PAST SOUNDS: NEW PERSPECTIVES IN THE FIELD OF ARCHAEOACOUSTICS

ARTSOUNDSCAPES CONFERENCE. 20-21 OCTOBER 2022

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20 October

Location: Sala Miquel Siguan (Graus), Edifici de Ponent, Facultat de Psicologia, Campus Mundet, UB.

Introduction

09.30h - Margarita Díaz-Andreu (ICREA, Universitat de Barcelona): **Welcome to the Past Sounds Conference: new perspectives in the field of archaeoacoustics**

Psychoacoustics and neuroacoustical approaches in archaeology

10.10h - Pamela Jordan (University of Amsterdam): **Employing psychoacoustics in sensory archaeology**

Psychoacoustics, which studies the human perception of sound, offers a promising, subject-centered approach to unlocking the sonic experience of past built spaces. It is a tempting remedy to an essential challenge of sensory archaeology practice: the employment of individual experience as data. How can one person's experiences be compared to another's in order to create generalized observations? Moreover, what can be said about past experience as a result? These questions are central to the ongoing acoustic consideration of the ancient sanctuary to Zeus on Mount Lykaion. Here, the landscape that binds the sanctuary ruins offers noteworthy moments of sonic connectivity and isolation. A sensory approach was developed to explore these sonic relationships and determine what roles they could have played in original site usage, information beyond what the architecture and written record can offer. Extensive site research pairs first-hand observation with psychoacoustic analysis of binaural field recordings. Findings map out a sacred terrain of shared and singular experience orchestrated by sonic connectivity; they also underscore the necessity of caution in interpreting psychoacoustic findings as an empathetic understanding of past peoples.

10.50h - Raquel Aparicio-Terrés (University of Barcelona); Samantha López (University of Barcelona); Carles Escera (University of Barcelona): **A first approach to the study of neural mechanisms that make acoustics a phenomenon to be considered in ancient human experience**

Music is present in all human societies (Blacking, 1995) and has long been related to rituals (Bolch, 1989; Tuzin, 1984; Nettl, 2000). However, the study of the role of ritualistic music has been neglected in most scientific disciplines related to neuroscience and psychology. In this article, we review studies on the cognitive effects of present-day ritualistic music. By emphasising the methodological characteristics of these studies, we propose methodological considerations for future scientific investigations on the topic. Specifically, we observed that the function of music in modern rituals might be reduced to modulating emotions during the event and/or inducing alterations in the participants' mental states. Based on this observation, we suggest a series of target of cognitive and physiological measures to lead future research on the subject. Also, we propose ways in which brain activity in response to different ritualistic musical stimuli can be measured and analysed. We believe that exploring how music in present-day ritualistic contexts affects brain activity, cognition, behaviour, and physiology will deepen our understanding of ancient ritual activity.

11.30h - Coffee

11.50h - Samantha López (University of Barcelona); José Valenzuela (University of Barcelona); Raquel Aparicio-Terrés (University of Barcelona); Carles Escera (University of Barcelona): **Methods for perceptual and emotional evaluation of soundscapes in immersive auditory environments**

In the present work, we start by overviewing the most advanced methods in the acoustic study of archaeological sites. We focus on the use of the impulse response reverberation technique to record the acoustic properties of archaeological sites, extract parameters to carry out statistical analysis, and perform auralisation with which we can present the recorded acoustics to modern-day listeners. With the auralisation of archaeological sites –in particular, rock art sites– we can immerse listeners in a virtual reproduction of the past soundscapes, which has many applications in the preservation of historical spaces and in archaeological research. In this work, we describe some of these applications, focusing on psychological research, and describing several behavioural scales employed in the study of the perception and emotional responses to these soundscapes. The objective is to formulate hypotheses and extract conclusions related to the possibility that the acoustics played some role in the consideration of certain spots as sacred, and the selection of these spots for carrying out ritualistic activities involving rock art production. Finally, we present some limitations and further perspectives in this new field called psychoarchaeoacoustics.

12.30 - Visit to the Immersive PsychoAcoustic Laboratory (ImmpaLAB) and to the Brainlab

13.30h – Lunch

Musical instruments

15.00h - Simon Wyatt (Independent Researcher): **Archoustemology and the Aurignacian**

The sophistication of Upper Palaeolithic aerophones is often commented on and they represent the culmination of a long development, most likely occurring in other more-perishable materials. But a serious problem for the music archaeologist is the nature of the remains which, even in the more durable material of bone or ivory, are commonly fragmentary. Such is the case for the swan-radius aerophone from Geissenklösterle. The surviving evidence does provide some interesting lines of enquiry, if we consider the perspective of acoustic studies of aerophones. Such explanations are based on cylindrical and conical tubes; not the non-uniform bore of bones. Yet several acoustic factors areintriguing, given the nature of the finds, how they were made, and the original dimensions of the materials used. Furthermore, if we consider that the surviving form of the aerophones wasintentional, it may imply a well-developed tradition and acoustic understanding which supports the claim for sophistication. These observations may equally be applied to other Palaeolithic aerophonessuch as the mammoth ivory example from Geissenklösterle and the griffon vulture artefact from Höhlefels. This discussion is presented against a backdrop of double description, a model presented by Gregory Bateson (1973, 1979, 1987) to create a deeper form of relational knowledge. I have presented aspects of such multiple perspectives before (Wyatt 2012, 2014a, 2014b, forthcoming: Wyatt and García Benito 2014) with the aim of combining cultural, ritual, ecological, psychological, and musical aspectsof the past. This being the case I propose the use of the term archoustemology: a combination of archaeology and Steven Feld's acoustemology: acoustic epistemology (Feld 2017). Although the narrative here explores the acoustic nature of the aerophones, this only represents a part of the cultural understanding of sound-making artefacts and the environment in which the people of prehistory lived.

15.40h - Raquel Jiménez Pasalodos (University of Valladolid): **The materiality of the immaterial: A theoretical approach to the study of archaeological musical instruments**

Despite the immateriality of sound, as well as the cultural conceptions related to performing and listening to music, material culture is an important element for the comprehension of musicking. Musical instruments are among the most important objects associated to this practice. The archaeological record shows to what extent past human groups have invested time and resources in the invention, construction, dissemination and mastering of sound-producing artifacts. Music archaeological methodologies applied to the study of these artefacts can reveal some aspects of vanished musical cultures, such as manufacturing processes, acoustic knowledge, cultural connections, performative techniques, music theories and cultural practices. However, this materiality should not be only understood as inert objects shaped by human actions, but also as agentic entities, co-creators of human musical and sound experiences. In this paper, diverse methodological and theoretical approaches to the study of archaeological instruments will be discussed, taking into consideration relatively recent theoretical proposals such as new materialism, object-oriented ontology and the material aspects of power and ritual.

16.20h – Coffee

16.40h - Neil Rusch (University of the Witwatersrand): **The results are audible: Constructing ancient instruments what more can we learn?**

There is a view of archaeology promoted by the Oxford historian R. G. Collingwood (1889-1943) who argued that knowing the past means re-enacting it. This idea is alive today in experimental archaeology. In this article I revisit the concepts of "re-enactment" and "actualization", drawing on my experiences creating musical instruments for archaeoacoustic purposes. Further, I investigate MET (material engagement theory) and the hypothesis that material engagement and musical instrument making are intertwined and should be traceable in the archaeological record. Four case studies inform this enquiry. The results suggest that 4E cognition as it is theorized by MET - embodied, embedded, enactive and extended - could radically reshape the approach we take to archaeoacoustic instrument fabrication.

17.20h - Francisca Zalaquett (National Autonomous University of Mexico): **Research on sound instruments in Maya Archaeology and the dissemination of results to the public**

We present our study of Mayan prehispanic sound instruments manufactured during the Preclassic and Late Classic period (650-850 A.D.), in archaeological sites throughout the Yucatec Peninsula (Jaina, Calakmul, Comalcalco, etc.), Chiapas, Guatemala and Honduras. We have analysed frequencies and intensity related to their organological aspects and the contexts where these instruments were obtained. We have also worked with Mayan potters specialists to determine the manufacturing process of these instruments, the ritual and daily actions in which they are used today. These sounds have been conceived as a sacred, encrypted and rhythmic language, with negative and positive powers and influences, used intentionally during rituals and offerings at precise times. The refinement perceivable from the study of manufactured sound instruments demonstrate prehispanic craftsmen's great acoustic knowledge, and that the control of sounds and rhythms came as another form of perception directly linked to architecture, sculpture and sensatory practices crucial in the process of sharing messages and sensations between humans and supernatural entities. Iconography and archaeological data suggest that these auditory and sensorial settings were shared by performers as well as spectators. This importance of sound instruments is still significant today and allows us to propose an interdisciplinary and diachronic analysis of the acoustic perceptual world of Mayan life.

18.00h – Laura de Castellet (Universitat de Barcelona/Apémutam): **Researching and performing on medieval music**

This presentation is part of the doctoral thesis "Sound landscape of medieval Catalonia (VI-XIV): an exercise in emotional restitution from the archaeology of sound", an investigation into iconography, documentation, literature, linguistics, comparative ethnology or the history of technology, which give way to archaeology as an approximate methodology for the restitution of sound. Much of the research has been developed in the restitution of popular musical instruments and their performance contexts from an archaeological perspective, since the music of aristocratic and religious minorities has already been approached from other fields. The restitution of

sound objects and instruments and their techniques thus allow a contextualization of both the soundscape and the aesthetic and emotional environments of sound.

21 October

Location: Sala de Juntes, Facultat de Geografia i Història, Universitat de Barcelona.

Archaeoacoustics and ontology

09.00h - Bernd Brabec de Mori (University of Innsbruck/University of Marburg): **The role of listening in the prehistoric emergence of speech and song: a precursor of becoming human?**

Various theories about the origin of music (and of speech, or language) are based on the idea of evolutionary adaptation, starting with Darwin, and following up into contemporary theorizing. Other scholars prefer the idea of music serving as a form of "social glue" that does not provide individual benefits but increases a group's survival again in adaptation. Besides further advances into "non-adaptationist" (or "exaptationist") theories, few scholars explore the probably ancient connection of the musical with the metaphysical (but see Nadel 1930, Parncutt 1993, Tomlinson 2015). Based on a theory of listening postures (Stoichiță & Brabec 2017), I propose that the changing affordances of growing group size and interaction with non-present entities subjected early homo sapiens to a need for new forms of interaction. In philosophical anthropology it was often argued (though challenged in recent research) that the faculty of abstract thought would be a distinctive feature for humans in comparison to other animals. If so, it is still unsure how the cognitive faculty of abstraction emerged. I think that a posture of listening we call "enchanted listening" provides the base for developing cognitive skills needed for abstract thinking: by formalizing sound utterance (in both production and listening), the listener construes a space that is detached from the three-dimensional space perceived with other senses like sight and touch. Within this auditory space, entities can be "heard into being" that interact and exert agency only in the auditory domain. Like Tomlinson, but in a distinct line of thought, I argue that the formalization of sounds (i.e. "proto-music") provides the link between humans/hominins and the "supernatural" domains, as the auditory space and the supernatural space can readily overlap. While the emergence of discrete phonemes ("proto-language") was afforded by the growing groups as well as the distinction of "us" from "them" – who should not understand "our" phonemes –, the affordance of the invisible (but possibly audible) made forms of bridging communicative gaps between humans and non-humans possible. "Non-humans" in this context may include invisible beings (hidden animals, spirits, dead ancestors) but also non-present beings like neighbouring human groups that may have appeared "non-human" to early humans.

Archaeoacoustics, storytelling and shamanism

09.40h – Margarita Díaz-Andreu (Universitat de Barcelona); Andrzej Rozwadowski (Adam Mickiewicz University); Raquel Jiménez Pasalodos (University of Valladolid); Neemias Santos da Rosa (Universitat de Barcelona); Daniel Benítez-Aragón (Universitat de Barcelona); Lidia Alvarez Morales (Universitat de Barcelona): **Music and storytelling in rock art sites? The archaeoacoustics of the Urkosh area**

In this paper, the potential of archaeoacoustics for understanding past communities is discussed by looking at a range of acoustic parameters. Our case study is the Urkosh rock art area in the Republic of Altai (Russia). The rock art of this area dates possibly from the Neolithic and surely from the Early Bronze Age, with important periods in the Early Iron Age, and the medieval period after which there are later additions to our days. Tested sites include major and minor sites as well as sites with no art. The results of the tests undertaken with the Impulse Response method provide high values for speech (C_{50}) and music (C_{80}) clarity, but not only in the rock art sites. Although these parameters cannot explain why rock art was produced precisely in particular locations, they give us information about the acoustic conditions in which particular intangible cultural practices were most likely produced. In particular, we focus on storytelling and music, cultural practices for which there is a wealth of information in the ethnographic sources written about the area.

10.20h - Riitta Rainio (University of Helsinki); Elina Hytönen-Ng (University of Turku): **Ringing tone and drumming shamans in the crevice cave of Pirunkirkko, Eastern Finland**

Pirunkirkko ('Devil's Church') is one of the famous caves in Finland. Tradition says that this crevice cave leading inside the Koli mountains was a meeting place for sages, who typically used sound and making noise to contact the spirit world. Today the place is visited by practitioners of shamanism, who organise drumming sessions at the back of the cave. This paper examines Pirunkirkko and the related traditions from the perspective of acoustics, hypothesising that the acoustic characteristics of the narrow crevice might have played a role in the ritualisation of the place as well as in the power of its sonic rituals. Methods employed include impulse response recording, spectrum analysis, archival research and an interview of a shamanic practitioner analysed with discursive psychology. The results indicate that the corridor-like back of the cave houses a distinct resonance phenomenon. A standing wave between the smooth parallel walls generates a ringing tone at 219–232 hertz that stays audible after sharp impulses or tones vocalised at the same frequency. Surprisingly, the local folklore or the interviewed practitioner do not mention this ringing tone at all. Instead, they speak about the "spirit of the cave", "special energy" or "new horizons" opened up by drumming. This leads to reflection on cultural frameworks of thought that guide sensory perceptions leading to differing experiences and interpretations.

11.00h – Coffee

Architectural archaeoacoustics

11.20h - Angela Bellia (Italian National Research Council): **Listening to ancient places: towards an aural architecture of the past**

This paper aims to analyse recent studies which have raised new hypotheses concerning aural architecture as a new trend in humanities research, with a particular focus on the intersection of sacred space, rituals, and sound in the past. These studies have highlighted how sacred buildings not only defined a sacred place as a physical and symbolic expression of a specific form of worship, but also established the setting for performative and multisensorial ceremonies in which music, dance, and other sonic events played an important role. In this contribution, we investigate studies on aural architecture in order to discover if the location of sacred spaces tells us whether ancient people reacted to ritual and musical developments by modifying sanctuaries or by designing and constructing new buildings and spaces for performances. In addition, we explore studies on aural architecture to obtain an overview of how specific sonic features could have influenced the soundscape of sacred spaces, which consisted not only of songs, music, prayers, recitations and religious sonic and vocal utterances, but also of natural elements, such as animals, water and wind. In this overview, we will also take into consideration how digital technologies and virtual acoustics can contribute to the understanding of the architecture-sound nexus.

12.00h - Davide Nadali (Sapienza University of Rome): **How to hear architecture. On the acoustic properties and implications of built spaces in ancient Mesopotamia**

The existence and, therefore, the quality of sounds also depend on the properties and characteristics of spaces: in this respect, not only the shape of each building, but also the materials used affect the possibility of making spaces sound and, moreover, the possibility of making those sounds listened to and heard by either a restricted or large audience. The acoustic properties of architecture can thus be purposely projected or it might in fact be a natural consequence made of several concurrent concause and targeted choices. The present communication takes into account Mesopotamian contexts of built spaces, that will be analysed from a phenomenological and acoustic perspective, points to: 1) identification of the acoustic properties marked and ascribed, 2) analysis of the acoustic implications on the buildings themselves, the surrounding spaces and places (encompassing the landscape and environment) and the people that were supposed to live in or nearby. The use and reference of textual and visual documents will complete the comprehensive analysis of the phenomena of sounds, on one hand, and noises, on the other: while the former can be translated as the human transformation of noises, the latter are the results of natural, indeed mainly anthropic activities in built spaces and surrounding areas: as a matter of fact, the action itself of building (i.e. work) is characterized by sound and noise. In the end, following the recent archaeoacoustic approaches to ancient Near Eastern contexts, I will attempt to trace and suggest the main elements for an acoustic evaluation of ancient Mesopotamian architecture for a more comprehensive understanding of the complex interactions and relationships of human

beings and (un)built environment in an effective sensorial system of reference and communication.

12.40h - Zorana Đorđević (University of Belgrade): **Sound imagery in medieval Serbian churches**

The aural experience of the Orthodox religious service, which was dominantly based on the human voice both spoken and chanted in a church nave and sanctuary, was complemented with fresco paintings covering medieval church walls and domes. The analysis of church mural painting in medieval Serbia, so far, only indirectly addressed the aspect of sound. However, the previous research of the Byzantine churches in Thessaloniki suggested the correlation between the church acoustics and the images related to chanting (Antonopoulos et al. 2017). This paper seeks to make an inexhaustive overview of the themes that could be considered sound imagery and thus a base for a further archaeoacoustic analysis. The paper is divided into three parts, each supported with examples. Firstly, it considers the representations of musical instruments in medieval frescoes, their meaning and sounding. Secondly, it investigates the iconographic inscriptions and their contribution to the aural experience of the religious service. Finally, it examines the relation of the image and sound in the depiction of Heavenly and Earthly liturgy. Each part of the paper opens new questions regarding the relation of sound imagery and church acoustics and eventually suggests further steps in archaeoacoustic examination.

13.20h - Lunch

14.20h - Braxton Boren (American University, Washington DC): **Estimation of Speech intelligibility in the past**

Among prominent acoustic sound sources in human history, one of the most socially significant was the practice of oration to large crowds before the invention of amplification. Such orations occur in military, religious, and political settings, but they are not reported equally often throughout different nations and cultures. Traditionalist historians have tended to take such reports at face value, while skeptical historians tend to conclude that many or all such accounts were largely fabricated. However, even in cases where the original sounds have decayed, geometric clues, such as reported crowd size, measured lengths, and the speaker's training in elocution can allow a present-day analysis of such accounts. After inputting our best estimates of effective levels of the speaker and the ambient noise, computer simulations can map the sound across large crowds, allowing first-order estimates of the number of people who could have reasonably heard the speaker. For this type of investigation, the Speech Intelligibility Index (STI) is the best current tool for analysis as it includes both the speaker's level and spectrum, as well as background noise and sound reactions. It is argued that more consensus is needed across the archaeoacoustics community on the best practices for thresholds, noise levels, and crowd densities in such studies. Some discussion is given to alternative STI-like metrics which could be adapted for past languages, dialects, and accents and their effect on human speech intelligibility.

15.00h - Kamil Kopij (Jagiellonian University); Adam Pilch (AGH University of Science and Technology,); Monika Drab (Wroclaw University of Science and Technology); Szymon Poplawski (Wroclaw University of Science and Technology): **One, two, three! Can everybody hear me? Acoustics of Roman 'contiones'. Case studies of the Capitoline Hill and the temple of Bellona in Rome**

Rhetoric was one of the cornerstones of Roman education and public speaking, the essence of being a Roman politician. This article aims to estimate the number of people who could intelligibly hear a speaker delivering a speech from two speaking platforms located in the city of Rome: the podium of the Temple of Bellona in the Campus Martius (in the Late Republican and Late Augustinian periods) and the Capitoline Temple. To do this, we built virtual reconstructions of both venues according to the current state of knowledge about them, taking into account both the geometry of the space and the materials from which they were built. On the models thus prepared, we carried out acoustic simulations for three different levels of background noise (36dBA, 49dBA and 55dBA), resulting in Speech Transmission Index (STI) maps. The results became the basis upon which we estimated the size of the maximum potential crowds that could hear speech intelligibly, using two methods, based on the behaviour of contemporary crowds. We further compared our results with those of previous studies that concern other speaking platforms in Rome.

Virtual acoustics

15.40h - Cristina Manzetti (University of Cyprus); Giacomo Landeschi (Lund University): **Virtual acoustics and 3D GIS in archaeology**

During the last few years, research on acoustics and 3D GIS in archaeology has been continuously advancing. These fields of investigation have proven to be a meaningful enhancement to archaeological research. In this sense, the aim of this paper is to show how virtual acoustic analysis can be integrated into 3D GIS to improve the study of ancient theatres and the dissemination of the results. The case study presented here has been applied to one of the Roman theatres in Crete (Gortyna, in locality Kazinedes). The virtual reconstruction of the theatre has been imported in ArcGIS Pro together with the outcomes obtained through the virtual acoustic analysis, consisting ofacoustic values of five different parameters (T30, EDT, D50, C80, STI). The result is a detailed informative geo-located 3D model with the additional data precisely placed within the reconstructed building. The 3D GIS virtual theatre thus becomes a storage of information which are not only geometrical and that can be used for further analyses related to its acoustics and for punctual comparisons.

16.20h – Coffee

16.40h - Rupert Till (University of Huddersfield): **Presenting archaeoacoustics results using multimedia and VR technologies**

Music and sound cannot be experienced through writing and numbers, writing freezes time onto paper, and as a time-based medium, sound cannot be heard without temporal motion. More than this, for an experience of sound to be complete it needs to engage our bodies. Digital multimedia technologies offer powerful approaches to understanding the acoustics of the past; this presentation will explore a number of those affordances. This paper will explore how an app that illustrates archaeoacoustic effects, set digitally within visual and acoustic archaeological cultures, was used with school groups to explore history curriculum covering Roman culture, early British history, and European prehistory. It will discuss ways of engaging audiences further with similar content, including video projection, acoustic simulation, field and studio recordings, and musical performance. It explores how VR headsets can be used to create a sense of flow amongst audiences, and immerse them in an experiential phenomenological understanding of complex comparative archaeoacoustics metrics, as well as setting such results within an appropriate context. The paper will examine how acoustics results at caves in Northern Spain, in various phases of Stonehenge, and at Paphos Theatre (all World Heritage Sites) can be explored using VR and multimedia technologies, evaluating the comparative advantages of the use of different technologies. It proposes that such approaches are effective as non-representative theory (NRT) approaches to empirical studies, allowing understanding that goes beyond binary dialectics, and address the real-world complexities of acoustic ecologies.

17.20h - Graham Goodwin (University of California Merced): **Exploring the potential of immersive virtual reality for experiencing archaeological soundscapes**

The increasing adoption in archaeology of geospatial technology has had a significant impact. A large and growing percentage of published archaeological literature incorporates or relates in some way to geospatial technology (McCoy 2021). A key area of geospatial technology is High-density survey and measurement (HDSM) instruments like terrestrial lidar that can acquire precision 3D data relevant to research that is concerned with space and form (Opitz and Limp 2015). Importantly this data can be presented at a scale and granularity relevant to individual human experience. Which means HDSM data has the potential for use in experiential focused research, in particular research that focuses on the experience of archaeological soundscapes in virtual reality (VR). However, HDSM data has primarily been utilized in the study of the visual experience of archaeological material and phenomenon (Opitz 2017). Yet humans are spatial beings, and hearing is inherently a spatial perception, making sound as interconnected to space and form as any other sensory stimuli. Therefore, it is worth exploring if HDSM data is relevant to modelling soundscapes in virtual reality (VR). The ability to acquire a better understanding of the space and form of an archaeological context at multiple scales make HDSM data relevant to modelling soundscapes in VR. Game engines like Unity are one potential software for modelling soundscapes that can be utilized in experiential focused research. HDSM data from an archaeological research project can be integrated into a singular virtual environment at the scale of individual human experience. Engaging with this environment as an immersive VR experience may help in presenting archaeological material or phenomenon (Tost and Economou 2009). However, since the medium used to present data alters how it is perceived (Di Giuseppantonio Di Franco et al.

2015). Immersive VR is likely to convey some spatial attributes of the soundscape more effectively than others, but this will require further research. As an initial case study on the possible use of immersive VR for understanding how archaeological soundscapes are experienced, this paper focuses on the utilization of airborne lidar data acquired at the Late Classic Maya site of Las Cuevas in western Belize.

18.00h – Tess Knighton (ICREA/Universitat Autònoma de Barcelona): **Presentation and tour Barcelona acoustics**

CONFERENCE Organised by Margarita Díaz-Andreu & Neemias Santos da Rosa

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