

## **ITERATED LEARNING IN POPULATIONS: LEARNING AND EVOLVING EXPECTATIONS ABOUT LINGUISTIC HOMOGENEITY**

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Natural languages do not differ arbitrarily, but are constrained so that certain properties recur across the languages of the world. One theory argues that language universals are a direct reflection of constraints hard-wired into the language acquisition process (Chomsky, 1965). An alternative suggestion (e.g. Kirby, Dowman & Griffiths, 2007) is that the same universals could arise given only weak biases in individual learners, as a consequence of cultural transmission. This debate has profound implications for theories of the origins and evolution of language, because the culturally-mediated mapping between learner biases and language structure complicates the biological evolution of the language faculty (Smith & Kirby, 2008).

One technique for investigating the relationship between language structure and the prior expectations of language learners is to treat language acquisition as Bayesian inference, and model cultural transmission as the process of iterated learning. Using this framework, Burkett & Griffiths (2010) model the situation where learners learn one or more languages based on linguistic data produced by multiple teachers, where learners have a prior preference for languages of one structural type. Burkett & Griffiths identify two patterns of results, depending on the assumptions learners make about the linguistic homogeneity of their speech community. When learners expect their community to be relatively heterogeneous (i.e. they expect to learn to speak multiple languages), then populations converge to a situation where each language is spoken with a frequency given by its prior probability: in other words, the distribution of languages in a population (and within each individual in that population) accurately reflects the expectations of individual learners about language structure. However, when learners expect their speech community to be homogenous (i.e. they expect to learn one or a few languages), a single language

type dominates the population: consequently, the distribution of languages does not just reflect the biases of learners regarding language structure, e.g. a priori less probable languages can dominate if initially frequent.

Burkett & Griffiths therefore show that learners' expectations regarding the homogeneity of their speech community mediate the relationship between properties of individual learners and language universals. We explore two explanations of how these expectations could be formed. In the first model, we assume that learners infer the homogeneity of their speech community from their linguistic data, at the same time as inferring the distribution over languages implied by that data. Under some conditions, the learner's inferences about the homogeneity of their linguistic input can be affected by the social structure of their population, which can in turn affect the types of languages that evolve in that population; however, the determining factor is generally the learner's prior expectations about the homogeneity of their speech community. In the second model, we explicitly evolve these prior expectations: this expectation is genetically transmitted, with reproduction depending on ability to coordinate on a shared language. Under this scenario, we see strong selection for learners who expect linguistic homogeneity, even in situations where such genotypes are rare; consequently, populations converge on languages which do not straightforwardly reflect the learners' expectations about linguistic structure.

This work indicates that there are plausible circumstances under which cultural transmission obscures the relationship between learner biases and their linguistic consequences. Evolutionary pressures acting on the language faculty therefore face an opaque mapping between the structure of languages (over which selection presumably acts) and the cognitive traits that produce those linguistic structures, rendering the evolution of the language faculty problematic.

## References

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