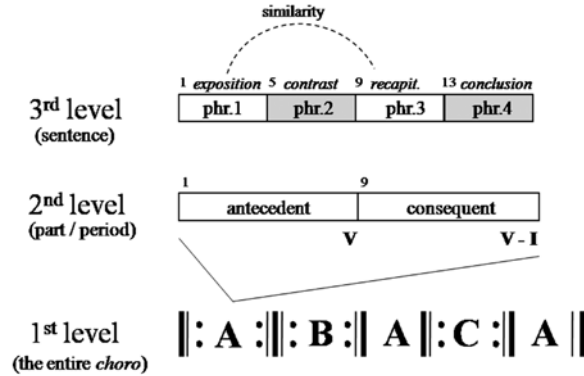
Figure 1. The tree levels of formal structure of the *choro* model

It is still worth to mention that the three parts are established in distinct, close keys. In practice, there are only a few recurrent patterns of tonal configurations in Pixinguinian *choros*: in the major mode (considering the sequence of parts A-B-C): **T-sm-D** or **T-D-SD**; and just one in the minor mode: **t-M-T**.[8] In addition, some tonalities (C, F, G, Dm, Am, etc.) are much more frequent than others, which can be due to their adequacy to the string instruments that usually form the modern *choro* groups (besides guitar and *cavaquinho*, mandolin and 7-string guitar).

3. Harmony

As above mentioned, the harmonic structure of the abstract model is also hierarchically organized in three layers. In the basic one, we can consider a kind of idiomatic harmonic vocabulary that orients the choice of chords. For instance, it is normative in Pixinguinian *choros* the use of triads (with the exception of the employment of sevenths in secondary dominants and diminished chords), not only in the diatonic set, but also in the borrowing chords (IVm, bVI and bII in the major mode, and bII in the minor mode). The second level is represented by the harmonic progressions. The analysis revealed that there are some patterns more recurrent than others, what suggests the existence of specific syntactic rules for the harmonic construction in *choros*.[9] The highest level covers the complete part, with its four harmonic phrases (i.e., the sentence). As can be observed in Figure 2 (that presents the harmonic structure of a hypothetical *choro* in major mode), there is a consistent correspondence between the functions of the formal (cf. Figure 1) and harmonic phrases.
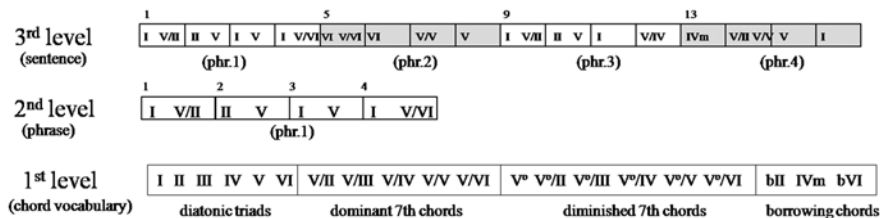

Figure 2. The three levels of harmonic structure of the *choro* model

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8   The symbols for tonal regions here adopted were created by Schoenberg (1969: 19–29), with capitals referring to major regions, and the small letters to the minor ones: **T/t** (for tonic), **D** (dominant), **SD** (subdominant), **sm** (submediant, or minor relative), and **M** (mediant, or major relative). For example: F-Dm-Bb; and Am-C-A, for *choros* in, respectively, major and minor modes.

9   The discovering of these rules (and, as will be mentioned, especially those related to the rhythmic construction) is one of the most important tasks of the present research.

4. Melody

The melodic construction can be also viewed as an abstract stratified structure (Figure 3a). The lower level is essentially represented by a sequence of arppegios, derived evidently from the harmonic progressions. In second level, passing notes are added to the line and the interval directions are alternate in order to correspond to characteristic *choro* melodic contours, with its typical up-down topographic configurations (exemplified in Figure 3b). In addition, the chord changing points are generally made by smooth melodic connections (with notes chosen by their proximity). The surface level supports the application of the so-called *melodic inflection formulas*, a set of idiomatic schemata that maybe represents the most salient aspect of melodic construction in *choros*.[10]
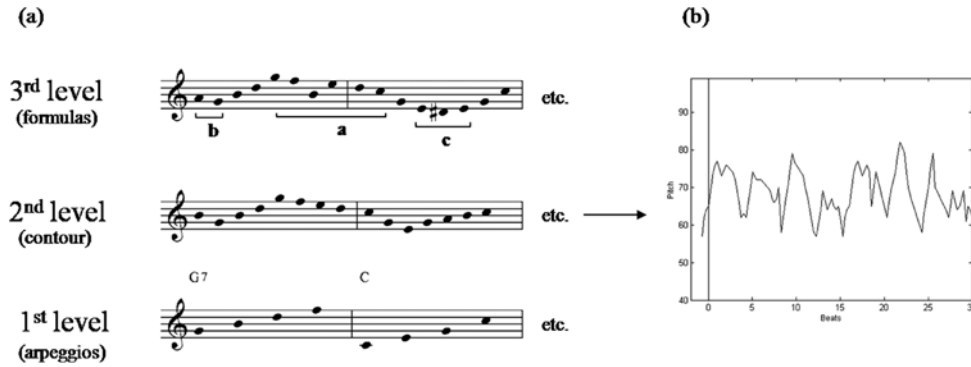
Figure 3. The three levels of melodic structure of a hypothetical *choro* (a);
Melodic contour of first part of *Abraçando Jacaré* (Pixinguinha)

5. Rhythm

In the abstracted model, the rhythmic structure is also hierarchical and interacts with the other domains. According to the analysis results, it is possible to consider four levels of rhythmic organization, each one corresponding to different time spans: (1) beat level (unity: quarter note), (2) bar level (minim), (3) phrase level (4 bars), and (4) part level (16 bars).[11] From a metaphorical perspective, we can associate each one of these structures to corresponding terms of linguistics: *letter* for level one, *syllable* for level two, *word* for level three, and *sentence* for level four. This analogy is in several aspects very useful for the research's purposes, but perhaps the principal reason for its employment is that it reveals the combinatory nature of the *choro* rhythm, in a considerably similar manner as happens in the words and sentences formation process in an ordinary language.[12] The four levels of rhythmic organization are examined in the detail in the following subsections.

5.1. Letter level

It corresponds to the presentation of the typical *choro* rhythmic cells. However, rather than durations patterns (as normally happens), the *choro* rhythmic cells are treated in our model as unities of *inter-onsets intervals* (or IOI's, according to David Temperley's terminology).[13] They consist of abstract rhythmic categories (or classes), which "normal forms" can represent several concrete possibilities, as we can observe in Figure 4.
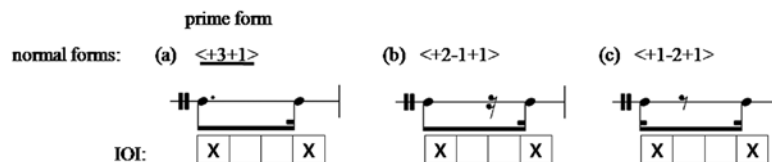

Figure 4. Possible descriptions for a given IOI

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[10]   According to a previous study (Almada, 2006), the melodic inflections formulas are in number of six, each one with specific features. Three instances of the formulas (labeled as **a**, **b**, and **c**) are presented in Figure 3a. A detailed study of this topic is beyond the scope of the paper.

[11]   Of course, we could still extended the structure to a higher level – of the complete *choro*, encompassing its three parts – but that is not necessary, in accordance to the study objectives.

[12]   For a detaied discussion about the combinatory linguistic processes, see Pinker (2000).

[13]   Temperley (2001: 27–28).

In this case, the three alternatives correspond to just one class of letter, since all of them are but different manners to express a same IOI pattern: an one-bar rhythmic configuration with its first and fourth 16th notes articulated. In our terminology, the signs "+" and "−" represent, respectively, presence and absence of onsets points. The selected letter description (or the configuration's "prime form") must be that which corresponds to the most economic, compact form, by combining numbers and signs (therefore, the alternative "a" in Figure 4).

The statistical analysis has found 19 characteristic letters in Pixinguianian *choros*, forming which is named the *alphabet* of the model (Figure 5). The two last positions ("y" and "z") are reserved for important rhythmic building blocks in *choros* that describe, respectively, the unique onset in the down beat and the full rest.
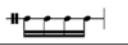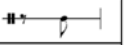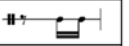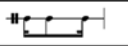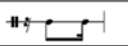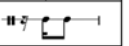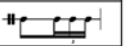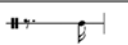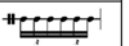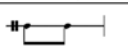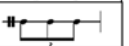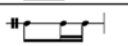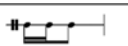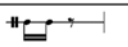
Figure 5. The rhythmic alphabet of the *choro* model

It is worth to add that the order of the letters in the alphabet correspond approximately to their frequency of occurrence in Pixinguinian *choros* (with some exceptions, especially, letter *y*), as displayed in Figure 6.
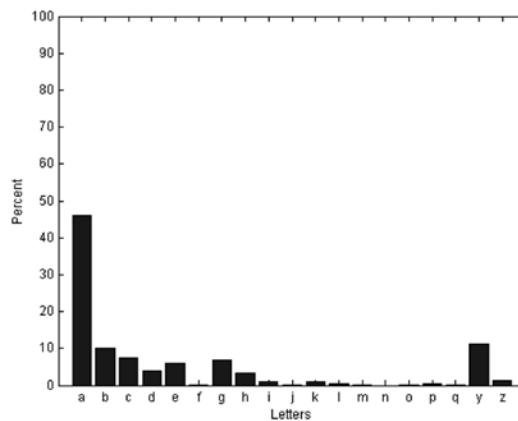
Figure 6. Statistical graph of the occurrence of letters in Pixinguinian *choros*

5.2. Syllable level

In this layer, two letters are combined to form a syllable. The events in this level correspond to the motivic dimension in *choros*, as can be observe in the following examples, extracted from the analyzed pieces (Figure 7). As another result of the statistical analysis, it is remarkable that some syllables are very recurrent (as, for instance, **<ab>**, **<cc>**, **<fg>**, etc.), while some possible combinations (**<mf>** or **<qa>**, among several others) never occur.

Figure 7. Initial syllabes in four Pixinguinian parts of *choros*

5.3. Word level

The concatenation of four syllables (or eigth letters) yields a word. In a similar manner as conventional words (in English, for instance) are not merely resulted from free permutation of letters, well-formed *choro* rhythmic words are in very small number, if confronted to the total possible combinations.[14] As with the syllables case, some of the words collected in the analyzed *choros* are relatively quite recurrent. The statistics has revealed that the words with the highest frequency of occurrence are the following (considering the data shown in Figure 6, the prominence of letter *a* in all of them is hardly surprising):

(1) **<aaaaaaay>** (approximately 4,2 % of the occurrences);

(2) **<aaaaaaaa>** (2,6 %);

(3) **<hahahaaa>** and **<aayyaayy>** (1,3 %).

The formation of a word is normally done in interaction with the formal and harmonic domains (in both cases, considering the second level – cf. Figures 1 and 2). Besides, it was found in the analysis that the internal configuration of a word depends strongly on the pre-established functions. Generally, a word associated with phrases 1, 2 or 3 presents a symmetrical structure that approximately replicates in small scale the similarity-contrast relationships present in the period practice form (especially, the duality antecedent/consequent). In the case of a word associated to phrase 4 (whose primordial function is to conclude the part), in general there is no internal symmetry, but rather rhythmic homogeneity, corresponding to an intended harmonic-melodic intensification. According to these characteristics, it is possible to elaborate modeled configurations for both words 1–3, and 4, as exemplified in Figure 8.
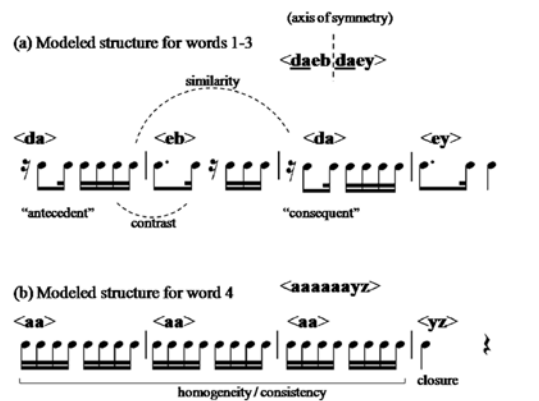
Figure 8. Modeled internal structure of words 1–3 (a) and 4 (b)

Figure 9 displays some words extracted from Pixinguinian *choros* that present the configurations of the abstracted patterns shown in Figure 8. It must be observed in each case as harmony and melodic contours reinforce the rhythmic structure, according to the intended functions.

Figure 9. Examples of words in Pixinguinian parts of *choros*

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[14] More precisely, the number of possible words in *choros* is equal to 16,983,563,041 (or 19^8).

5.4. Sentence level

In this level, the junction of four words forms a sentence. As the previous cases, this concatenation is not fortuitous. On the contrary, in the archetypal *choro* of our abstracted model the primordial functions of formal and harmonic phrases orient the choice of words in favor of, so to speak, the narrative. This is the same as saying that in this level form, harmony, melody, and, especially, rhythm, interact to produce the global meaning of a given *choro*'s part.

Therefore, by considering the abstracted model, the structural relationships established in the third level of the formal and harmonic grids (cf. Figures 1 and 2) serve as an important reference for the construction of a rhythmic sentence, even influencing the selection of the words to be used. Figure 10 presents an example of formation of a rhythmic sentence from Word 1 shown in Figure 8. The pre-established phrases functions, acting as shaping forces, condition the elaboration of possible solutions (of course, among several other appropriate alternatives) for words 2 (that must express contrast), 3 (similarity), and 4 (closure).

Figure 10. Example of construction of a sentence from a given word

Even acknowledging the existence of some alternative procedures in real *choros* (like that composed by Pixinguinha), the above presented sentence pattern is statistically very recurrent (see an example in Figure 11), what makes it perfectly adequate as one of the model's building strategies, according to the research's objectives.

Figure 11. Sentence (part A) in *Os Oito Batutas* (Pixinguinha & Benedito Lacerda)

6. Conclusions

Although the present branch of the main research is still at an early stage, the results until now obtained by the statistical analysis of Pixinguinian pieces are quite promising, considering the processes of construction of the *choro* model, and the formalization of a set of syntactic rules, which will consist the basis for the future program for idiomatic composition of *choro* variations.

Three conclusions of this study are especially meaningful and deserve to be summarized: (1) formal, harmonic, melodic, and rhythmic structures in *choros* present multilayered, hierarchical organization, as well strong correlations; (2) among these structural domains, the rhythm seems to be the most complex, and decisive factor

for the stylistic characterization. This may be due to its combinatorial nature, what raises two important questions: how does a *choro*'s composer (or improviser) makes his or her adequate choices of letters and syllables? Why are few syllables or words so recurrent while many and many other possible combinations never occur? The search for the answers of both questions is of central importance for the continuation of this research, especially taking into account the issue of *choro* idiomatics; (3) by addressing the rhythmic levels in isolation, it is possible to affirm: (a) the peculiar frequency of distribution of the basic construction unities – the letters – in the *choro* alphabet can be considered a kind of idiomatic filter, since it prevents the propagation of ill-formed (i.e., non-characteristic) structures to the higher levels; (b) while the syllables correspond to a kind of semantic component in *choros* (since they are linked to the motivic characterization in the phrases),[15] the words (and, by extension, the sentences) act rather as syntactic forces, in close conjunction with the formal and harmonic structures, in favor of the musical narrative organization.

All of these facts suggest that the creative processes for (conventional or improvised) composition of idiomatic variations in *choros* evolve – intuitively, of course – through intense interaction of the several levels of those structures. The deep understanding of these processes is the key for their systematical reproduction.

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Santrauka

Braziliškojo *Choro* ritminės struktūros hierarchinė ir kombinacinė prigimtis

Straipsnio tikslas – pristatyti kai kuriuos rezultatus iš didžiulio tyrymų projekto, skirto sisteminėms studijoms apie Schoenbergo varijavimo principus ir pagrindinę formą (*Grundgestalt*) iš analitinės ir kompozicinės perspektyvos. Šis požiūris yra taikomas tyrinėjant variacijų technikas *choro* muzikoje (dažniausiai improvizuojamos prityrusių atlikėjų) – brazilų populiariosios muzikos žanre, kuris atsirado Rio de Žaneire XIX a. II pusėje. Pagrindinis darbo tikslas – idiomatinių variacijų kūrimo proceso analizė *choro* žanre. Šiuo tikslu bus kuriama kompiuterinė *choro* variacijų algoritminės kompozicijos programa, kuri veiks pagal muzikinės konstrukcijos taisyklių rinkinį, sukurtą pagal modeliuotą *choro* abstrakciją. Šis modelis konstruojamas remiantis duomenimis, gautais iš statistinės Alfredo Viana Filho (Pixinguinha) 78 kūrinių analizės, apimančios keturis glaudžiai susijusius struktūrinius aspektus (formą, harmoniją, melodiją ir ritmą), kurie suformuoja daugiasluoksnę hierarchinę sąrangą.

Trumpai panagrinėjus pagrindinius *choro* modelio formos, harmonijos ir melodijos bruožus, susitelkiama ties ritmine struktūra. Būdama sudėtingesnė už kitas sritis, ji apima keturis organizavimo lygmenis, atitinkančius skirtingus laiko matmenis: 1) metro lygmuo (ketvirtinė nata); 2) takto lygmuo (*minim*); 3) frazės lygmuo (4 taktai); 4) partijos lygmuo (16 taktų). Šiems keturiems lygmenims buvo sukurta speciali iš lingvistikos pasiskolinta analitinė terminologija (raidė, skiemuo, žodis ir sakinys), ji remiasi kombinacine *choro* muzikos ritmo sudėtimi ir yra panaši į žodžių formavimo procesus kalboje. Pirmas lygmuo yra siejamas su būdingomis *choro* ritmo ląstelėmis. Šiame modelyje ritmo ląstele laikoma ne tiek paprasčiausia trukmių seka, kiek tarp atakų susidarančių intervalų struktūra (Temperley, 2001); tada kompaktiškiausias tokios struktūros apibūdinimas yra raidė. Statistinė analizė rado 19 tokių raidžių Pixinguinha atliekamoje *choro* muzikoje, kurios suformuoja modelio ritminę abėcėlę.

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[15]   As a recent refinement for the model, it is being considered the possibility of creation of a new rhythmic element – the morpheme – intermediate level between syllable and word. In contrast with the other types, the morpheme would not be associated to a fixed time span, functioning as kind of meaning unity. This issue will be properly treated in future studies.

Antrame lygmenyje dviejų raidžių sujungimas suformuoja skiemenį. Įvykiai šiame lygmenyje atitinka motyvinę *choro* dimensiją. Trečiame lygmenyje iš keturių skiemenų junginio gaunamas žodis. Pastebėtina, kad skiemenų ir žodžių formavimo procesas nėra savavališkas, nes ne visos įmanomos kombinacijos idiomatiškai yra teisingos, – tiksliau, neteisingos yra dauguma galimybių (kaip ir kalbos žodžiai nėra laisvo raidžių perstatymo rezultatas). Ketvirtame lygmenyje keturi žodžiai sujungiami į sakinį, kurio išdėstymas priklauso nuo atitinkamų formos ir harmoninių frazių funkcijų. Vienas iš pagrindinių šio tyrimo tikslų – nustatyti idiomatiniu požiūriu teisingus skiemenų, žodžių ir sakinių kombinacijų pasirinkimo kriterijus bei numanomas sintaksės taisykles, numatančias ritmo konstrukciją.