Speech and sun: New research on climate and how we speak

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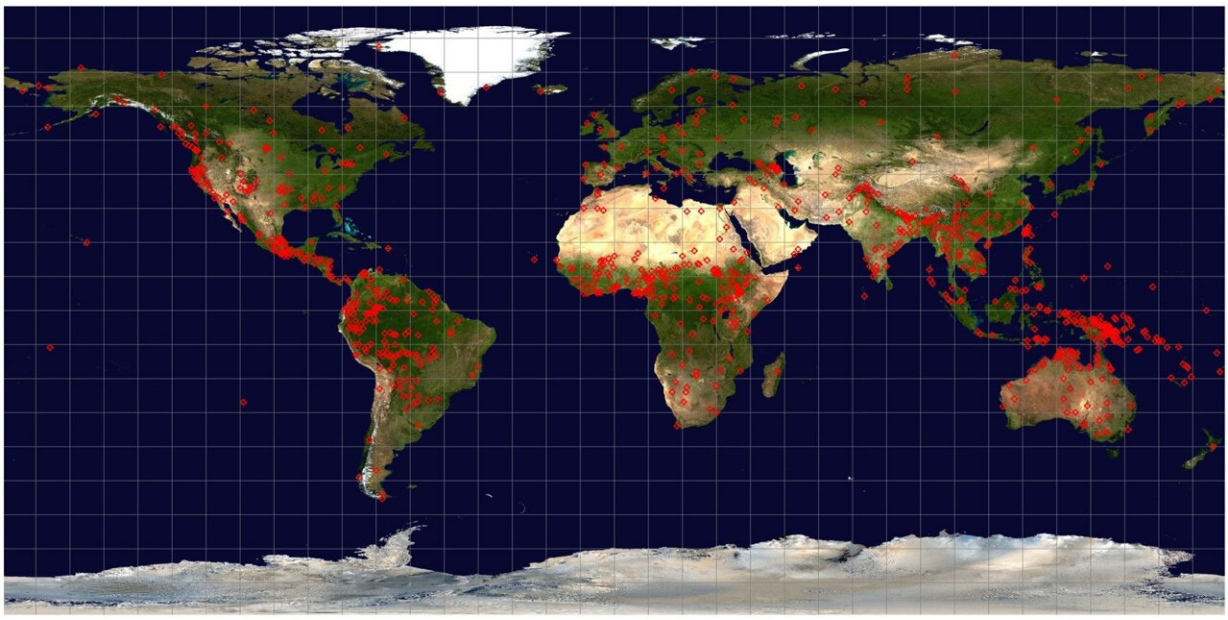

Global distribution of languages included in the dataset. Each language location is indicated by a red diamond superimposed on the Blue Marble Next Generation (NASA Earth Observatory, 2005) global satellite image. Credit: *Frontiers in Psychology* (2023). DOI: 10.3389/fpsyg.2023.1200463

Whether it's another language, how you pronounce "pecan," or using the word "y'all" instead of "you guys," where you live has an impact on how you speak.

That's a cause and effect of which we've only scratched the surface, according to new research from the University of New Mexico's Department of Linguistics Adjunct Research Professor Ian Maddieson and College of University Libraries and Learning Sciences (CULLS) Director of Research Data Services Karl Benedict.

"One of the major focuses so far has been in developing a framework. I almost think of it as building our laboratory where we've now stocked the shelves with the environmental and linguistic data to now start performing our experiments," Benedict said.

The pair of dedicated UNM researchers has just published "Demonstrating environmental impacts on the sound structure of languages: challenges and solutions" in *Frontiers in Psychology*.

While Maddieson had always been intrigued by sound systems and the environment, he was missing his other half in the data-gathering side of things.

"I needed a collaborator to work on finding out where to obtain the data on the climatic and ecological variables that I wanted to pair with the linguistic data," Maddieson said. "I thought I would go to the Centennial Library and I was directed to go and see Karl, who was extremely gracious and enthusiastic."

Given Benedict's long term, large-scale work with environmental data sets, and Maddieson's history as a linguist, their immense interest matched the immense size of the project they took on.

"This was very much in the wheelhouse that I'm very comfortable in. The magnitude of the sort of data management and analysis activity was pretty substantial and it was something that very much piqued my interest. It very quickly turned into a research collaboration that has been

a lot of fun to work on," Benedict said.

Together, over the course of three years, Maddieson and Benedict cross-analyzed maps, facts and trends to piece together the grand puzzle they had begun.

"The representation of a diversity of languages were scattered geographically over the widest possible range of global environments," Benedict said. "Ian went to great lengths to specifically build the linguistic data set to provide that geographic diversity. We tried to be intentional about making sure that we had languages in all environmental areas that are implicated in the potential development of these linguistic features."

They evaluated environmental conditions like humidity, altitude, and temperature, precipitation and density of vegetation across language locations. How were these things affecting speech over time?

"That's what's at issue: Is it a combination of various features? We had a large data set, a large number of variables both on the linguistic side and on the environmental side," Maddieson said. "What we've tried to do is set up a more kind of global perspective on this, and look at how various environmental and linguistic variables are actually quite highly correlated with each other."

Over 1,000 globally distributed languages, documented over 300 years, were under the microscope, all being evaluated for phonological differences and the environmental factors behind them, following ideas that others have suggested and their own hypotheses.

"One suggestion is that at high altitude, you want to preserve the moisture in your vocal tract, so you use sounds that don't involve connecting to the outside air. This is the kind of sound where the vocal

folds are closed, so you're isolating the air that's in the mouth from the rest of the lungs or from connecting to the outside world," Maddieson said.

"Most of the properties of a language, as it's spoken today, are inherited from earlier stages of the same language," Maddieson said. "That's where the majority of whatever attributes the language has come from. They're inherited from an older generation of speakers of the same language, but over long periods of time, spoken languages do subtly change shape."

"What we're looking at are these subtle changes over a period of time. The idea was to basically look for what kinds of correlations there are between these design features of sound systems of languages and the properties of the environment in which they are spoken," Maddieson said.

Some of the key findings revealed in the process of testing the developed analytic framework included:

- greater reliance on vowels in areas with high temperature and humidity,
- more use of ejective consonants within higher altitude areas,
- more complex tone systems in humid areas,
- fewer complex consonants used in areas with more precipitation and a higher temperature.

This was the first step: establishing the variables and variability. Still, there is much more to understand, say, when evaluating how multiple factors that are correlated with each other might affect speech.

"In terms of digging more deeply into these relationships, this will involve asking if it's elevation or temperature or air density affecting

speech, that all are correlated with each other for high altitude regions," Benedict said.

Climate change was not an extenuating factor in the data Maddieson and Benedict laid out. However, as time goes on, that impact will not be unavoidable when it comes to sound systems.

"If we think about time scales of a century or more of habitual mask use in areas where diseases are common, or you know, air quality is such that it's a standard practice, I would expect to see changes in the way that we communicate with each other," Benedict said.

For now, Maddieson exemplifies that expectation with the mannerisms of birds.

"There's some research on bird song which shows that with birds that live in both urban and rural settings, the birds that live in urban areas tend to pitch their songs a little higher to get above the background noise of cars and things like that," Maddieson said. "We know that some species do adapt to these relatively recent changes because the lifespan of a bird is much less than human lifeform."

As for the biggest factor to take note of from this research, Maddieson and Benedict say it's that they're just getting started.

"We're developing access to data that is replicable and reusable for others. My selfish goal as a part of this has been to also have a demonstration that we can show other researchers that we work with, that there are returns on impact, on visibility of research by taking these more intentional approaches around how you organize, document, manage and ultimately how you share your data," Benedict says. "This could maximize the benefits to you as a researcher in addition to your professional colleagues, beyond your specific project."

With only so much time on their hands, it's been a pleasure for Maddieson and Benedict to see that people are downloading and reading their research. It's a positive sign for future interest beyond what they can do.

"One of the main points is simply that this is a serious research area and is worth pursuing. There are results out there that teach us something about how people adapt in a very broad way, how people adapt to where they're living. Where they are living forces them to come up with optimal optimizing strategies to ensure that they can be understood," Maddieson said.

"Five years from now, 50 years from now, 100 years from now, it would be interesting to see what grows from the sort of the seed that we've planted with this particular development," Benedict said.

More information: Ian Maddieson et al, Demonstrating environmental impacts on the sound structure of languages: challenges and solutions, *Frontiers in Psychology* (2023). DOI: 10.3389/fpsyg.2023.1200463

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