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Digitizing the Txalaparta: Computer-based Study of a Traditional Practice

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Abstract

This article describes a software implementation engaging with the ancient Basque musical tradition of the txalaparta. The research is different from earlier
studies of the txalaparta in that by digitizing the instrument and its performance rules, we have had to formalize and make explicit conventions that hitherto have been tacit knowledge of improvisational practice. Analysis through software development is an unusual case of musicological analysis as it demands clarity and precision, and often requires multidisciplinary approaches to understand the studied subject. We have developed software in order to analyze and understand a practice that has not received much musicological analysis. By expounding musical patterns and performers’ behaviors that have hitherto been difficult to analyze, we reveal the social and cultural aspects of the play. The txalaparta is a two-performer instrument and the software produces txalaparta rhythms and plays along with a human player, whilst learning and adapting to the player's style. The system helps novices to explore its rules, and also trained players to approach the instrument from a new perspective. In this research we have applied a user-centered approach, where feedback from players using the digital txalaparta was collected. This feedback allowed us to get the reflective vision of the txalaparta players and their opinions on the results of this research.

The Txalaparta

The txalaparta (Pronounced [tʃəˈlaparta] cha-la-par-ta) constitutes a percussion tradition that originates from the rural areas of the Basque Country. The instrument belongs to the category of struck idiophones and consists of thick planks of wood placed horizontally on two trestles, and beat vertically with weighty wooden batons. Other materials have
also been used (metal, stone, plastics) but wood is the most common. The txalaparta is typically played as a solo-instrument by at least two performers alternating their strokes in a call-and-response pattern, generally improvised, to construct a rhythm. This particular setup leads to a quite unique and close interaction between the players. Indeed, the txalaparta is one of few instruments in the world that cannot be played by only one performer: the collaborative play is its nature. The txalaparta was an obscure tradition that was not integrated with the main [or mainstream] tradition of Basque folk music until the past few decades. This is perhaps because of its peculiar rhythm, improvisational nature, and exotic character. Yet, it is precisely this unique character of the txalaparta that has attracted the interest of avant-garde...
artists and experimental musicians since the 1960s. In this article, we will first describe the musical practice of the txalaparta and present a contextual history of its role in contemporary culture. We will then demonstrate our work in formalizing its rules as part of the creation of a software-based txalaparta.

Very little is known about txalaparta practice before the 20th century, although various theories exist regarding its origins (Beltran 2004, 124; Aguirre 2004; Goiri 2008, 43 and 64). Some theories link the txalaparta to the festivities around the harvesting of apples for cider production. Others suggest that the txalaparta was used to communicate between mountain farms. The first historical reference to the txalaparta appears in a book from 1882 about cider production in the Basque Country (Aguirre 129), although there are previous mentions of the tobera (metal variant of the txalaparta), the earliest found in a proclamation document from 1688 (Lekuona 1920, 52). In the mid-1960s the practice of txalaparta playing had almost disappeared and was unknown to most people in the Basque Country. Only two pairs of players would play the txalaparta publicly, although it is believed that more people played in private. However, the txalaparta was known by some anthropologists and by people in the cultural and arts sectors, who were becoming increasingly concerned with its disappearance, and these people would try to bring the tradition to the attention of young artists and musicians.

During the late 1960s, like in many other places in the world, a strong popular cultural movement began to grow in the Basque Country. This was an important movement, because in the Spanish Civil War (1936-1939), and in the cultural repression that succeeded it with the dictatorship of Franco, many Basque artists and intellectuals had either been killed or had left the country. The new artists and musicians began to be interested in traditional oral literature, dance, and music with the purpose of generating a new culture based on a traditional lineage, but one that would fulfill the needs of modern society at the same time it elaborated on ideas.
from avant-garde modernity. This connection between the popular and the avant-garde did not only happen in the Basque Country and it is described by Fisher (2014, 33) who calls it ‘popular modernism’. It implies a dissemination and reformulation by the popular culture of ideas and concepts explored by modern art, music and literature. In the Basque Country this movement brought with it a strong revolutionary and anti-dictatorial ideology and the txalaparta became a perfect vehicle for this context, as it was unknown, thus free from the weight of tradition, yet at the same time very unique and distinct from other musical local traditions. New players began to eagerly study the art of txalaparta from the two pair of players still active, and thus the practice moved from its traditional rural environment to the one of art, cultural activism, national identity, and political struggle.

The txalaparta is therefore a fascinating cultural manifestation in many respects, relating to Basque national identity, the revolutionary period of the 1960s, folk music, but interestingly also within the context of contemporary experimental music. The recovery of txalaparta during the 1960s, and its evolution since then, is an interesting process for two key reasons: first, like other traditional music, the txalaparta has bespoke and unique sets of formal rules, among other characteristics (such as the use of collective improvisation, exploration of timbre, use of irregular rhythms, virtuosic performance, etc.), which have proved inspiring to practitioners of experimental music. Secondly, the process of its recovery happened under a strong influence of cultural avant-garde artists, such as the artist Jorge Oteiza who was very important in the Basque Country during the 1960s and 1970s. Oteiza developed an aesthetic theory that argued that socio-political reality can be transformed using artistic activities. Influenced by the avant-garde movements of lettrist and concrete poetry, another prominent artist during that time, José Antonio Artze, together with his brother Jesús, conceived of the txalaparta as poetical
rhythm, almost phonetic, in an attempt to contribute to the construction of a Basque cultural identity, and joining tradition with contemporary experimentation in the process. This combination led to an ancient tradition meeting radical modernity, receiving interest from groups outside the community of musical practitioners, to the point that nowadays txalaparta is one of the most well-known and popular musical instruments in the Basque Country with thousands of amateur players, and has become an icon symbolizing Basque culture.

What is known from the old style of playing the txalaparta prior to the 1960s (known as txalaparta *zaharra*) is based on the descriptions and recordings of the very few players left in the early 1960s when the txalaparta was recovered. The players take clearly defined roles in the call and response improvisatory process where the bar is split in two parts, roughly equal, each for one player. The first role, called *txakun*, maintains a rhythm of two strokes with a fluctuating pulse. The second role, *errena*, is freer and is able to response with one or two strokes as well as resting (See beginning of video 2. Video examples are available at <<URL at mitpress.edu to be specified later>>). Performances usually start with a medium tempo that increases until a climax in which the rhythm reaches a static stage lasting a few seconds, after which the performance stops abruptly. The players do not seek to maintain a clear metric pulse or regular subdivisions and this results in a very organic rhythmical structure. The old instrument consists of a single plank of around two meters long, sometimes longer, and players will search for timbrical variations in the plank with their strokes.

Nowadays, txalaparta players usually study and practice both the old and the new styles of playing and the old style is still well alive. The new styles of txalaparta that developed after the 1960s are usually known as txalaparta *berria* (new). Here both players are free to play without any restrictions and can play in their part of the bar with up to four strokes (sometimes more), as well as resting. Free form
responses are also allowed but they are not so common (See beginning of video example 1). Any type of metrical structures can be used and interpreters can play around with the time gap between the strokes, its amplitude and timbre. In addition to these innovations, a wide range of tempo can be used and it is common to change tempo several times within the same performance. These performance sessions are usually longer than the traditional ones and often have very strong changes in dynamics (See video example 1). The new txalaparta emphasizes virtuosic playing, which means that performers must listen carefully to each other in order to adapt and build a meaningful improvised development of the session. Performers are now more interested in the timbral palette provided by different materials, so different types of woods and even other materials are now used (such as stone, glass, or plastics). Although performers of the new txalaparta do not try to break away from the traditional txalaparta, these minor changes in performance and instrumental nature are quite noticeable, considering how minimalist this musical style is. The old txalaparta rhythm was additive, where parts progressed over fluid time, whilst the current txalaparta tends to be subdivisive, where parts are like musical bars in a set tempo, although this is not necessarily always the case. It is also important to note that the old players would play txalaparta only a few days a year, typically during festivities, whilst some of the new players practice it every day and perform publicly dozens of times per year.

In the mid and late 1990s the situation changes further with the development of the pitched txalaparta – a process Argibel Euba has defined as ‘xylophonisation’ (2004, 32). In addition to pitched wooden planks, metrical structures have also become increasingly standardized (e.g., pulse, subdivisions, and rhythmic changes), thus more ‘aligned’ with other musical practices, also better suited to the concerns of common musicological analysis. The popularization of the use of the txalaparta to play melodies, during the last decade, has in some cases weakened the complex
interrelation between players to the point that sometimes, it is only the practice of interlocking beats that remains from the old performance style (Escribano 2012, 225). These changes in performance and organology have resulted in a style of playing where the txalaparta has become a form of marimba, as the planks and sticks shorten in order to accommodate the requirements of new players who search for tonality.

Related to these changes, a form of musical notation has emerged for txalaparta playing. However, although some composers have written pieces for the txalaparta using notation (e.g., Eneko Abad and Sergio Lamuedra) most players prefer to improvise and this might have to do with the intense focus on speed and player communication that often characterizes the modern play. The musical notation such as the one shown in Figure 2 is still useful as descriptive notation preserving performer style and knowledge, as well as for students of the txalaparta. In the txalaparta scores time is mapped to space (read left to right), vertical lines represent strokes, dotted vertical lines represent rests and the numbers above and below set which plank correspond to each stroke. The long horizontal line separates the strokes assigned to the first player (above the horizontal line) and those to the second one (below the horizontal line). Although most scores usually follow those conventions there is not a fully standardized way.


Figure 2: Detail of a txalaparta score by Eneko Abad.

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to write scores and there are differences between players. We followed some of
those conventions while designing visualization aids in our software, as we describe
later. For more details on txalaparta scores read “Notating the non-notateable:
digital notation of txalaparta practice” (Hurtado and Magnusson 2016).

The above developments have raised concerns about some of the txalaparta’s
original characteristics being lost, to the point that some players claim that
developments such as the ‘xylophonisation’ cannot be defined as txalaparta
anymore. This is a process that has already happened to other musical traditions,
when faced with notated music:

‘The petrifying effect of European classical music on those things it
touches - jazz, many folk musics, and all popular musics have suffered
grievously in their contact with it - made the prospect of finding
improvisation there pretty remote.’ (Bailey 2010, 56).

The current use of scores or the practice of tuning the planks are also
controversial, reminding us of the criticism in the late 1980s, stating that the
introduction of regular metrics was changing the practice too much. However,
despite of this tendency of metrical and tonal standardization, the txalaparta
remains a heterogeneous practice with no standard way of playing, building the
instrument, teaching, or writing scores.

**Txalaparta, Experimental Music and the Avant-garde: On
Processes and Rules**

Since the 1950s, many composers have eagerly explored the idea of the ‘open
work’ (Eco 1989), rejecting the idea of a fixed determined composition, and applying
various techniques to produce different results every time the music is interpreted. Techniques such as the use of indetermination, formal processes, or improvisation have been key elements in contemporary music. Composers such as Cornelius Cardew, La Monte Young, Christian Wolff, and Earl Brown implemented these types of strategies, but it is perhaps Terry Riley’s popular *In C* (1964) that most perfectly embodies these characteristics. In his piece, Riley proposes a situation where, based on predefined musical material and by following a set of rules through collective improvisation, a structure emerges where the relationships and interactions between interpreters are crucial to the development of the piece. Riley defines the situation and the process as parts of the composition that yield potentially infinite versions of the piece, which is one of the main characteristics of generative processes. In the context of this article, we could define the following as the main characteristics of generative music:

1. Those works are process based
2. The process can be described as a set of instructions
3. The process leads to different results each time it runs
4. The process can be autonomous or semi-autonomous
5. Those works are not only computer based or digital

The renewed interest in the txalaparta in the 1960s was concurrent with globally emerging compositional trends in experimental music that emphasized process-based and nonlinear compositions, which sometimes embraced improvisation and the use of semi open rules. This led to compositions that produce different results every time the music is interpreted, such as the old style of txalaparta play (and most of the new one). It is the 1972 Encounters Festival in Pamplona, organized by the composer Luis De Pablo, that consolidated the
relationship between the txalaparta and international experimental music. Artists and musicians from all over the world met at that multidisciplinary encounter full with exhibitions, concerts, performances, and film screenings. The Artze brothers played at the festival in front of an audience formed by artists and musicians, which included among others, John Cage, Steve Reich, and Walter Marchetti. Cage was fascinated by the rhythmical structures of the txalaparta and stated that it was the best work performed at the Encounters Festival:

Ah, Txalaparta? Ah, the music with the sticks with the natural rhythm of the gallop... I just listened to it and it is absolutely delicious. I could listen to it for hours. It is a very flexible and malleable music. (Jover and Amestoy 1972, our translation from the Spanish article)

Steve Reich also expressed his surprise in discovering such rhythms in a Western musical tradition and wrote enthusiastically about the concert in his notebook (Reich 1972; Hurtado 2015, 109, 232) and spent some time studying the txalaparta in the ensuing days.

[...] completely hocketing only 2 people - player said more than 2 would fill up all the spaces making melodic patterns. the _only_ objection I would make to what I heard is that it lacked a system, a process and so the technique is fantastic, the sound is fantastic but, perhaps because it was improvised and not part of fixed tradition it lacked a certain depth. (Reich 1972)
In 2009, Reich acknowledged (in an unpublished interview carried out by Euba as part of his PhD research) the influence this event had on his composition *Clapping*, written that summer, and the subsequent *Music for Pieces of Wood*, from 1973.

The txalaparta seemed to fit well to this new musical landscape that emphasized rules, improvisation, collaboration, and the non-notated – eagerly incorporating elements from outside the Western musical tradition. The unpretentious and low-level approach, the humble origins, and the obscurity of the practice seemed to attract the international composers and theoreticians. Furthermore, some commentators and practitioners of txalaparta claim that the txalaparta is not the physical instrument itself, but the rhythm and the rules that are applied (Escribano 2012, 4; Beltran 1998, 198). Like many contemporary musical compositions, the txalaparta play can be described as a process defined by a series of instructions that the interpreters use as guideline to improvise rhythms. This distinction between the txalaparta rules and the physical instrument was fortunate for this current research, as designing a digital version of the txalaparta engages primarily with its rules as opposed to its materiality.

**Digitizing the Txalaparta: Context**

Although there has been much interest in the txalaparta since the 1960s, formal musicological analysis of the practice has not been conducted until now, probably because of its nature as an improvisational practice with no common repertoire, recordings, or written documents to study. Another reason explaining the lack of musicological work might be the fact that the music was unpitched, consisting of rhythm only, it has frequently been played by musicians with no formal training, and often performed outside contexts that we would define as being musical.
Finally, we might explain the practice’s exclusion from musicological study by considering that it has been often considered more of a game than a form of music by some – lacking performance contexts, a lineage of performers, and organological knowledge – and for that reason early ethnomusicology ignored the practice. This is now changing, and the txalaparta is increasingly gaining interest from the ethnomusicology research community.

Nowadays there are academic papers that introduce the practice (Leaf 2007), explore notational transcription (“Txalaparta. Transcription and Analysis” by Euba dating from 2004), perform acoustic and rhythmical studies of the instrument (Ralla 2014; Gambra 2008; Sanchez and Siguero 2000). Doctoral research has been conducted: there is an extensive anthropological thesis by Escribano (2012), this article reports on the recent research conducted by Hurtado (2015), and a recent thesis by Euba (2017) engages with the tradition from the perspective of ethnomusicology. Furthermore, Ralla is finishing his thesis from the perspective of pedagogy (‘La Rítmica Jaques-Dalcroze en el contexto de la txalaparta: cómo es percibido y aplicado’). There are also some book publications by key practitioners working outside the academy who attempt to trace the origins of the instrument and its history after the 1960s, (see for example Beltran 2004; Beltran 2009; Goiri 1994). This sums up most of the literature on the instrument.

There have been some attempts at producing software based on the txalaparta, and these projects are worth mentioning here. In the 1990s the Laboratorio de Tratamiento de Palabra y Música in Madrid developed a software they called the Tecnotxalaparta, which was a command-line application capable of listening and responding to human players in real-time. The input was done through keystrokes on the computer’s keyboard and the output was MIDI messages sent to a sampler with txalaparta samples. This software was never released and is now abandonware (Sanchez 2014, personal email). In 2002, ixi audio released an application called
Txalaparta and developed by Hurtado, which consisted of a display where two pairs of rectangles representing the sticks could be controlled and an on-going rhythm would be produced by the system (This application was never made publicly available and was only ever used by a limited number of musicians in the Basque Country). Ttakun was another software, made in 2005, which worked as a sequencer aimed at creating compositions and exercises for the txalaparta (https://github.com/Soinuenea/ttakun). It provided dozens of exercises grouped by levels of difficulty. It could be used as an accompaniment by creating a sequence containing one player’s part, after which the user would play a real txalaparta while the computer played back the sequence. Recently there have been some attempts to use touch interfaces to replicate the interface of the txalaparta. The Txalapartapp for the iOS is the most sophisticated of them, where the user can play the planks on screen and it also has a mode where the user must follow the rhythm the app plays. However, the play is not generative in any way and consists of predefined looped sequences.

Whilst the software mentioned above have all focused on the txalaparta in some way or another, none of them are generative or collaborative where the human performer plays with a listening machine. There are, of course, plenty of such projects, for example The Continuator (Pachet 2002), which is one of the most relevant giving the objectives and the technology used, but it does not engage with the txalaparta. Others are ImprovGenerator (Kitane and Koike 2010), GenJam (Biles 2002), Haile (Weinberg, Driscoll and Parry 2005), Robotic Marimba Player (Weinberg and Driscoll 2007) and Shimon (Hofman and Weinberg 2011). Some of these projects focus, as we do here, on traditional music. For instance music from Ethiopia (Herremans, Weisser, Sörensen and Conklin 2015), or tal music from North India (Wright and Wessel 1998). We have been fortunate to conduct this study in a well-defined, yet open practice, interacting with a closely-knit community of
practitioners who have been interested in the research project from the start. In the following sections we will describe the Digital Txalaparta, its development and community reception.

The Digital Txalaparta

Objectives, research questions and methodology

A key objective of the Digital Txalaparta was to understand and formalize the rules manifested in txalaparta playing, such that we could develop software applying those rules. The research questions can be grouped into three areas. Firstly, we wanted to study the relationship between the txalaparta and the avant-garde music: why did the txalaparta catch the interest of artists and musicians in the 1960s and 70s? Considering that these people were often pioneers in electronic music, we seek to understand the practice in this context. Secondly, we wanted to formalize the txalaparta rules and explore how the computer can help us to understand them from a new perspective: is the txalaparta an instrument, a type of rhythm or a set of rules? Is there anything unique in txalaparta practice compared to other improvised music? Can the rules of the txalaparta be described and translated into a digital algorithm? Finally, we were interested in reflecting on the reactions of the musicians who worked with our software and discuss with them the stylistic and organological changes the txalaparta has undergone, with the digital txalaparta as part of that process.

We applied methods from different disciplines such as sociology, ethnomusicology, software development, and human-computer interaction. We used semi-structured interviews, observation, documentation research, user tests, casual talks, and online surveys. The relationships with key practitioners that we
have established have continued and we now work in a close collaboration with experienced txalaparta interpreters, some of whom have become intimately involved in the development of the software. We also created a survey sent to txalaparta players, the first ever on the txalaparta, which helped us collecting opinions about different aspects touched on this research.

Describing the rules

The txalaparta play can clearly be described as a highly rule-based activity albeit of a characteristically tacit nature. This suggests that the task of creating txalaparta-software would require a strong explicit understanding of its nature and formalization of its rules (unless a machine-learning approach is taken, which was not our case at that point, mostly because we were particularly interested in trying to understand the link between the txalaparta and the rule-based compositions from the 1960s experimental music). Here, therefore, the txalaparta appears slightly differently from many other percussion instruments, as the txalaparta is a manner of playing (the rules applied) as well as the physical instrument itself, as we have already pointed out.

A summary of the tacit rules we observed during our research of txalaparta play will be described here below. Note that this description only covers what we think is the more standard way of playing improvised txalaparta, and that there are styles of playing and performers who will not fit fully with this description.

1. The txalaparta improvisatory play is performed by two performers who split the bar in two roughly equal parts, each taken by one performer.

2. Although players are free, often one of them takes a leading role while the other one tends to follow the first. These roles can move between players during a performance, akin to a human conversation.
3. The performance typically presents a loose call-and-response structure, where the first performer plays a theme that is answered by the second player.

4. Within its part of the bar each performer can perform up to four strokes or a rest. Any combination of strokes is possible but not two consecutive rests (a rest cannot be followed by a rest) as that would be understood as the end of the play.

5. Within their part of the bar, players can position strokes tightly together to the point of stroking at the same time with both sticks, or spread them in time, but they rarely go over the other player’s part of the bar (as seen in videos 6 and 7).

6. Strong variations in dynamics can be applied both to the general structure of the play or to the individual strokes within a response.

7. Any plank can be struck (unless some kind of restriction has been agreed beforehand).

8. Performers can strike any part of each available plank but they tend to concentrate in the areas where planks vibrate more freely.

9. Although each response is unique, players often repeat a response for a few bars introducing small differences each time they play it. They also sometimes come back to a previously played response or work out new variations of previously played ones.

10. Txalaparta performers are in constant negotiation to establish a consensus on the tempo, time distance between strokes and amplitude, while they tend to diverge playing around consensus-divergence-copy in other options such as the number of strokes in the responses and the planks they hit.

11. The length and global structure of the improvised play can be totally free, although most players often agree upon some kind of loose structure beforehand (For example: start slow, speed up then keep the tempo for two-
three minutes while performing different rhythmical combinations, finally transition to a faster tempo to end up abruptly).

A set of videos demonstrating several txalaparta rhythms and styles were produced as part of this research. They can be accessed at <<URL at mitpress.edu to be specified later>>

**The Software**

Our aim was to create a software that would produce generative txalaparta rhythms and that could run on standard laptops without the use of expensive sound interfaces or sensors. The result was the Digital Txalaparta, a software in two parts: The Autotxalaparta and the Interactive Txalaparta. Both applications were developed using the SuperCollider programming language and produce sound by using real txalaparta samples. Users can record and introduce into the application several strokes recorded from each plank in their txalaparta (we suggest to record strokes with different amplitudes and from different locations on the plank). Up to 25 samples per plank can be introduced, as we divide each plank horizontally in five areas, with up to five strokes per area. Sounds can be just copied manually into the the samples folder following a naming convention, which is specified in the documentation, or they can be recorded using a small control panel we developed in SuperCollider and that automatically records, splits, normalizes and saves the individual strokes in the right folder with the correct naming. However, this system sometimes fails to detect and extract the strokes properly and this is why recording and introducing them manually is the preferred option at the moment.

*The Autotxalaparta*
The Autotxalaparta (see Figure 3) is a semi-automatic generative software that emulates the txalaparta play. It generates both parts of the txalaparta rhythm (it simulates the two players) and its development allowed us to understand better the options the performers face when they play, the tacit rules that we have just described. The GUI enables to control the main parameters of the rhythmical process. Those are amplitude (“amp” slider), tempo (“tempo” slider), time distance between strokes within responses (“gap” slider), number of strokes each of the players is allowed to perform within responses (“Hits” buttons) and chances for

Figure 3: Screen capture of the Autotxalaparta software. The main controls are on the left side window while the right window contains the aids to help visualize the rhythm.
each of those options to happen ("Hits % chance" sliders), which planks are available to each performer ("Planks" buttons) and chances for each available plank to be struck ("Planks % chance" sliders) and finally a time swing that allows the tempo and the strokes swinging around the "correct" timing ("tempo swing" and "gap swing" slider). This last option is an attempt to simulate swing. The Autotxalaparta can be set to only produce a single voice, enabling people to play the real txalaparta following the computer’s output. Here the software plays in the first part of the bar and the human responds in the second one (see video example 3). Performers who tested this feature found it very intriguing and strange at the same time, as we will discuss below.

*The Interactive Txalaparta*
We received very interesting feedback and suggestions while showing the Autotxalaparta to txalaparta players. This led to the development of the Interactive Txalaparta (see Figure 4), a new software that analyzes the human performer’s play, using a standard microphone and machine listening techniques, to answer producing the second part of the txalaparta rhythm, thus allowing a human to play txalaparta with the machine. We use several techniques to analyze the microphone input. When a human plays with the Interactive Txalaparta, their responses are followed by an empty gap for the second player’s response, in this case the computer. Therefore we use a silence detection system (DetectSilence in SuperCollider) to detect the start and end points of the human responses. This allows us to estimate the length of the bar, calculate the tempo and split the bar in
two parts, in the second of which the computer responses are played. We average the tempo of the last two bars in order to get a stable estimation. This technique fits well with the txalaparta play where the tempo is in constant negotiation and players who tested this said it felt natural. An onset detection system (Onsets in SuperCollider) reports the number of strokes within each human response and the amplitude of each stroke is analyzed with the Wamp class which averages the absolute value of incoming signals received during the stroke. Finally, the analysis of the timbre, performed with the Chromagram class, allows us to identify which planks are being struck. In this case, we compare the timbrical data from the current stroke with the data from a reference stroke of each plank in the txalaparta that is being used, which has to be provided in advance. This system only fails when comparing planks of similar timbre (something txalaparta sets usually avoid). For more details on the analysis techniques used see files TxalaOnsetDetection.sc, TxalaSilenceDetection.sc and TempoCalculator.sc at http://github.com/enrike/txalaparta.

The analysis system can be calibrated to accommodate the txalaparta performer’s playing style and their instrument’s sound. The calibration must be done manually using a small popup window with sliders and tested by trial and error. Apart from using a microphone to receive the input, other options could be explored (e.g., using piezos) but we decided to focus on simplicity and the equipment the user is most likely to have access to (e.g., a standard microphone, even a laptop mic). Approaches involving machine learning and more sophisticated machine listening could be also explored to analyze the data but we decided they were out of the scope of the research at this point.

The data generated by the analysis system is, by default, being stored into memory as the human plays (this can be disabled from the “Memory manager: learn” button) and it is later used to generate the computer responses. On the one
hand we store the symbolic description of the human responses classified in four groups depending on their number of strokes. This symbolic description contains (for each stroke in each response) information about amplitude, plank being hit and time distance between the current stroke and the first stroke of the response it belongs to. On the other hand, we keep updating a transition matrix with the data from the changes between number of strokes (rest, 1, 2, 3 or 4) of the current play (for eg. txalaparta player A strokes twice to which player B might answer stroking three times, and so on). All this data can be saved by the user in a text file to be later reloaded. This allows to subsequently reuse and feed the application with different sets of data corresponding to different txalaparta styles or constrains to be applied to the system.

In a similar fashion to that faced by txalaparta players, to construct a computer response we need to decide upon the following options: when to issue the response, how many strokes the response will have, average time distance between strokes of the response, overall volume as well as the [relative] amplitude of each individual stroke, and finally, which plank and where within the plank each stroke hits.

The graphical user interface allows the user to switch between three answering modes using the “answer” pull-down menu. The labels in the menu are “imitation”, “memory 1 bar” and “memory 2 bars”. The “imitation” mode just tries to respond with an exact replica of what the human plays. This mode is useful to test the calibration of the analysis system. The two other answering modes use a combination of techniques including reusing and adapting data collected from the human play together with Markov chains and weighted randoms. The only difference between those two modes is that each uses Markov chains of different orders. The Interactive Txalaparta tries, like any human txalaparta player would, to accommodate to and follow the human tempo, amplitude and average time distance between strokes of responses. As for the other options available when building
responses, we use Markov chains to decide how many strokes new responses should have, although Markov chains have been often used in computer music to generate notes and melodies. Possible states in our Markov chain are: rest (0), 1, 2, 3 and 4 (see Figure 5). As we just mentioned, the information in the transition matrix is constantly updated to reflect the decisions the human takes when answering to the machine.

![Diagram of the Markov chain that describes the possible stroke options for txalaparta players. Produced with marko.yoriz.co.uk.]

Once the Markov chain decides the number of strokes for the next response, we choose randomly, from the collection of symbolic descriptions of previous responses by the human that we keep saving, one that corresponds to the decided number of strokes. The symbolic data of the chosen response must be then adapted to the current conditions of tempo, average amplitude and average time distance between strokes of the same response, by stretching the time distance between hits and recalculating the amplitudes. The plank pattern (which plank corresponds to each hit within a response) is copied
from the symbolic description of the human response we have just chosen. We considered creating Markov chains to generate those patterns but the number of planks in txalapartas vary strongly from one to seven, sometimes even more. This means that the states and transitions in the Markov chain describing the plank patterns would grow exponentially with each plank added to the txalaparta.

Finally, as described above, txalaparta players strike different areas of each plank to play around with timbre variations, tending to concentrate in some areas more. When we are creating a response, once a plank has been assigned to a hit, we perform a weighted random to decide which part of the plank the stroke should be assigned to. The weights were estimated after observing txalaparta performers playing, but they were as well discussed with them. We then take a sample which corresponds to that area of the plank and that matches the current amplitude conditions better.

**Graphical aids**

We designed graphical representations (see Figure 3 and 4) of the software’s rhythm to allow performers to understand better the computer’s output, as the visual feedback (even just in the form of peripheral vision) proved to be crucial in the txalaparta play. When a human plays the txalaparta, the body gesture of the player to perform a stroke starts immediately when the previous one finishes, the body, and specially the arms, are in constant movement. This is an important part of the play and it helps players to foresee the partner’s actions, as we noticed when they played with early versions of our applications. This gestural element of the performance required us to develop a system of visual feedback when playing with a computer. The first visualization system simulates the up-and-down movement of the txalaparta sticks (Figure 3, top-right. Figure 4, center). The second system is a circular representation of the bar where the last response’s strokes played are drawn.
(Figure 3, bottom-right. Figure 4, center). Time is mapped clockwise and it helps visualizing the time distance between the stokes of the same response as well as their amplitudes (the sizes of the small circles, as seen in Figure 3). This last system is based on a figure from a paper by Sanchez and Beltran (1998) used to describe the way the bar is split by interpreters in the txalaparta play. Finally, only in the Interactive Txalaparta, we created a piano roll-like system (Figure 4 above) that displays the strokes as they are being played. It follows some of the conventions of the txalaparta scores such as representing the strokes with vertical lines across a long horizontal line, but we also introduced some features to allow to visualize better the different parameters of the play.

Evaluation
From user-tests we learned that performers who used the software were generally positive about the experience. For all of them, it was the first time that they could improvise txalaparta with a computer (see Figure 6) and this situation led to questions on the txalaparta play itself and the way interpreters interact with each other which should be subject of further research, such as the visual feedback (as we just mentioned) the role of memory and social aspects of the players’ interaction that work on top of the basic musical rules of the play. The development of the software made evident that players were interested in improvising with the computer as second player, which was something we did not expect. Txalaparta performers

Figure 6: Single txalaparta player improvising together with a computer running the Interactive Txalaparta software.
found that playing along with the Autotxalaparta felt rather aleatoric compared to playing with humans. Playing with the Autotxalaparta is a very different situation to that when human performers play, as they must listen carefully to each other to negotiate meaningful txalaparta rhythms, but the Autotxalaparta does not listen or react in any way to the interpreter’s play. The techniques we use to generate the rhythm in the Autotxalaparta seem to create convincing txalaparta music but only for a limited span of time and under some configurations of the application. After a while interpreters felt like the music goes nowhere, because it does not build any structure, and they thought the Autotxalaparta should be able to develop musical structures on a longer term as well as engage with the performer’s play. Other possible configurations of the application are just too far away from a normal txalaparta play, they are too irregular.

However, it was interesting to observe that all of them felt that both playing with the Autotxalaparta or listening to the rhythms it generates, whether they felt those rhythms were correct or not, was an enlightening experience which strengthened their self-awareness of the strategies they develop while interacting with another human. When the computer generates “weird” txalaparta music the tacit rules that describe what “normal” txalaparta music is unfold. The Interactive Txalaparta, however, produced almost the opposite reaction. Interpreters thought it should be able to introduce new ideas in the play, be more creative, diverge from the consensus. We believe that the fact that in the Interactive Txalaparta we are using the data extracted from the human play to generate the responses allows the software to feel realistic. However, at the same time, this means that the application does not diverge from the ideas proposed by the human, it follows them too closely. This is probably why they found the program too docile. The txalaparta improvisation is based on a constant negotiation between the interpreters where they tend to play around the agree-disagree dichotomy, often following each other,
but also contradicting and opening new directions which might or not be followed by the other interpreter (See video examples 4 and 5).

The usage of Markov chains with different orders did not make a big difference on the generation of structures as we did not have the time to fully explore and test the differences in the music they generate, and this is a strand that could developed further. However, despite of this, interpreters who used the Interactive Txalaparta felt quite intrigued and found the experienced very interesting. From our perspective, this feedback helped us envision different features to develop, such as the visual feedback systems, the calibration system or the system to sample sounds from any txalaparta. We presented a preliminary version of our research at the Txalaparta Congress in Pamplona in March 2015. We were delighted to discover that practitioners found our approach interesting because of the questions it arises about the nature of the txalaparta and its play, even those of them who had never considered music making using a computer. Our concerns that the txalaparta community would be skeptical about digital software were thus lowered. The community has shown itself to be interested in innovation, collaboration and alternative approaches to study the practice. This is perhaps a result of the txalaparta’s history as a practice that was rediscovered by the avant-garde in the 1960s, and a fact that cannot be projected so easily onto other traditional folk music.

More recently, during January 2019, we played the Autotxalaparta and the Interactive Txalaparta in two concerts together with one of our collaborators (Ibon R.G.), who has an experimental pop-folk project. The applications, together with a real txalaparta, were used to arrange some of the songs composed by the musician. The response by the public and in the media were quite positive and we found that it was quite interesting to use the programs to both play “normal” txalaparta rhythms but also to explore combinations that the software allows but no human interpreter would ever play (to escape the tacit rules). This influenced the way we
played the txalaparta in those concerts and we tried out options outside the
conventional styles of playing.

Finally, we also conducted an online survey among txalaparta players with
questions about the txalaparta and their opinions on the changes it has undergone
since the 1960s. This was the first survey ever on txalaparta and it provided us with
many insights on several aspects covered by this research, as well as helped us
framing many aspects and ideas about the txalaparta play (Hurtado 2015, 185-188).

For instance, we noticed that there is a deep debate on the rhythmical and
organological changes the txalaparta has undergone in the last decades. Another
issue is the different opinions on the txalaperta notation, while some strongly reject
it, others are enthusiastic about it. We also collected interesting data on the nature of
txalaparta that should be subject of further research, for instance the different
approaches on txalaparta that seem to exist between trained and untrained
musicians, especially in relation to improvisation, or the divergent understandings
of the txalaparta nature that performers express (a small group strongly support the
idea that the txalaparta is a type of rhythm rather than an instrument, while others
do not support this claim, but most performers support both ideas). To sum up,
players who played with the software became more aware of the tacit rules they
apply when playing, and for some of them it opened up a space for a more “out-of-
the-box” way of playing that explores the limits of the current txalaparta.

**Conclusion and Future Work**

This research into the txalaparta and the resulting software has portrayed the
practice as a highly heterogeneous and multifaceted. We have found that this is a
consequence of its peculiar history with an unknown past and a period of
resurrection in the context of experimental music and avant-garde art culture during
the 1960s and 70s, as well as the mutual historical and formal links between txalaparta and contemporary music. Much of the common interest exhibited by artists and musicians on txalaparta can be explained by how contemporary it feels with its formal characteristics, such as the lack of defined rhythm and tonality, the use of collaborative improvisation defined by generative rules, the exploration of timbre, the economy of the language, the use of repetition and pulse and the process of using alternation in the construction of the rhythm. However, this is slowly changing as the txalaparta accommodates to western music in an effort to keep up with times and evolve.

Some practitioners claim the txalaparta is a style of playing rhythms and not the physical instrument. We agree that the nature of the txalaparta rhythm is unique, but we argue that the uniqueness of the practice is largely defined by the physical nature of the instrument – its weighty vertically played batons, the solid wood (or other materials used nowadays), the size of the instrument, etc. We agree with other authors that one of the more unique characteristics of the txalaparta in an instrumental and organological context is how the construction of the rhythm emerges from alternate call-and-response performance technique quite special to the practice. This results in a special relationship between the players, as they are not playing together with two instruments: they are one coherent system where skill, timeliness, creativity, personal understanding etc. rendering the play a rather peculiar and unique musical mode of interaction.

Through the software development we have discovered the hard way how many different levels of rule sets there are in the practice. On a lower level there are rules that determine the musical material (how many strokes, how to define the alternate timings/roles) and on a higher level there are rules that define how the interpreters interact each other during the play to construct long term structures, like when they repeat a response for a few bars introducing small variations or re-work previously
played responses. We have seen that some characteristics of the txalaparta are easy to translate to the digital domain (rhythmical characteristics) while others are more difficult (richness of timbre). The process of developing the software, and engage with users in the testing of the software, has been an enlightening process to both parties: by attempting to formalizing the rules of the software, latent knowledge becomes explicit, and practitioners described that the process of contributing in this participatory design development changed their own understanding of their practice, as well as bringing in fresh perspectives, not to mention the software tool itself, which is open source and freely available on the researcher’s website (http://www.ixi-audio.net/txalaparta).

Future work will involve the development of more functional and complete software that would allow to research further the txalaparta rhythms. We will improve the algorithms that analyze the human play to overcome the current stylistic limitations, as well as improving system’s response to make it more complex and richer, closer to the complexity of the human play. For this, we have begun to apply new techniques developed as part of new machine learning neural networks. Further plans, include the analysis and cataloging different txalaparta stylistic ‘dialects’ as played by different performers. That way, the practitioners could improvise using this software with a data set from different well known txalaparta players, which we hope will speed up learning and understanding. The musicological study of the relationship between the txalaparta and experimental music is also a topic that can be deepened, using more in-depth interviews with key participants.

In conclusion, we find that this research is really a starting point for further investigations on txalaparta from the view of experimental music, given the multiplicity and richness of the aspects we found, ranging from human collaboration, unique performance style, improvisation to issues of invented
tradition and formalized software development.

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