Songs of the Caves: Sound and Prehistoric Art in Caves

Initial report on a study in the Cave of Tito Bustillo, Asturias, Spain

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Introduction

The visual primacy of rock-art imagery can sometimes blind researchers to equally important but less obvious, non-visual aspects of rock art. Recent work from southern Africa indicates that certain San rock engravings were hammered, rubbed, cut and flaked in order to produce sound; to touch certain numinous images and rocks; and to possess pieces of potent places. Ouzman 2001: 237.

A significant amount of evidence exists for the significance of organised sound in prehistory (Seewald 1934; Megaw 1968; Wyatt 2009). Research in this area has progressed for over 30 years, for example within the International Council for Traditional Music (ICTM) International Study Group for Music Archaeology (ISGMA). This includes the discovery of fragmentary sound making devices dated to 40,000 BP (Conard et al 2009). The age of this discovery, a fairly advanced example of an aerophone, emphasises the complex nature of such sonic artefacts, even during the Palaeolithic period, and earlier precursors may have been made from less durable material. A number of archaeological finds that are thought to be musical instruments from prehistory have been found in caves, particularly well known are bone flutes such as those found in Isturitz and Hohlefels (see Morley 2013).

This field of research includes organological and experimental approaches, but surviving artefacts are not the sole method of examining prehistoric sonic behaviour. In addition, on-going research has addressed the appearance of musical capabilities within anatomically modern humans and explores the functional role of organised sound through for example neurological insights (Morley 2003, 2013; Cross 2001; Cross and Morley 2008). It is from within the context of such wide ranging approaches that the subject of acoustic archaeology developed in the 1980s, (e.g. Reznikoff and Dauvois 1988; Scarre 1989; Watson 1999; Lathelma 2010) culminating with a conference entitled Archaeoacoustics (Scarre And Lawson 2006) and the creation of the Acoustics and Music of British Prehistory Research Network (AMBP) in 2010, funded by the UK Arts and Humanities Research Council (AHRC) and Engineering and Physical Sciences Research Council (EPSRC) as part of the Science and Heritage Programme.

A number of research partnerships emerged from this network, which was managed by Till, Scarre
and Kang, all of whom are involved in this project. Discussions with researchers at the universities of Valladolid and Zaragoza in Spain, led to the initiation of a project that aimed to explore the relationships of Palaeolithic cave art in Northern Spain, with sound, music and acoustics. Till and Fazenda, who had worked together previously exploring the acoustics of Stonehenge (Till 2010, 2011; Fazenda 2013; Fazenda and Drumm 2013), visited caves in Asturias (including Tito Bustillo) and Cantabria in the summer of 2012. This was in order to carry out an initial pilot study, supported by a small amount of funding from the Universities of Huddersfield and Salford, and with the help of the Goberno Del Principado De Asturias. Initial results indicated that this was a subject that would benefit from a fully funded research project. Till, Fazenda and Scarre were successful in gaining grant funding from the UK AHRC Science and Heritage Programme to carry out a fully funded research project in 2013.

The remit was to explore the relationships between the use of sound and specific kinds of prehistoric activity, and to define and employ a scientific methodology appropriate for the creation of records of the acoustics of important sites such as this. This work emerges from a developing recognition of the importance of our intangible cultural heritage (Brezina 2013), which has come to the fore recently with the creation of the UNESCO list of intangible cultural heritage and a register for best safeguarding practices (UNESCO 1). Such recognition adds to the importance of this project, which takes place within the Cave of Altamira and Paleolithic Cave Art of Northern Spain World Heritage Site (UNESCO 2: Ontañón et al 2008). This includes Tito Bustillo. A greater understanding of the value that past societies placed on their acoustic environment will perhaps help us to better understand our ancestors. Arias (2009) has discussed the meaning an image would have had in relation to environment, illumination, movement and sound. We may suppose that the creation of imagery was associated with certain ritual practices within the very special environment of caves such as Tito Bustillo, and this is suggestive of group activities involving sound and perhaps even music, something that will have aided group cohesion and consolidated a sense of identity among the participants (Blacking 1976; Freeman 2001; Morley 2006). This use of sound and music helps create a sense of identity within communities and an attachment to the past through the stories people tell about themselves (Rowlands 2002: Tosh 2002).

We know that the acoustics within a cave are strikingly different from those outside. At the very least it is important to characterize and record the acoustics of important archaeological sites such as Tito Bustillo as part of a complete archaeological assessment. This project also intended to assess, analyze and interpret the affordances these acoustics offered to human sound production and music making. It is clear that prehistory was not silent, deaf or mute, and that many activities in the cave would have made sound, whether this was talking and moving, or grinding and preparing pigments for painting, and indeed in the dark flickering light of a prehistoric cave, sound may have been particularly dramatic and important.

**Relevant Existing Research**

Archaeological investigations in Tito Bustillo have included those by Garcia Guinea in 1970; Alfonso Moure Romanillo between 1972 and 1987; Moure with the collaboration of Rodrigo de Balbin Behrmann systematically recording the art beginning in 1974; and Balbin Behrmann and Alcolea (2007-8) who created a high quality digital record of the imagery between 2004 and 2007. This recent recording project resulted in the discovery of unknown decorated spaces and also a pit in the gallery of the Anthropomorphs which contained ochre and crushed bone, teeth and shell
dated to 32 990 +/- 450 BP (Beta 170181) (Balbin Berhmann and Alcolea 2007-2008: 139). Not only does this suggest a far greater age for at least some of the imagery present than previously thought, but it encourages intriguing hypotheses about the significance of creating art, and the symbolism of the pigments. It is fitting then, that this new visual recording project should be matched by a parallel sonic recording of the characteristics of the cave, and the opportunity to identify correlation between the sonic and the visual.

The work of Reznikoff and Dauvois (1988: 245) brought the idea of a relationship between imagery in caves and the acoustic environment to the fore. Not all details of their research project are published, meaning their results are difficult to assess. Their initial conclusions were suitably understated, claiming only that while some imagery had been placed where it was convenient, others were related to the acoustic environment, as may be expected within a cave. These researchers continued exploring this relationship (Reznikoff 2000; Dauvois 2005). A subsequent publication stated “the location for a rock painting was chosen to a large extent because of its sound value” (Reznikoff 2000: 6 although this is qualified by the comment that these “results occasion many more considerations and questions” (Reznikoff 2000: 11).

For the purposes of the current project we look upon the work of Reznikoff and Dauvois as an initial study that has produced a testable hypothesis. The Songs of the Caves project stems from the exploratory fieldwork carried out in 2012, and with significantly greater funding the project was expanded in 2013 to thoroughly investigate the acoustic environment of the Asturian cave of Tito Bustillo, as well as four Cantabrian caves, La Garma, El Castillo, Las Chimeneas and La Pasiega. The project aims to examine the plausibility of the hypothesis of a relationship existing between the acoustic environment and the placement of imagery in caves. It also aimed to explore such acoustics experimentally, using sound-making devices of kinds that may have been available at the period when the art was made. This experimental research seeks to examine how human agency would be able to activate the acoustics of the cave, and what range of sounds would have been possible. In so doing, it adopts and develops the methodology of Reznikoff.

**Results of the initial 2012 pilot study**

Our initial research in 2012, although somewhat limited in scope, prepared us for the subsequent, more sophisticated study. We carried out acoustic measurements in a number of spaces in the cave, and explored a number of its different areas. Clearly the main painted “Horse Panel”, located near the original entrance, and decorated with for example numerous images of horses, was a particularly interesting acoustic environment. We noted an echo, as well as the proximity of the panel to a large and deep opening in the ground, at the bottom of which can be heard an underground river, a significant physical and sonic feature. The floor of this panel had been lowered, altering its physical and acoustic characteristics, and creating issues of authenticity, but this was still a site we wanted to explore in more detail in 2013.

Another large, long, open space in the main central passageway that leads to the modern entrance of the cave, had a number of interesting sonic characteristics. It seemed to have the longest reverberation (sustain) we observed, and seemed to be the largest, most dramatic acoustic. Initially Till and Fazenda selected it for study as an example of an impressive acoustic where there appeared to be no decoration. However, we were informed by the local archaeological expert who was guiding us, that this was a particularly significant position which originally had large dramatic paintings, although much of the decoration on the walls had been washed away by flooding, and
could not now be clearly seen.

At one end of this area was a lithophone, which we were able to examine. This consisted of sedimentary deposits that were capable of ringing when struck, sounding much like xylophones. The various elements of this feature produce different tones and pitches when struck gently with a finger, and some had been snapped off or removed. It was not clear if these breakages occurred recently, but it was indicated to us that the damage may well have occurred in antiquity, raising the possibility that the musical qualities of this material feature may have been known in the ancient past. When we later listened back to audio recordings made in this area, we were surprised to hear what sounded like the lithophone being played. In fact this was the effect of water dripping onto other stalagmites in this area, suggesting we needed to explore whether there were further unknown parts of the cave that might ring when struck. Investigating the sound-making potential of this area would be an important part of further study.

We were able to carefully enter a number of small chambers at the side of the main central gallery of the cave. We were shown that some of these had many paintings and carvings, and others seemed to have few or none. We were able to record and detect some acoustic effects in some of these small side chambers, and it seemed on a subjective level that those that were decorated were more interesting acoustically. In this first pilot study we had two forms of equipment. One was a small sound making device, which could be used to create a basic excitation of the space, and that was useful for example in these less accessible side chambers. Unfortunately this had a restricted frequency response and was not suitable for a full scientific evaluation. Our second option was a large dodecahedron loudspeaker, specifically designed for acoustic testing. This was very large and difficult to manipulate, it took considerable time to set up, and could not be readily used in the side chambers. Although we were able to collect some good results, it was clear that if we returned we would need equipment that would better balance size and scientific reliability.

García, Jiménez and Till drew explored various musical sounds, including the use of reconstructions of archaeological musical instrument finds. Performing within the side chambers or in the main space provided valuable illustrations of what musical activity within the cave might have sounded like, and provided a useful illustration of the acoustical behaviour of the cave.

In conclusion, in the 2012 pilot study we were able to establish that many of the most dramatic positions in the cave also had significant acoustic effects present, an echo and the sound of water at the horse panel, long reverberation at the large central area, and interesting although subtle effects in some of the side chambers. It confirmed that this was a subject that warranted further investigation.

**Acoustic Characterisation and Cave Imagery**

The primary aim of the 2013 project was to explore, record and analyze the sonic characterisation of Tito Bustillo. In order to facilitate this work, a team was brought together of experts from Spain and the UK. This included archaeologists, acousticians, archaeoacousticians, and music archaeologists. The project would include experimental musical and sound making performances, and the collection of acoustic impulse responses for several positions within Tito Bustillo. We would also carry out similar tests in Cantabrian caves, which would allow us to compare these sites. An impulse response is a sample of the acoustic response of an environment in a specific position. From such an impulse response, numerous acoustical parameters can be extracted for
study, and the sound of the particular position can be recreated or “auralised”. We aimed to examine, compare and illustrate the diversity of these acoustic environments. The characterisation of the space would allow the identification of positions within the cave of sonic significance.

Impulse responses were captured through the use of a sine sweep signal played through a loudspeaker. This signal sweeps through all frequencies within the range of human hearing, from 16 Hz up to 20000 Hz, systematically stimulating the response of the space to each frequency. Calibrated measurement microphones attached to a laptop computer recorded this acoustic response for later study. A Soundfield microphone was also used to sample the acoustics of the space at multiple positions. This type of microphone is capable of capturing sound arriving from all directions, encoding the signal into the 3D Cartesian coordinates (x, y, z). Recordings were also made of the background “silence” of the caves. The use of multiple microphone and source positions enabled the calculation of the international ISO standard for reverberation time. A Bang and Olufsen loudspeaker was purchased specifically for use by this project. It is highly portable with a rechargeable battery, yet is capable of high volume with a wide, flat frequency response. All equipment was tested and calibrated at the University of Salford Acoustics Research Centre’s anechoic chamber. Knowing the frequency response of the system used allowed the team to compensate and adjust for any sonic inaccuracies.

This project aimed to establish a rigorous recording methodology, not only of the acoustical effects present, but also of information about positions of the equipment and its relationship to the imagery in the Cave. Meticulous records were kept of every acoustic measurement, and of the archaeological context, in order to ensure the repeatability and testability of the results, something largely lacking from a number of similar other projects.

**Sound Making Devices**

While technical equipment is able to characterize the acoustic nature of the caves in a somewhat clinical manner, the use of model sound-producing devices allowed us to investigate what form of artefacts, available to prehistoric people, may have been able to excite the acoustic space of the caves. This involved a combination of devices with different amounts of supportive evidence. There have been found for example numerous examples of aerophones made of vulture bone, swan bone and mammoth ivory from archaeological sites such as Hohlefels, Pair non-Pair and Isturiz (Buisson 1990; Conard et al 2004; Conard et al 2009), which have several different possible interpretations (García Benito 2011; Wyatt 2012). Similarly while there are numerous examples of Palaeolithic objects interpreted as phalange whistles (Megaw 1968; Clodoré-Tissot and Leclerc 2002; Dauvois 2005), there are suggestions of different interpretations (Caldwell 2009; see also Arias et al 2007-8). Similarly there is evidence from France and Spain of objects that have been interpreted as bullroarers (Barandiarán 1971; Bahn and Vertut 1999; Clodoré-Tissot 2002). It is also very likely that sound making devices existed which were made from more perishable materials such as wood, reed, horn or antler, or which leave no record at all, such as the voice (Morley 2002). We used a range of sound making devices, including reconstructions of Palaeolithic bone flutes and bullroarers, as well as drums (reconstructions of historic ethnographic examples from museums), bark rattles, cow horn trumpets, bones, wooden sticks and even simple river pebbles. The use of the latter is partly inspired in part by the research of Blake and Cross (2008), but relates to the discussion of Dams (1984: 1985) who explored the existence of damaged and decorated stalactites within Palaeolithic caves and interpreted them as possible lithophones. Additionally several examples were recorded of voices.
Small, simple percussion instruments such as river stones and bones hit together were found to be particularly effective. It may have been that rather than what we think of as “music”, the ritual sounds heard in these spaces were more abstract, or related to more functional sounds created by what we might regard as mundane activities, such as grinding or carving. Drums had particularly powerful effects in all situations, as they are able to produce lower frequencies, and thus produce a loud enough sound to stimulate sonic effects not otherwise heard. Voices were sensitively flattered by the acoustics of the spaces, and bone flutes also were enhanced by the reverberation present. The long reverberation of the main open central space made speech difficult to understand, but it was particularly supportive to a wide range of musical sounds. We also found that sounds associated with the imagery on display was particularly effective. Using a cow horn to play a single note in front of a bovine image, was effective, but perhaps more striking was using it to simulate the bellow of a bull by vocalizing as well as using the pitched note of the horn. Playing two bone flutes together using portamento seemed to create a sound that reflected an engraving of an image of a whale. A bullroarer left a powerful sonic and visual impression. While it is possible to produce numerical data to describe the acoustics of a space, acoustics cannot be heard without a stimulus, and the recordings of these sound examples provide valuable illustrations of the acoustics of the cave that are readily understood without a technical knowledge of acoustics.

When heard from a distance these sounds all took on an otherworldly effect that illustrates their potential for ritual use. Filtering, resonance and reverberation made the sounds seem ghostly and distant. The diffusion effect of reverberation also made it difficult to locate the source of the sound, sometimes seeming to come from all around simultaneously. The sounds could be heard from as far as 50m away, and they illustrated a range of sonic textures. The level of background noise in the cave was as low as our sound level meter was capable of measuring at 17db, close to the inherent self-noise of the equipment. This was far lower than the 30db we might expect in a quiet environment outside, and the real level could have been far lower. This makes any acoustical effects in the cave particularly noticeable and striking.

We brought with us marimba sticks, the heads of which are made of wound cotton. Marimbas will be detuned by any kind of mark, and these sticks are designed to leave no kind of impact or residue on wood. We used them to test the lithophone in Tito Bustillo, which we hit very gently to stimulate any sounds present. The lithophone produced a range of notes, and was able to act as a somewhat beautiful and gentle musical instrument. We tested some stalagmites near the lithophone by very gently tapping them. We discovered over 50 that produced clear ringing notes in an area between the lithophone and the main central open space nearby. Some of these were over a meter tall and produced a powerful low note. It would be difficult to establish whether these were ever struck by humans as if they were musical instruments, but we know that as drops of water fall on them, the notes ring out from time to time by themselves, and would have surely done so in the past. These sound experiments established that this is a sonic environment of great interest, and supported our suggestion of a sound based study. It has provided a number of illustrative audio recordings that demonstrate the kind of acoustic effects that the structure of the cave generates.

**Initial Acoustics Results**

There were a number of tasks related to the acoustic study of this cave. The first task was to record the acoustic character of the various spaces within the cave. A number of acoustical parameters, or metrics, were calculated from the impulse responses recorded at various positions. These
parameters included metrics for reverberation (T20, T30, EDT), speech intelligibility (STI) as well as those often used in the context of concert halls, such as definition or deutlichkeit (D50), Clarity (C80), lateral energy (LEF) and envelopment (LG80). Knowledge of these metrics allows a characterization of the spaces in terms of their acoustic response.

Another task was to investigate whether there were statistical correlations between acoustical and archaeological characteristics. The variance of these acoustic metrics was analyzed in relation to five contextual archaeological characteristics that related to paintings and motifs within the cave, for each position where an acoustic measurement was taken. These five criteria were type of decoration, colour, number of images present, chronology, and depth within the cave.

Image type indicated a description of animal species (such as horse, goat, bear etc.), or of the form of motif, such as dot, line, hand or abstract form, and presence/absence. Where possible the team tried also to find positions at which to take measurements where there were no images, but where imagery would have been possible, for example on flat, blank wall panels. Colour of motifs was usually red or black, but with some examples of purple, brown or ochre, as well as many engravings with no colour. Chronology of these motifs is a somewhat contentious issue, and was thus simplified to either likely pre-Magdalenan or Magdalenan dates. Depth within the cave was estimated as the distance from the original (rather than modern) entrance. Statistical analysis software would then be able to examine relationships between these acoustical and archaeological parameters.

The project aimed to analyze the acoustic response in a number of side chambers in the cave, categorized into those that were decorated and those that were not. These side chambers were relatively smaller spaces in terms of volume, compared to the main central part of the cave. The proposed hypothesis was that metrics of acoustic response might have a particular value depending on whether the chamber was decorated or not. Figures 1, 2, 3, 4 and 5 show the results obtained for every measurement taken within this cave. Cave sections are indicated along the x-axis. Metrics reporting decay time (T30 and EDT) are plotted for the low frequency 125Hz octave band, for checking low frequency response, and the average of 500 and 1000Hz octave bands, complying with ISO 3382 standard for reporting reverberation times in enclosed spaces. Measurements were also taken outside each side chamber to provide further comparison.

Figure 1 above contains T30 results, which provide information about reverberation. These are conservative estimates, as the low noise floor in the cave means that reverberation will be more prominent and easier to detect than it would be in most spaces. However they are the standard measures. One can see that results for mid-frequencies (in red) are varied, with a range in seconds
from about 0.25s (no detectable reverberation, often described as “dry”), to almost 2s (long obvious reverberation, often described as “wet”). One can also see a number of groupings, with a number of low readings clustered around or below 0.5s and others somewhat higher. Lower frequency reverberation was higher than at mid-frequencies and, at times, as high as around 3s.

Figure 2 shows early decay time (EDT), an acoustic parameter that has a closer relationship to perception of reverberation. Here the clustering of results appears somewhat more defined. Figures 3 to 5, reporting metrics of definition (D50), clarity (C80) and speech intelligibility (STI), show that the data also somewhat clusters in two groups. For D50 there are a number of cases within the top of the range (0.8-1); for C80 there seems to be a cluster between 10 and 15dB and another of values below 10dB; STI results follow a similar pattern. That these results are similar to those for EDT reflects that all these metrics stem from the same raw data, the impulse response, and that they are all related to measures of energy within that response (apart from STI). Clustered results suggest that groups of positions have shared acoustic behaviour.
In an attempt to correlate the acoustic response to the existence or otherwise of decorations, a statistical analysis of variance (One-way ANOVA) was performed between the decorated and non-decorated sections in Tito Bustillo. Figures 7, 8, 9, 10 and 11 show mean and 95 percent confidence interval (C.I.) for comparisons of acoustic features between decorated and non-decorated chambers. Effect size for each acoustic metric is indicated in each figure.

With the exception of T30, all comparisons of acoustical parameters between decorated and non-decorated caves show a statistically significant difference at the p<0.05 level. This result suggests that, according to the measurements, there is indeed a different acoustic response at the sections where decorations are found. As a consequence, we can say that EDT is higher at decorated chambers and D50, C80 and STI are lower. An analysis of the effect size shows that EDT varies by 0.24s, increasing from about 0.25s, very low reverberation, to about 0.5s, which is a region where reverberation starts to become noticeable (Kuttruff 2000). For D50 and C80, the effect size is 0.13 and 8dB respectively, which are considerable differences for these metrics, although the range within which they are varying is well outside the recommended values for architectural acoustic design and it is thus difficult to infer what these differences mean in perceptual terms. It may well suggest that these are unusual spaces acoustically. STI decreases from about 0.85 in non-decorated chambers to about 0.75, which once again is a considerable step size, but the range of values stays well within the good intelligibility category. Thus the intelligibility of speech would not have been a very noticeable factor between the two categories of chambers.

Figure 6: Statistical Comparison at Tito Bustillo Cave Sections

Further analysis will investigate the acoustics outside each side chamber to see how acoustics
inside and outside the chambers are related. In addition three separate measurements were taken inside each side chamber, one next to an acoustic feature, one next to the entrance, and one away from any decoration, and these results also need to be compared and analyzed.

In general, the acoustic results show that Tito Bustillo has short reverberation in the smaller side chambers and much longer reverberation in the larger central avenue spaces, as one might expect since reverberation is directly proportional to the volume of the enclosed area. More interestingly, these results suggest that one could (and can) detect the chambers where decorations are present from their acoustical characteristics, in particular from their reverberation (in terms of EDT). This interpretation needs to be taken with some caution since the levels observed are quite low in perceptual terms, and the variance of the data is somewhat large, meaning that there are examples of decorated chambers with quite low EDT values, while some at non-decorated ones have large values. As is often the case, this is not an absolute rule.

![Figure 7: Statistical Comparison at Tito Bustillo Cave Sections](image)

Conclusions

Tito Bustillo does indeed have sonic features that are as of significant interest. Nearer the entrance
sounds made in front of the large panel of painted horses produce a distinct and delayed reverberation, sounding like an echo. In addition this space features the sound of running water rising from deep below. Side chambers known for their images of vulvas, horses, anthropomorphs and a whale have more reverberation than those that are largely undecorated. One has to consider these initial results in their Palaeolithic context in order to appreciate their significance. Tito Bustillo has reverberation (EDT 1000) in a main central space of up to 2.5 seconds. This, as can be seen in Table 1 below, is considered today a typical, almost ideal value (Akutek 2008).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Term</th>
<th>Range</th>
<th>Music</th>
<th>Central Space</th>
<th>Anthropomorphs Gallery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>D50</td>
<td>0.3 to 0.7</td>
<td>0.2 to 0.7</td>
<td>0.6 to 0.7</td>
<td></td>
</tr>
<tr>
<td>Clarity</td>
<td>C80</td>
<td>-5 to +5dB</td>
<td>-3.2 to 8.8</td>
<td>-1 to 3dB</td>
<td>5.7 to 5.8</td>
</tr>
<tr>
<td>Reverberance</td>
<td>EDT</td>
<td>1 to 3s</td>
<td>0.5 to 2.5</td>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Typical general ranges of acoustic parameters for concert halls, and recommended values for musical material, and values at Tito Bustillo.

Our ears may consider this a fairly normal amount of reverberation, quite high for a concert hall, low for a church and certainly lower than many cathedrals. However we must remember that such acoustics were otherwise unknown to Palaeolithic ears: there were no large stone buildings, and open air spaces do not have this kind of sound. This would have been a truly unique acoustical environment. The less obvious acoustic effects of Tito Bustillo’s side chambers, such as the Anthropomorphs Gallery with EDT of 0.7s, is nothing unusual to modern ears used to brick built or plastered rooms, or tiled rooms such as bathrooms. However in Palaeolithic Spain, the acoustics of these spaces would have also seemed unusual, especially since other similarly sized chambers had no noticeable reverberation.

The term “live” is used for spaces with reverberation, and “dead” for those without, and these are useful ways of thinking about how these spaces would have been seen. The spaces with no reverberation may have seemed dead to prehistoric visitors. Those with reverberation would have seemed live indeed, either living spaces, or spaces that were alive with ancestor or animistic spirits, they would have had a sense of place, rather than just being a space. Thus it is understandable that it is these live spaces that contain images, whether these are forms of communication or representation. We have gathered evidence that one can detect from the amount of reverberation present, whether or not there is decoration in these side chambers. This provides support for the idea that those making these decorations would have been aware of whether the space was acoustically “live” or “dead”, and that the acoustics of a place could well have influenced whether it was selected as the position of a painting or engraving. In addition, although speech would have remained intelligible (good STI), voices, or other sounds, would be less defined (D50) and clear (C80) in these side chambers, adding to their mystique.

Caves such as these were the only places where Palaeolithic people would have encountered such acoustic effects, and grandeur. This project has provided evidence of how sounds within them would have contributed to a sense that these were places of importance. Although there is more work to be done, it is clear from this study that sound and image were both significant in the ritual culture of Tito Bustillo in prehistoric times.
References


Acknowledgements

AHRC/EPSRC Science and Heritage Programme UK

with additional funding from AHRC
This project would not have been possible without the support of Goberno Del Principado De Asturias