Archaeoacoustic Investigation of a Prehistoric Cave Site: Frequency-Dependent Sound Amplification and Potential Relevance for Neurotheology

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Abstract

Evidence of hominid use of the prehistoric *El Castillo* cave site in Puente Viesgo, Spain site date back at least 40,800 years. Simulated audio tones were emitted at a location which is thought to be have been used by shamans in ritualistic ceremonies. The sound was simultaneously recorded within the same cave at a position where laymen would observe the ritual.

Subsequent analyses identified a frequency-dependent amplification of recorded sound intensity for frequencies approaching 100 Hz, with the greatest effect observed at 108 and 110 Hz.

Methods

A total of 31 audio tones ranging from 80 Hz to 1 kHz were created with the addition of pink noise and a 16 Hz to 20 kHz increasing amplitude sound. Audio was recorded and generated at -3 dB using Pro Tools software. Each frequency was presented for one minute. Audio at the cave site was played using a 15 W amplifier and a single omnidirectional speaker.

The sound files were then played and the response from the chamber recorded in stereo WAV format (32-bit, 44.1 kHz sample rate). The recorded sound files were then analyzed using Pro Tools software.

Results & Discussion

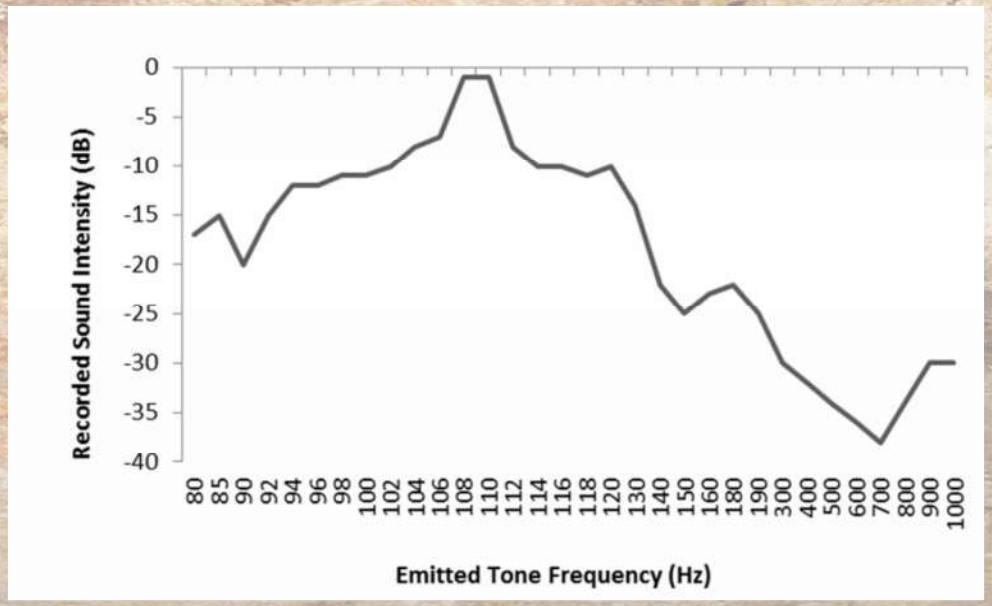
A110 Hz resonance within prehistoric sites has been identified in previous research, congruent with our findings, as well as specific sonic stimuli evoking neuroelectrical responses. Quantitative support of 110 Hz is found in the convergence of biophysical values: a 110 Hz standing wave has a wave length equivalent to the average human skull (49.63 cm); the energy of this wave is within range of infrasonics capable of altering brain function (3.5×10^{-18} J); the sound pressure energy is sufficient to stimulate the entire cerebral cortex with a unit energy converging on the fundamental unit of energy, 10^{-20} J.

110 Hz can induce resonance in human vocal cords, and lowers left frontal activity while simultaneously increasing right temporal activity. 110 Hz is sufficient to stimulate Pacinian corpuscles, can induce calcium efflux, and is a fundamental frequency of the hippocampus CA3.

These results and quantitative support suggests that the rituals of prehistoric *El Castillo* utilized the natural resonance of the cave which enhanced a frequency with known neurological effects. These neurological effects are particularly salient with respect to sacred or neurotheological phenomena.

The mountain *Monte Castillo* near Puente Viesgo, Spain where the prehistoric *El Castillo* cave system is located

Central carved stalagmite located within the ritual chamber and the focus of shamanic practices



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