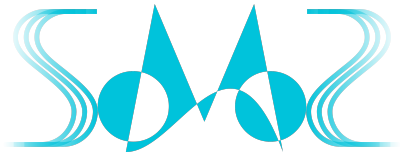
Proceedings of the

First Symposium of the ICTM Study Group on Sound, Movement, and the Sciences (SoMoS)

28-30 September 2020
Stockholm, Sweden

Editors:
Rainer Polak, Rafael Caro Repetto, Andre Holzapfel, and Lara Pearson

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- Gediminas Karoblis, Professor at the Department of Music, NTNU

Preface

The First Symposium of the ICTM Study Group on Sound, Movement, and the Sciences (SoMoS) was originally planned to take place from 28 to 30 September 2020 in Sweden, hosted by the KTH (Royal Institute of Technology) in Stockholm. Due to the global pandemic, the program committee, local hosts and executive board of the study group decided jointly to turn the event into an online symposium. Our host Andre Holzapfel thankfully became the primary online host, and to keep some Swedish "flavour" he organized a wonderful opening event with Swedish folk music played by Sven Ahlbäck, Petter Berndalen, and Olof Misgeld. Andre was joined by several voluntary co-hosts (members of the program committee as well as SoMoS executive board) who helped to chair sessions, manage the meetings, and provide back-up online space.

All presentations were pre-recorded, but the presenters attended in person online for their respective sessions and answered questions after their presentations. Altogether more than 40 participants took part, from all over the globe and across multiple time zones. To accommodate for time differences, all video presentations were made available online for the duration of the event.

The main aim of the ICTM SoMoS study group is to bring together and support scholars whose work combines methods and approaches from ethnomusicology and/or ethnochoreology with those from the sciences to explore sound and movement in musical and dance contexts. For our first official symposium, we welcomed proposals on any topic that aligns with the aims and themes of the Study Group. In particular, we invited contributions that either combine ethnographic and science-based approaches, explore the issues involved in such endeavours, or present reflective discussions on relevant theories and methodologies. As hoped, the accepted presentations brought together scholars of diverse backgrounds and approaches and resulted in exchanges of perspectives that proved fruitful for many involved.

At the meeting, two open discussion sessions provided opportunities to communicate on a professional and organisational level. After all, a symposium is as much about more general scholarly exchange as it is about presenting and learning about each others' research. Even in this online format, the symposium served to strengthen our community and encourage and encourage discourse across the areas addressed by our study group.

These proceedings are a record of the symposium in the form of short and extended abstracts. All authors were given the option to decide in which of these two categories they wished to submit their contributions. Short abstracts were up to 300 words in length, while extended abstracts had a limit in the main text of 1,500 words. The extended abstract format, which is commonly used in the proceedings of disciplines such as music psychology, was chosen instead of full articles to take into account the preferences of the majority of presenters, as many needed to publish their full articles in discipline-specific journals. All abstracts received were peer-reviewed and copyedited by the team of editors to ensure a high-quality publication by the SoMoS study group.

Finally, we would like to thank all authors who contributed to the proceedings, and all reviewers who volunteered and invested considerable time and energy to make this a peer-reviewed publication: a valuable and tangible outcome of the first SoMoS symposium.

Graz, July 2021.
The SoMoS Executive Committee.

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Symposium Program

First Symposium of the ICTM Study Group on Sound, Movement, and the Sciences (SoMoS)

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10:30 – 11:00	Visualization of melodic motives for music understanding	Rafael Caro Repetto
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11:30 – 12:00	Physiological Interpretation of 'Bambara Walalla', a Rotation Technique in Ritual Dance in Southern Sri Lanka	Hasanthi Niriella
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11:00 – 11:30	Closing comments	Andre Holzapfel with members of Study Group Board and Programme Committee

Chapter 2

Long Abstracts

Visualization of Melodic Motives for Music Understanding

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Music Technology Group, Universitat Pompeu Fabra

Motives are key elements in the definition of the melodic system of many music traditions. Indeed, they have been identified as essential components for the characterization of modes in Middle Eastern and Asian musics (Powers et al. 2001). Consequently, recognizing the significant motives of a specific entity from a music tradition's melodic system, as well as understanding their function in performance, is essential for the comprehension and appreciation of that particular performance in terms of its music tradition. Understanding and appreciation of unfamiliar music cultures is precisely the goal of the Musical Bridges project. In this paper I present two recent tools developed in this project focused on melodic motives in North Indian classical music and Arab-Andalusian music.

THE MUSICAL BRIDGES PROJECT

Contributing to the development of listenership (Elliott & Silverman, 2015) for music traditions unknown to a listener is the main goal of the Musical Bridges project.[2] To that aim, online computational tools are developed which, through visualization of selected musical elements and interactive functionalities, guide the user's listening attention. The final goal is to enhance attentive and engaged listening (Campbell, 2004) for the aural perception of those selected elements. Using a data driven approach, Musical Bridges draws on the research corpora gathered in the CompMusic project[3] (Serra, 2011) for the computational study of North and South Indian classical music, Ottoman-Turkish *makam* music, Chinese *jingju* music and Arab-Andalusian music. Therefore, these also are the five music traditions researched in Musical Bridges, and for which tools focusing on different elements of their musical systems are developed. In the next section I describe how melodic motives are approached in two tools developed for North Indian classical music and Arab-Andalusian music.

PROTOTYPE TOOLS

The goal of tools presented in this paper is to guide the listener attention to the performance of the motives that characterize specific entities of the melodic system in these two music traditions. The tools not only indicate where the motives are performed, but also their melodic contour and their relationship with other musical elements. In addition, they allow the user to navigate a recording in terms of the performed melodic motives and visualize how they contribute to the structure of a composition or performance.

Even though I will focus here on the use of these tools for the understanding of melodic motives, they also offer other functionalities, detailed on their respective webpages. Both the tools and their code are publicly available.[4]

Tool for characteristic phrases in North Indian classical music

The importance of characteristic melodic phrases for the identification of *rāgas* in North Indian classical music has been extensively discussed in the literature (Bagchee, 1998; Bor, 1999; Ruckert and Widdess, 2000; Powers et al., 2001; Widdess, 2001). For the development of the tool presented here, I have drawn on the Saraga Hindustani collection gathered in the context of the CompMusic project. This collection contains audio recordings, as well as both automatically and manually generated annotations, all published under Creative Commons licenses.[5] The manual annotations include files containing details of characteristic phrases performed in a particular recording, in which experts on this music tradition annotated their time boundaries and their transcription in *sargam*.[6] These recordings and annotations were used for the development of the tool shown in Figure 1.

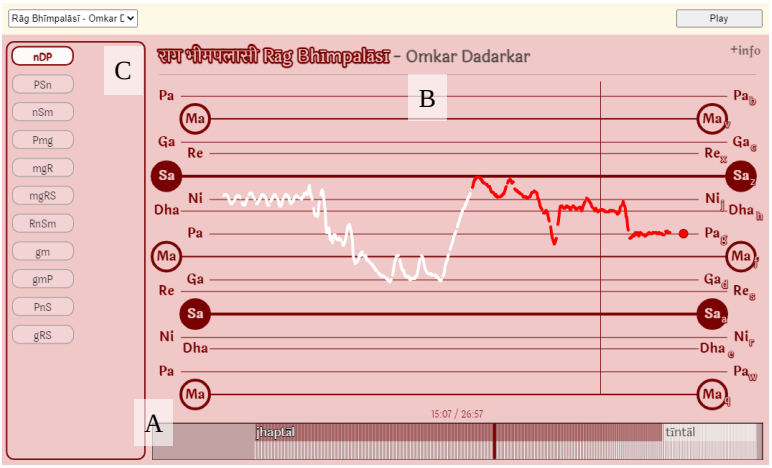

Fig. 1. Musical Bridges tool for characteristic phrases in North Indian classical music. Its main components are: A. main navigator, with white lines indicating *sama* positions; B. central panel, showing the performed melodic line, with a characteristic phrase in red, and a vertical line indicating a *sama* position; C. list of annotated characteristic phrases.

In order to visualize how a particular characteristic phrase is used for the development of a *rāga* in performance, the user can select one of them from the list of phrases (Fig. 1.C), and all its occurrences will be shown in the main navigator (Fig. 1.A). By clicking on this navigator, the playback of the recording will jump to that point, showing the melodic contour of the phrase in the central panel (Fig. 1.B), in relation to the *svaras* of the *rāga* and the *samas* of the performed *tāla*.[7] Figure 2 shows how the tool can be used for comparing three realizations of the same phrase.

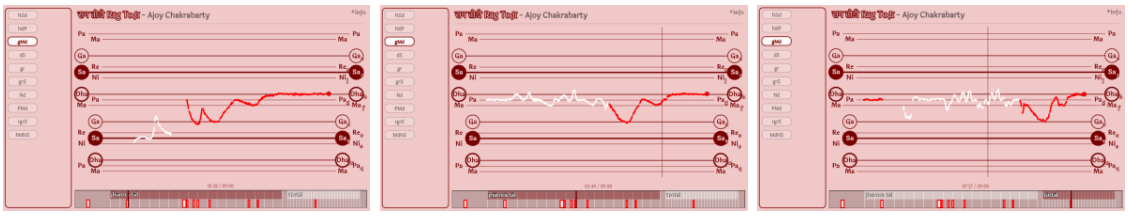

Fig. 2. Three occurrences of the same characteristic phrase ('gMd', highlighted with a red line) in a performance of *rāga toḍi*, at different positions, as indicated by the cursor in the main navigator.

Tool for *centos* in Arab-Andalusian music

The work on Arab-Andalusian music carried out in Musical Bridges is focused on its Moroccan tradition, known as *al-Āla*, since the data available in the CompMusic Arab-Andalusian music corpus correspond to this tradition. This corpus contains audio recordings, their transcriptions in MusicXML format, and their related lyrics, all published under Creative Commons licenses.[8] The central concept in Arab-Andalusian music is the *nawba*, which can be understood as a long suit of sung poems known as *ṣanā'i'* (plural of *ṣan'ā*), occasionally alternated with different types of interludes. A whole *nawba* was traditionally performed in one single *ṭab'* or melodic mode. Amin Chaachoo, a performer and researcher of *al-Āla*, has been developing a theory for this tradition, claiming that its musical system derives from the Iberian medieval traditions, to which Arabic poetry and performance aesthetics were added. Based on this claim for the definition of Arab-Andalusian *ṭubū'* (plural of *ṭab'*), Chaachoo borrows the concept of *centonization*, a compositional technique for plainchant melodies based on the use of stock melodic phrases (2016, pp. 272–279). Therefore, the author defines a series of *centos* as a characteristic component of each *ṭab'*, arguing that they are used as material for the composition of Arab-Andalusian melodies.[9]

According to the characteristics of this tradition, and drawing on Chaachoo's theory, the tool developed in Musical Bridges focuses on the *ṣanā'i'* with the aim of offering a visualization of how *centos* are used in the construction of the melodies, taking the poetic line as basic unit. Since the available recordings contain large *nawba* sections, the segmentation of selected *ṣanā'i'*, as well as the required manual annotations were made by the author specifically for this tool. Due to the semantic relationship between poetry and *ṭab'*, a translation of the lyrics (currently only in Spanish) is also provided. The *centos* present in a particular *ṣan'ā* (Fig. 3.D) can be identified with a particular color in the currently performed lyrics line (Fig. 1.C, with lyrics in Fig. 3.B), as well as in the general structure of the *ṣan'ā* (Fig. 3.A).

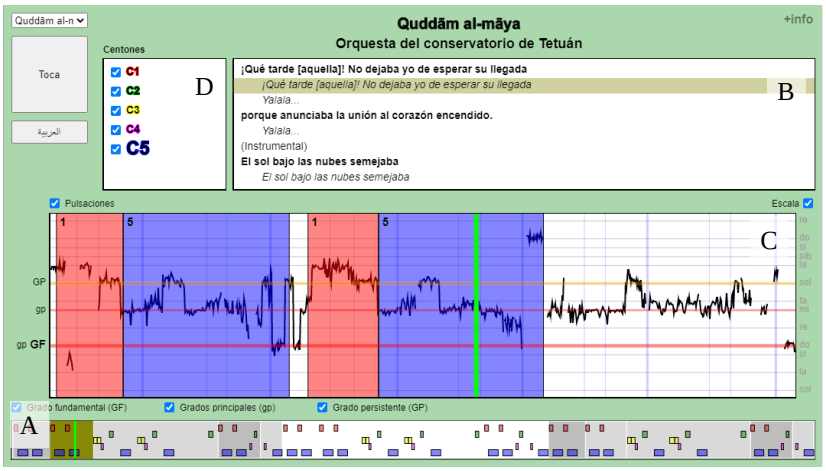

Fig. 3. Musical Bridges tool for *centos* in Arab-Andalusian music. Its main components are: A. main navigator, where gray boxes indicate lyrics lines, and colored boxes indicate *centos*; B. lyrics box, with the currently performed line highlighted; C. central panel, corresponding to the currently performed line, showing its melodic line and *centos*; D. list of *centos*, identified by both colors and numbers.

CONCLUSIONS

The tools here presented are still prototypes, and therefore open to future improvement. However, they demonstrate the general aim of the Musical Bridges project to develop computational tools for aiding the understanding and appreciation of unfamiliar music traditions. To this end, each tool is tailored to the specific characteristic of their musical systems. Some of the challenges faced during their development are related to the state of the art technologies for music analysis from audio recordings that have rarely been evaluated on these music traditions, and therefore can result in poorer performance and less meaningful results. Evaluating whether the tools indeed contribute to the development of listenership for these music traditions is an important task to be undertaken in future work. To that aim, courses addressed to the general audience and to music or general students are intended to be organized from the Musical Bridges project, in which the tools will be tested. Its impact is planned to be measured both through questionnaires and by tracking their usage online. Specific tools drawing on gamification techniques are also planned to be developed.

ACKNOWLEDGEMENT

The research leading to these results has received funding from RecerCaixa.

NOTES

[1] Correspondence can be addressed to Rafael Caro Repetto (email: rafael.caro-repetto@kug.ac.at). A video recording of the presentation of this paper at the symposium can be seen at https://youtu.be/qKZ3I6NOjyU.

[2] The Musical Bridges project is carried out at the Music Technology Group (Universitat Pompeu Fabra, Barcelona). Project's website: https://www.upf.edu/web/musicalbridges.

[3] The CompMusic project was carried out at the Music Technology Group (Universitat Pompeu Fabra, Barcelona) from 2011 to 2017, funded by the European Research Council. Information about the project and about the gathered research corpora can be found in its website: https://compmusic.upf.edu/.

[4] The tools are accessible through the "Resources" section of the Musical Bridges website: https://www.upf.edu/web/musicalbridges/recursos. The code is available in the GitHub site of the project: https://github.com/Musical-Bridges.

[5] For a detailed description of the collection and information about how to access it, see Srinivasamurthy et al. (in press).

[6] Here *sargam* refers to the names of the *svaras* (see footnote 7) that form the scale of a particular *rāga*, abbreviated as *sa*, *re*, *ga*, *ma*, *pa*, *dha* and *ni*. It is similar in function to *solfège*.

[7] *Svara* refers to the scale degrees of a *rāga* and their particular realization in the context of that *rāga*. *Sama* refers to the initial beat of a *tāla* (metrical cycle), also considered to be its last one.

[8] For a detailed description of the corpus and information about how to access it, see Caro Repetto et al. (2018).

[9] Chaachoo's theory is still in development, and in each new publication small modifications are introduced to the set of *centos* defined for each *ṭab'*, based on continuous analyses of the repertoire (personal communication). For the development of the tool here presented I used his latest French publication (Chaachoo, 2016). The author has published a new revision of his theory in 2019 in Arabic (French version forthcoming).

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Multi-modal Recordings of Maracatu *de Baque Solto* (Brazil): Technical Concerns and Preliminary Analyses

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MARACATU *DE BAQUE SOLTO*: FROM BRAZIL TO LISBON

Maracatu *rural* or *de baque solto* (rural-style or free-beat) is a Carnival performance-ritual occurring in the Zona da Mata Norte region of Pernambuco state (Brazil), and strongly associated with an afro-indigenous worship known as Umbanda-Jurema (Garrabé, 2010; Teixeira, 2018). While the urban type of Maracatu, called *nação* or *de baque virado* (nation-style or turned-around beat) has spread out internationally (Cruz 2012), Maracatu *de baque solto* has remained a local and understudied cultural practice.

Maracatu *de baque solto* is a "multi-modal" performance, featuring up to 200 members: a board of directors, tens of masqueraded dancers, 2 poets (*mestres de apito*) improvising short, chanted verses, a brass section formed by 2 to 4 musicians (*músicos*) playing trumpets and trombones, and a group of 5 percussionists called *terno*[2] (Figure 1). Previous field research suggested that these aesthetic means act as protective devices against negative entities unleashed by rivals' envy, affecting people's health (Bonini Baraldi, in press). Sounds and movements, when executed "in consonance" (*consonância*), i.e., in a highly coordinated way, are believed to "lock" (*fechar*) the performers' bodies, protecting them. Conversely, a non-coordinated musical or kinetic action produces "holes" (*furos*) that may "fracture" (*desmantelar*) the group, exposing its members to any kind of health problems.

Our long-term aim is to understand how this high level of acoustic and choreographic coordination is achieved in Maracatu performances. In conjunction with field-research, we believe that recording the *terno* in separate parts, and the musicians' and dancers' movements with Motion Capture (MoCap) technologies, will allow us to "translate" the concepts of "consonance" and "closure" at the formal level of music and dance analysis. This paper describes how we obtained these multimodal recordings. Additionally, we present some preliminary considerations on the automatic onset detection of the *terno* instruments. In future research, these onsets will be useful to analyze what musicians mean when they say that the *terno* is "closed" (highly coordinated). Onset detection also allows the visualization of microtiming profiles, thus contributing to ongoing research on timing deviations in other Latin-American musical genres (Naveda et al., 2011, Fuentes et al., 2019).

Fig. 1. Dancers of the Maracatu group *Leão de Ouro* ("Golden Lion") in Pernambuco. Photo: F. Bonini Baraldi, 2017.

Fig. 2 Poet and percussionists of the Maracatu group *Leão de Ouro* in Lisbon. Photo: F. Bonini Baraldi, 2019.

MULTI-MODAL RECORDINGS

In December 2019, we invited 13 Maracatu performers (1 director, 1 poet, 2 musicians, 5 percussionists, and 4 dancers) to Lisbon for a 10-day residence. A one-week workshop with local inhabitants was organized in order to form a larger Maracatu group. During an outdoor party in a fixed location, we realized a multi-track recording of the 5 percussionists (Figure 2). Two days later, we organized a multi-modal recording in the Faculty of Human Kinetics of the University of Lisbon. In a studio equipped with MoCap equipment, we simultaneously recorded the 5 percussionists in separate tracks and in stereo; the musicians' gestures with Qualisys MoCap optical system; the dancers' movements with Xsens MoCap kinematic system; and standard video with a Sony portable camera.

Audio signal acquisition

From an audio analysis perspective, Maracatu presents a particularly complex sound scene to interpret. The proximity of the percussionists, together with their loud and fast playing style make it extremely challenging to obtain isolated recordings per instrument using conventional microphones. Alternative means for signal acquisition must be pursued to facilitate the precise annotation of temporal events necessary for microtiming analysis. As detailed in Davies et al. (2020), our approach used contact microphones. We placed two pickups (less than 1 cm in diameter) on the *gonguê* (one per bell), two on the *bombo* (one per skin) and a single pickup for *tarol*, *porca*, and *mineiro* (Figure 3). The contact microphones were connected to an eight-channel USB audio interface for synchronous signal acquisition. We used this setup both in the live performance and the laboratory session. In the first case, we recorded 34 pieces pertaining to 2 different rhythmical genres (29 *marcha* and 5 *samba*, approx. duration 35 s each), in the second case, 17 pieces (11 *marcha* and 6 *samba*).

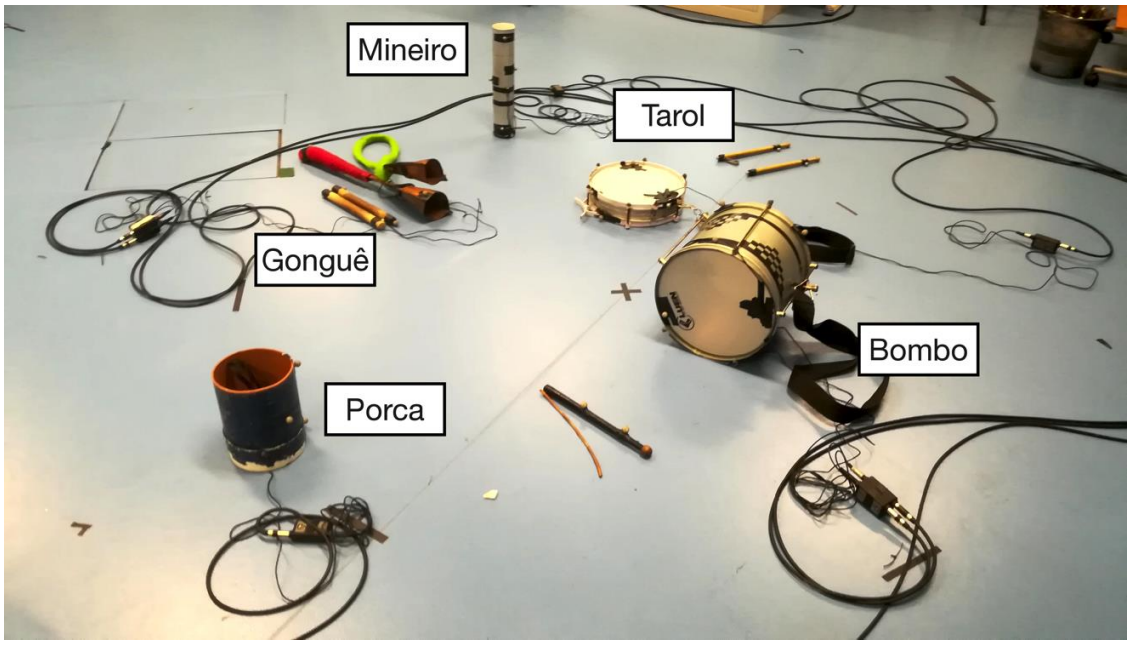

Fig. 3. The 5 percussion instruments of the *terno* with the connection of contact microphones. Photo: M. Davies.

Musicians' gestures

The upper body kinematics of the 5 percussionists were recorded with an optical system of 14 infrared high-speed cameras (Oqus 300, Qualisys AB, Sweden) and 2 video cameras (Oqus 210c), using the Qualisys Track Manager software. We placed a total of 173 reflective markers (25 mm diameter) on each instrument (3 to 5), drumsticks, and on specific anatomical landmarks of each of the five musicians (28 to 30 markers for each musician). The main challenge of this MoCap recording consisted in preserving the musicians' playing style and position in space (in a circle and close to one another), while avoiding light interference among markers (Figure 4). Even though the set-up was somewhat laborious and intrusive due to the many markers used, the musicians affirmed they were not disturbed by the markers while playing. The virtual reconstruction of the musicians' movements was successful, with minimal loss of information on the markers. With this setup, we also recorded the sounds and movements of each percussionist playing *marcha* alone, then in all combinations of 2, 3, and 4 instruments playing together.

Dancers' movements

Full body kinematics of the dancer were recorded at 240Hz with a full-body IMUs (Inertial Measurement Unit) suit (Xsens MVN Link System, The Netherlands), using the Xsens MVN Analyse software. The dancer's Xsens recordings were synchronized in time with the musicians' Qualisys recordings using an external trigger button (Qualisys AB, Sweden). The post-recording synchronization with the audio capture was made possible through an initial single clap from the dancer. With this setup, we recorded short extracts (30s to 1 min) of *marcha* and *samba* movements of 3 different dancers, one at a time (Figure 5). Since Maracatu performances often feature a sort of "battle" between two dancers, we also recorded the movements of one dancer (wearing the Xsens suit) while "fighting" with another one (not wearing the suit). The videos of the dancers' Xsens MoCap "avatars" were projected on a screen in real-time, stimulating comments and discussion with the performers.

Fig 4. The 5 percussionists and a dancer during the MoCap laboratory recordings. Photo: F. Bonini Baraldi, 2019.

Fig. 5. Aguinaldo Roberto Da Silva wearing the Xsens suit. Photo: F. Bonini Baraldi, 2019.

ONSET DETECTION AND MICROTIMING

Since manual annotation, even on well-separated signals, is extremely labor-intensive, we adopted a semi-automatic approach where automatic onset estimates were corrected by a human annotator. To streamline this process, we retrained an existing deep neural network for temporal analysis (Davies & Böck, 2019) on a per-instrument basis. This use of "instrument-adapted" networks drastically reduced the number of missed and erroneous detections. Next, we automatically realigned the detected onsets at the sample level of the waveforms, greatly improving the temporal accuracy. The final output was obtained by human intervention using the open source software, Sonic Visualiser.

Over the 34 pieces of the live performance, we annotated 45,000 onsets across four instruments of the *terno*: the *tarol*, *bombo*, *porca* and the low bell of the *gonguê*, omitting the *mineiro* from our initial analysis due to the difficulty of making precise annotations. As described in (Davies et al., 2020), we adapted an existing approach applied to Brazilian samba and Uruguayan candombe (Fuentes et al., 2019) in order to visualize the microtiming profiles of Maracatu.

CONCLUSIONS

For the first time, a Maracatu *de baque solto* group was invited to perform in Portugal, both in a public space and in a laboratory setting. We obtained multi-track recordings of the percussion instruments in a live performance, as well as a multimodal corpus (multitrack audio, stereo audio, MoCap gestures, standard video) of the musicians' and dancers' action in a laboratory setting. While MoCap techniques are increasingly used in the ethnomusicological domain (among others, see Bonini Baraldi et al., 2015), to the best of our knowledge optical and kinetic MoCap systems have never been combined in a single recording session. The audio recordings allowed the development of new algorithms for automatic onset annotation. On a longer time frame, the multimodal corpus here described will allow us to "translate", at the level of formal analysis of music and dance, local concepts such as "consonance" and "closure". Combined with long-term ethnographic field research, they should deepen our understanding of how participants of a music-dance culture conceive relations among sound, movement, and health. Additionally, our preliminary microtiming analyses (Davies et al., 2020) contribute to ongoing research on timing deviations and groove in Latin musical genres (Naveda et al., 2011, Fuentes et al., 2019).

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NOTES

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[2] The percussionists are never called "musicians", and people say they "hit" (*bater*) their instruments rather than "play" them (*tocar*). This vocabulary reflects their lower social status and lack of musical studies, in comparison to brass "musicians".

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Diversity of Traditional Dance Expression in Crete: Data Collection, Research Questions, and Method Development

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INTRODUCTION

For a period of more than 10 years, we have been conducting field research on the island of Crete, with a focus on local music and dance practice. Throughout that period, we were able to observe that the number of frequently practiced dances is not very high - basically five widely distributed dances, and in the recent years a number of few specific local dances. However, the style and the steps of the dances vary strongly between regions. Regional dance associations exist, and despite the dances being thought of as "pan-Cretan" repertoire played by musicians who perform in various regions, we observe a number of specific differences, which often emerge even between various villages. Such differences were often emphasized by musicians and dancers in our interviews: Good musicians are assumed to recognize differences in dance style, and to react to the specific dancer by choosing appropriate tunes, lyrics, dynamics, modalities etc.

The study of dance style and of the interaction between musician and dancer has been previously approached using ethnographic methods as well as more quantitative, recording-based experimental approaches. Focusing on Cretan music in such studies offers several advantages. First, traditional dance in Crete is a thriving tradition, practiced by a very large part of the Cretan population. Along with that came an increasing trend among the local population to develop teaching methods for instrumental and dance practice. The emerging (mostly) oral theory provides a rich field for ethnographic work, the outcome of which is in turn of high value for the local population, if conducted in close collaboration. Second, the combination of diversity and liveliness of Cretan music and dance offers a rich field to develop methods that combine ethnographic endeavor (i.e. observation, interviews) with computer-based analyses of recordings. The state of the art in analysis of human motion in music is very much focused on studio recordings, and the development of appropriate data acquisition for the case of Crete can contribute to a more wide applicability of computational analysis.

Research questions that drive our work include: What are the basic differences in the style of a pan-Cretan dance between the west and the east of Crete? Which body parts of dancers relate to which part of the musical meter? How can the fluctuation of synchronization help to indicate the distribution of the initiative between dancer and musician? How does the tightness of synchronization relate to perceived moments of togetherness? The scope of the present paper is to develop and evaluate a recording method that will facilitate addressing such research questions.

Cretan music events are characterized by difficult conditions for video and audio recordings, at least when further analysis and documentation towards our research questions is the goal. The dancer who is at the focus of attention is performing at the first position of a counter-clockwise moving dance circle. In most larger events, this circle transforms into a spiral due to the large number of participants in the dance, with the view on the first dancer being occluded by the other dancers. Even with a lower number of dancers, the lighting conditions do not allow for a high quality recording in most cases. For an analysis of detail in dance style, the first dancer should be visible. For an analysis that takes into account the interaction between dancers and musicians, another camera would need to capture at least the lead musician as well. Even with multiple cameras, such a documentation is not feasible in Cretan music events according to our long experience.

DESCRIPTION OF THE RECORDING SESSIONS

The difficult recording conditions motivated us to consider the use of motion capture technology, and to plan a first motion capture recording field trip in Crete. Since time was limited, we aimed to conduct a preliminary experiment, with the goal to test technical feasibility, acceptance by the local consultants, and the expressiveness of the emerging documentary material. We employed an inertia-based motion capture system to record the accelerations of one dancer at a time (Figure 1, left). The limitation to one dancer was due to the resources that were available to us. The use of inertia-based motion capture was essential to avoid problems of occlusion that occur with optical systems in the presence of several dancers. In addition to the motion capture, we placed single accelerometers at the arms of the performing musicians, to facilitate analyses of synchronization between dancer and musicians. Video was recorded using three high-quality consumer cameras, two capturing the dancers, and one capturing the musicians. Audio was recorded using a multitrack system, employing both dynamic microphones and instrument pickup systems.

Synchronization between these heterogeneous, partially non-professional devices was reached using a clapperboard activated by the dancer in front of each camera, while wearing the motion capture suit and the musicians' sensors, and placing one dynamic microphone close to the clapper board (Figure 1, right). Our approach was to communicate with local culture associations in various regions, and to ask them to suggest locations, musicians and dancers for a recording session. We attempted to cover at least some part of the diversity by choosing the region of Sitia in the East, and of Meronas in central Crete. In order to facilitate a comparative approach, we focused on pan-Cretan repertoire, specifically the Syrtos dance and the leaping dance Pentozalis. As a third dance, we included a dance that is better described as a family of dances, with the Maleviziotis being the most common member of that family, but with the Stiakos Pidichtos being a local member of that family practiced in the east of Crete. We left the choice of this third dance to the local consultants. The three dances were performed in two repetitions, which proved to be an important aspect, because the first take was often characterized by an initial insecurity of the actors towards the recording situation.

Fig. 1. Illustration of motion capture set-up (left), dance recording (middle), and clapper-board synchronization (right).

The chosen locations were rooms of the local culture associations (Figure 1, middle). Dancers and musicians did in most cases not need to move far to reach the location, and were familiar with the place. We encouraged the dancers to invite friends to dance with them if they wish, some food and local brandy was provided, and spectators were welcome to sit in the recording venue and follow the recording or participate in the dance. All this helped to create an environment that was as ecologically valid as possible, and the creation of this environment was actively and enthusiastically supported by all local consultants.

DISCUSSION

Our experience from these first recordings is that musicians and dancers were generally open and interested to participate. The performances were deemed satisfying by the involved dancers, musicians, and audiences. In our sessions with dancers that are involved in teaching dance, the sessions evoked additional explanations and demonstrations by the dancer of, for instance, local details and differences between dances. Apparently the created experimental environment was apt to motivate the dancer to provide additional information, which were not accessible to us before. This created a novel and interesting

interview situation, with our cameras capturing the bodily responses and explanations of the interview partner.

Judged from the compiled demonstration videos for each dancer, the analysis of the dancers' movements can go into very fine detail. One the downside, the motion capture suits are only appropriate for relatively short sessions, because the heat creates discomfort after about one hour of practice. The synchronization of the heterogeneous data streams was time-consuming, since a manual identification of the clapperboard impact in all signals was required. However, this signal was clearly observable in all cases. Since there is no external synchronization source involved, a crucial questions was to investigate the amount of time that the independent digital devices drift away from each other. The result after the complete synchronization of all signals is that the maximum mutual drift between two devices is smaller than 40ms per hour of recording. This implies that the various data streams can be used to examine aspects of synchronization and interaction.

The recorded material can now be presented online, which enables dancers and musicians to easily use it as study and teaching material. This is another important contrast to recordings at festivities, where specific consent from all participants is impossible, and therefore the publication of recordings encounters severe difficulties. Our consultants in Crete are very interested in the recordings that emerged from the described field trip. To serve this demand from our side, we created a series of demonstration videos, and published them online [2]. The videos received almost 3000 views so far, and we were informed that the videos are used by dance schools in Crete for instruction purposes.

Our plans for the future include the continuation of the initial experimental setup in other regions, with additional musicians and dancers. Applying inertia-based motion capture by equipping several dancers in festivities is another further extension that we strive for. Apart from extending our recording activities, the almost concluded organization of the recorded data will soon facilitate addressing our research questions from a quantitative point of view. We look forward to take these insights back to the field to discuss them with our consultants in our future field work.

NOTES

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[2] https://www.youtube.com/playlist?list=PLIAxGZFQFeH1KHXaV2HA_wlyx28UA7hkL

Determining Style in Tango Movements with a Triangulation Research Approach: Motion Capture, Embodied Expert Knowledge, and Labanotation

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I present a triangulation research approach in the study [1] of a movement motif [2]: the *ocho atrás* in socially danced *tango argentino*.[3] Triangulation here is understood as utilizing three perspectives or methods to study a phenomenon, which enables the researcher to get more thorough and complete insights. The three perspectives – and in this case also methods – applied are motion capture, Labanotation, and a dancer's embodied and explicit knowledge.

Motion Capture: The system we used was an optical motion capture system (Optitrack) with 40 markers and 12 infrared cameras. The three couples were invited into the lab for one day each. We used the datasets both for statistical and visual analysis of the movements. The experts in the lab were Christopher Dick and Kurt Schatz.

Labanotation: In this case Kinetography Laban. Experts educated in this movement notation method are not only able to capture movement in detail but are also trained to analyze movement visually. In cooperating with Raymundo Ruiz Gonzales, this competence added to insights into movement details.

Embodied Knowledge: I define embodied knowledge here as "human action as expressed through corporeal articulation and body movements" (Leman, Lesaffre & Maes, 2017, p. 1), emphasizing the element of cultured corporeality (Mashino & Seye 2020). The embodied knowledge is based on my own experience as a tango dancer for more than a decade. Additionally, we were fortunate to work with the tango dance professionals Cristina Ladas, Homer Ladas, Yanina Quiñones, Neri Píliu, Maja Petrović and Marko Miljević as part of the project.

To demonstrate the relevance and validity of this approach in ethnochoreology, I present a study of the *tango argentino*[4] motif *ocho atrás* (see figure 1). The focus of the study is on differences in individual execution of the movement by six representative expert tango dancers with the aim to 1) detect differences between the tango dance styles *milonguero*, *salón*, and *neotango* [5], and 2) determine individual style of carrying out the *ocho atrás* motif.

Fig. 1. The motif, presented by Federica Rubattu, photograph by Amalia Asaro (2020).

Among other factors, we looked at the dissociation (separation of chest from hip by twisting) of individual dancers in the turning and stepping phase of the *ocho atrás*. The dissociation is visualized here (figure 2) by the angle (red line) between shoulder line and hip line in correspondence with the ankle distance (black line). An obvious difference between the two dancers is visible. In Neri's dissociation, a

second peak occurs, representing the moment in which he shortly releases the dissociation to go even further into it. Yanina on the other hand transitions from dissociation right into a counter-dissociation, making the whole movement much smoother on a visual level.

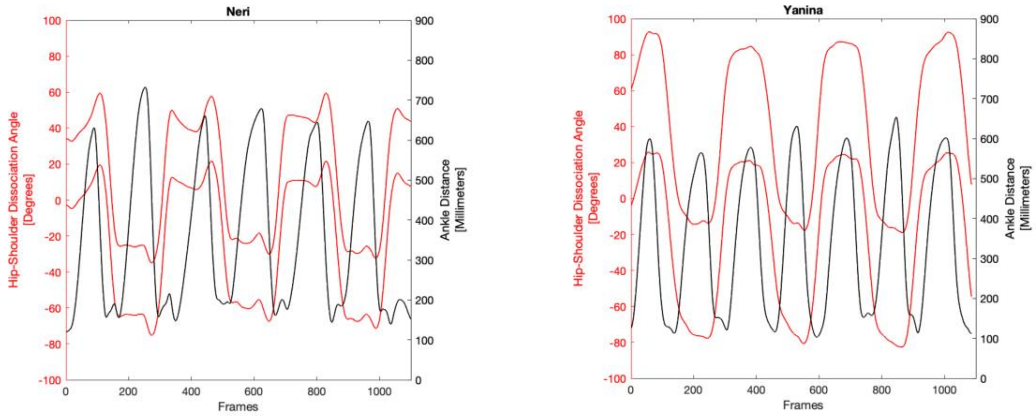

Fig. 2. Dissociation angle data visualization of the ocho atrás carried out by Neri Píliu (left) and Yanina Quiñones (right). Graphic by Kurt Schatz.

The Labanotation version of the same movement (figure 3) shows that Yanina's technique (right graphic) is to dissociate continuously while stepping and turning; both movements (dissociation and step, dissociation and pivot) overlap. This is the cause for the smoothness detected in the data. Neri (left graphic) twists first and then steps while keeping the dissociated position. He carries out untwisting and twisting only while he pivots.

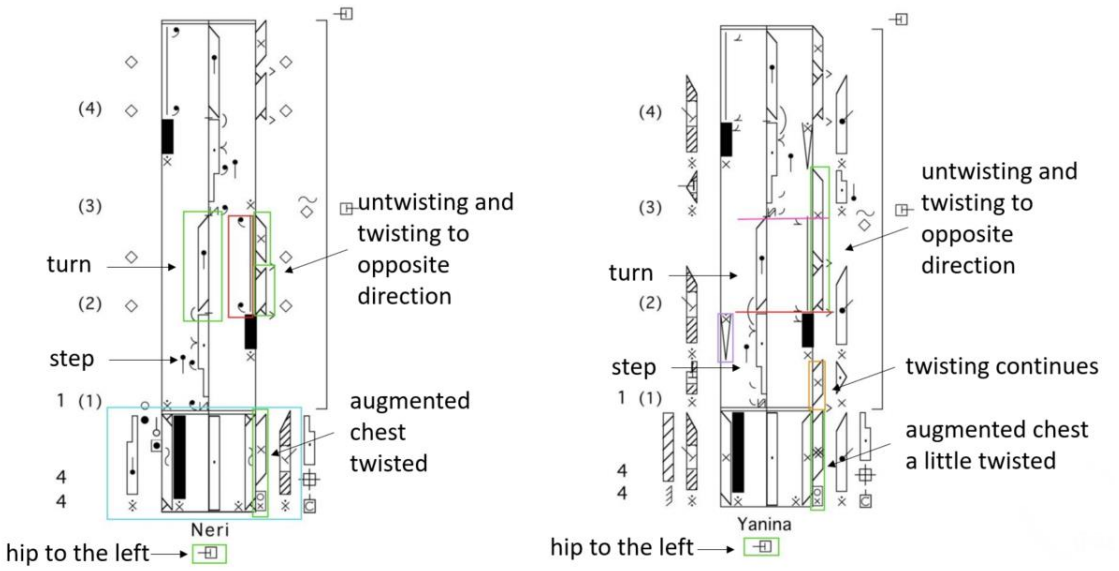

Fig. 3. Notation in Kinetography Laban of the *ocho atrás* by Neri Píliu (left) and Yanina Quiñones (right). Notation by Raimundo Ruiz Gonzales (2020).

Both analyses together – in combination with the embodied knowledge and expert interpretation – give insights into individual abilities and movement techniques. They particularly show how a smooth transition from a dissociation into a counter-dissociation in an *ocho atrás* can be carried out to achieve a smoothness in the transition that is generally considered to be desirable by tango dancers.

The triangulation research approach presented here yielded significant insights into the fundamental *ocho atrás* movement structure, not only by adding perspectives, but even more so by combining analytical possibilities and insights. Through this study, we – the collaborators in the research project – were able to pinpoint differences in movement by professional dancers on a structural level, of which dissociation angle is one exemplary result.

The impact this research has for the tango dance community is to provide more detailed information about dance styles, and knowledge of the concrete elements that allow for differentiation of tango styles and individual tango dancers in terms of movement execution. Furthermore, on an individual level, the dance experts captured for the study can use the recordings for their own benefit, to improve or reconsider their teaching or dance technique.

In developing a triangulation method that combines insights and approaches to understanding a movement system, we were able to not only advance the theoretical knowledge about the tango argentino dance motif *ocho atrás* but also contribute to contemporary, translocal tango argentino discourse and practice.

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NOTES

[1] This study is part of the FWF (Austrian Science Fund) sponsored project "Tango-Danceability of music in European perspective" V 423 Richter-Programm.

[2] See Kaeppler (1972, p. 202) for a definition of a motif in dance.

[3] A full paper on this topic is published as "Using Motion Capture to Access Culturally Embedded and Embodied Movement Knowledge. A Case Study in Tango Argentino" (Stepputat, 2021).

[4] For an introduction to tango argentino dancing as translocal practice see Merrit (2012).

[5] Homer and Cristina Ladas prefer the term "organic tango" for their dancing.

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A Preliminary Approach to Corpus Driven Research of Persian Classical Music

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The development of technologies for the computational analysis of music recordings from the fields of audio signal processing and music information retrieval has brought new opportunities for music research. We aim to benefit from such methods and to contribute with quantitative information to the ethnomusicological work on Persian classical music's grammar (Babiracki & Nettl 1987; Farhat 2008; Nooshin 2018). In this paper we introduce first the KUG Dastgāh Corpus (KDC), which was specifically created for the computational research of Persian classical music. Then we explore the possibilities of state-of-the art technologies for the analysis of the KDC, present some preliminary results, and reflect on the opportunities and challenges of such an approach.

Our main interest in this project is to better understand the modal rules of Persian classical music. In comparison to other Iranian music genres, this tradition is the most studied musical practice in Iran. Some analytical studies include those by Farhat (1990), Babiracki and Nettl (1987), Talai (2001), and Nooshin (2003). In all these studies, however, the analyzed corpora are limited. Some of them are limited to a specific mode, while others to a specific instrument or specific canonic repertoire, called Radif. As a result, the theories derived from these studies can only illustrate the musical rules related to the specific and limited repertoire that has been used. For instance, in Nettle and Babiracki's study the analytical process is limited to a collection of only one mode, namely *šur*, in eighteen *radifs*. Similarly, Nooshin details the motivic structures and music making formulae just in *dastgāh segāh*. Meanwhile, Talai refers to a certain canonic repertoire arranged by Mirza Abdollah. Our idea is, however, to examine a larger and more diverse corpus in order to expand the relevance of these theoretical assertions. To put this into effect, we considered the use of computational methods to reveal the modal structures from larger recorded datasets. Of course, we are aware that the findings from these methods are different from qualitative manual analyses. We do not claim that the former should substitute the latter, but rather could complement each other. Our long-term goal is to develop a flexible theoretical framework that continuously learns from its outputs, and that also includes musicians' perspectives in order to understand how people make music out of existing modal structures and models.

Persian Classical Music is a modal music. This means that in addition to intervallic structures we have some melodic figures, which are used as a model for music making. These melodic models, which represent a certain mode, are called *guše*, which have a modal central tone named *šāhed*. The related *gušes* are put together in a specific collection, and the relation between *gušes* is traditionally fixed and has a specific order. This doesn't mean that in a performance all *gušes* from one collection should be performed, but their order should be maintained. The first *guše*, called *darāmad*, has a very significant meaning and introduces the collection. Most of the time a performance starts and ends in *darāmad*. The umbrella term for each collection, depending on school, is *dastgāh* or *āvāz*, and each particular one has its own specific name. The whole canonic repertoire including all *dastgāhs* and *āvāzes* is called *radif*, which contains the most significant modal rules for music making.

As a long-term goal, we conceive the KDC as an ever-growing corpus of recordings of Persian classical music, both commercially available—by well-respected musicians and ensembles from different generations—as well as originally recorded specifically for this project. At present, the KDC contains 58 recordings (34 commercial and 24 original), which accounts for close to two hours of music (112'13"). In the future, we plan to include all mode collections (*dastgāh* and *āvāz*), all musical instruments, different schools (Tehran school, Isfahan school and contemporary performances) and all canonic repertoires (*radifs*). In addition, the KDC also includes analytical recordings, which exemplify theoretical aspects, to help us confirm specific findings or better understand specific structures. An essential aim of the KDC is careful documentation and annotation of the recordings, so that they can become a valuable source for any

future research on this music tradition. For the organization of the KDC we draw on the FAIR principles[3] of Findability, Accessibility, Interoperability and Reuse. Regarding the latter, we plan to publish the original recordings made for the KDC under Creative Commons licenses, and organize their metadata using the website *MusicBrainz*[4]. Table 1 gives an overview of the current status of the corpus.

Table 1. Current status of the KDC

***Dastgāh* / *āvāz* (12)**	**Instruments (7)**	**Artists (11)**
Abuatā (4'00")	Ney (44'25")	M. Khodadadi (25'36")
Afšāri (3'43")	Tār (27'33")	M. Hosseynqoli (15'26")
Bayāt-e Tork (4'41")	Āvāz (12'12")	A. Afsharnia (1'30")
Čāhārgāh (5'22")	Āvāz and tār (10'49")	M. Karimi (12'12")
Dašti (5'11")	Kamānče (4'59")	M. Shajarian & D. Talai (10'49")
Esfahān (2'15")	Āvāz and santur (9'15")	N. Kharkan (4'59")
Homāyun (1'32")	Setār (3'00")	H. Kasai (17'19")
Māhur (44'00")		M. Shajarian & H. Nahid (6'04")
Navā (13'26")		H. Alizadeh (6'03")
Rāst-Panjgāh (3'24")		M. Shajarian & F. Paivar (9'15")
Segāh (21'56")		D. Talai (3'00")
Šur (2'43")		

In order to test the state-of-the-art technologies for audio analysis on the KDC, we performed a series of simple preliminary computational analyses related to tasks of relevance to this music tradition. To this end, we mostly drew on Essentia (Bogdanov et al., 2013), since it is one of the most complete open-source libraries of algorithms for audio analysis. The implemented tasks are the following:

- Pitch extraction, using the algorithm `essentia.standard.PitchYinFFT`.
- Intonation analysis via pitch histograms, computed according to Koduri et al. (2014), in order to
  - estimate the pitch of the *šāhed*
  - analyse intervallic structure
- Vibrato analysis, using `essentia.standard.Vibrato`
- Loudness analysis, using `essentia.standard.Loudness`
- Based on `essentia.standard.PitchContourSegmentation`, pitch estimation for the first and last notes

The code is published in the form of a Jupyter Notebook in order to facilitate its reproducibility [3]. It is also accompanied by a spreadsheet containing metadata for all recordings, as well as manual annotations of the values for different parameters used when executing the code.

One of our performed analyses concerns the concepts of *āqāz* (beginning) and *forud* (landing), which is a frequently discussed issue in theoretical studies and among musicians. To investigate their possible rules, we performed the aforementioned estimation of pitch of the first and last note for all the recordings of the KDC. It is not complicated to identify these notes manually, however, for their analysis in a larger corpus, either in its entirety or in a customized subset – for instance limited to specific *dastgāhs*,

instruments or *gušehs* – it is much faster to work with computational methods. In our preliminary study, we observed that in *abuatā*, the *šāhed* is identical to the *āqāz* in all recordings; however, in the *darāmad* of *čāhārgāh* the *āqāz* is three steps below the *šāhed*. Although this may seem to be a minor finding, the expansion of the corpus and the analysis of all *darāmad* or any other *gušeh* is expected to lead us to wider conclusions about whether *āqāz* and *forud* are *gušeh*-specific.

Apart from the potential that computational methods open up in corpus driven analysis of Persian classical music, as exemplified above, our preliminary study has highlighted some challenges too. Firstly, the tested algorithms in Essentia do not perform as optimally in this music tradition as in those for which they were originally developed. This is especially relevant for pitch track extraction, since many of the subsequent computational tasks rely on this first pitch estimation step. Secondly, technologies recently developed for some of the tasks undertaken in our analysis are not easily accessible, and not easily usable by researchers without a solid background in music technology.

As a result of the preliminary study presented here, we propose the following tasks for future research: One ongoing and long term task is to continuously expand the corpus according to the criteria previously described, with a special emphasis on original recordings that can be openly shared. As a shorter term goal, we aim to work on melodic pattern analysis, a task for which we will seek collaboration with specialists in music technology. We envision this collaboration as the most fruitful approach for the corpus driven research of Persian classical music. Finally, we will involve musicians in the research process by presenting and discussing with them the obtained results, and integrating their feedback in further analyses.

NOTES

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Quantitative Approaches to the Analysis of Central Javanese Pathet: First Steps

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Since the late-eighteenth century, Javanese and non-Javanese scholars have written and published myriad texts in which *pathet*, or Javanese musical mode, has been described and analyzed. These include works addressing the topic of pathet from philosophical, epistemological embodied, mystical, grammatical, organizational, and music-analytical approaches and contexts.[1] Most recent musical analysis of Javanese pathet has focused on metered music notated in cipher notation. The notated melody is called the *balungan*. It is performed by a differentiated sub-group within the larger ensemble on metallophones called *saron*. Notated in ciphers, the balungan is usually grouped into four-note "measures" called *gatra*. Gamelan music is end weighted. Colotomic instruments such as gongs and *kenongs* mark the ends of some gatra at regular intervals. Instruments that play more complicated parts fill out the texture of the performance, weaving their own interpretations of instrument-specific melodies that coincide with one another at the end of each gatra. These patterns should be predictable, as they are limited in number and are generally selected according to the pathet, or modal categorization, of the piece being performed.

Analyzing pathet gets interesting when we realize that not all performers 'know' the rules of 'correct' pathet usage (even though they can perform with others who do), everyone performs exceptions to the interpretive rules some of the time, and these variant interpretations are subject to debate after performances or during rehearsals. All of this generates questions about what we actually know about pathet. How is pathet used and how does it function in different compositional and performative contexts? What level of variance in relation to theorized pitch hierarchies is possible? What is the range of acceptable differences in *garapan*, otherwise known as interpretation of melodic phrases in different performative contexts? How does garapan change over time or in different regional or styles? Based on pitch hierarchies as described in written pathet theory (Hastanto, 1985) and performance experience, the research reported in this short contribution comes from a pilot study in which we designed a corpus to test some of the things we 'know' about pathet through the analysis of balungan melodies notated in cipher notation.

DEVELOPING PATHET CORPORA: GRIMINGAN CORPUS

The first Javanese music corpus I developed was part of my research on female musicians who accompany all-night, shadow-puppet performances called *wayang*. These women performed two-part polyphony on a multi-octave metallophone called a *gender*.[2] In addition to playing in all musical contexts during the eight-hour *wayang* performances, the *gender* also play solo, background music called *grimingan* when the puppeteer, or *dhalang*, is speaking and requires no other musical accompaniment. Unmeasured and highly improvisational in nature, performers nevertheless indicate there is an underlying structure that they repeat and manipulate as required by the dhalang's needs. Grimingan should be played by someone who knows the dhalang's style well and can anticipate his (they are almost all male) musical decisions, in particular those related to conveying the emotion of narrative moments. Many performers and participants report that grimingan captures the affective essence of the three primary pathet or modes used in the performance of *wayang* – *pathet nem*, *pathet sanga*, and *pathet manyura*; but they also say that the *gender* performers, most of whom never studied in a conservatory, do not understand pathet theory and therefore do not play in a theory-based style. These often-stated conflicting beliefs led me to embark on an extensive project transcribing and analyzing the performances of multiple examples of grimingan, in the three primary pathet, as found in the pentatonic *slendro* scale, used in *wayang* in order to determine: first, the process through which performers created 20-30 minute-long, seamless segments of grimingan; and second, if the 'rules' of pathet pitch hierarches, as articulated in many text books and by many teachers, could actually be heard to function in the grimingan performed by older, usually female *gender* players who were 'uneducated' in terms of pathet theory.

The construction of the grimingan corpus involved the following stages. I first collected more than 150 hours of live performance both at full-length wayang performances and in recording sessions. Because many of the performers whom I recorded found it difficult to perform grimingan outside of the linear context of a performance, I encouraged the performers to create their own context by performing or singing the kinds of pieces that would normally occur before and after moments in which grimingan would be required by the dhalang. From these many hours of recorded music, I excerpted grimingan selections in all three of the primary

pathet used in wayang, including examples of all known (to me) grimingan types in each pathet as performed by multiple players. Where possible I recorded the same *gender* player accompanying different dhalang, in order to see if she altered her style of grimingan development to accommodate the performance habits of different dhalang. I then proceeded to transcribe extensive portions of grimingan in each pathet. I compared my transcriptions with sound sources multiple times to ensure accuracy and also to confirm emerging structural elements.

My analysis generated the following results. I identified underlying patterns of pitch relations and series of what I call 'arrivals' (mid-line and end-line pauses) heard as phrases and determined that similar phrases can be found, albeit in idiosyncratic order, in the *grimingan* of most individual players. I confirmed that different listeners agreed with the performer-indicated pathet assignments when they heard recordings out of context. I identified motivic elements that were suggestive of particular pathet and then checked that those identifications could be confirmed by other performers and listeners. I proposed a theory about the "process" of grimingan. Based on my analysis of the corpus, I suggested that grimingan did in fact have a form, one that was malleable but nevertheless predictable once one understands the style of the individual performer. I demonstrated that the basic form of each of the grimingan types could actually be seen/heard in performances by different *gender* players across the corpus. Finally, I proposed a theory suggesting that pathet, as it is taught and studied in conservatories today, is similar to – perhaps even derived from – the basic tonal hierarchies indicated in the grimingan as performed by older female *gender* players despite their not being trained in pathet theory. This work was published as appendices on a CD-ROM with sound and visual materials in Weiss (2006) and in part in an article (Weiss, 2011).

DEVELOPING PATHET CORPORA: YALE BALUNGAN CORPUS

I decided that the next step for the grimingan corpus would be to digitize the samples and the analyses, not only to make the data available to other researchers but, even more importantly, to ensure that performers and their families would have access to the information by creating a website to host the materials. I imagined organizing the grimingan corpus first by pathet and then by type of grimingan. But without previous experience in creating digital corpora, and therefore with little knowledge of how to organize data in ways that are machine searchable, I decided I should practice by developing a corpus based on balungan notation of which I could also ask questions about pathet. Represented in a single line of ciphers, balungan posed many fewer problems for corpus development than the more complex, irregular grimingan. In addition, I could follow the masterful statistical study of balungan contour by Alan Templeton (1980) and the analyses of Judith and Alton Becker (1982) and David Hughes (1988).

Working with Ian Quinn (Yale University, New Haven) and two student assistants, Chia Pei Yun and Theodore Lai (Yale-NUS College, Singapore), we developed a small corpus of 200 pieces in the *ladrang* form with examples from each of the three primary pathet used in wayang performance. A ladrang is a Javanese form with 32 balungan beats, organized into eight 4-beat melodic phrases called *gatra*. Each ladrang cycle is divided into four phrases of 8 beats – two gatras – in which the last note of each 8-beat phrase is marked by the stroke of a *kenong* – a large, pitched, kettle gong – and where the fourth kenong stroke, falling on beat 32 of the cycle, occurs simultaneously with the stroke of the large gong, together indicating the end of the cycle. Pieces in ladrang form were selected from Boston Village Gamelan Javanese Gamelan Notation Collection prepared by Barry Drummond. Machine readable documents were created by Chia and Lai, coded by Quinn and his assistants, and used in one Yale graduate course on math and music. This is now known as the Yale-Balungan Corpus.

Working with Rafael Caro Repetto, we curated and refined the Yale Balungan Corpus by defining the nature of a ladrang as a section of a file that contains any number of cycles that have no more than 32 notes, the last note of which is marked by both a gong and a kenong and where the last note of gatras 2, 4 and 6 is marked only by a kenong and *not* a gong.[3] This more specific definition of ladrang form generated 182 files each with at least one ladrang cycle. The total number of readable ladrang cycles contained in these 182 files is 415, of which 83 cycles are in pathet nem – 20%; 199 are in pathet sanga – 48%; and 133 are in pathet manyura – 32%.

To see if the corpus search facility was functional, we began by asking some simple questions with the expectation that the results would confirm the pitch hierarchies described in multiple sources explaining pathet theory (Hastano, 1985; Surjodiningrat et al., 1977; Martopangrawit, 1972–75; Perlman, 2004; McDermott & Sumarsam, 1975). The results of this query are shown in Figure 1.

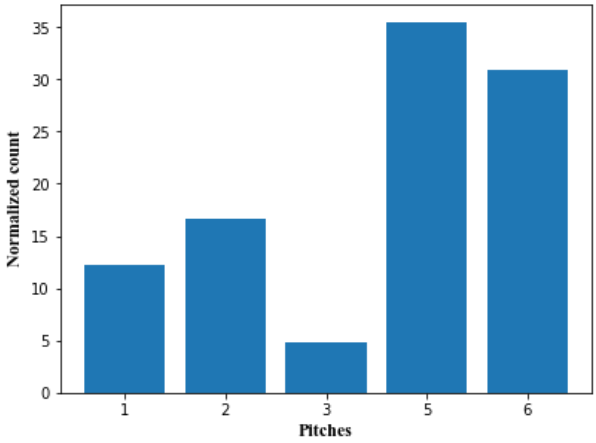
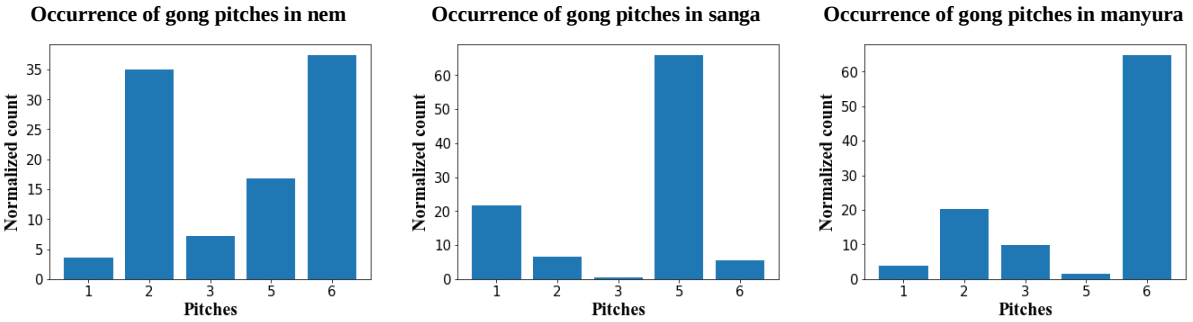


Fig. 1. Distribution of Final Gong Tones in the Corpus Without Reference to Pathet. This chart represents the distribution of the pitches struck as final gongs, defined as the 32nd note in any cycle, irrespective of pathet. The chart shows that 68% of the final gongs fall on pitches 5 or 6, with pitch 5 being the most common and pitch 3 the least.

We then queried the distribution of gong tones, as defined above, in each pathet. This generated results that generally confirm the tonal hierarchies commonly understood to be functioning in pathet theory. Those hierarchies state that: pitch 6 is the strongest final tone in pathet manyura; pitch 5 is the strongest final tone in pathet sanga; and the pitches 2 and 6 are the strongest final tones in pathet nem.



Pitch	Percent	Occurrence
1	3.61%	3
2	34.94%	29
3	7.23%	6
5	16.87%	14
6	37.35%	31

Pitch	Percent	Occurrence
1	21.61%	43
2	6.53%	13
3	0.50%	1
5	65.83%	131
6	5.53%	11

Pitch	Percent	Occurrence
1	3.76%	5
2	20.30%	27
3	9.77%	13
5	1.50%	2
6	64.66%	86

Fig. 2. Gong Tones Distributed According to Pathet. In both visual representation and percentages, this figure demonstrates that pitch 6 is the strongest and most likely final gong tone in pathet manyura; pitch 5 is the strongest and most likely final gong tone in pathet sanga; and the pitches 2 and 6 are the strongest and most likely gong tones in pathet nem. These results confirm tonal hierarchies outlined in pathet theory.

Finally, we asked how many kenong, defined as the tones occurring on beats 8, 16, 24, and 32 in a ladrang cycle, fall on each pitch in all ladrang cycles in the corpus. We asked that the data be organized according the designated pathet for each piece in order to see if the pitch hierarchies outlined in pathet theory would be upheld as they were in the gong distribution. The query generated the results shown in Figure 3.

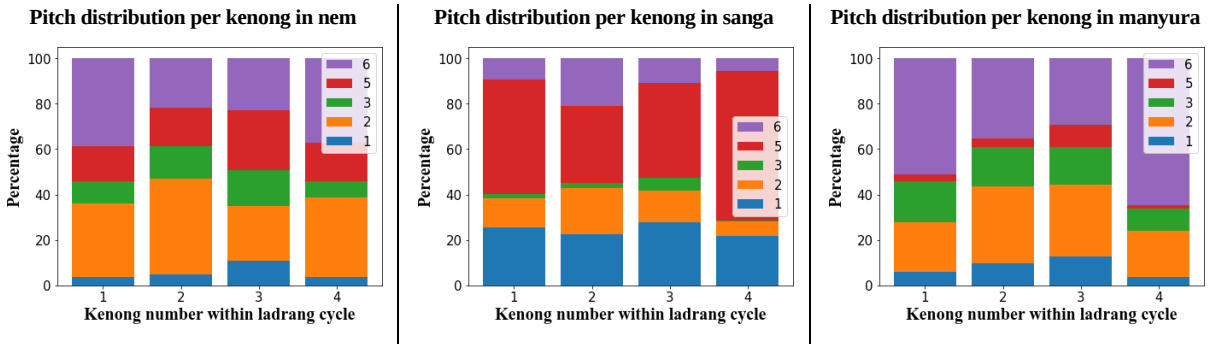


Fig. 3. Distribution of Kenong Tones per Position in the Corpus Organized by Pathet. See main text for explanation of this figure.

The distribution of pitch over kenong tones within ladrang cycles is more variable than that for final gong tones. Starting with the chart on the far right, pitch distribution per kenong in pathet manyura reveals that for each of the kenong positions, numbered 1 through 4 (coinciding with beats 8, 16, 24, and 32 respectively), the first kenong falling on beat 8 and the last kenong falling on beat 32 in the cycle, have a more 50% likelihood of falling on pitch six, indicated by the purple coloring on the chart. Pitch five indicated in red, is the least likely tone at any of the kenong positions in pathet manyura while pitch two, in orange, is more likely than pitch three, in green, or pitch one, in blue, in all kenong positions 1 through 4. The middle chart showing kenongs in ladrang in pathet sanga reveals that pitch five, in red, is the most likely tone for a kenong in any position and pitch 1, in blue, has, on average, a 20% likelihood of being struck at a kenong in any position in pathet sanga. The distribution of pitches over all kenong positions in ladrang in pathet nem (chart at far left) is more mixed than either those in pathet sanga or pathet manyura. The likelihood of kenongs falling on pitch one in each kenong position in pathet nem follows closely the distribution seen in pathet manyura. The likelihood of kenongs falling on pitch two in pathet nem follows the expectation that pitch two is at the top of the pitch hierarchy in pathet nem according to pathet theory. Pitch five and pitch six show near-equal likelihood of falling on kenong position 2, arguably the second most important kenong position in a ladrang. This suggests that although pitch five is not listed as one of the most important pitches in pathet nem in pathet theory, in fact it has a strong presence in pathet nem.[4]

CONCLUSION

The preliminary data described above confirm the pitch hierarchies outlined in pathet theory even in this small set of 182 files with 450 readable ladrang cycles. One surprising finding is shown in Figure 1, indicating that there are more final gongs falling on pitch five in the whole corpus than any other pitch. Pitch five is the predominant tone *only* in pathet sanga, while pitch six is a predominant tone in both pathet manyura and pathet nem. This suggests that we might expect that pitch six would appear as gong tone in the corpus more frequently than pitch five. I suspect that the comparatively higher number of ladrang cycles in pathet sanga represented in the corpus has skewed the results toward pitch five and that if the cycles contained in the corpus were distributed more evenly across the three pathet, pitch six would be the most represented gong tone. This is a question for future research with a more developed corpus, as will be finer-grained queries testing the capability of the arrival tones that fall between kenong strokes to predict the pitch of the next kenong and those of the first pair of notes in any 4-beat gatra to predict the second pair.

NOTES

[1] Consult among others: Becker (1980), Becker and Becker (1982), Brinner (1995), Grupe (2008), Hastanto (1985), Hastuti et al. (2017), Hood (1954, 1966), Hughes (1988), Kusumadilaga (1981), Martopangrawit (1984/1972-4), McDermott and Sumarsam (1975), Perlman (1998, 2004), Powers (1980), Sastrapustaka (1984/1953), Supanggah (2002, 2007), Surjodiningrat et al. (1977), Sutton (1993), Syarif et al. (2020), Templeton (1980), Walton (1987), Weiss (2006, 2011).

[2] I will continue to use *italic* font to distinguish the instrument called *gender* from the more common English word gender.

[3] These limitations removed cycles with irregular melodic lines that had previously ‘confused’ the data and also the analysts when used in the course taught by Quinn.

[4] Gamelan performers will know that it is this stronger presence of pitch five on significant structure arrival tones that most distinguishes pieces in pathet nem from those in pathet manyura.

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A Socially Situated Aesthetics: Arguments from Anthropology and Neuroaesthetics

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In this conceptual paper, I explore arguments regarding aesthetics from two fields that differ greatly in their methods and epistemologies: namely, anthropology and neuroaesthetics. In particular, I discuss work by two neuroaesthetics researchers, Martin Skov and Marcus Nadal, whose arguments, I suggest, converge with, and even support, socially situated and anti-Eurocentric concepts of aesthetics developed in anthropology.

BACKGROUND

Aesthetics is a problematic concept for anthropologists (as well as for ethnomusicologists and ethnochoreologists) due to the socio-historical specificity of many notions associated with the term: for example, the disinterested aesthetic stance, the autonomy of art, and the entanglement of concepts of aesthetics and art. The difficulties are nicely illustrated in a debate that took place between prominent anthropologists on whether aesthetics can be considered a cross-cultural category (Ingold, 1996). Proposing the motion, the anthropologist Howard Morphy argues that aesthetics is a cross-cultural category due to it being concerned with "the human capacity to assign qualitative values to properties of the material world." For Morphy, "[a]esthetics is concerned with the whole process of socialization of the senses with the evaluation of the properties of things" (Ingold, 1996, p. 258), a process that he suggests is applicable to all cultures. In response, the opposing camp in the debate counters that the term aesthetics cannot be separated from its socio-historically specific, eighteenth-century European conceptualizations, and is therefore unsuitable for application beyond this context. The opposing camp won the debate convincingly. Nevertheless, the term "aesthetics" continues to be used in anthropology in a socially situated sense, broadly in line with Morphy's proposals, wherein "aesthetics" is considered to refer to the socialized values and expectations held by people regarding the sensory qualities of their own cultural practices and objects (Pearson, 2020).

In this paper I discuss the aesthetic notion of disinterestedness, which has been the focus of counterarguments from anthropologists as well as from Skov and Nadal (2020). In addition, I examine shared arguments for the disentanglement of art and aesthetics. My goal is to highlight the potential for common ground between anthropology and neuroaesthetics, notwithstanding the considerable differences in their respective epistemologies and methodologies.

DISINTERESTEDNESS

The notion of disinterestedness can be traced back to the 18th century ideal, expounded by Immanuel Kant, that judgments of beauty are necessarily disinterested; that is to say, the object should be appreciated for its own sake, without the observer having any interest in relation to the object, its uses and any moral good that might come from it (Kant, 1790/1911, pp. 202-210; Berleant, 2017, p. 10). Such disinterestedness can only be achieved when an observer takes a contemplative stance towards an object, and has no interest in the outcomes of the encounter. It thus effectively excludes all cultural practices that have overt functional or participatory aspects – the majority of cultural practices across the globe. While Kant, in his *Critique of Judgment* (1790/1911), does mention other categories of experience, including "delight in the agreeable" and "delight in the good," these are never referred to as "aesthetic" and exist largely to delimit that which is excluded from "judgments of beauty" (elsewhere referred to simply as "aesthetic judgments"). Thus, in Kant's critique, it seems that aesthetic judgments must have the quality of disinterestedness.

Anthropologists and sociologists typically view Kantian aesthetic notions as reflecting the ideals prevalent in their social and historical context, rather than as being relevant universally. For example, Pierre Bourdieu explains disinterestedness and related ideals as products of a particular socio-economic

context, designed to elevate certain cultural practices and modes of interaction above others, and with them, certain social groups (namely the bourgeoisie) above others, thus fulfilling a function of legitimating social differences (1984, pp. 4-7).

But what do publications in the field of neuroaesthetics say on the matter? As Martin Skov notes, when the field arose, one of its main aims was to test existing models of aesthetics (2019, p. 230). Someone engaged in contemplation of an artwork may feel they are immersed in appreciation of the object for its own sake, without any other interest, but is this really the case? According to Skov, evidence from neuroscientific studies suggests that aesthetic appreciation is not a matter of disinterested contemplation, but rather that multiple forms of interest and contextual influences are at play. Summarizing, he argues, "aesthetic appreciation does not come down to computing aesthetic judgments to a perceptual input. It comes down to assessing what value a stimulus has for the organism, in its current context, relative to previous experiences, its homeostatic state, and behavioral options" (Skov, 2019, p. 222). Thus, in practice, aesthetic judgment appears to be fundamentally self-interested and context dependent; the way in which we respond to an art object varies greatly depending on our current regulatory needs and also the contextual information provided. Evidence for this latter point can be found in studies examining "framing effects." For example, a study by Kirk et al. (2009) demonstrates that participants' assessment and experience of visual art depends on whether they are told the art is from prestigious art galleries, or made by the researchers.

Of course, neuroaesthetics deals with evidence regarding what people experience and believe rather than with ideals, and so it would be easy for those supporting Kantian notions such as disinterestedness to counter with the claim that participants in neuroaesthetics studies merely fail to appreciate the art correctly – they fail to reach the ideal. But, in response we might ask, what is the point of a model of aesthetic experience centered on an ideal that is rarely realized?

The arguments presented by Skov (2019), highlighting the significance of context and assessment of value in aesthetic experience, support dominant approaches in anthropology where aesthetics is typically conceptualised as bringing together the perceptual with the social through the attribution of value. As Morphy proposes, aesthetics is concerned with "the incorporation of perceivable properties in systems of value and meaning that integrate them with cultural processes" (2005, p. 54). From this perspective, disinterested contemplation can be viewed as an ideal existing within a system of value and meaning found in one particular cultural context, but which might be absent in other aesthetic systems.

THE DISENTANGLMENT OF ART AND AESTHETICS

Another key point of agreement between Skov and Nadal (2020) on the one hand, and anthropologists such as Morphy (2005) on the other, is in their respective proposals that the concepts of art and aesthetics need to be disentangled in order for work in their fields on aesthetics to progress.

In a recent article, provocatively titled "A Farewell to Art," Skov and Nadal (2020) note that "empirical aesthetics and neuroaesthetics study two main issues: the valuation of sensory objects and art experience," and that the two issues are often treated as if they were "intrinsically interrelated" (2020, p. 630). They argue that although the two issues do overlap in many cases, the idea of their interdependence is a misconception that confuses the field. In an earlier publication, they explain that current evidence points to art-related pleasure as being indistinguishable at a neurobiological level from other forms of pleasure (Skov and Nadal, 2018). Thus, they view the notion that art-related pleasure is fundamentally different to pleasure derived from other objects as responsible for holding back research in their field, acting as an erroneous basis for the construction of studies and isolating neuroaesthetics from other disciplines within the broader fields of psychology and neuroscience (2020, p. 631).

Similarly, in anthropology, Morphy proposes that the first step in using the concept of aesthetics cross-culturally is to disentangle aesthetics from art (2005, p. 52). Noting that the concept of art is a product of recent Western history, Morphy argues that the notion cannot be used in an unmodified way in cross-cultural analysis due to its appropriative nature: "It swallows up the products of other places and other times and transforms them into commodities to be viewed, understood and valued in ways unrelated to the intentions of their producers" (2005, pp. 52-54). In line with the approach suggested by Skov and Nadal for neuroaesthetics, much of the current work on aesthetics in anthropology looks beyond art-analogous objects, instead focusing on everyday and social aesthetics (e.g. Coleman, 2005 and 2018).

CONCLUDING THOUGHTS

In conclusion to this brief discussion, I ask what can be understood from this convergence of arguments found in two such otherwise distinct fields. It is my hope that the socio-historical insights of disciplines such as anthropology and sociology, and experimental studies in neuroaesthetics, might support each other in contributing to understandings of aesthetics that shift away from certain Kantian notions that tend to either exclude most of the world's cultural practices, or force them to be understood with reference to Eurocentric concepts. There is still much work to be done towards decolonizing concepts of aesthetics, and I hope that the convergence of arguments noted in this paper bodes well for this movement.

NOTES

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Music-Movement Synchronization in Capoeira

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INTRODUCTION

Previous literature on synchronization to music using finger tapping tasks in a laboratory or otherwise controlled setting has led to invaluable theories about time and synchronization. Dynamic Attention Theory (DAT) is among the most recognized and well-known of these theories. For a review of pertinent literature, see (Jones & Boltz, 1989; see also Large, 2000; Large & Palmer, 2002; Jones et. al, 2006; Madison, 2009). Many previous studies that have promoted DAT include finger tapping tasks in controlled settings. Other times, participants might be asked to respond to music through a survey, or have their brain activity measured through functional magnetic resonance imaging (fMRI). While these studies are invaluable for learning about specific effects of music, controlled environments do not represent how individuals typically interact with music. Fieldwork-based studies, therefore, can offer significant insights into music cognition and musical rhythm research to support laboratory-derived theories (see Du et al., 2017; Koehne et al., 2015; Mitchell et al., 2017; Ellamil et al., 2016; Vicary et al., 2017; Bishop et al., 2019).

In the present study, I examine the extent to which participants of a Capoeira class synchronize to external timekeepers by analyzing icti, or point of rebound in a trajectory, in several types of movements and comparing them to musical rhythmic beats. While many similar studies observe synchronization and embodiment in dance situations, this study is unique in that it examines a martial art in which synchronization to music is encouraged. As a form of compensation, one of my primary interlocutors, a Capoeira instructor, requested videos to be released to the school for students to study their own synchronization to musical elements.

BACKGROUND

Capoeira is an Afro-Brazilian martial art, developed by enslaved people under a pretense of dance. Despite its origin and functional use as a martial art, many researchers, such as John Lewis, give Capoeira an apt description as a "blurred genre," incorporating music, dance, combat training, play, and way of being. Capoeira *rodas* or "games" are a form of non-contact sparring, which involve the embodiment of not only learned movements, but philosophy and learning as a Capoeirista. Over the course of its history, Capoeira demonstrated its efficacy during the Paraguayan War (Chvaicer, 2007), in street gangs (Crocitti, 2012, p. 132), and has grown increasingly popular outside of Brazil. Mestre Bimba (1899-1974) is credited with the inception of *Capoeira Regional*, which has become more widely played than its more traditional counterpart, *Capoeira Angola*. This study examines music synchronization as it occurs within a *Capoeira Regional* school in Phoenix, specializing in *Sao Bento Grande de Angola* toques. Toques are the ostinato patterns that designate the style of game being played. In this case, the games involved more offensive strikes, were played upright as opposed to close to the ground, and relied less on *malicia,* or trickery/cunning, commonly encouraged among Capoeira Angola practitioners (Downey, 2002).

Sports psychology studies have shown that the presence of music can have involuntary effects on exercise. For example, walkers and runners will spontaneously synchronize gait to auditory signals (Dyck et. al, 2015; Buhmann et. al, 2016). However, running rarely requires the level of variation, e.g., positional changes or acrobatics employed in Capoeira. This study contributes to the literature of music-synchronization research by adding observations and analyzing degrees of synchronization in a practice that prioritizes elements relatively unaddressed in running and walking studies.

In Capoeira, participants are expected to attend to music. The degree of synchronization that occurs in a Capoeira class can then be compared with synchronization in martial arts that have music solely as a background component. Such comparative studies can draw examples from this empirical study on beat synchronicity in an ecological or field setting.

METHODS

I designed a pilot study analyzing movement synchronization in Capoeira. Rosa Abraham's method of motion tracking was modified to fit the purposes of this study (Abrahams, 2017), and movement icti (singular: ictus) will be used as an indicator of timing for whether a movement is synchronized or not. In addition to creating a model for future motor-synchronization studies in exercise settings, I aim to provide some initial data on the degree of synchronization that participants exhibit in a martial art that emphasizes beat synchronicity.

All members of a UCA/Capoeira Topaziao school in Phoenix were recruited for this study. 8 adults and 8 children consented to be part of this study, although no participant was required to attend on days that the class was recorded. Skills among participants ranged from beginners to instructor level, with the majority of participants having practiced Capoeira for 2-4 years. 8 videos were recorded across a 3-week time period using a 2017 9.7" iPad. Videos were then analyzed using Logic Pro X.

The icti of a random sampling of movements from each video were denoted in each video with a marker. This marker was then referenced with the underlying auditory beat present by either recorded or live Capoeira music and participant clapping present during each recording session.

Madison and Merker argue that pulse attribution occurs within an 8.6% difference threshold of the inter-onset interval (IOI) of a musical isochronous rhythm (Madison & Merker, 2002, p. 205). In other words, subjective experience of isochrony with an auditory stimulus is dependent on the auditory stimulus not deviating from isochrony by more than 8.6% of the duration between beats. While the percentages in Madison and Merker's study were based on an individual's perception of pulse in the context of isochrony, I applied this as a guideline for whether the individual can respond to a pulse, with roughly the same tolerance, to determine the synchronicity of their actions. I operate under the idea that if one can recognize the phase variance, then they should be able to attempt to act on the beat with the same variability, and that this follows the anticipatory/reactive model of musical entrainment in Dynamic Attention Theory (see Jones et al., 2006; Jones and Boltz, 1989; Clayton et al., 2004).

Table 1. Roda 1-5, Participant Degree of Synchronized Movements.

Participants	A	B	C	D	E	C.A	C.B	C.C	C.D.	C.E.
Roda 1	7/13	9/11	N/A	6/14	N/A	10/18	N/A	N/A	N/A	N/A
Roda 2	7/11	N/A	2/4	5/12	N/A	N/A	N/A	9/21	2/6	4/6
Roda 3	14/21	4/14	23/38	10/16	N/A	N/A	N/A	N/A	N/A	N/A
Roda 4	7/18	7/23	N/A	9/18	N/A	N/A	N/A	N/A	N/A	N/A
Roda 5	16/33	10/19	N/A	4/12	N/A	N/A	N/A	N/A	N/A	N/A
Total	51/96	30/67	25/42	34/72	N/A	10/22	N/A	9/21	2/10	4/10
% Synchronization	53%	38%	60%	47%	N/A	56%	N/A	43%	33%	67%

Note. Participant fraction of movements that were recorded as synchronized to the secondary threshold, as well as total synchronization percentages. Adult participants are listed in order of experience, starting with A and ending in E, and child participants are listed in order of age, starting with C.A and ending in C.E. Child age also corresponds with order of experience, with the exception that C.E. is the most experienced among child participants. The table listed all participants who consented to be a part of the study, although not all participants were present on dates recorded, resulting in an absence of scores for Participants E and C.B.

RESULTS

Movement icti that were within 10% of a musical rhythm were considered to be synchronized, and recorded movements that did not fall within this threshold were considered non-synchronized. Following this metric, around 40-50% of non-beginner Capoeirista movements were synchronized to the underlying musical beat. When taken out of a partner context, however, these percentages dropped significantly, especially for less experienced Capoeiristas. Context, expertise, and age all have significant impact on individual scores. This is true for the degree of successfully synchronized scores, but also for consistency of scores recorded among different days. The following table represents synchronization percentages among participants in a *roda*. Note that these *rodas* used recorded live Capoeira music, rather than live performance.

Table 2. Video 6 and 7, Participant Degree of Synchronized Movements.

Participants	P.A	P.B.	P.C	P.D.	P.E	C.A	C.B	C.C	C.D	C.E
Video 6: Total Synchronized Movements	50%	33%	17%	33%	33%	N/A	N/A	0%	33%	N/A
Video 7: Total Synchronized Movements	33%	25%	18%	43%	33%	0%	33%	N/A	N/A	N/A

Note. This table shows synchronization as it occurred in exercise drills within a Capoeira class context. These drills involved no partner synchrony, but still took place alongside recorded Capoeira music. See note under Table 1 for explanation of abbreviations.

CONCLUSION

In Capoeira, movement icti tend to synchronize to tactus musical rhythms when coupled with partner synchrony with 40-60% of movements among participants. Experience appears to correlate with consistency of synchronization, and higher degrees of synchronization (Jones et. al, 1997). Children tend to score lower, and music synchronization occurs more frequently in *rodas* than in general drills. Scores between 40-60% indicate some level of music-motor synchronization. It is possible that participants allocate differing degrees of cognitive resources to synchronizing to the music, and the amount of resources allocated varies in different contexts (for more on this, see London, 2004).

I suggest further research comparing Capoeira, with its emphasis on music synchronization, with other martial arts that do not have such emphasis. Comparing two could allow researchers to examine the roles of music attending and the dichotomy of background and foreground music in a martial arts setting. Furthermore, I only observed movement icti as a point of synchronization to tactus rhythms, and not any oscillation patterns in movement that could entrain to rhythmic beats (Large, 2000).

NOTES

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Aesthetic Evaluation of Timing Patterns in Music: A Comparative Experimental Study Across Three Styles and Cultures

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INTRODUCTION

The concept of timing variations in music addresses contingent flexibilities, dynamic changes and structural peculiarities which concern the performance of diverse temporal aspects of music, including rhythmic figures, metric pulsations, tempo, and ensemble synchrony. The relevant research includes contributions from European historical musicology and music theory, comparative and ethnomusicology, and empirical musicology and music psychology. This research relates to phenomena and repertoires as diverse as free rubato ("expressive timing") in European piano music (Ohriner, 2020; Repp, 1997; Todd, 1985); stable phrasing patterns ("systematic variations of duration") in European folk and social dance music (Bengtsson & Gabrielsson, 1977, 1983); ensemble asynchronies ("participatory discrepancies") in jazz (Keil, 1987, 1995; Prögler, 1995); the variative and flexible timing of non-isochronous, that is, temporally uneven beat subdivisions ("microtiming/microrhythm") associated with the concepts of swing and groove in jazz (Benadon, 2006; Butterfield, 2011); and the rather systematic and recurrent patterns of non-isochronous beat subdivision ("metric feeling") in Afro-Brazilian (Gerischer, 2003; Guillot, 2011) and Malian (Polak, 2010; Polak & London, 2014) drum ensemble musics. It is often assumed that timing variations represent performance deviations from some cognitive or nominal reference framework (Clarke, 1985). However, there is no agreement on how to define this reference framework and its distinction from timing variations (Bengtsson, 1987). For example, empirical research has demonstrated that tempo rubato in European piano music and uneven beat subdivisions in dance drumming from Mali, both of which were traditionally understood as examples of timing deviations, can be stable and consistent to a degree that suggests they themselves represent norms or reference structures (Repp, 1997; Wolf et al., 2018; Polak, 2010; Polak et al., 2016; Polak et al., 2018).

The present study was motivated by an inconsistency between a musicological claim and its experimental-psychological testing. While musicologists have strongly claimed that the aesthetic appeal of musical rhythm – its rhythmicity (Bengtsson et al., 1972), expressivity (Clarke, 1985), groove, or swing (Keil, 1987, 1995) – depends on timing variations, experimental studies have found that timing variations have little, no, or even negative effects on the appreciation of musical rhythm by participants in laboratory test situations (Butterfield, 2010; Cameron et al., 2019; Datseris et al., 2019; Davies et al., 2013; Fruhauf et al., 2013; Hofmann et al., 2017; Madison et al., 2011; Matsushita & Nomura, 2016; Senn et al., 2016).

However, this experimental research suffers from two methodological limitations. First, it does not control for the cultural bias potentially inherent in the fact that so far only Euro-American listener groups and almost only Euro-American styles of music were tested. Thus, there is no empirical evidence which

allows to evaluate whether or not these findings would generalize across the vast diversity of musical styles and cultural groups that characterize humanity. Secondly, previous results on the effects of timing variations have often proved difficult to compare due to the diversity of stimulus manipulations employed. Furthermore, some previous studies have focused on timing deviations of note onsets *from* the music's underlying metric structure and the resulting asynchronies between ensemble parts, whereas others have also considered variations *of* the metric structure in terms of the time intervals between consecutive beat subdivisions and the resulting isochronous/non-isochronous metric patterns.

METHODS AND RESULTS

Here, we report the core results of a large-scale collaborative research project (Jakubowski et al., in review). We aimed to take a crucial methodological step forward in systematically responding to both of the limitations outlined above. First, we developed a novel paradigm for investigating the influence and interaction of stimulus-level, participant-level, and cultural group-level factors on aesthetic preferences. We compared responses of 176 participants from three countries (UK, Uruguay, Mali), with distinct cohorts of expert musicians and non-musicians in each country, to systematically manipulated versions of musical examples of three different styles of music, namely, swing jazz, candombe from Uruguay, and jembe music from Mali. Secondly, we isolated and manipulated separately within the same stimulus sets both synchrony/asynchrony (the extent of temporal offsets between onsets of different instruments in the same metric location) and isochrony/non-isochrony (the degree of evenness (temporal equidistance) of subsequent metric units) as two distinct key dimensions of timing variation. In the manipulation of synchrony, we varied the distribution and/or magnitude of the original (performed) asynchronies (deviations from perfect synchrony) between the ensemble parts in a musical excerpt while keeping the metric structure constant. In the manipulation of isochrony, we set all asynchronies between ensemble parts to zero and manipulated the metric structure of the music, by calculating the mean timings between beat subdivisions (that is, the "swing timing pattern") from the original performance of an excerpt and varying the distribution and/or magnitude of these timings. This approach allowed us to work with the timings of real musical performances, but also to vary both isochrony and synchrony in a controlled and analogous way.

The main findings of the study were the following. On the one hand, we found a cross-cultural preference for minimal asynchronies between ensemble parts. Manipulating synchrony had little effect on preferences unless asynchronies were strongly exaggerated. In particular, the stimulus utilizing the magnitude and distribution of asynchronies from the original musical performance was not preferred over either alternative distributions (inverted, random) of the same magnitude nor over the perfectly synchronized version (quantized). This finding was invariant across all styles of music and all participant groups we tested. On the other hand, we found manipulations of isochrony to elicit preference ratings that varied systematically in relation to style, country and expertise. In the UK, both musician and non-musician groups preferred isochrony, not only in the music they were most familiar with (jazz), but also in more unfamiliar styles (candombe, jembe). By contrast, musician groups (but not non-musicians) in both Uruguay and Mali preferred the original pattern of non-isochronous metric subdivision structure that is characteristic of the performance practice, yet only with respect to their own music style (Uruguayans in candombe, Malians in jembe music).

DISCUSSION

Our finding of a general, cross-cultural preference for maximally tight synchrony suggests that the performers' deviations from synchrony in the recordings we used for stimuli construction did not represent musically intentional patterns of aesthetic relevance. This conflicts with musicological theories proposing that small-scale timing variations, and asynchronies in particular, represent a major source of why humans appreciate music (Keil, 1987, 1995); but it aligns with those experimental studies which have found little or no effects of such timing variations on the feeling of "swing" or "groove", or the urge to move along with the music (e.g., Butterfield, 2010; Datseris et al., 2019; Senn et al., 2016). Note, however, that in comparison with other styles of music, the degree of synchronization in our excerpts of African and African-diasporic styles (mean asynchronies in the range of 10–20 milliseconds), though typical of these music styles, appears very tight in comparison to other musical styles, such as art music traditions in European and Asian countries (see Clayton et al., 2020). It remains possible that other types of music with

looser and more variable synchronization patterns – the example of Noh music from Japan springs to mind as an extreme case (Fujita, 2019) – may contain asynchronies that are not only more perceptually salient, but also more aesthetically relevant.

Our results on the timing of metric subdivision patterns on the one hand replicated previous research which found that Euro-American listeners tend to prefer isochrony over non-isochrony, yet on the other hand demonstrated that this is not true for all kinds of music and listener groups. Some listener groups do prefer non-isochrony when it comes to evaluating highly familiar music (their "own" music) which in real world performance involves non-isochronous beat subdivisions. Our results from Mali here replicate earlier research that also studied Malian jembe music and musicians (Neuhoff et al., 2017).

In summary, our findings suggest that not all types of small-scale timing variations are perceptually and aesthetically irrelevant or disadvantageous, as claimed by Merker (2014). In particular, we demonstrated that a preference for metric isochrony is widespread, but does not represent a biologically fixed universal.

To conclude, our study proved innovative at two levels. First, our approach to isolate and test isochrony and synchrony separately, in contrast to indifferently subsuming both of these rhythmic properties under the single concept of microtiming, demonstrated the modularity of these two rhythmic features: while synchrony preferences elicited similar responses across cultures, expertise, and style, isochrony preferences were dependent on culturally-specific exposure and experience of particular musical styles. Secondly, we showed that the effects of experience-based, listener-specific factors, such as taste and familiarity, which play a strong role in the appreciation of music (Madison & Schiölde, 2017) and rhythm in particular (Senn et al., 2019), are likely to involve systematic variation across cultural contexts.

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NOTES

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Chapter 3

Short Abstracts

Exploring Beat Connections in Swedish Folk Music and Dance

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The link between musicians and dancers is generally described as strong in many traditional musics and this holds also for Scandinavian Folk Music – *spelmansmusik*. Understanding this interaction has potential for developing theories on performance strategies that can be useful for artistic and pedagogical purposes. This serves the aim of the ongoing doctoral project "Oral Music Theory – music theoretical tools for performance expression within folk music" conducted in collaboration between KMH Royal College of Music and KTH Royal Institute of Technology.

Motion capture data of live performances of three fiddlers and two dancers were recorded, as well as dancing of the same dancers to recordings by an influential player. A first paper (Misgeld & Holzapfel, 2018) incorporated measurements and visualizations of performance data, contextualized by interviews with the performers. A second study (Misgeld et al., 2019) further investigated the link between dancer and musician by having the same musicians perform to animations generated from the motion capture recordings of the dancers. This way, the musicians' ability to connect musical beats with dance movements was explored in a local Swedish music style – *polska*. The different stimuli focused on motions of selected body parts with the aim to understand how different movements can provide reliable cues for musicians. Results illustrate a reliable alignment to renderings showing full skeletons of dancers, and an advantage of focused displays of movements in the upper back of the dancer.

Based on these results, we currently explore how asymmetric beat patterns relate to melodic rhythmic surface structures in Swedish local *polska* traditions. Our paper will summarize our previous results, introduce the collected data, and provide first results from this current work. Examples of results include the relation of onset frequency and rhythmic gestalt to non-isochronous beat.

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Physiological Interpretation of '*Bambara Walalla'*: A Rotation Technique in Ritual Dance in Southern Sri Lanka

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The rotation technique *Bambara walalla* is one of the important and powerful movement techniques performed by men in dance rituals practiced in western and southern coastal areas of Sri Lanka.[2] In this practice, while the dancer rotates around his axis of rotation, he also rotates around the center of the circle. There are common characteristics between this rotation technique and the phenomenon named gyration in physics. Focusing on *bambara walalla*, the multi-rotation technique, this paper examines angular velocity (how fast the dancer spins and the direction of his rotation axis point), orbital angular momentum, and its relationship to gravitational force when the dancer performs the rotation. My research also examines dancers' thought processes when they perform this movement. Based on interviews and analysis of movements of selected dancers, I argue that the axis of rotation becomes angular towards the center of the circle that the dancer moves around, and that the angle may vary depending on dancer's weight, height, and speed of movement. This angular momentum creates a tensile force away from the center of the circle. In addition, I suggest that the momentum achieved in *bambara walalla* helps the dancer in his body-mind centering process. Just before the rotation begins, dancers focus their eyes on the center of the circle, which helps them to focus their mind and execute the movement. Gravity, angle, speed, and the dancer's body-mind all contribute to the rotation. The study of momentum and other aspects of *bambara walalla* is still ongoing. Initial observations indicate that kinesthetic empathy could be generated between the dancer and the audience, as seen in the way that some audience members tense and then relax their bodies coinciding with the end of the climax of the dancers' rotation. In this way, the dancers' rotational techniques seem to have a kinesthetic effect on the audience and possibly also a therapeutic effect. These possibilities require further study.

Keywords: *bambara walalla* - a multi-rotation technique, Sri Lanka, ritual dance, body- mind centering

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[2] The Sinhala language term *bambara walalla* can be translated into English as circulating in a circle.

Considering a Science Perspective on Dance Structures: Romanian Traditional *Hora* Chain Dance as an Example

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A science methodology and perspective can extend beyond the collection and analysis of quantitative data, and analytic study using methods from physics and mathematics. Here, I want to open a discussion about using scientific thinking (abstract logic) when dealing with cultural data that is bounded by cultural interpretation. Typically, human interpretive methodologies (humanities), which are in themselves culturally determined, are used for academic analyses of cultural activities such as dancing. It is clear that the interpretation of insiders has to be included; however, through the application of abstract logic (scientific thinking) within the interpretation, I argue that it is possible to yield a clearer understanding of the data.

I will consider problems with dance "structural analysis" as a methodology for extracting the dance concept. This is a mainstay of southeast European dance academic research, and often uses Laban notation as the defining terminology. Many decades of academic discussion has led to a common (shared?) methodology; however, this is by definition no longer representative of the insider interpretation. The fixed nature of such approaches serves to reduce the data to a few concepts, but in doing this the alternative parameters and potential relationships between these are excluded.

I will discuss this issue using an example of Romanian traditional dancing, centring on the most common structural pattern which is represented in many of the chain dances based on the generic *hora*.

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Computational Approaches to Aid Ethnographic Research on Maqam Melodies

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There has been a recent trend towards examining the Indian Ocean as an "aesthetic space" in which artistic patterns and practices circulate and evoke the broader Indian Ocean through the specific sensual experience they create. One such endeavor is a project by Eisenberg et al., entitled "The Swahili Musical Imagination: Intercultural Style and Aesthetics in the Compositions of Ally Salim Basalama" that aims to chart a path toward an ethnomusicology that productively combines ethnographic and computational methods, and forging new ways to systematically approach the interdependence of music and poetry. Whereas qualitative (ethno)musicological studies of patterns in musical style necessarily home in on representative examples, the "sonic digital humanities" methods that the Music and Sound Cultures (MaSC) research laboratory at the New York University Abu Dhabi have been developing work at the level of the corpus, and are therefore particularly useful for drawing out similarities between multiple traditions or genres. We employ computational audio analysis, machine learning, and visualization techniques to explore similarities in music corpora from different regions. Methods proposed by Ganguli (2019) and Şentürk (2016) that develop a heuristic melodic stylization algorithm combining domain knowledge- and data-driven optimizations, are adapted to study the corpora of the "music from the region". One of the aims of the computational analysis is to model the melodic similarity space between Ally Salim's songs, Egyptian song, and Hindi film song, with a view to understanding sources of melodic inspiration for Ally Salim. This paper discusses methodological details at various audio processing stages – fundamental frequency (F0) extraction, tonic estimation, histogram characterization, and stable note transcription. The outcome of the analyses also finds its place in pedagogical and mainstream music information retrieval applications. We believe, this approach where scientific/computational research complements ethnographic studies, can lead to a better understanding of cultural migration in the Indian Ocean space.

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Decoding Improvisation in Indian Art Music: A Computational Ethnomusicology Approach

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Indian art music is predominantly transmitted orally with raga playing a critical role in the melodic organization. Raga performance allows for considerable flexibility in the interpretation of the raga lexicon/grammar – often found in a rather prescriptive manner in musicological texts – in order to incorporate elements of creativity via improvisation. A raga, alongside its tonal material, is characterized by a set of characteristic melodic motifs that serve as important points of reference in music performance. It is therefore of interest to understand how the musical concepts are manifested in performance, and how the artist uses the stock knowledge in "new" ways, while carefully maintaining the distinctiveness of each raga in the ears of trained listeners. This phenomenon of "learned schema" for the performers, vis-à-vis, melodic expectancy for the trained listeners, might be expected to influence the musicians' perception of variations of the melodic motif in terms of pitch contour shape. While a general engineering approach is to optimize certain evaluation metrics, we aimed to ensure that our findings are informed by musicological knowledge and human judgment. To achieve this, our approach is two-fold: computational modeling of the melody on a sizable, representative corpus (Ganguli & Rao, 2018; Ganguli et al., 2017; Ross et al., 2017); then validating the models through behavioral experiments towards understanding the learned schema by trained musicians. Motivated by the parallels between the musical structure and prosodic structure in speech, we present behavioral experiments (listening/imitation) that explore the differences between trained musicians' and non-musicians' perception of ecologically valid synthesized variants of a raga-characteristic motif, presented both in and out of context. Our findings suggest that trained musicians clearly demonstrate elements of categorical perception – being relatively insensitive to acoustic differences associated with note duration in the vicinity of a prototypical phrase shape while also clearly demonstrating the heightened sensitivity – in the context of the technical boundary between allied raga-pairs.

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Medicalization, Europeanization, and Musical Healing in the Ottoman Empire and Turkey

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Biomedical research in Turkey has, for at least two decades, included government-funded research and published studies on the potential uses of Ottoman-era musical healing practices. Under both Seljuk and Ottoman rule, hospitals were constructed across the Anatolian peninsula with sound in mind: construction plans show a concern for acoustics, with space being organized around central water fountains where patients receive music therapy. These practices were codified near the turn of the 19th century in musico-medical treatises such as those by Gevrekzâde Hafız Hasan Efendi, the chief physician to Sultan Abdülhamid I. Understanding the body as comprised of the Greek humors, the Ottomans associated particular *makam*-s (system for structuring microtonal musical melodies and improvisation) with the humors/bodily processes and substances, as well as times of day, weather, and emotion. *Makam*-s were then prescribed based upon the patient's condition. Contemporary physicians thus ask, does *makam* therapy work? Can we measure its physiological effects with standard biomedical metrics?

Based on Ottoman musico-medical treatises, analyses of biomedical studies, and interviews with physicians, this paper examines Ottoman/Turkish music therapy through the lenses of medicalization and Europeanization. Drawing on feminist science studies and postcolonial studies, I offer a critique of musical-medical scholarship that assumes stable Enlightenment notions of 'body' and 'health', which shifted drastically in the 19th and early 20th centuries of the Ottoman Empire. Likewise, I highlight this shift in the relationship between music and the body/health that is not reflected in contemporary biomedical and music therapy research that largely assume music is of the mind and primary effective for mental-emotional health. This study elucidates the parallel assumptions of musical and biomedical etiologies rooted in European post-Enlightenment thought and offers an alternative model for conceiving this relationship within Ottoman medicine: approaching contemporary practice as an integrated form separated only through biomedical imperialism, not naturalized difference.

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Folk Music Preservation through the Encouragements of Computer Gaming: A Case of Converting Body Movements in Azeri Music to Melodic and Rhythmic Patterns

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ABSTRACT

The aim of the current project is to find a creative way of converting the body movements of Azerbaijani dancers to melodic and rhythmic patterns based on the nature of Azeri music. Thus, 6/8 meter and two-core phrases were selected as the structural elements of Azeri music (Sipos, 2004). The dance used as the case study is called *Tərəkəmə*. This dance is a female solo dance and contains a series of fixed steps and body movements which means that no manipulation is allowed by its performer. The dance is in 6/8 meter and its tempo is slower than typical Azerbaijani dances (Bəhmənli, 2002). Data collection of dance movements was performed using a Perception Neuron IMU system (Yadaei et al., 2020). In this method, right wrist rotation along the x-axis and left wrist rotation along the y-axis were matched to 7 notes with suitable distribution in 360 degrees. Accordion and Tar Instrumental VST sounds were used for the melodic line's notes. Predefined notes were chosen from rotation data according to an Azeri modal scale by the algorithm. Also, right foot rotation along the x-axis was matched to Nağara[3] prerecorded soundtracks for the accompanying rhythmic line. The whole project was designed in the 3D environment of Unity game engine, in which the player can move around and get closer to the dancer's avatar from different sides and angles. Players can also hear the real-time music generation while the avatar is dancing. Finally, the generated melodic and rhythmic patterns form a piece of abstract music consisting of a two-core motif along with unification. Through this research, the excitement of computer gaming encourages the young generation to learn folk and traditional dances while hearing the generated music. This research can facilitate the geospatial dance databases for in-cultural-context music creations for the preservation and education of the descendants.

Keywords: Azerbaijani dance, musically movements of the body, creation of melody, creation of rhythm, motion capture dance data, music preservation, geospatial database

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[3] Azeri traditional frame drum

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