

# Commentary: Desiccation and tone within linguistic theory and language contact research

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## 1. The data gold rush allows us to revisit long-held linguistic traditions

The notion that there may be causal connections between the environment and language structure has long been in disrepute. In part, this is due to earlier connections to racist ideologies. And in part, this is due to the more recent Chomskyan tradition, which sees language as an autonomous and innate faculty. Within the domain of phonology, the general sentiment that there can be no causal relationship between the environment and language is nicely expressed by the following quote:

*There is no correlation whatever between [...] any aspect of linguistic structure and the environment. Studying the structure of a language reveals absolutely nothing about either the people who speak it or the physical environment in which they live. (Kaye 1989: 48)*

This claim bristles with confidence, using phrases such as ‘absolutely nothing’ and ‘no correlation whatever’, making it clear that the author—like many other linguists—is convinced that environmental influences on language are not worth studying. We note that this statement (and its context) do not reference positive evidence for this conclusion, but rather express the absence of correlations as an established scientific statement. Has Kaye sieved through quantitative data of hundreds of languages to show that there is *no* correlation between the environment and linguistic structure? No, he did not. The quote is an expression of tradition, not an expression of fact. Everett et al. (2015) rightly point out that unquestioned beliefs about the absence of environmental influences are just as speculative as the racist ideas that were circulating within linguistics of the 19th and 20th century.

Happily, tradition and force of rhetoric are becoming less constraining now. We are currently experiencing a ‘data gold rush’ within linguistics, what some have called ‘computational cognitive revolution’ in analogy to the ‘cognitive revolution’ ushered in by Noam Chomsky (Griffiths 2015). The increased availability of data is changing how people do linguistics and how people think about linguistics. This change gives us an opportunity to transform many past speculations into well-formulated scientifically addressable hypotheses, such as: Is there a significant correlation between lexical tone and humidity?

## 2. Theoretical frameworks that accommodate the tone/humidity correlation

First, we want to point out that contra to Everett et al., it is not the case that ‘language is presumed to be ecologically autonomous by most language researchers’. There are, in fact, varied linguistic approaches that are not principally opposed to the idea that environmental factors influence language structure. For example, the embodied cognition approach starts from the observation that language and the mind are *embodied* and *situated* (e.g. Lakoff and Johnson 1999; Gallese and Lakoff 2005; Gibbs 2005). This research tradition, in contrast to the Chomskyan tradition, assumes that language and the mind arise from interactions ‘with the world via our bodies and brains’ (Gallese and Lakoff 2005: 456). Although there are many different variants of the embodiment framework (Wilson 2002), they share an approach to studying language and the mind not as self-contained autonomous systems, but as systems that are multiply constrained by external influences—in fact, the

related *extended cognition* and *distributed cognition* frameworks even go as far to say that these external factors are logically part of ‘higher-level cognition’ and are not ontologically distinct (e.g. Hutchins 1995). An influence of the environment on language structure is expected within this set of theories.

Within the domain of phonology more specifically, opposition to the idea that the environment could influence language structure is stronger if one believes in phonology as distinct from phonetics, as well as distinct from considerations of language use. However, there is a very long tradition of looking beyond properties of a putative universal, language-specific cognitive module to account for properties of phonologies (reviewed in Blevins 2004). These approaches can be broadly framed as evolutionary, in that they focus on phonologies as changing entities. And they can be framed as usage-based and ‘functional’ in that they focus on how certain forms are more or less frequent and stable within a language as a function of how apt these forms are for communication. Within these approaches, subtle usage disadvantages (such as communicating tones less accurately with dry air) can compound over time and result in phonological change (see Blevins 2004; Wedel 2007; Winter and Wedel *in press*). This body of work has amassed a good share of evidence showing that phonological systems are influenced by such things as word frequency and social factors. Additional environmental biases could easily be accommodated in this framework. Given the wealth of evidence that long-term language change can be influenced by qualitatively very different factors from diverse sources, potential influences on language structure from the physical environment must now be assumed.

### 3. What about intonation?

When discussing the Everett et al. (2015) findings with colleagues, we often hear that ‘intonation’ (the use of pitch to signal pragmatic meanings) should be a counterexample to their findings. Why is intonation seemingly less affected by humidity, even though intonation is also pitch-based? First of all: this claim has not been tested so far, and it cannot be a true counterexample unless empirically investigated. Second, a critical difference between intonation and lexical tone lies in the rate of information transmission through the pitch channel. While lexical tones are properties of single syllables, intonational contours often stretch over multiple syllables, or even phrases, providing much greater redundancy in the signal. Following from intonation’s greater signal redundancy, we expect that the overall robustness of

information transmission by intonation should be greater than that for lexical tone. As a result, dry air should have a strong negative impact on lexical tone but not necessarily on intonation.

We note that the distribution of simple versus contour tones in tonal languages is consistent with the idea that the evolution of pitch cues in language are influenced by channel characteristics. In addition to simple tones, tone systems often include *contour* tones, such as rising or falling tones. Interestingly, many tone languages only allow contour tones on long vowels. The avoidance of contour tones on short vowels may arise through similar channel restrictions on information transmission: if the faster pitch transitions inherent in contour tones are harder for listeners to reliably detect, contour tones should be less likely to develop/persist in short vowels (Gordon 2001). This is conceptually parallel to the hypothesis that complex tone is less likely to develop/persist in the context of low ambient humidity.

### 4. Distinguishing between direct and indirect causation is difficult

As is clear, we support the general research agenda by Everett et al. However, we want to emphasize that finding a statistically supported correlation is just a first step in investigating potential causal relationships between environment and language. Given the previously established effects of desiccation on precision of pitch production (reviewed in Everett et al. 2015), the authors reasonably hypothesize that dry ambient air directly discourages the development or persistence of complex tone systems. As a counterpoint, we want to propose that precisely because there are many environmental effects (as Roberts et al. *nicely review*), it is quite plausible that some hidden factor, or some interaction of factors, might be causing the result. Crucially, this does *not* question (at all) the statistical data presented by Everett et al. (2015). Instead, it questions the proposed mechanism.

Humidity has many effects on humans, including on linguistic diversity: Nettle (1999) showed that dry areas have more ecological risk, which necessitates trade networks, leading to lower linguistic diversity—compared with humid areas where growing seasons are longer and linguistic communities can stay within smaller areas. There is evidence suggesting that tone is difficult to acquire by L2 speakers (e.g. Wang et al. 1999), hence we ask: could increased bilingualism due to the different contact dynamics of dry areas be the ultimate cause of the correlation? To at least show that this additional mechanism is plausible, we compared census data on the

number of bilinguals used in Bentz and Winter (2013) with the WALS lexical tone variable (one of the two linguistic datasets analyzed in Everett et al. 2015). There was little match between these two datasets (sixty-two languages), but an initial look at the data is promising: languages that have no tone according to WALS have 38 per cent L2 speakers, more so than languages that have simple tone systems (27 per cent) or complex tone systems (24 per cent). Following the approach in Bentz and Winter (2013), we fitted a logistic mixed model on tone presence versus absence with random effects for area and genus, which yielded a significant result when taking the log ratio of L2 speakers ( $P = 0.001$ ) or the percentage of L2 speakers ( $P = 0.03$ ) as predictors. This model is likely anti-conservative because random slopes could not be fitted (cf. Jaeger et al. 2011), but this initial evidence together with the relatively big difference in percentages (38 per cent versus 27/24 per cent) suggests that contact patterns might be a viable alternative explanation to be pursued in future research.

Notice, however, that if indeed the tone  $\sim$  humidity correlation is not due to humidity *per se* but due to the influence of humidity on linguistic diversity, the original results in Everett et al. (2015) would still hold as an influence of environmental humidity onto language, albeit as a more indirect effect, mediated through another factor.

## 6. Conclusions

To conclude: the correlation between humidity and the environment is an exciting example of the transformation of the field of linguistics toward more evidence-based approaches. We need to move away from dogmas and toward a discourse where we can openly talk about these age-old ideas, using modern quantitative methods and empirical data. Moreover, we have shown how the mechanism proposed by Everett et al. (2015) is plausible from the perspective of a number of different linguistic theories—including embodiment and functional approaches to phonology—but we contend that further tests need to be done to investigate additional factors, such as language contact.

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