The impact of population dynamics on language evolution

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Language is culturally transmitted — children learn their language on the basis of the observed linguistic behaviour of others. A recent trend has been to explain the structural properties of language in terms of adaptation by language in response to pressures acting on it during its cultural transmission. Using this approach, properties of language such as recursion (Kirby 2002) and compositionality (Smith *et al.* forthcoming) have been shown to be adaptations which help language survive the repeated cycle of production and learning. A particular feature of this research has been the extensive use of computational models.

These models suffer from an impoverished treatment of population dynamics. Population sizes are severely restricted, with populations consisting of a single individual at each generation being common. Within-generation horizontal transmission is typically ruled out. Population turnover is also highly simplified, with populations usually being modelled as a series of discrete, non-overlapping generations.

This simplified treatment of population dynamics is rather unsatisfactory, particularly given the importance of factors such as population structure and demography in language evolution in the real world. In surveys of the importance of population factors in language birth and language change, Ragir (2002) and Kerswill & Williams (2000) highlight three aspects of population dynamics which impact on linguistic structure: languages are more likely to acquire complex linguistic features, or to change in ways which preserve such features, when 1) populations are large; 2) the proportion of adults to children is low; 3) there is a high degree of child-child contact.

An important next step for models of the cultural evolution of language is therefore to develop more sophisticated treatments of population dynamics, in order to explore and ultimately understand why population factors play such an important role in language birth and change. I will present an extension to Kirby's (2002) model of the cultural evolution of recursively compositional syntax, which is designed to allow a treatment of varied population dynamics. Experiments carried out using this model show that the emergence of structured languages is dependent on three factors: 1) learners must acquire their language based on observation of a small number of cultural parents; 2) the optimal number of cultural parents depends on overall population size, with larger populations requiring smaller numbers of cultural parents; 3) learners must not learn from other learners — even small amounts of horizontal transmission impede the evolution of linguistic structure.

The extended version of Kirby's Iterated Learning Model therefore makes a series of incorrect predictions — the results of the experiments carried out using this model suggest that structured languages will only emerge when populations are small, the proportion of adults to children is high and there is little child-child contact. These predictions are exactly the opposite of the real-world data summarised by Ragir and Kerswill & Williams. This extension to a well-established model shows that a richer treatment of population dynamics is a challenging and important future development in the computational modelling of the cultural evolution of language, and one which may not prove straightforward.

References

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