

## THE CULTURAL EVOLUTION OF COMMUNICATIVE CONVENTIONS: INTERACTIONS BETWEEN POPULATION CONNECTIVITY DYNAMICS AND COGNITIVE BIASES

JOSÉ SEGOVIA MARTÍN<sup>1</sup> AND MÓNICA TAMARIZ<sup>2\*</sup>

\*Corresponding Author: M.Tamariz@hw.ac.uk

<sup>1</sup>Universitat Autònoma de Barcelona, Barcelona, Spain

<sup>2</sup>Psychology, Heriot-Watt University, Edinburgh, UK

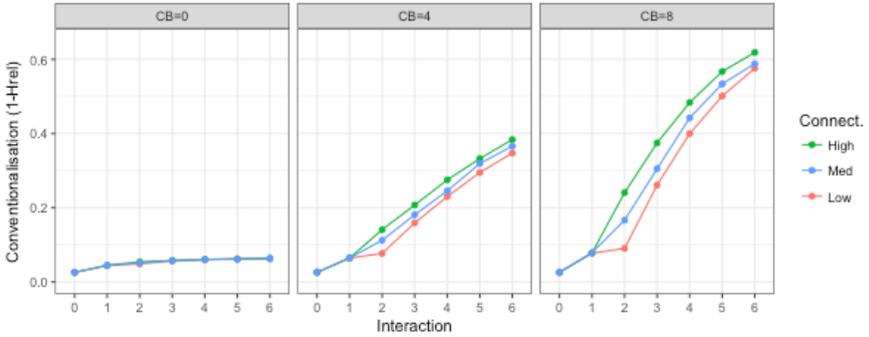
Languages work because speakers in a community share linguistic conventions. The process of spread of new signals in a population, or *conventionalisation*, is affected by multiple factors related to population structure (Lupyan & Dale, 2010) and to cognitive biases (Tamariz et al. 2014). The present study tests the separate and joint effects of social network connectivity, content bias and coordination bias on the spread of conventions in a population.

We ran simulations of the spread of signal variants in microsocieties of 8 agents. Each agent starts off with a distinct variant; then, over successive pairwise interactions in which it communicates with every other agent, it may adopt its partners' variants. Conventionalisation (*Conv*) was quantified as the relative entropy of the 8 variants produced by the 8 agents at the end of each interaction subtracted from 1; in other words, as the rate of redundancy increase over interactions that occurs as some variants spread to multiple agents while others disappear.

We manipulated: (a) *Population connectivity*: high, medium and low levels of connectivity were simulated by keeping two halves of the population isolated from each other for the first one, two or three generations. (b) *Content bias*: in a scale from no bias to strong preference for one of the variants. And (c) *Coordination biases*: in a scale from full (Egocentric) preference for one's own variants to full (Allocentric) preference for others' variants.

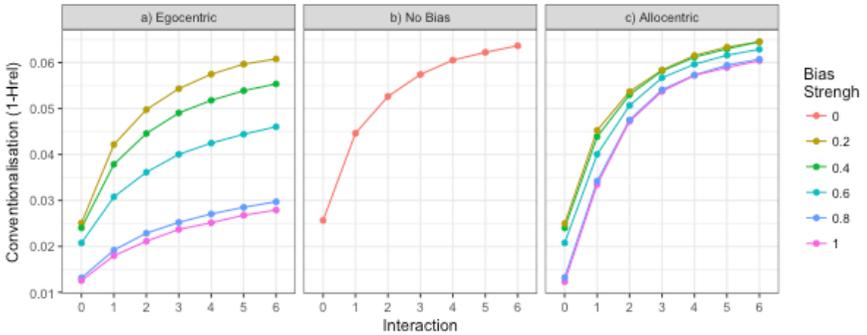
Results: (a) *Conv* is faster in highly connected populations (Fig. 1): Changes in population connectivity dynamics lead to bursts and periods of evolutionary stasis (punctuated equilibrium). (b) Content bias increases *Conv* and amplifies the effects of connectivity (Fig. 1): the preferred variant spreads very fast.

Figure 1. Conventionalisation over interactions by isolation level in 3 levels of content bias



(c) Coordination biases disrupt *Conv* (Fig. 2): When agents stick to their own variants (Egocentric), variants spread / conventionalise less over interactions. When agents switch to their partners' variants (Allocentric), spread also slows down, but less so.

Figure 2. Conventionalisation over interactions for all levels of Coordination Bias



This model reveals how complex interactions between cognitive biases and population dynamics shape the evolution of communicative variants as they spread in populations. The model can be fitted to real data or experimental results to estimate the magnitude of those effects.

### References

Lupyan, G. & Dale, R.A.C. (2010). Language Structure is Partly Determined by Social Structure. *PLoS ONE*: 5(1): e8559.

Tamariz, M., Ellison, T. M., Barr, D. J., & Fay, N. (2014). Cultural selection drives the evolution of human communication systems. *Proceedings of the Royal Society B: Biological Sciences*, 281(1788), [20140488].