and cotton there, they would have needed to irrigate their lands—the first people to do so in the Americas. In all likelihood, observes Haas, the geography of the Supe Valley helped greatly in this development. Today, farmers irrigate the area by cutting a shallow channel 2 kilometers upstream to a simple headgate that controls the flow; in most other Peruvian valleys, they must build far longer and deeper channels and construct a series of sophisticated gates.

As the earliest urban center in the Americas, Caral now casts doubt on a favorite idea of many Andeanists: the maritime hypothesis of the origins of Peru's civilizations. First proposed by archaeologist Michael Moseley of the University of Florida, Gainesville, in 1975, the hypothesis suggests that Peru's rich marine resources—huge schools of fish and shellfish beds—permitted early fishers and foragers to settle along the coast, build elaborate architecture, and develop complex societies, moving inland only later. But Caral is centuries older than any of the early large urban centers outside the Supe Valley. "Rather than coastal antecedents to monumental inland sites," says archaeologist Shelia Pozorski of the University of Texas–Pan American in Edinburg, "what we have now are coastal satellite villages to monumental inland sites."

One of the great challenges now is to explain how this satellite system worked. In all likelihood, the ancient Peruvians moved inland to Caral to expand their diets, adding plant carbohydrates to seafood proteins, and created their elaborate civilization in their new home. Excavations at Caral have turned up abundant fish bones and mollusk shells, and the inhabitants' ancient desiccated feces, notes Haas, "all have anchovy bones in them." But it is uncertain exactly how Caral's people, living so far from the ocean, acquired all this seafood. One possibility is that they walked half the distance, trading a commodity such as cotton for coastal fishers' surplus. "Cotton was critical for the marine exploitation," says Haas. "That's what people used to make the nets with."

Haas and Winifred Creamer, an archaeologist at Northern Illinois University in DeKalb and co-author of the paper, who is married to Haas, now hope to begin piecing together Caral's economy, examining ancient cotton production along the Peruvian coast during this period and developing a trace-element analysis for cotton fiber grown in different regions. Whether Caral really was an early center of cotton agriculture remains to be seen, but the site's new dates will certainly provoke much debate about the origins of Peru's ancient civilizations.

–HEATHER PRINGLE

Heather Pringle is the author of *In Search of Ancient North America.*

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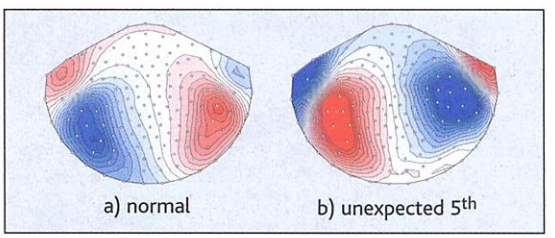
NEUROSCIENCE

How the Brain Understands Music

The essayist Thomas Carlyle called music "the speech of angels." And indeed, music and language are being found to have quite a lot in common. A brain imaging study in the May issue of *Nature Neuroscience* confirms that people's brains are finely tuned to recognizing "musical syntax," just as they are for verbal grammar. What's more, they have found that some of this musical processing goes on in Broca's area, which is chiefly associated with language.

Physicist Burkhard Maess and colleagues at the Max Planck Institute of Cognitive Neuroscience in Leipzig, Germany, tested responses of six right-handed people with no musical training. Using magnetoencephalography (MEG), an imaging technique that uses supersensitive magnetic field detectors to register electrical activity in the brain, they measured responses to three sets of five musical chords concocted by team member Stefan Koelsch, who is also a musician. The first set were five chords in the key of C major that ended, following convention, on the tonic (C major) chord. The second and third chord sequences threw in a wild card: a "Neapolitan" chord that contains two notes that are not found in the key of C major. When inserted as the third in the five-chord sequence, this chord is a bit incongruous. When put in the fifth position it definitely sounds inappropriate, as the first four chords create the expectation of a resolution on the home (tonic) chord.



Syntax of sound. Brain activity in Broca's area increases in response to an unexpected chord (b) compared with a normal one (a).

Each sequence produced a different MEG pattern, with the largest difference seen between the in-key sequence and the one ending with the Neapolitan chord. The in-key chords were mainly registered in the primary auditory cortex, located in the temporal lobes. But the incongruous set lit up areas above and in front of the temporal lobes, in the speech area known as Broca's on the left and its corresponding region on the right. The data suggest that while, just as with speech, the auditory cortex receives incoming sounds, it is Broca's area and its right-hemisphere mate that are in charge of the trickier job of making sense of them. Adds Koelsch, "We found that musical syntax is not only processed in the same area [as speech] but also with the same time-course of neural activity." (That is, brain responses to incongruities peaked at about 200 milliseconds after the stimulus, as they did in an earlier study using verbal incongruities.)

Because the effects occurred in subjects with no musical training, the study supports existing evidence that the brain has an "implicit" ability to apply harmonic principles to music, the authors write. Overall, the effects of the music were more pronounced in the right hemisphere than the left, where more speech functions are headquartered. "Currently, we cannot prove that the processes underlying language and music processing … are the same," says Maess. Nonetheless, there is "still more overlap than we thought."

"Studies such as this teach us to be cautious when talking about 'language areas' in the brain," says Aniruddh Patel of The Neurosciences Institute in San Diego. He says the work goes against "a prevailing view that language is 'modular' [and draws] on special mental operations and brain regions that are not used by any other domain." Because linguistic and musical syntax are different, he notes, a demonstration that brain regions known to be involved in one are also involved in the other "raises the question of what these brain areas are really doing."

Even more precise probes will be required to sort that out. Neuroscientist Robert Zatorre of McGill University in Montreal says the Maess team has successfully demonstrated the "physiological trace" of musical syntax processing and shown that it overlaps with language responses. But whether they are "part of the same [system] or independent is not yet certain."

–CONSTANCE HOLDEN