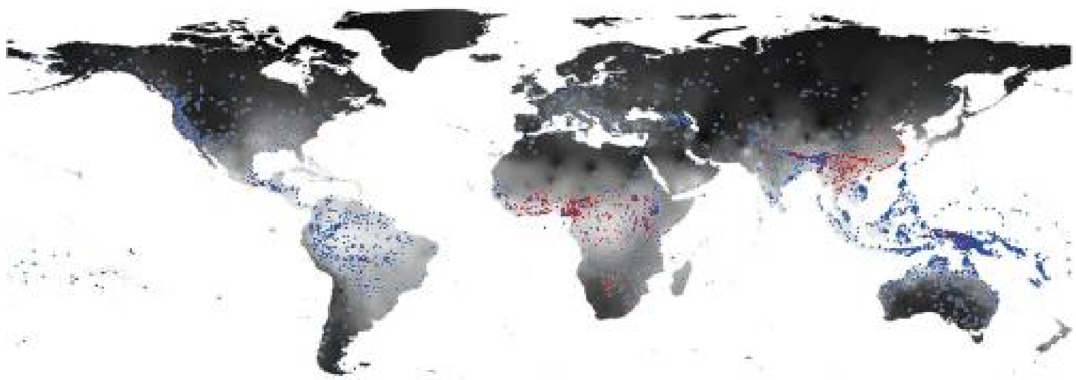
The clime's speech: Data analysis supports prediction that human language is influenced by environmental factors

January 30 2015, by Stuart Mason Dambrot



Distribution of languages with complex tone (red dots) and without complex tone (blue dots) in the Phonotactics Database of the Australian National University (ANU) database. Darker shading on map corresponds to lower mean specific humidity (MH). Credit: Everett C, Blasi DE, Roberts SG (2015) Climate, vocal folds, and tonal languages: Connecting the physiological and geographic dots. Credit: *Proc Natl Acad Sci* USA published online before print January 20, 2015.

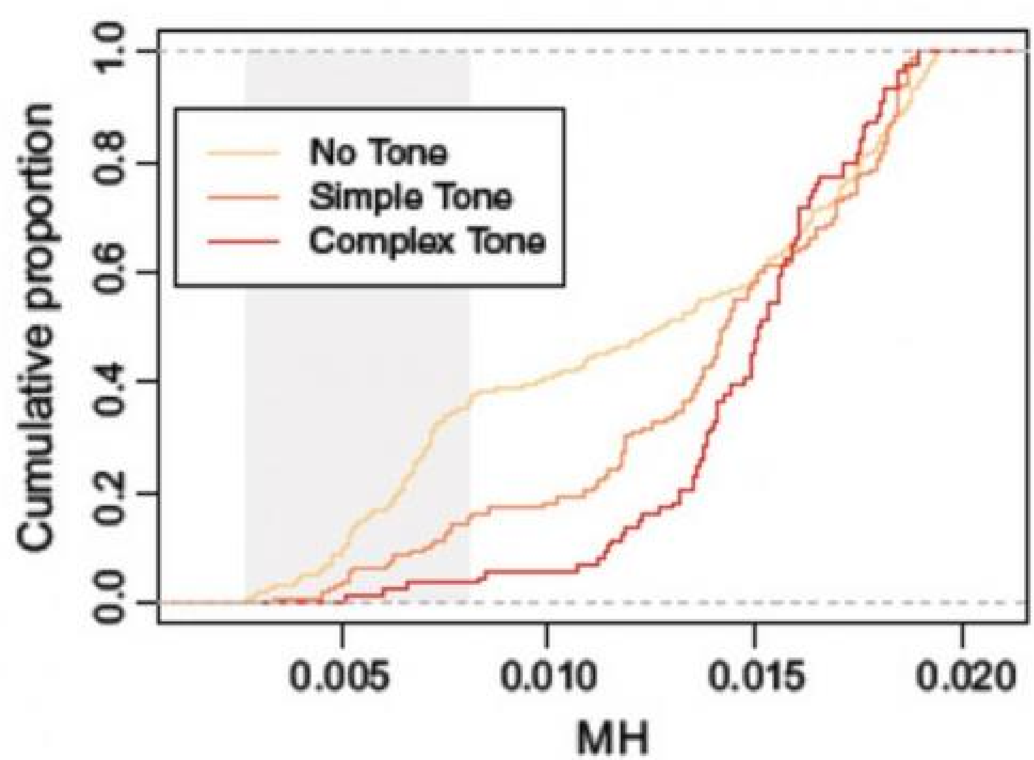
(Phys.org)—Human speech is not typically thought to adapt to the environment, and a standard assumption in linguistics is that sound systems are in fact immune to ecological effects. Recently, however, scientists at University of Miami and several Max Planck Institutes in Germany and The Netherlands have, in a single study, predicted that complex tone patterns should not evolve in arid climates by reviewing laryngology data on the negative effects of aridity on vocal cord movement, and – by analyzing climatic and phonological data on over 3,700 languages – found support for their prediction.

Specifically, the researchers identified a negative correlation between linguistic tone and characteristic rates of desiccation in ambient air. Furthermore, unlike previous studied correlating geography and phonemes, they relied on data from extensive experimental research on the human larynx – data that were until now not applied to the analysis of phonemic tonal languages. (A tonal language, such as Mandarin Chinese, uses pitch as a part of speech that can change a word's meaning.) In so doing, they were able to conclude that human language sound systems do indeed adapt to ecological factors.

Prof. Caleb Everett discussed the paper he, researcher Damián E. Blasi and Dr. Seán G. Roberts published in *Proceedings of the National Academy of Sciences*. "In using findings from vocal fold physiology to predict that climatic factors constrain the use of phonemic tone," Everett tells *Phys.org*, "the main challenge was simply familiarizing myself with the research on laryngology – which is not an area most linguists or anthropologists have investigated. However, once I began reading work related to vocal fold dehydration, the prediction made in our paper came about in a pretty straightforward way."

Everett points out that their hypothesis predicted that very dry environments should, over the long haul, block the development of complex tonality – but notes that they did *not* predict a simple association between tonality and humidity. For that reason, he adds, the initial regression-type analyses were limited, leading Blasi and Roberts to develop more nuanced ways to test the hypothesis while controlling for the relatedness of the languages in their databases. "The results clearly support our hypothesis, and suggest the distribution of languages vis-à-vis aridity was not due to, for instance, the presence of a few language families in very dry or humid regions."

Phys.org asked Everett if regarding the study's finding that perturbations of phonation, including increased jitter and shimmer, are associated with desiccated ambient air, if the causative factor might not be the lack of humidity itself, but perhaps a derivative effect such as higher concentrations of fine particulate matter (e.g., dust or sand) circulating in the ambient environment. "This is a great point," he replied, "and in fact particulate matter does associate with dehydration and a variety of laryngeal maladies. Nevertheless, in laboratory conditions without dust or sand simple dehydration results in vocal fold perturbation – meaning that while particulates in naturally dry air may be an additional factor, we need not appeal to them in our investigation."



Empirical cumulative distribution function for languages according to the MH of their locations, World Atlas of Linguistic Structures (WALS) sample. The bottom quartile of language locales (by MH) is shaded. Credit: Everett C, Blasi DE, Roberts SG (2015) Climate, vocal folds, and tonal languages: Connecting the physiological and geographic dots. Credit: *Proc Natl Acad Sci* USA published

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That said, Everett stresses that the paper is *not* suggesting that the evolution of sound patterns is motivated entirely or even primarily by ecological factors. "There are numerous cultural and language-internal factors that shape that evolution," he explains. "We're just suggesting – in contrast to what linguists generally assume – that ambient aridity is one of them. This latter assumption is, from my perspective, not really supported by much other than traditional dogma."

Moreover, Everett notes that despite projected climate change-induced increases in aridity (desertification), humidity (rain and flooding) and temperature (global warming), the scientists do not make claims regarding time scales at which these climate changes might impact human speech systems. "In addition, the patterns we've uncovered developed primarily before industrialization and associated changes to the environments people are in – so while global warming is leading to higher temperature, it is doing so in part because many people are often in air-conditioned environments, where humidity is relatively fixed."

Moving forward, Everett says that the scientists have discussed ways of investigating the effects of ambient air conditions on the production of tones and other sound patterns by attempting a study where the same speakers are tested in different contexts. "One option would be to contrast the abilities of a given population to produce or mimic certain linguistic tones, and then test that population under different natural conditions," he illustrates." Speakers would be given certain tone-producing tasks after they spend 24 hours in an extremely dry dessert, and conversely the same tasks after 24 hours in a humid locale. "We're still thinking this through, and hopefully experimental phoneticians will engage with the work and come up with other possibilities."

In addition, he continues, "there's a hypothesis several anthropologists have put forward that languages in warmer climates tend to have higher rates of mouth opening. Linguists are quite skeptical of this hypothesis, but I think it might be supported and have a similar physiological grounding. Basically, my hypothesis is that languages in very cold climates have higher rates of mouth closure because of the ill-effects of cold and dry air – and it seems there may be support for this hypothesis."

At the same time, he notes that in laboratory conditions, perturbation effects apply independently of temperature. "Low temperatures outside rarely change the temperature at the larynx, but they seem to be able to in the case of oral breathing."

Everett tells *Phys.org* that other areas of research might also benefit from their study. "I would assume that, beyond linguists, at least physical anthropologists and biologists would be interested in the results, since they're concerned by the ways in which we adapt non-consciously to environments. The communication of some birds is characterized by ecological adaptability," he concludes, "so this work might also interest avian specialists and others."

More information: Climate, vocal folds, and tonal languages: Connecting the physiological and geographic dots, *Proceedings of the National Academy of Sciences* published online before print January 20, 2015, doi:10.1073/pnas.1417413112