A CRITICAL POPULATION THRESHOLD FOR CONTACT-INDUCED SIMPLIFICATION

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Learning biases have long been theorized to play a causal role in the cultural evolution of linguistic systems. In particular, existing literature suggests that the difficulty encountered by second-language (L2) learners in acquiring complex linguistic features may contribute to the loss of those features from the target language in situations of language contact (Bentz & Winter, 2013; Berdicevskis & Semenuks, 2022; Lupyan & Dale, 2010; Sinnemäki & Di Garbo, 2018; Trudgill, 2011; Walkden & Breitbarth, 2019; Weerman, 1993; also see Jansson, Parkvall, & Strimling, 2015 on modelling creolization). Against the backdrop of this body of research, it is reasonable to expect that the population fraction of L2 learners may act as a bifurcation parameter: if sufficiently many L2 learners are present in a speech community, the loss of L2-difficult features may be permanent. Without an explicit model combining population and learning dynamics, however, it is impossible to say where the critical value of such a putative bifurcation parameter might lie.

We propose such a model by extending the variational learner (Yang, 2002) to cover L2 as well as L1 acquisition. For L2 (but not L1) learners, the extended model includes a learning bias that works against the successful (native-like) acquisition of the L2-difficult variant. The asymptotic dynamics of this extended learning model can be studied just like those of the ordinary linear reward–penalty learning scheme (Bush & Mosteller, 1955) that underlies the variational learner. In particular, we show that an L2 learner's expected probability of employing an L2-difficult grammar G_1 over its easier-to-acquire competitor G_2 tends to a definite value as learning iteration tends to infinity.

Taking the usual infinite learner limit (cf. Yang, 2000) then yields a deterministic dynamical system that describes the evolution of a mixed population of L1 and L2 speakers. This system has three parameters: σ, the fraction of L2 speakers in the population; D, the learning-theoretic strength of the L2-difficulty of G_1; and α, the fitness ratio (Kauhanen & Walkden, 2018) of the two grammars.

We show analytically that this system always has exactly one stable equilibrium. The system's dynamics are, however, separated into two phases: in one phase, the stable equilibrium satisfies $p > 0$ and $q > 0$, where p and q stand for the probability of the L2-difficult grammar G_1 in the L1 and L2 populations, respectively. In other words, the L2-difficult grammar is retained in each population at some non-zero (and possibly high) frequency. In the second phase, however, the attractor is the origin $(p, q) = (0, 0)$, meaning that the L2-difficult grammar is wiped out from *both* populations, including the L1 speaker population which itself is not subject to the learning bias (but feels its effects through interactions with the L2 population). This bifurcation occurs as σ crosses the critical value

$$\sigma_{\text{crit}} = \frac{(\alpha - 1)(D + 1)}{\alpha D}, \tag{1}$$

that is, fractions of L2 speakers $\sigma > \sigma_{\text{crit}}$ exhibit simplification dynamics (Fig. 1).

To provide some empirical support for the model, we estimate the parameters σ and α from demographic and corpus data, and provide reasonable orders of magnitude for the learning bias D, for two historical developments: the loss of verbal inflection in Afrikaans (Trudgill, 2011) and the partial loss of null subjects in Afro-Peruvian Spanish (Sessarego & Gutiérrez-Rexach, 2018). Empirically, the simplification process in Afrikaans went to completion, whereas in Afro-Peruvian Spanish null subjects retain a partial status. These facts are predicted by the model, in the sense that $\sigma > \sigma_{\text{crit}}$ in the former case but not in the latter.

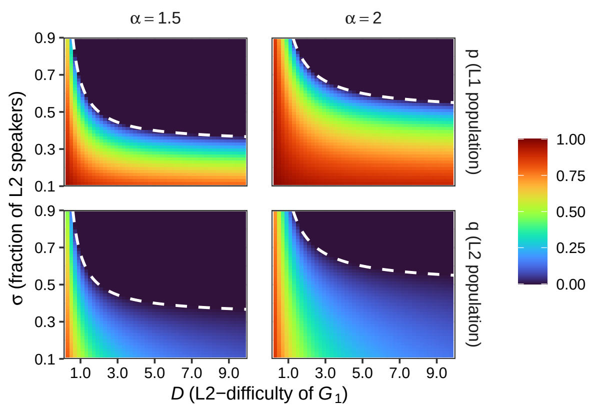

Figure 1. Stable equilibrium (p, q) of the mixed speech community (top row: probability of G_1 in L1 speakers; bottom row: L2 speakers). Full simplification occurs above the bifurcation threshold σ_{crit} (equation 1), depicted as the dashed white curve.

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