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REPLY to Comments on: 'SOUND REFLECTION AS AN EXPLANATION FOR THE CONTENT AND CONTEXT OF ROCK ART'

I thank Drs. Paul Bahn, Jean Clottes and Jack Steinbring for their thoughtful and encouraging comments. I begin my reply by agreeing wholeheartedly that there is much more study needed in the field of rock art acoustics.

Paul Bahn's assertion that all rock art cannot possibly be explained by a single motive is an opinion I do not contest, since we have not even defined exactly what the term 'rock art' includes (Odak 1991). However, it seems to me that the European cave art tradition, the canyon art of the Americas, the Australian aboriginal rock shelter art (as well as African and Asian), are all similar enough that it is unlikely that they would each have a different motivation. A general feature that they have in common is the rock surfaces, which have the potential to reflect sound. Since multiple cultures from different regions of the world are known to have considered echoing a supernatural phenomenon, it is not unreasonable to suggest that a number of cultures worldwide could have gone through a period of decorating echoing locations with the images that the echoes evoked. This still leaves room for rock art performed for other reasons, and acoustical studies should help to distinguish between these classes of art. Even if a certain category of art can be definitely associated with acoustics, secondary factors would have undoubtedly been influential also, such as the suitability of the surface for art or the ability to reach certain areas, and these factors do need to be considered.

While there is no a priori need that the content and context of rock art must be related, there is a need for the perplexing features of each to be explained. I find it exciting that sound has the potential for correlating with both the context and content of a large amount of rock art; this is simpler than having two separate, unrelated theories (or no satisfactory theory for either). The acoustic theory predicts that rock art motivated by sound correlates with acoustics, and that the subject matter relates in some way to sound. It does not necessarily mean that every echoing spot should be expected to be decorated, because of the impossibility of the task and due to the unfortunate losses of some art over time

from weathering, etc. Jack Steinbring raises an interesting and fundamental issue when mentioning definitions of 'context'. If we can't explain why rock art was positioned where it is, how can we be certain any modern definition of 'location' or 'placement' (such as 'lighted occupation zones' vs 'deep cave') agrees with the artists' concepts? A major weakness of Leroi-Gourhan's plan of Palaeolithic cave decoration is his lack of a clear definition of the topographical zones he proposed. While I am not yet ready to offer an exact definition of context, these studies imply the need to include acoustical components, e.g., points in space possess definite acoustic characteristics, and may be related in ways that have not previously been considered.

Inclusion of Proboscidea as ungulates is not my own classification. Although Ungulata as a proper taxonomic category was discontinued quite recently, the term ungulates continues to be used for practical, descriptive purposes, and does include the family Elephantidae (Grzimek 1990, p 440). Biologists refer to the thick, keratinous structures on elephants' feet as hooves (Parker 1982, p1055). Aside from this, elephants do make loud pounding sounds as they run. Kangaroos are colloquially known as 'thumpers' in Australia because of the percussive noises they make while bounding, and images of kangaroos could have occurred to Australian aboriginal artists upon hearing percussive echoes, while their European and North American counterparts were familiar with the hoofbeats of ungulates. I am not suggesting that peoples everywhere perceived percussive echoes as hoofbeats, but that they drew images of what they perceived to be causing the echoes, based on their experience.

Paul Bahn asks about the Chapelle de la Lionne in Les Trois Frères as a test case for my hypothesis that carnivores correlate with decreased sound reflection, and it is helpful that Jean Clottes provides a confirmation that the Chapelle de la Lionne is not very good for sound reflection, as predicted. The point regarding mixtures of carnivores and ungulates at a given location is raised by both commentators. This is a reasonable concern, but not an insurmountable objection. As the data indicate, carnivores are not necessarily associated with a complete lack of sound reflection, but rather with a decreased sound level relative to the rest of the cave. Although the sound may be 'impressive' at the big lion in Les Trois Frères, what remains to be measured is the sound level at that lion relative to the other portions of the cave.

I have not myself tested Réseau Clastres. The diagrams of Dauvois and Boutillon (1990) demonstrate that sound reflection does occur at the locations of the paintings, and also at non-decorated locations nearby. Their conclusion that the location of the paintings corresponds to the presence of lithophones rather than the acoustics of the cave is based on quite small differences in reverberation time (approximately 0.14 vs 0.19 sec), and because of only gradual changes in sound reflection from decorated to non-decorated locations. There is much room for improvement in methodology in the analysis of acoustics, such as determining the direction from which the sound reflections appear to emanate. The lithophone connection may be real where these occur and might further underscore the importance of acoustics in general; however that connection cannot be very widely applicable since many decorated caves do not even have stalactites, much less lithophones.

Regarding Jean Clottes three main points:

1. I used stone tool-making as one example of percussion because we have concrete evidence in the excavated tools themselves that humans of the Upper Palaeolithic were indeed making percussion sounds by striking rocks together. The echoes of stone tool-making can sound like the clacking or clip-clopping of hooves (even unshod) on a hard, rocky surface. Percussion sounds can also be made by clapping or drumming, a behavior that has not been conclusively demonstrated to have been exhibited by humans of that period, but which is reasonable to expect given it is ubiquitous in so many cultures. The tone of clapping can vary from a high-pitched 'slap', to a deep 'thud' from using cupped hands. Likewise, the tone of drumming can vary from clicks to thuds depending upon the type of instrument used, e.g., sticks vs leather. The interpretation of echoes of these various percussion noises could have easily ranged from bulls or goats on hard rock, to unshod horses on sand, to bison or deer on grass, to elephants or kangaroos on packed earth (all of which I have heard personally).

2. Although intelligence is not necessarily directly related to brain size, physical anthropological studies show that homo sapiens sapiens, which includes both present-day humans and Cro-Magnon, have a cranium capacity averaging 1360 cubic centimeters. Since the artists of 'the Upper Palaeolithic (period of Cro-Magnon)' (in the words of Bahn and Vertut 1988, p 16) left a legacy of magnificent and sophisticated rock art, this is another support of their high degree of intelligence. I am not suggesting, nor do I agree, that having a spiritual or mythical explanation of echoes would justify labelling a culture as 'dense' or stupid. Many present-day cultures have beliefs some members of other cultures might consider unfounded or even ludicrous; Westerners are not more intelligent than others today, except perhaps by their own arbitrary standards. I don't think that anyone would label pre-agricultural societies 'dense' on the basis of them not having the brains to plant seeds. The persistence of a set of behaviours is the result of not only intelligence capacity, but also of learned cultural habits and traditions passed down through generations. The archaeological tool record demonstrates an extent of conservatism unfamiliar and perhaps even repulsive to most twentieth century Westerners, but this does not per se dictate lack of intelligence. There are many cultures today that highly prize ancestral beliefs, traditions and stability; is Western 'progress' that has resulted in fusion bombs and global pollution any wiser? To propose that echoes were misperceived for 20 000 years is not inconsistent with the extreme conservatism demonstrated by the archaeological stone tool record.

3. Far from omitting signs, my article does discuss abstract symbols in relation to acoustics several times. By definition, symbols are called abstract because what they represent is not readily apparent, so it is difficult to determine what the content signifies. For the analysis of content, my article does therefore, out of necessity, emphasize the figures or representations of recognisable individuals. To clarify, tabulations show the recognisible individuals to be 91.1% ungulates (see Table 1).

Although a rare theme, fish were an element of both mobile and parietal Palaeolithic art, e.g., in Pech Merle, so this subject should not be ignored. The notable observation that most of the fish depicted are of the salmon family, and in some cases the artists took care to show the kipe that appears on the jaw of the male during spawning (Bahn and Vertut 1988, p 132), raises the possibility that some unique characteristic of this type of fish differentiated it from other fish, and salmon are known for jumping noisily upstream during spawning. [Evidently, though, the fish was less palatable than the beef for all three reviewers!]

It is difficult to compare the number of recognisable individuals with the number of abstract signs. For example, does a row of about 40 dots in Lascaux count as 40 different works of art, a single symbol, or is it a mere fraction of a larger work of art together with the

other symbols nearby? If we didn't recognise a figure at Covalanas to be a hind drawn with dots (Bahn and Vertut, p 102), it would be counted as hundreds of symbols instead of a single animal. Using the concept of 'themes' animal representations were found to outnumber signs including hands, 719 to 412 (Leroi-Gourhan, 1967, p 506). This is not to say that one is more or less important than the other; both types are prevalent enough that they should both be considered important.

My article draws attention to signs several times. Consistent with hoof beat-like acoustics, the 'vulva' signs might be hooves or hoof-prints. Even if these did only appear early in the course of rock art, in my opinion that makes them all the more significant. I also describe instances of symbols drawn at positions where acoustics can be heard particularly well, such as in Bernifal and Cougnac. Although insufficient data has been collected to defend any exact interpretations of symbols, it is conceivable that the abstract signs are attempts to accomplish the difficult task of visually representing sounds. Modern techniques used to depict sound range from showing representations of the source of the sound as a way of implying sound, to the abstract symbols of cartoonists, to the dots and strokes of musical scores. Written language itself represents spoken sounds and onomatopoeia via abstract letter symbols originally derived from representations. If acoustics were indeed the motivation for certain symbols, then acoustical studies might be the only hope for interpretation. This does not need to conflict with the attractive theory of phosphenes or entopic images (Lewis-Williams and Dowson 1988), since it could very well be that sound evoked these images, especially since rhythmic percussion is known to help induce trance.

I was glad to read about the Saskatchewan rock art sites that Jack Steinbring describes as supporting my acoustical theory. It is anticipated that many more such examples can be found to support a relationship between acoustics and the content and context of rock art. I agree that it is important to distinguish between hard facts and impressions. In my article, I first present the quantitative sound level measurement data. This is followed in separate sections by my subjective aural observations, tentative interpretations, and speculations on motivation, which are arguable. Others may form their own opinions based on the actual data. The ear is more sensitive to subtle nuances and qualities of sounds that are not analysed by simple sound level measurements. A worthwhile goal would be to measure and characterise some of these other sound qualities to attempt to determine if these might also have been important to the artists. Sound level measurements serve to objectively document the mere existence of significant sound reflection, and are only the beginning.

The expertise of acoustics experts is very much needed for further research, and it is hoped that these preliminary results will encourage their interest in rock art, as well as stimulating the interest of current rock art researchers to become more familiar with acoustics. I hope that attenders of the 1994 International Rock Art Congress in Arizona will use the field trip opportunities to test sound reflection for themselves. It would be useful if descriptions of the results of any future acoustical tests, whether positive or negative, formal or informal, could please be sent to me for compilation.

ADDITIONAL REFERENCES:

GRZIMEK. Encyclopedia of Mammals. 1990. Vol 4, pp 440-448. McGraw-Hill. New York.

LEAKEY, R. E. 1981. The Making of Mankind. Dutton. New York.

LEWIS-WILLIAMS, J. D., and T. A. DOWSON. 1988. The signs of all times: entopic phenomenon in Upper Palaeolithic art. Current Anthropology 29:201-245.

ODAK, O. 1991. A new name for a new discipline. Rock Art Research 8:3-12.

PARKER, S.P. (Ed.) 1982. Synopsis and Classification of Living Organisms, Vol 2. McGraw-Hill. New York.

Table 1. Recognisible individuals in Upper Palaeolithic parietal art*.

Number	Common name of species	Order**
610	horses	Perissodactyla
510	bison	Artiodactyla
205	mammoths	Proboscidea
176	ibex	Artiodactyla
137	ox	Artiodactyla
135	hind	Artiodactyla
112	stag	Artiodactyla
84	reindeer	Artiodactyla
16	rhinoceros	Perissodactyla
+ 8	large-horned deer (megaceros)	Artiodactyla

1993 total ungulates, out of 2188 total representations (91.1%)

* Data from Leroi-Gourhan, (1967, pp 111, 503.), and do

not include: '2 boars, 2 probable chamois, and 1 probable antelope', nor 'the composite animal at Lascaux (the so-called unicorn), the "antelopes" at Pech Merle, the "giraffes" at Lascaux and Le Gabillou, and the reindeer with palmate hoofs at Les Trois Frères' -- all of which could be considered ungulates also.

**Could it be possible that prehistoric artists noticed the resemblance between Artiodactyla's cloven hoof vs the vulva, and the Perrisodactyla's horse hoof vs the penis, leading to Leroi-Gourhan's proposal that Upper Palaeolithic art represents male/female??