

THE EFFECTS OF MODIFIED VARIABLES ON AN ITERATED LEARNING MODEL OF LINGUISTIC EVOLUTION BY CULTURAL TRANSMISSION

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It has been suggested that human language emerged as a function of three adaptive processes: evolution by natural selection, individual learning, and cultural evolution (Kirby & Hurford, 2002). In this paradigm, biological evolution is intrinsically difficult to explore due to the ephemeral nature of language; however, the interface between learning and cultural evolution has been tested in a variety of mathematical, computational, and experimental models. These models demonstrate that systematic linguistic structure can arise from the transmission of language across multiple language users. Kirby, Cornish, and Smith (2008) introduced an experimental method for studying the cumulative effect that cultural transmission has on language, and their iterated learning model represented the first experiment on human participants to suggest that the cultural transmission of language leads cumulatively to the appearance of linguistic design without any explicit designer.

A new version of this experiment was conducted with a number of modified variables allowing us to test the resilience of the experimental paradigm. The modifications introduced to this version of the experiment were:

1. the addition of an auditory modality in the learning phase by means of a synthesized voice
2. a different set of meanings, which include shape, colour, and number
3. a larger syllabary from which the initial randomly-generated languages were concatenated

This version of the experiment also adopted a different approach to the inter-generational filtering strategy, which exposes each participant to learning material of equal size (14 items), which arguably promotes a more controlled experiment. Despite these modifications, the learnability of the artificial languages increased

over the course of the experiment in a way that is strikingly similar to the results observed by Kirby et al. (2008). However, the emergence of compositional linguistic structure was less forthcoming. This presents a problem: if the languages evolve to become easier to learn, yet a strong degree of compositionality does not emerge, then there must exist at least one other mechanism by which the languages optimize their successful transmission.

The results suggest that this mechanism might lie in a different type of linguistic adaptation. Specifically, the size of the signal-space (i.e. the syllable structures employed by a language) tended to shrink over the course of the experiment, which appears to make the languages easier to learn. Although this in itself is interesting (demonstrating that languages can find novel and perhaps unexpected ways to circumvent a bottleneck), a consequence of the shrinking signal-space is that the probability of a chance alignment between signal and meaning becomes increasingly more likely to occur as the experiment progresses. It is therefore hypothesized that, by allowing the languages to evolve further, a level of compositional structure comparable with Kirby et al. (2008) might eventually emerge under this modified paradigm.

In addition to supporting the general findings of Kirby et al. (2008), these results highlight two important points. Firstly, the experimental outcome is sensitive to the experimental environment, and small changes in the variables can have complex and unexpected effects on the results. Secondly, a language whose signal-space is not optimized to transmission through a given bottleneck must firstly undergo phonological optimization (towards a stable syllabary) before it becomes conducive to the evolution of grammatical structure by means of fractionation.

References

- Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences of the United States of America*, 105(31), 10681—10686.
- Kirby, S., & Hurford, J. R. (2002). The emergence of linguistic structure: An overview of the iterated learning model. In A. Cangelosi & D. Parisi (Eds.), *Simulating the evolution of language* (pp. 121—147). London: Springer Verlag.