Speech Insights Sound Off in the Brain

Talk is cheap and, not surprisingly, plentiful. It gushes from our mouths like water from a burst dam. Yet we capture meaning from the conversations cascading around us with seemingly little effort. This impressive achievement depends as much on the ability to track the rhythm and intonations of spoken language as on the more obvious need to interpret word meanings and grammar, according to a new study.

Brain cells react in a unique pattern and with lightning speed to so-called prosodic features of speech, such as drawing out a word, pausing for emphasis, and raising the pitch of one's voice, reports a team of neuroscientists headed by Karsten Steinhauer of the Max Planck Institute of Cognitive Neuroscience in Leipzig, Germany. Immediate neural responses to these speech modulations allow listeners to get a head start in decoding the sometimes fuzzy meanings of sentences, Steinhauer and her colleagues contend.

Their findings dovetail with recent evidence, gathered by psychologists such as Peter W. Jusczyk of Johns Hopkins University in Baltimore, indicating that infants and young children closely track prosodic aspects of speech to gain a foothold on its grammatical structure.

"I'm not surprised that there are specific brain responses linked to prosodic features of language," Jusczyk comments. "We find that infants as young as 2 1/2 months begin to notice prosodic cues used by adult speakers and use them to mark phrases within sentences."

Traditional theories of language comprehension have held that adults employ prosodic cues only to flesh out a sentence's meaning after they have deciphered its grammatical structure. For instance, rising pitch toward the end of an utterance signals a question, whereas falling pitch indicates a statement.

The new study, published in the February NATURE NEUROSCIENCE, places prosodic cues at the core of understanding the grammatical structure of speech.

The researchers placed caps studded with electrodes on the scalps of 56 native German speakers. The setup allowed for recordings of electrical activity at the brain's surface as the volunteers heard a series of sentences.

Some sentences were grammatically straightforward, such as "Since Jay always jogs a mile and a half this seems like a short distance to him." Others were harder to understand, such as "Since Jay always jogs a mile and a half seems like a very short distance to him." Especially for readers, "a mile and a half" is first perceived as the object of "jogs" rather than the subject of the subsequent verb "seems," as required in the second sentence.

When sentences such as these are spoken, differences in the duration of words and pauses and variations in pitch and loudness serve to group words into distinct "intonational phrases," Steinhauer's group asserts.

While listening to both straightforward and ambiguous sentences, participants exhibited neither of two brain-wave responses known to indicate difficulty at understanding words, the scientists say. The researchers then spliced the recorded sentences so that prosodic cues did not match sentence structure. Upon hearing the first word in a sentence that signals its grammatical structure ("seems" in the second sentence above), volunteers displayed the neural signs of confusion about word meaning.

Moreover, a distinct type of brain-wave response occurs within a fraction of a second after the conclusion of each intonational phrase in a sentence, the investigators find.

The discovery of this new component of the brain's electrical activity suggests that the detection of intonational phrases is a crucial aspect of speech perception, note psychologists Cyma Van Petten and Paul Bloom of the University of Arizona in Tucson in a commentary on Steinhauer's article.

"Intonational cues may control initial decisions about sentence structure," Van Petten and Bloom remark. —*B. Bower*

Southern twisters: Don't blame La Niña

Storms in the southern United States turned vicious this month, spawning 150 tornadoes and killing 18 people during a time of year when funnel clouds normally are a rare sight. Meteorologists are still struggling to explain what caused the unprecedented number of January twisters, but they can rule out any direct link with the climatic hellcat known as La Niña, a cooling of Pacific waters.

Last year, press reports tied extreme weather—often erroneously—to El Niño, a warming of the equatorial Pacific that ended midway through 1998. With the Pacific now colder than normal, the question arises whether La Niña should shoulder any blame for the severe storms in January, such as the southern tornadoes and the 18.6-inch snowfall in Chicago. Last week, a press release issued by the National Oceanic and Atmospheric Administration (NOAA) trumpeted: "La Niña drives some U.S. winter weather extremes."

NOAA meteorologists, however, disavow any concrete connection between the Pacific conditions and the storms. Joseph T. Schaefer, director of the National Weather Service's Storm Prediction Center in Norman, Okla., examined U.S. tornado records going back a half century, looking for evidence that January tornadoes come more frequently during episodes of La Niña. "From my 49 years of data, I find nothing," he says.

Take Arkansas, for example. Dozens of tornadoes raked the state last week, killing seven people. To test for a connection with La Niña, Schaefer searched through the database for the months with the most Arkansas tornadoes. Nine of the top 11 occurred in normal years, when neither La Niña nor El Niño held sway in the Pacific. One of the remaining two months was in a La Niña year, the other in an El Niño year.

Tennessee, also hit by tornadoes this year, showed a similar pattern—indicating that the equatorial Pacific had no clear influence on tornado frequency.

Ed O'Lenic, who makes forecasts for NOAA's Climate Prediction Center in Camp Springs, Md., says that it is impossible to connect La Niña to any one storm, such as the Jan. 2 blizzard in Chicago. He notes, however, that NOAA's long-term forecasts were for a general increase in precipitation around the Great Lakes and in the Northwest in early winter.

Forecasters agree that La Niña makes U.S. weather much more variable. The colder-than-normal conditions in the equatorial Pacific weaken the jet stream that sometimes flows over the southern states and helps keep weather constant. Without the strong southern jet, the path of Pacific winds can jump erratically as they pass over North America. Researchers are trying to determine whether that increases the odds of blizzards.

Climate models suggest that La Niña will endure at least until June. While meteorologists can't say whether to expect more record tornado outbreaks or snowfalls, they foresee continuing changeable weather. "I think it's good for people to be aware there is a lot of variability and that the potential for severe weather still exists," says O'Lenic. —*R. Monastersky*