Toward a Theory of Structuring Rhythm in Improvisation in Timeline-Based Musics

Stephen Paul Guerra
Nothern Arizona University
stephen.guerra@nau.edu
Orcid: 0000-0002-1907-112X

Abstract: *Among high-level performers of Afro/diasporic musics, it is generally assumed that solo and timeline rhythmic structures relate in some meaningful way(s). Despite the substantial ethnographic and music-theoretic research that has been done with regard to Afro/diasporic timelines in the past sixty years, little work has explicitly attempted to define and demonstrate the would-be nature of such relationships. This article intends to stimulate a new research agenda that will close this gap between theoretical and practical knowledge. It posits four techniques (two transformational and two non-transformational) that allow one of Afro-Brazilian guitarist Baden Powell's most rhythmically challenging recorded solos to be clearly and concisely understood as essentially six consecutive cycles of a samba timeline under various manipulations. Demonstrating the potential analytical and pedagogical economy that a theory of solo and timeline rhythmic structure relationships may underwrite, this article aims to inspire other authors to study the relationships of solo and timeline in the musics of their own specializations.*

Keywords*: Timeline. Samba. Improvisation. Baden Powell. Afro-disporic.*

I. Introduction

Figures 1 and 2 transcribe passages from Afro-Brazilian guitarist Baden Powell's (1937-2000) solos to *É de lei* (It's a given) [47] and *Samba triste* (Sad samba) [45] respectively. Based on my experience talking, studying, and performing with high-level musicians of Afro/diasporic timeline-based musics,[1] I assume that the rhythmic procedures of Baden's solos would be immediately recognizable to practitioners. Regarding Figure 1, they would say that Baden is "playing with" a samba timeline, or, if influenced by Afro-Cuban pedagogy, that he is playing "in [samba] clave." In either case, they would be drawing attention to the fact that the majority of onsets in each of Baden's two-bar phrases coincide with an instantiation of a prominent samba timeline, pictured floating above the staves in Figure 1. Baden's phrases in mm.1-2 and 5-6 are identical to the timeline except that they add a pickup to the latter's fourth onset. The third phrase of mm.3-4 has only a few more differences. In addition to the pickup to the timeline's fourth onset, it also fills the space between the timeline's fifth and sixth onsets

[1] I have studied and played Brazilian choro and samba (mainly as a guitarist but also as a percussionist) for more than ten years. During the summer months of 2016 and 2017, I conducted music-technical formal interviews with more than twenty high-level professional musicians based out of Rio de Janeiro and São Paulo. I also performed informally with many of the same. Over the last three years in New York City, I conversed and/or worked with advanced musicians (native to the US and not) of Brazilian and Afro-Cuban music. Then, I use "Afro/diasporic" to mean the whole of both African and Afro-diasporic traditions after Gerstin [16].

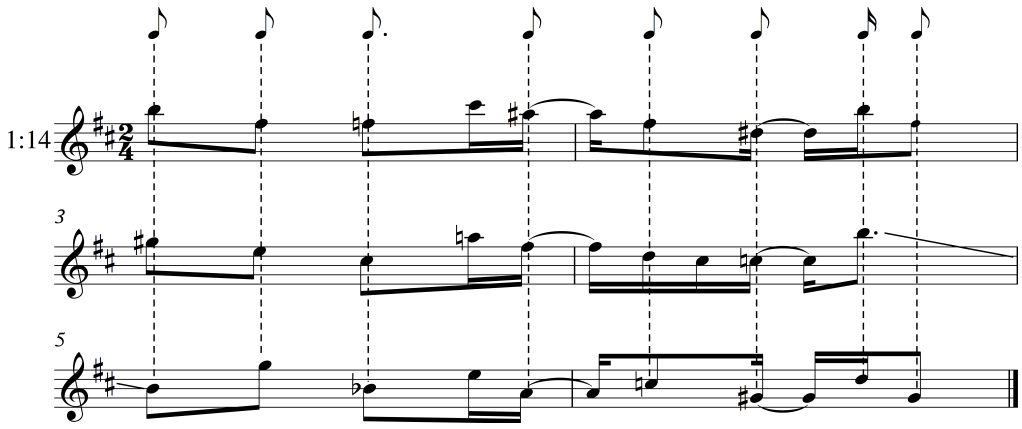

Figure 1: *Transcription of guitar part from É de lei [47].*

and deletes the timeline's final onset, resulting in a feel of slight syncopation relative to the timeline. Regarding Figure 2, I imagine that practitioners would say that Baden plays with the ♪ ♪ ♪. ♪ ♪ ♪ ♪. timeline twice across the first four bars and then takes the final ♪. duration of the same timeline and propagates it forward across the following eight bars. Because the 16-span cycle length of the timeline and the 3-span cycle length of the ♪. propagation are unequal, the cyclic onsets of the timeline and the propagation will conflict through time. In my conversations, performers tend to consider such conflicts as engendering forward-driving tensions that install an expectation for eventual resolution back to the timeline.

Although these two procedures would be (I expect) immediately recognizable to more advanced performers of the style, there is virtually no literature to which an academic study can point to support the same claims. That is, at present we have no theory to support analytical studies of rhythmic structure in improvisation in timeline-based musics. By "timeline-based" music I mean to include any tradition (whether from the Caribbean, South America, Africa, etc.) whose rhythmic language centers around one or more memorable and pervasive rhythmic patterns. I can think of two reasons that can explain this gap between theory and practice. First, transcribing solos by master drummers, guitarists, etc. can be prohibitively challenging. In this respect, (unwritten) theories of timeline-based rhythmic improvisational procedures may lie largely with high-level performers because they are among the few who can access the source materials (the solos) in all their detail. Second, timeline theory first had to address questions of the ensemble/metric function, traditional contexts, and structural properties of the timelines themselves before engaging more complex and potentially more speculative questions of how timelines can be manipulated to structure solos.

I understand the discourse surrounding timelines since the term's coinage by Nketia [39] to consist of, broadly speaking, three overlapping phases. Timeline theories first emerged in the ethnographic work of Africanists studying various types of ensemble musics of sub-Saharan West and Central African ethnic groups.[2] The primary charge of this work was documentary, sometimes comparative (as in theorizing general principles of temporal organization in "African" music), and ethnographic. Here, questions of improvisation are often limited to considerations of variation in and between ensemble parts. As Africanist work brought more source materials into printed English-language view, music theorists began to investigate the structural-mathematical properties of timelines: their being prime generated, maximally even, maximally individuated, and analogous

[2]See [20][39][40][21][42][27][28][29][30][32][33][8][4][5][23][24]

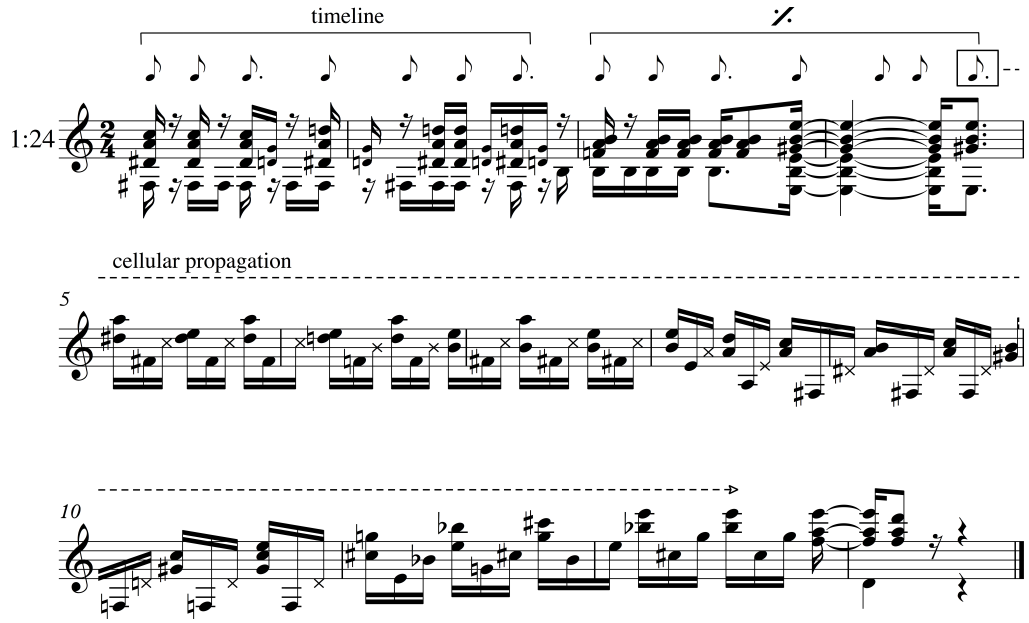

Figure 2: *Transcription of guitar part from Samba triste [45].*

to certain pitch collections to name a few [48][49][13][52] [53]. Such findings gradually stimulated other, more recent research lines investigating the possibility that timelines be heard as projecting non-isochronous meters, as in London [34] and Guerra [17]. The third and current phase has been one of critique and repertorial expansion. Agawu [1][2] investigates the tenability of claims made in music theoretic studies vis-à-vis the theory and language of native practitioners, and Gerstin [16] highlights the fact that most theories of Afro/diasporic rhythm and meter tend to extrapolate broadly from a data set that is essentially limited to only Ewe and Afro-Cuban traditions. In response, Gerstin and various Brazilianist scholars [22][50][43][55][14] have begun to expand the timeline studies corpus in their work on under-documented and contrasting Afro-diasporic traditions of the black Atlantic.

To my knowledge, only two prior studies–Anku [3] and Diaz [14]–have touched upon the topic of this paper. Anku argues that the complexity of a master drummer solo in "African music" can be analyzed in terms of two kinds of timeline set manipulation: "shifting set orientation" and "using successive sets."[3] The former would appear to be set rotation by another name, and the latter seems to be (or to at least include) a procedure similar to that which was discussed in the context of Figure 2 above–that is, improvising some rhythmic surface by weaving together various contiguous timeline duration subsets. Diaz studies how the timelines composed for the music of big band Orkestra Rumpilezz from Bahia, Brazil, can be related to traditional Afro-Bahian timelines by truncation/expansion and rotation transformations. While not explicitly their ambition, both articles suggest in their theoretical overlap the possibility of a coherent theory of rhythmic structure in improvisation in timeline-based music.

In this article, I define four techniques that together or separately can shape the rhythmic dimension of a solo out of a timeline. In an analysis of a passage from Baden Powell's guitar solo to the samba *Deixa*, which genre I consider to be a multiple-timeline-based music, I show

[3]Despite the breadth presupposed by Anku's stated repertory of "Africa music," it would seem by the examples he chooses that he has in mind specifically the dance-drumming traditions of Ghana.

how Baden transforms six consecutive cycles of an 8-span timeline across more than fifteen (2/4) bars. I end with a plot of Baden's trajectory through a transformational space, which informs a characterization of his improvisational strategy.

II. *Deixa* and samba timelines

The theme of *Deixa* is a 44-bar (in 2/4) parallel period in which each phrase is a sentence.[4] The 20-bar antecedent phrase comes to a half cadence in the tonic key of A-minor, and the parallel consequent 24-bar phrase comes to a full cadence. Baden's 1966 recording of *Deixa* [46] opens with a quasi-rubato setting of the 8-bar half cadence of the antecedent phrase of the period, presents the theme in tempo beginning at 0:15, and continues with a solo that extends across three cycles of the form. The first cycle begins at 1:11, the second at 2:04, and the third at 2:56. The performance ends in a brief fade out as Baden vamps on the tonic Am chord.

Deixa is a variant of the urban samba (*samba urbano*) native to Rio de Janeiro.[5] Like Guillot [18], I consider samba to be polymetric in the sense that in any given performance there are multiple timing frameworks available to both performer and listener.[6] The timing frameworks are the various timelines that have become canonic over the lifespan of samba through some process of spontaneous creation and imitation.[7] First among equals is the 8-span *surdo* timeline (see Figure 3), which enforces through its onsets and cycle length, respectively, the ♩ and 𝅗𝅥 pulses of samba's pure-duple metric background.[8] Surdos are large, cylindrical bass drums. The first hit is higher-pitched and often muted (represented with an "x" head in Figure 3); the second is lower-pitched and resonant. Even when they are not physically present, their timeline is assumed and internalized by knowledgeable performers and listeners. All other timelines in samba are learned and felt in terms of the surdo timeline. Arguably next in order of importance or prevalence is the 16-span timeline that Sandroni [50] calls the "Estácio paradigm," so named after an influential group of early samba composers and musicians from the Estácio neighborhood in Rio de Janeiro that defined the "new" and still current samba style (*estilo novo*). Note that only one of many possible instantiations is given in Figure 3.[9] Various instruments in a typical samba ensemble work with this timeline, including the *tamborim* (small, hand-held frame drum), *cuíca* (a friction drum), *violão* (guitar), and *cavaquinho* (ukulele-sized steel-string instrument). The asterisk

[4] Baden Powell composed the music for *Deixa* and poet/diplomat Vinícius de Moraes (1913-1980) wrote the lyrics.

[5] The adjective "urban" is commonly used to distinguish the samba that emerged and flourished in Rio de Janeiro from other "sambas," e.g., the Bahian samba-de-roda. Kubik and Pinto suggest that the number of types of Brazilian samba might be closer to a hundred [25, p. 153] but offer only a few examples by name: bossa nova, partido alto, samba-de-roda, samba chula, samba-de-viola [25, p. 156].

[6] Hudson [19] proposes a more subjective and dynamic way to metrically attend to music that may help to clarify what I mean by "polymetric" here. According to his theory, a samba timeline could serve as a "metering construction," a physically entrained or imagined background reference rhythm that shapes one's interpretation of a rhythmic surface. Performers and listeners can choose the same or different timelines-*cum*-metering constructions in any given moment and can switch freely among the same as they wish or as makes sense with respect to the exact character of the changing musical surface.

[7] For example, Didier [15] characterizes the change from old to new samba styles in the early 1920s as essentially a spontaneous and non-intellectual act of clever musical mischief. Over time and through a variety of reproductive means (e.g., radio broadcasting and federal government financial support), the exact rhythms of this mischief caught on and spread eventually coming to define the modern style. For more about this history, see Vianna [54], Moura [37], and McCann [36] among others.

[8] I measure spans of musical time in terms of the unit- or fastest-moving pulse–a 𝅘𝅥𝅯 pulse in notated samba. The term "pure-duple" comes from Cohn [9, p. 194]. It refers a span that can be represented as 2^n.

[9] Perhaps unlike other Afro/diasporic traditions, in samba there are no model timelines with accompanying sets of permissible variations. Rather, there seems to be an abstract possibility space determined by a small set of intuited rules that separates some rhythms from others as valid instantiations of a given timeline. See Guerra [17] for a theorization of this possibility space.

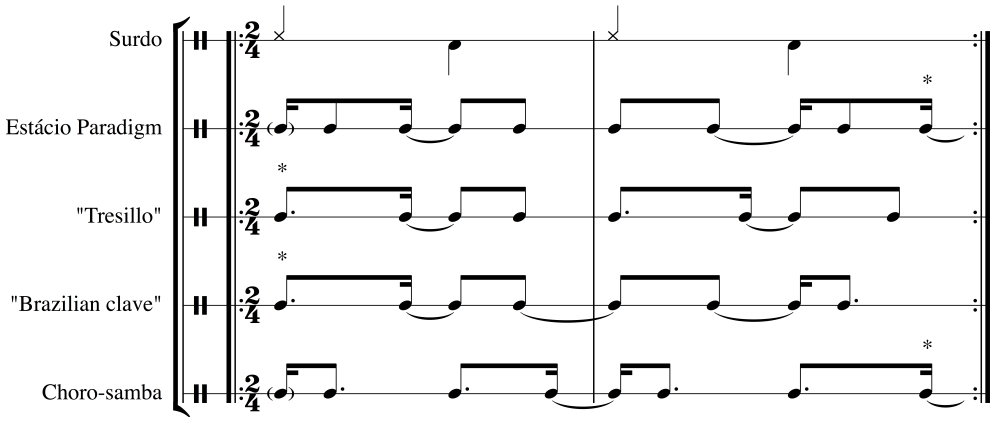

Figure 3: *Five samba timelines.*

in Figure 3 shows where the timeline phrase begins vis-à-vis a two-bar cycle of the surdo timeline. The third and fourth timelines are less ubiquitous. Third is what is known around the Western world as the *tresillo*, an 8-span timeline that is often carried by audience handclaps during a string of repeated choruses before the end of a samba song. Fourth is the 16-span, so-called "Brazilian clave." While this name is misleading ("Clave," whether by name or not, is not a well-formed and stable concept among practitioners of samba as it is among those of Afro-Cuban music.), it does appear to be well known and therefore expedient. The "Brazilian clave" is often heard in the rim shots of a *caixa* (snare) drum in a samba school or as part of a drum set in Brazilian jazz. Seldomly, it can be heard in a guitar part.[10]

To my knowledge, the fifth and last timeline printed in Figure 3 is nowhere described in the pedagogical and academic literature on either samba or choro–a sibling instrumental style-*cum*-genre that emerged in Rio de Janeiro around the same historical moment as samba. Despite this, one can easily hear this timeline emergent in many of the choro melodies written in a samba rhythm (sometimes designated "choro-samba" or "choro-sambado" or with such telling titles as "Receita de samba" or "Samba Recipe")[11] after the late-1950s, especially in those composed by Rio-native Jacob do Bandolim and his adherents, including Jonas da Silva (one of Jacob's accompanists) and Rossini Ferreira. Figure 4 suggests how one representative melody by each of these three composer-performers fits with what I will call the 8-span "choro-samba" timeline. The onset of the ♪ is in most cases suggested by its position at the end of a five-note run.[12] The onset of the first ♪. is suggested by its relatively isolated position, and the onset of the second ♪. is suggested by the implicit second and more resonant surdo beat mentioned above. The "downbeat" of the cycle, coincident with the onset of the ♪ duration, is induced by harmonic change (not shown). In both samba and choro, chords tend to change one sixteenth ahead of the notated bar.

Abstracted from their musical context, choro-samba and tresillo timelines are indistinguishable. In context, however, they differ by rotation and transposition. Different phrasings account for the difference in rotation. The onset of the ♪ duration in the tresillo generally functions anacrustically, while in the choro-samba timeline it acts as the cyclic "downbeat." Different alignments with the reference surdo timeline (indexed by the bar lines in the transcription) account for transposition differences. The downbeat of the tresillo coincides with the surdo's, while the downbeat of the

[10]The original 1961 recording of Jacob do Bandolim's choro-samba "Assanhado" begins in this way.

[11]For more on the history and conventions of this samba varietal, see Sève [51].

[12]See Povel and Essens [44, p. 415]. The authors report that in sequences of identical sounding tones those that are relatively isolated and those that begin and end a cluster of three or more tones become perceptually marked.

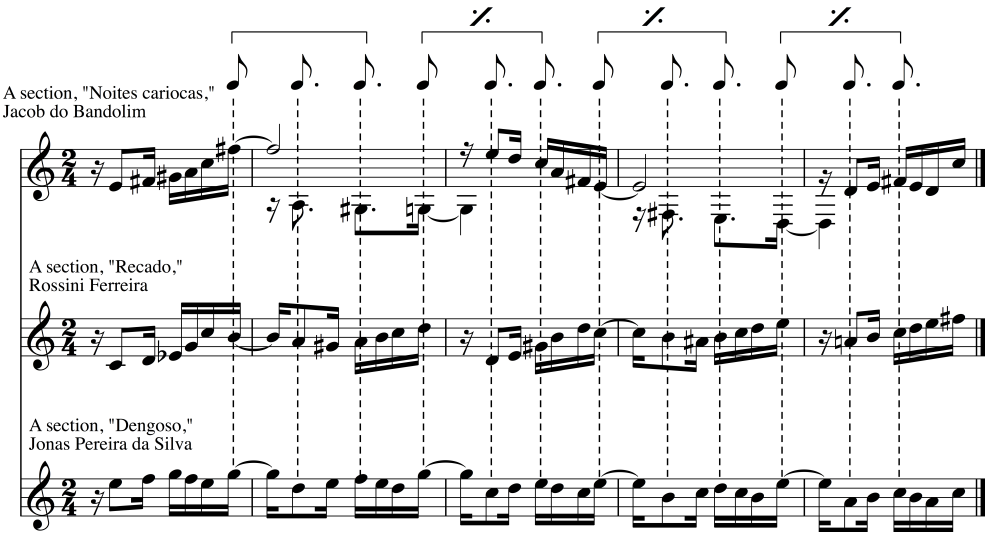

Figure 4: *Choro-samba melodies and the choro-samba timeline.*

choro-samba timeline anticipates the surdo's by one sixteenth.

III. Four techniques of timeline manipulation

In my analysis of the example passage from Baden's solo to *Deixa*, I recognize four techniques of improvised timeline manipulation: playing with the timeline, cellular propagation, augmentation/diminution, and rotation. While these four are all I need to explain my analysis completely, I in no way presume them to be exhaustive for all timeline-based improvisation. It is possible that other improvisations both within and without this style-genre may reveal other techniques.

The four techniques break down into two categories: transformational and non-transformational. The two belonging to the former category are augmentation (and its inverse, diminution) and rotation. Let an ordered set represent the interval structure of a timeline. For example, a tresillo could be represented with $(3,3,2)$. An augmentation transformation A_x applied to the set multiplies each interval in the set by the rational number subscript yielding the augmented product set. The double augmentation A_2 of the tresillo–what Biamonte [6] has called the "double tresillo" and Cohn [11] the "secondary rag"–is $(6,6,4)$. That is, $(3,3,2) * A_2 = (6,6,4)$. Rather than introduce another symbol, diminutions are represented with A fractions. For example, double diminution is written $A_{1/2}$. Applied to the double tresillo, $A_{1/2}$ yields the tresillo, or $(6,6,4) * A_{1/2} = (3,3,2)$.

Suppose an ordered timeline set were the dial of a combination lock. Rotations R_y turn the dial integral y notches clockwise or $-y$ notches counterclockwise. For example, $(3,3,2) * R_1 = (2,3,3)$. The modulus for y values depends on the cardinality of the timeline set. For example, a tresillo $(3,3,2)$ has a cardinality of three, so y is modulo-3. R_3 is the same as R_0 or not rotating at all. R_2 is the same as R_{-1}. Other timelines will have other cardinalities and therefore other rotation moduli.

Augmentation and rotation are commutative. Their order of application to the origin set does not affect the ultimate product set. In the analysis of Baden's solo, they effectively happen at the same time. Ordering their elapse would be arbitrary.

The two non-transformation techniques were discussed briefly at the head of this paper: playing with the timeline and cellular propagation. For the purposes of this paper, "to play with a timeline" means to play some figure that–via various cues of metric induction (after Lerdahl and

Jackendoff [26])–suggests a reduced rhythmic (or quasi-metric[13]) structure that is isomorphic to that timeline. Cellular propagation is where the performer takes one or more of the constituent durations from a timeline – in the same order, such that they would be recognizable as a contiguous subset to the original – and repeatedly propagates them forward through time.

IV. Six cycles of the choro-samba timeline

Figure 5 transcribes Baden's solo over the entire 24-bar consequent phrase in his second time through the form. This transcription is an edited version of the one by Magalhães [35] and follows a long-standing convention of notating samba in 2/4, which practice, if not owing to, at least reminds us of the primacy of the surdo timeline. My analysis will focus on mm.7-21, which passage I hear as six complete cycles (boxed and numbered) of the choro-samba timeline under various transformations.

In cycles 1 and 6 of Figure 5, Baden plays with the choro-samba timeline. The rhythmically identical phrases of 1 and 6 suggest the three onsets of the ♪ ♪. ♪. choro-samba timeline in various ways. The relatively isolated position of the chord change (one sixteenth before the bar line) suggests the first onset. The inception of the subsequent five-note run suggests the second. The final bass note (beat two in mm.7 and 21) suggests the third.

In cycles 2 and 3, Baden propagates the final ♪. cell of the choro-samba timeline from cycle 1 in a three-part treble/bass/midrange arpeggio figure twelve times over before this ♪. grouping of the sixteenth yields to that of the ♪ to be used in cycles 4 and 5. In cycle 2, the ♪. propagation provides the basis for a triple augmentation of the choro-samba timeline in rotation. That is, Baden transforms 8-span $(2,3,3)$ into 24-span $(9,6,9)$ by A_3R_1. The textural change from the block chords of m. 7 to the ♪. arpeggio articulates the first onset of transformed timeline $(9,6,9)$. The change from subdominant to dominant in the key of A-minor (m. 9) articulates the second. The descending-second G5-F5 melodic parallelism–downbeat of m. 9 and two sixteenths before m. 10–articulates the third onset. See Figure 6, which re-beams the first three choro-samba timeline cycles of Figure 6. Boxed numbers below the staff indicate which cycle is under way. The largest and boldened numbers above the staff identify the durations of the (transformed) choro-samba cycles. The lower row of smaller numbers above the staff shows how the ♪. propagation groups the unit ♪ pulse and how the propagated cell in turn participates in the timeline augmentations.

Cycle 3 transforms 24-span $(9,6,9)$ into 16-span $(6,6,4)$ by $A_{2/3}R_1$. The arrival of tonic Am harmony articulates the first onset of $(6,6,4)$. The F5 melodic parallelism–one sixteenth before m. 11 and three sixteenths before m. 12–articulates the second. The parallel C5s of m. 12, coincident with the change from ♪. to ♪ grouping of the unit pulse, articulate the third onset.

To build cycle 4, Baden propagates both the lower-level 2-unit and higher-level 6-unit durations from cycle 3. This is shown in the layered rows of smaller numbers above the staff in Figure 7. The largest and boldened numbers above the same staff show how these two simultaneous and hierarchic propagations allow for a triple augmentation of cycle 3 into cycle 4. That is, Baden transforms 16-span $(6,6,4)$ into 48-span $(18,18,12)$ by A_3 while he holds the rotation fixed. The 2-unit propagation can be heard in the parallel chord-melodic C5s, which continue the neighbor-note motive C5-B4 begun in the tail of the previous cycle. By m. 17, the parallel C5s of the motive are modified to parallels D5s. Bass notes further confirm the 2-propagation as three out of every four notes align with the ♪ propagation. The 6-unit propagation requires more explanation. Cycle 4 consists of back-to-back five-note runs in the treble blocks separated by a single sixteenth-note rest. These runs are located with brackets below the staff in Figure 7. One of the onsets from the

[13]Cohn [12] entertains the possibility of a cognitive/perceptual framework that sits somewhere between a rhythm and a meter. This follows various similar suggestions made by Butler [7], Osborn [41], and Cohn [11].

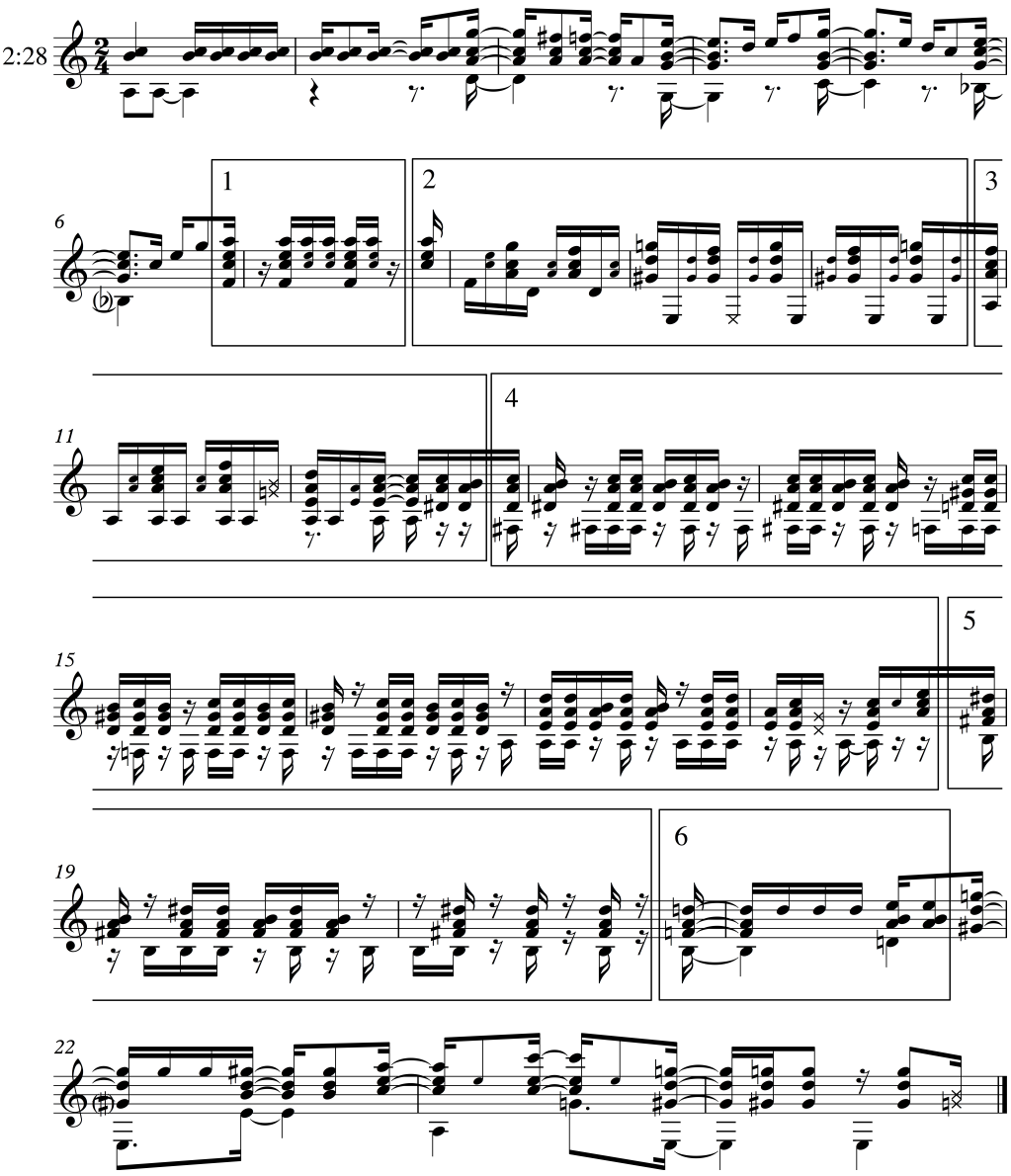

Figure 5: *Transcription of guitar part from Deixa [46].*

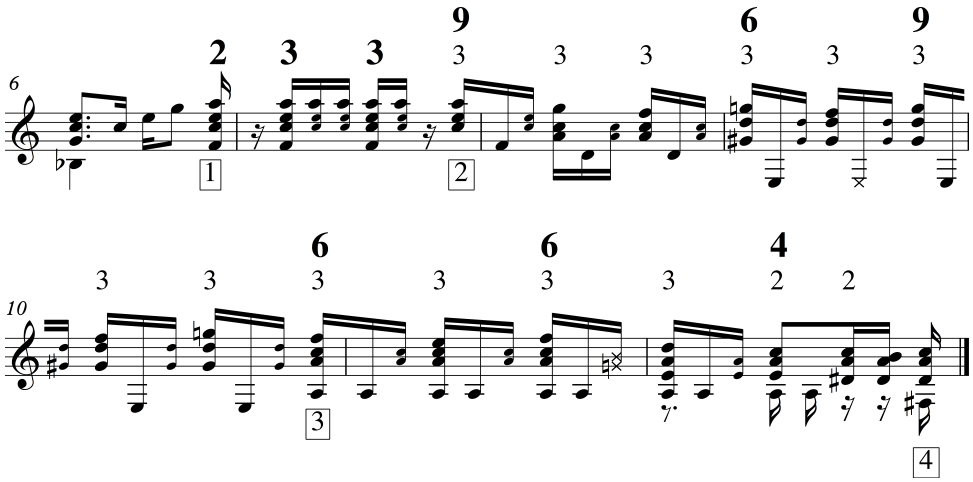

Figure 6: *(Transformed) choro-samba cycles 1-3.*

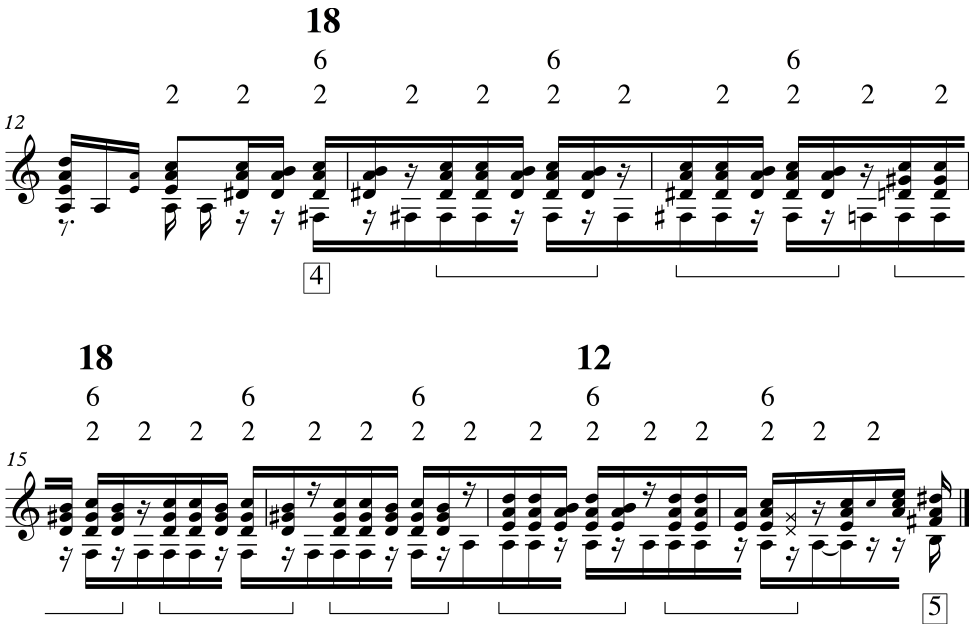

Figure 7: *Transformed choro-samba cycle 4.*

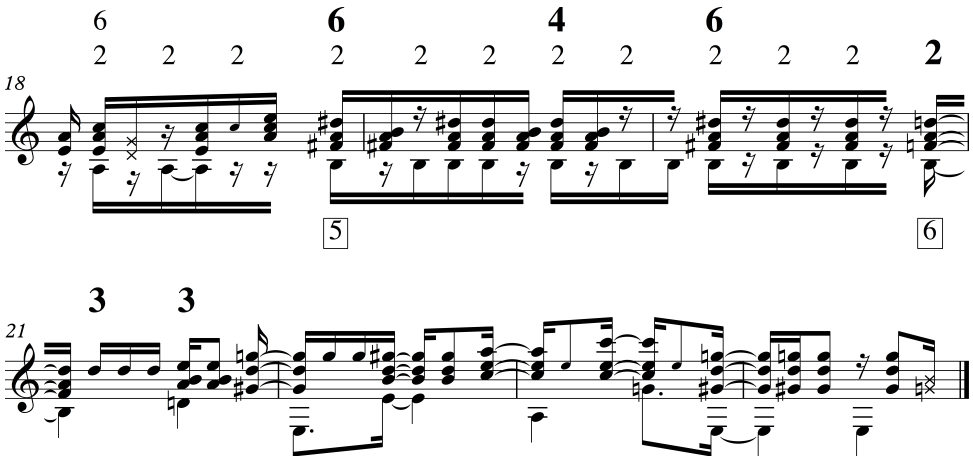

Figure 8: *(Transformed) choro-samba cycles 5-6.*

run will attract a "downbeat" status by virtue of the run's being cyclic, and it is preferable that such a downbeat should also coincide with an onset of the 2-unit ♪ propagation. Two onsets from each five-note run coincide with ♪ onsets, the second and fourth. There is a clear precedent in which to prefer. Cycle 1 (refer to m. 7 in Figure 6) also features an isolated five-note run.[14] There, the first and fourth onsets were relatively strong to the others, and the latter coincided with the surdo's low, resonant tone (whether imagined or real). Trained by cycle 1, I prefer to hear the fourth onset of each five-note cluster in cycle 4 as the cyclic downbeat, and this induces the sense of a 6-unit propagation. With clear perceptions of the 2- and 6-unit propagations, it is easy to hear the onsets of $(18, 18, 12)$. Each onset is articulated by a chord change, first from B7 to G♯dim7 (second sixteenth of m. 15) and then from G♯dim7 to tonic Am (fourth sixteenth of m. 17), where each change is preceded by a three-sixteenth-note anacrusis.[15]

Cycle 5 continues the 2-propagation in various ways: initially by the parallel D♯5s (a further development of the original C5-B4 neighbor-note motive begun in m. 12), and then by the isolated onsets of B7. Here, Baden organizes the 2-unit propagation into $(6, 4, 6)$, transforming the previous 48-span $(18, 18, 12)$ by $A_{1/3}R_{-1}$. The first two onsets of $(6, 4, 6)$ are projected by our existing hearing of the cyclic five-note run, and the third onset is suggested by the initiation (second sixteenth of m. 20) of the figural change to isolated block chords.

In cycle 6, Baden returns to his phrasing of the choro-samba timeline from cycle 1, transforming $(6, 4, 6)$ into $(2, 3, 3)$ by $A_{1/2}R_{-1}$. Once again playing with the timeline, Baden resolves the tension accumulated during his transformational journey and foreshadows the form's structural authentic cadence, which will arrive two bars later in m. 23.

V. Baden's solo in transformational space

My analysis identified six consecutive cycles of the choro-samba timeline connected by five transformations:

$$(2, 3, 3) * A_3R_1 =$$
$$(9, 6, 9) * A_{2/3}R_1 =$$

[14] Indeed, mm. 13-18 could be further characterized as a propagation of the five-note run from cycle 1.
[15] Such anacruses are characteristic in choro and samba.

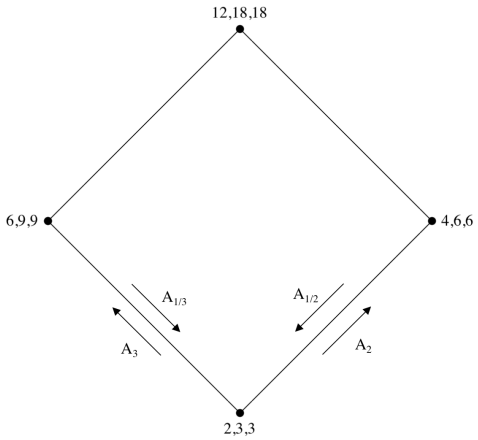

Figure 9: *Choro-samba augmentation lattice.*

$$(6,6,4) * A_3 =$$
$$(18,18,12) * A_{1/3}R_{-1} =$$
$$(6,4,6) * A_{1/2}R_{-1} =$$
$$(2,3,3)$$

In this section, I will summarize Baden's timeline-based solo as movement in a transformational space.

While theoretically unlimited, Baden's augmentations (and diminutions) are based on factors of 2 and 3 only. For example, A_3 takes cycle 1 to cycle 2, $A_{2/3}$ takes 2 to 3, and so on. In this way, augmentation transformations of the $(2,3,3)$ timeline can be represented on a two-dimensional lattice analogous to Cohn's [10] ski-hill graph. See Figure 9. Nodes represent (transformed) choro-samba timelines. SW-NE edges connect nodes related by transformation A_2; NW-SE edges connect those related by A_3. The lattice is infinitely extensible to the NW and NE. However, because Baden's most augmented timeline is a rotation of $(12,18,18)$, I need only the diamond of Figure **??** for my analysis.

Integrating the R transformation into the space means that every timeline node must connect not only to its A_2 (or $A_{1/2}$) and A_3 (or $A_{1/3}$) transformations but also to its R_1 and R_{-1} transformations. Thus, every node in the expanded A and R transformation graph will have four incident edges. In other words, any timeline node is one transformation away from four other distinct timeline nodes. Figure 10 suggests a possible visualization for the space. The three-axis legend to the left shows which transformations apply to which directions in the space. Importantly, note that the four nodes of the highest diamond–$(3,2,3)$, $(9,6,9)$, $(18,12,18)$, and $(6,4,6)$–connect to those respective nodes of the lowest diamond by a single R_1 edge. For example, $(3,2,3)$ from the top diamond connects to $(3,3,2)$ from the bottom diamond by R_1. To make the graph easier to read, I left these edges out. Including them would take the cube-shaped graph and wrap it around a cylindrical mold to connect the top and bottom planes.

Two caveats should be made about the space. First, this space is not meant to be extrapolated outside of its original context, whether to Baden's other samba improvisations, samba more

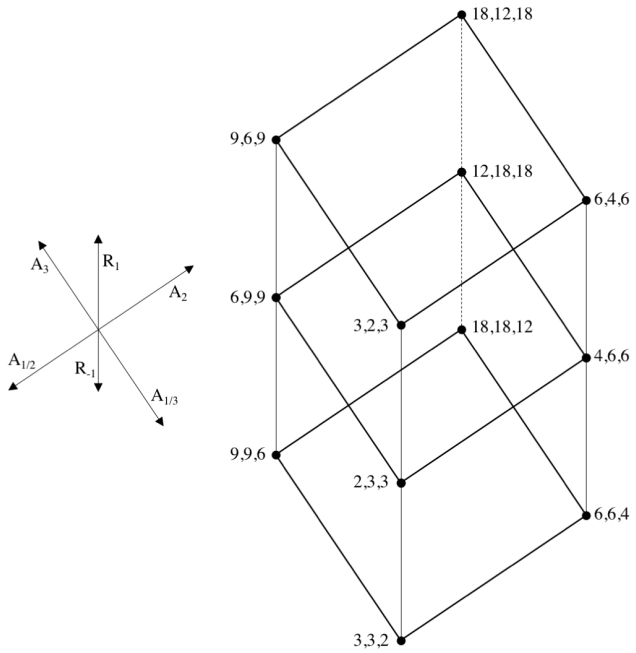

Figure 10: *Choro-samba augmentation-rotation space.*

broadly, or even Afro/diasporic music. The space is relevant to the analyzed passage only. Spaces for other improvisations inside or outside of samba could be similar or different; they could use the same two transformations or not. There is substantial work to be done ahead of any generalizing ambitions. Second, the construction of the graph suggests that we interpret the distance between any two timeline nodes as the minimal number of edges required to connect the two. This implicitly assumes that A_2, A_3, and R_1 transformational distances are all equal-weighted. Whether they are or not in perceptual terms I leave as an open question that is beyond the scope of this study.

Figure 11 plots Baden's trajectory through the transformational space. The gray-highlighted nodes are the five distinct timelines that Baden visits, and the dashed arrows – beginning and ending with $(2,3,3)$ – show the order in which he visits them. The plot helps visualize how the particular sequence of Baden's transformations achieves a sense of rhetorical balance in two related ways.

First, Baden's movement through the planes is palindromic.[16] He starts with $(2,3,3)$ on the middle plane and moves up to $(9,6,9)$ on the upper plane. From there, Baden moves up again, circling around in Figure 11 to $(6,6,4)$ on the bottom plane. He then stays on the bottom plane moving to $(18,18,12)$ before moving back down to $(6,4,6)$ on the top plane. Finally, Baden moves down again to $(2,3,3)$ resting on the middle plane. In short, Baden's palindromic movement follows the order middle-upper-lower-lower-upper-middle.[17]

[16] Recall that movement among the horizontal planes of Figure 11 is driven by the R transformation.

[17] Following the example set in Lewin [27] and carried forward by Cohn [10] and Murphy [38], it is tempting to model Baden's trajectory in Figure 11 as analogous to the three-termed dualism of subdominant-tonic-dominant, insofar as two nodes in the upper plane and two nodes in the lower plane flank the "tonic" $(2,3,3)$ of the middle plane. However

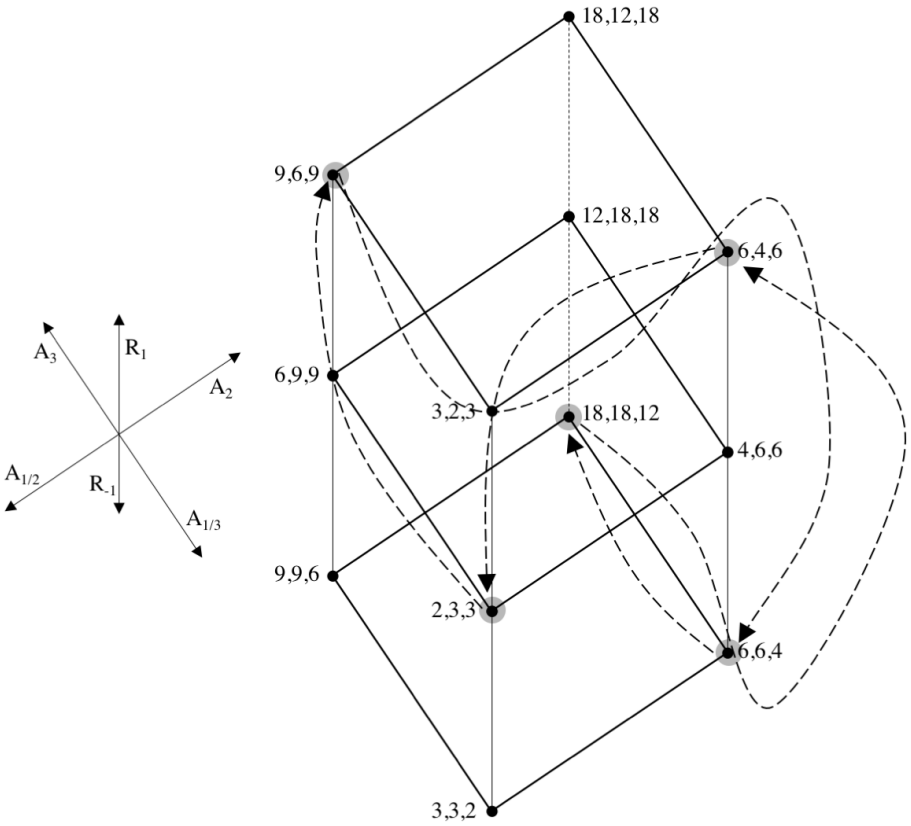

Figure 11: *Baden's trajectory through choro-samba augmentation-rotation space.*

A second way in which Baden's timeline-based improvisation achieves rhetorical balance is through two repetitions of a question-answer script. Baden's initial move away from $(2,3,3)$ to $(9,6,9)$ on the triple side of the upper plane seems to pose a question, which he then seems to answer by moving to $(6,6,4)$ on the duple side of the lower plane. Baden then poses another question, moving to $(18,18,12)$ in the duple-triple corner of the bottom plane, which he then answers moving to $(6,4,6)$ on the duple side of the upper plane.

VI. Closing remarks

In this study, I defined and analytically demonstrated four techniques that can meaningfully shape the rhythm of a solo out of a timeline. Two were transformational: augmentation/diminution and rotation; and two were non-transformational: playing with the timeline and cellular propagation. These techniques were all I needed to come to a more profound understanding of a single passage from a single recording. Zooming out to the larger world of Afro/diasporic music, however, many questions remain. Would analysis of other master instrumentalists, styles, and traditions, for example, suggest other techniques? Or are these the only four? And if they were the only four, why would there not be more? Are there some principles of cognition and perception which limit the range of techniques? Or perhaps we would find that these other instrumentalists, styles, and traditions emphasize some techniques while de-emphasizing or even excluding others. What would account for such differences? Culture? Language? Aesthetics? Instrumentation? Consider the fact that Anku [3] did not seem to need an augmentation transformation, whereas that was one of the primary drivers in my analysis of Baden's solo to *Deixa*. Could we assume that the rhythmic dimensions of solos developed on harmonic instruments have different capabilities than those developed on percussive instruments and therefore different tendencies? The list of questions easily goes on. And if this study has raised more questions than it has answers then it has done its job. As the field of music theory becomes more inclusive and as scholars continue to diversify the scope of their practice and study repertories, we are in an ever-better position to amass analytical data enabling more educated engagement with these and other questions concerning Afro/diasporic repertories. Moreover, as we come to a better understanding of how master soloists construct their solos to timeline-based musics, we will also be enrichening a larger, similarly underexplored discourse surrounding the question of what separates the intelligible from the unintelligible in a given style, whether it be Afro/diasporic or otherwise.

References

[1] Agawu, Kofi. (2003). *Representing African Music*: Post-Colonial Notes, Queries Positions. Routledge.

[2] Agawu, Kofi. (2006). Structural Analysis or Cultural Analysis? Competing Perspectives on the 'Standard Pattern' of West African Rhythm. *Journal of the American Musicological Society*, Vol. 59, pp. 1–46.

[3] Anku, Willie. (2000). Circles and Time: A Theory of Structural Organization of Rhythm in African Music. *Music Theory Online*, Vol. 6.

suggestive, the analogy is imperfect (if not misleading) for two reasons. First, the assignment of subdominant and dominant to upper and lower planes (or vice versa) would seem to be arbitrary. Second, neither assignment, whether T-S-D-D-S-T or T-D-S-S-D-T, would correctly mirror the standard asymmetric cadence model of T-S-D-T.

[4] Arom, Simha. (1989). Time Structure in the Music of Central Africa: Periodicity, Meter, Rhythm and Polyrhythmics. *Leonardo* Vol. 22, pp. 91–9.

[5] Arom, Simha. (1991). *African Polyphony and Polyrhythm*. Translated by Martin Thom, Barbera Tuckett, and Raymond Boyd. Cambridge University Press.

[6] Biamonte, Nicole. (2014). Formal Functions of Metric Dissonance in Rock Music. *Music Theory Online*, Vol. 20

[7] Butler, Mark. (2006). *Unlocking the Groove: Rhythm, Meter, and Musical Design in Electronic Dance Music*. Indian University Press.

[8] Chernoff, John Miller. (1981). *African Rhythm and African Sensibility*: Aesthetics and Social Action in African Social Idioms. University of Chicago Press.

[9] Cohn, Richard. (1992). The Dramatization of Hypermetric Conflicts in the Scherzo of Beethoven's Ninth Symphony. *19th-Century Music*, Vol. 15, pp. 188–206.

[10] Cohn, Richard. (2001). Complex Hemiolas, Ski-Hill Graphs and Metric Spaces. *Music Analysis*, Vol. 20, pp. 295–326.

[11] Cohn, Richard. (2016). A Platonic Model of Funky Rhythms. *Music Theory Online*, Vol. 22.

[12] Cohn, Richard. (2018). *Meter*. In Oxford Handbook of Concepts in Music Theory, ed. Alexander Rehding and Steven Rings. Oxford University Press.

[13] Demaine, Erik, et al. (2009). The Distance Geometry of Music. *Computational Geometry*, Vol. 42, pp. 429–54.

[14] Diaz, Juan Diego. (2017). Experimentations with Timelines: Strategies of Rhythmic Complication in Afro-Bahian Jazz. *Analytical Approaches to World Music*, Vol. 6, pp. 1–34.

[15] Didier, Caôla. (1984). O samba que veio do Estácio. *O Catacumba*, Vol. 1, p. 3.

[16] Gerstin, Julian. (2017). Comparisons of Africa and Diasporic Rhythms: The Ewe, Cuba, and Martinique. *Analytical Approaches to World Music*, Vol. 5, pp. 1–90. [

[17] Guerra, Stephen Paul. (2018). *Expanded Meter and Hemiola in Baden Powell's Samba-Jazz*. Dissertation (Ph.D in Music), Yale University.

[18] Guillot, Gérald. (2016). Hypothesis of Polymetric Structures in Afro-Brazilian Music. *Fourth International Conference on Analytical Approaches to World Music AAWM*. The New School, New York.

[19] Hudson, Stephen S. (2019). *Feeling Beats and Experiencing Motion*: A Construction-Based Theory of Meter. Dissertation (Ph.D in Music), Northwestern University.

[20] King, Anthony. (1960). Employments of the 'Standard Pattern' in Yoruba Music. *African Music*, Vol. 2, pp. 51–4.

[21] Koetting, James. (1970). Analysis and Notation of West African Drum Ensemble Music. *Selected Reports in Ethnomusicology*, Vol. 1, pp. 115–46.

[22] Kubik, Gerhard. (1979). Angolan Traits in Black Music, Games and Dances of Brazil: A Study of African Cultural Extension Overseas. *Junta de Investigações do Ultramar*.

[23] Kubik, Gerhard. (2010a). *Theory of African Music*—Vol. I. University of Chicago Press.

[24] Kubik, Gerhard. (2010b). *Theory of African Music*—Vol II. University of Chicago Press.

[25] Kubik, Gerhard, and Tiago de Oliveira Pinto. (2008). African Common Denominators across the South Atlantic: A Conversation. *AfricAmericas. Itineraries, Dialogues, and Sounds*, pp. 153–63.

[26] Lerdahl, Fred, and Ray Jackendoff. (1983). *A Generative Theory of Tonal Music*. MIT Press.

[27] Lewin, David. (1981). On Harmony and Meter in Brahms's Opus 76 #8. *19th-Century Music*, Vol. 4, pp. 261-–5.

[28] Locke, David. (1978). *The Music of Atsiagbeko*. Dissertation (Ph.D in Music), Wesleyan University.

[29] Locke, David. (1982). Principles of Offbeat Timing and Cross-Rhythm in Southern Ewe Dance Drumming. *Ethnomusicology*, Vol. 26, pp. 217–46.

[30] Locke, David. (1998). *Drum Gahu*. White Cliffs Media.

[31] Locke, David. (2009). Simultaneous Multidimensionality in African Music. *African Music*, Vol. 8, pp. 8-–37.

[32] Locke, David. (2010). Yewevu in the Metric Matrix. *Music Theory Online*, Vol. 16.

[33] Locke, David. (2011). The Metric Matrix: Simultaneous Multidimensionality in African Music. *Analytical Approaches to World Music*, Vol. 1, pp. 48–72.

[34] London, Justin. (2012). *Hearing in Time*. 2nd ed. Oxford University Press.

[35] Magalhães, Alain Pierre Ribeiro de. (2008). *Baden Powell*: Livro de partituras. Gryphus.

[36] McCann, Bryan. (2004). *Hello, Hello Brazil*: Popular Music in the Making of Modern Brazil. Duke University Press.

[37] Moura, Roberto M. (2004). *No princípio, era a roda*: um estudo sobre samba, partido-alto e outros pagodes. Rocco.

[38] Murphy, Scott. (2007). On Metre in the Rondo of Brahms's Op. 25. *Music Analysis*, Vol. 26, pp. 323–53.

[39] Nketia, J.H. Kwabena. (1963). *African Music in Ghana*. Northwestern University Press.

[40] Nketia, J.H. Kwabena. (1974). *The Music of Africa*. W.W. Norton.

[41] Osborn, Brad. (2014). Kid Algebra: Radiohead's Euclidian and Maximally Even Rhythms. *Perspectives of New Music*, Vol. 52, pp. 1-–25.

[42] Pantaleoni, Hewitt. (1972). Three Principles of Timing in Anlo Dance Drumming. *African Music*, Vol. 5, pp. 50–63.

[43] Pinto, Tiago de Oliveira. (1999/2000/2001). As cores do som: Estruturas sonoras e concepção estética na música afro-brasileira. *África*, Vol. 22-23, pp. 87–109.

[44] Povel, Dirk-Jan, and Peter Essens. (1985). Perception of Temporal Patterns. *Music Perception*, Vol. 2, pp. 411–40.

[45] Powell, Baden. (1964). *Le Monde Musical de Baden Powell*. Barclay.

[46] Powell, Baden. (1966). *Tempo feliz*. Forma.

[47] Powell, Baden. (1972). *É de lei*. Phonogram.

[48] Pressing, Jeffrey. (1983). Cognitive Isomorphisms between Pitch and Rhythm in World Music. *Studies in Music*, Vol. 17, pp. 38–61.

[49] Rahn, Jay. (1996). Turning the Analysis Around: Africa-Derived Rhythms and Europe- Derived Music Theory. *Black Music Research Journal*, Vol. 16, pp. 71–89.

[50] Sandroni, Carlos. (2001). *Feitiçco Decente, Transformações do samba no Rio de Janeiro*. Editora UFRJ.

[51] Sève, Mário. (2016). O choro no estilo sambado: Padrões rítmicas e fraseado musical. *Debates*, Vol. 17, pp. 219–249.

[52] Stover, Chris. (2009). *A Theory of Flexible Spaces for Diasporic African Music*. Dissertation (Ph.D in Music), University of Washington.

[53] Toussaint, Godfried. (2013). *The Geometry of Musical Rhythm*: What Makes a "Good" Rhythm Good?; CRC Press, Taylor & Francis Group.

[54] Vianna, Hermano. (1999). *The Mystery of Samba*: Popular Music and National Identity in Brazil. Edited and translated by Charles Chasteen. The University of North Carolina Press.

[55] Vicente, Alexandre. (2012). Moacir Santos, seus ritmos e modos: 'Coisas' do Ouro Negro. Thesis (Master in Music), UDESC.