Astrobiology News February 2018:
The Evolution of Life and Language

I generally like to stick to subject areas with which I'm more familiar, but I found this news feature on NASA's Astrobiology site[1] to be so fascinating that I wanted to draw your attention to it! So, with the disclaimer that as an astrophysicist I can hardly claim expertise in either evolutionary biology or linguistics, what follows is a great example of how advances in one field may find applications in others – in this case, how lessons learned through research in the evolution of languages may help advance research in evolutionary biology.

The article highlights the work of Eric Smith, a complex systems researcher at the Santa Fe Institute who studies both language and biology, and MIT biologists Rogier Braakman and Greg Fournier. Both linguistics and biology reason about the past to explain diversity. Both collect information into evolutionary trees, albeit using very different tools. While modern biology uses sophisticated computer methods to relate DNA sequences in the genomes of different organisms, linguists look broadly at the many facets of language, such as lexical roots, sounds, syntax, and grammar.

Funded by NASA's Astrobiology Institute, Smith has been looking at several linguistic elements to construct evolutionary trees that may provide insights to biologists for how they can broaden their perspectives to include more than DNA sequences in constructing narratives of life's past. The shapes of linguistic trees can inform linguists about migrations, exchanges, and cultural divides. Just as mutations in gene sequences can lead to the emergence of new species in biology, changes in the usage of sound units, known as phonemes, can result in the formation of new languages.

One important difference between biological evolution and language evolution is that genetic changes can occur sporadically, in isolation, while this rarely occurs in language. When a sound changes, it usually changes in many words at the same time. A counterpart to this collective behavior in biology is when relationships within a genome prevent individual genes from mutating without parallel changes in other genes. Since it's not always clear when this so-called "concerted evolution" applies, Smith and colleagues have been studying the relative importance of sporadic versus concerted evolution in the context of language. Their results indicate these models produce very different predictions of when language changes occur, so they devised a statistical method for identifying concerted changes in linguistic or genetic data.

Smith, Braakman, and Fournier think that analogies with language evolution may help inspire innovations in reasoning that can help "Evolution 1.0" evolve to "Evolution 2.0". Fournier says that a common over-simplification in genetic reconstruction is choosing an evolutionary path with the least number of changes, which can produce intermediate steps that would be non-functional in the real world. Linguists tend to avoid this mistake because they are aware that each evolutionary step must produce a working language. Smith and Braakman demonstrated how applying constraints in chemical pathways used by organisms to convert carbon dioxide into organic molecules could explain many of the early branches in the tree of life.[2]

I encourage you to read the full feature story on NASA's Astrobiology site! You might also want to check out a more technical article that applies Smith's analysis to a wide range of languages based on word meanings.[3] There are many examples of how innovations in one field have led to similar advances in other fields. This has certainly happened frequently in the space sciences, and I find it exciting that these successes are inspiring increasing numbers of cross-disciplinary collaborations!

Until next month,

Grace

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[1] https://astrobiology.nasa.gov/news/language-and-the-evolution-of-life-share-some-similarities/

[2] Braakman R, Smith E (2012) The Emergence and Early Evolution of Biological Carbon-Fixation. PLoS Comput Biol 8(4): e1002455. https://doi.org/10.1371/journal.pcbi.1002455

[3] Youn, H., Sutton, L., Smith, E., et al. (2016) On the universal structure of human lexical semantics, Proceedings of the National Academy of Sciences 113(7) 1766-1771.