The cultural evolution of communicative conventions: Interactions between population dynamics and cognitive biases

Monica Tamariz[1⋆] and Jose Segovia Martin[2]
[1]Heriot Watt University
[2]The University of Edinburgh
⋆monicatamariz@gmail.com

Languages work because speakers in a community share a set of linguistic conventions. Several factors affect the spread of conventions in populations: some relate to the structure of the population (e.g. Lupyan and Dale, 2010); others, to cognitive biases that affect the individual's likelihood of adopting a given variant (content-, frequency- and model-based; Boyd and Richerson 1988). We investigate the effects of population dynamics and cognitive biases on variant spread. We ran computer simulations of signal spread in microsocieties of 8 agents who communicate in pairs. At round 0, each produces its own unique variant signal; in successive rounds, agents switch partners, and each agent may produce their original variant or switch to a variant produced by one of their partners (Tamariz et al., 2014). Because some variants disappear while others spread to multiple agents, the entropy of the variant set always decreases. We measured the speed of entropy decline and the net variant production of each agent.

We systematically manipulated:

a) Initial isolation of subpopulations: members from two halves of the population are not paired with each other for the first round (low isolation), 2 rounds (medium) or 3 rounds (high).

b) Content bias: no bias to strong preference for a variant.

c) Coordination biases: form full (egocentric) preference for one's own variants to full (allocentric) preference for others' variants.

Results include: In high isolation populations (Fig. 1: each dot represents a population), entropy decreases more slowly (slower evolution). Differences are greatest at generation 2, when isolation differences are felt: each agent in low-isolation populations has had direct or indirect access to productions from all 8 agents; in medium, from 6; in high, from 4.

Content bias accelerates the spread of the biased variant. Moreover, this bias amplifies the differences between isolation population types.

Coordination bias also tends to slow down evolution (Fig. 2). Entropy decreases over rounds in all cases. With allocentric bias, entropy values are slightly higher; with egocentric bias, they are much higher (little evolution when agents stick to their own variants).

Furthermore, we describe simple rules explaining the effects of population dynamics on signal production.

This model reveals how complex interactions between cognitive biases and population dynamics shape the evolution of communicative variants as they spread in populations.

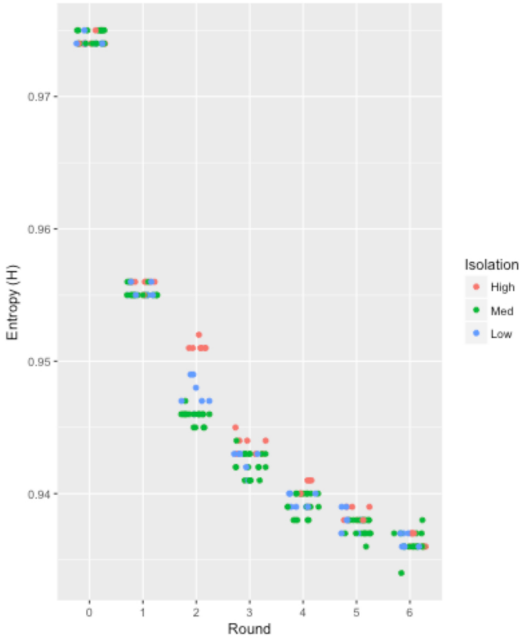

Figure 1: Subpopulation isolation

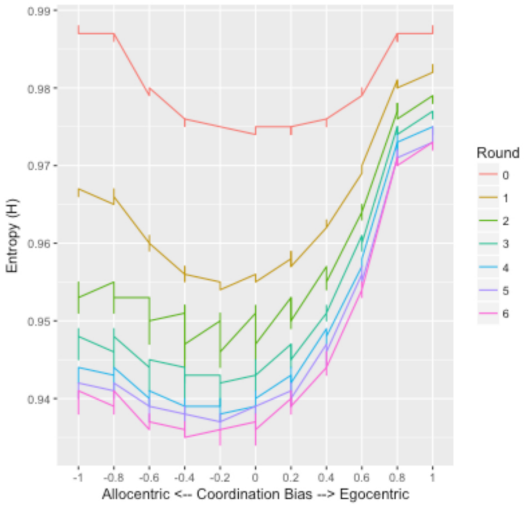

Figure 2: Coordination bias

Keywords: population structure, content bias, coordination bias, spread of variants, communication