

# Agents and Evolution

## Ling 496

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Office Hours: TTh: 10am - 11am

**Course Description:** Language is an example of a self-organizing biological system; its patterns emerge from the complex push and pull of a variety of social, psychological, biological and physical forces. In this course we will explore the hypothesis that languages are a population-level biological phenomena that has co-evolved with human culture. We will begin by surveying self-organization and evolution, then turn to the formal analysis of the cultural evolution with particular reference to the evolution of cooperative behavior and complex signaling behavior. After establishing a foundation in physics, biology and linguistics, we will explore a number of case studies. In the course of doing so, we will develop a set of interactive python notebooks that will be made available online.

**Grading:** Grades will be based on a project, and homeworks. Projects can either be a paper (up to 15 pages, double-spaced) or a mathematical model or programming project, depending on the approval of the instructor. Projects will be developed in consultation with the instructor. Homeworks will be short written assignments.

Table 1: Course Grading

Project	30%
Homework	70%

## Topics and Readings

### Self-Organization and social physics

Scott Camazine, Jean-Louis Deneubourg , Nigel R. Franks, James Sneyd, Guy Theraulaz, and Eric Bonabeau. 2001. *Self-Organization in Biological Systems*. Princeton Studies in Complexity. Princeton University Press. (excerpts)

Charles L. Nunn (2011). *The Comparative Approach in Evolutionary Anthropology and Biology*. University of Chicago Press, Chicago, IL. Chapter 5, “Modeling evolutionary change”

Richard McElreath and Robert Boyd (2007). *Mathematical Models of Social Evolution: A Guide for the Perplexed*. University of Chicago Press, Chicago, IL. Chapter 1, “The theoretician’s laboratory”

Claudio Castellano, Santo Fortunato, and Vittorio Loreto (2009), “Statistical physics of social dynamics”. *Reviews of Modern Physics*, 81(2), 591-646.

### Signaling and Cooperation

Richard McElreath and Robert Boyd (2007). *Mathematical Models of Social Evolution: A Guide for the Perplexed*. University of Chicago Press, Chicago, IL. Chapter 3, “Altruism and inclusive fitness”  
Chapter 4, “Reciprocity”  
Chapter 5, “Animal Communication”

Charles L. Nunn (2011). *The Comparative Approach in Evolutionary Anthropology and Biology*. University of Chicago Press, Chicago, IL. Chapter 10, “Human cultural traits and linguistic evolution”

### Case Study: Structure of Vowel Inventories:

De Boer, B. 2000. Self-Organization in Vowel Systems. *Journal of Phonetics* 28 (4): 441-65. doi:10.1006/jpho.2000.0125.

Bart de Boer. 2001. *The Origins of Vowel Systems*. Studies in the Evolution of Language. Oxford University Press. (excerpts)

Liljencrants, Johan, and Björn Lindblom. 1972. Numerical Simulation of Vowel Quality Systems: the Role of Perceptual Contrast. *Language* 48 (4). Linguistic Society of America: 83962.

Lindblom, B. 1986. Phonetic Universals in Vowel Systems. *Experimental Phonology*.

## Gene-language covariation

Charles L. Nunn (2011). *The Comparative Approach in Evolutionary Anthropology and Biology*. University of Chicago Press, Chicago, IL.  
Chapter 6, “Correlated evolution and testing adaptive hypotheses”  
Chapter 7, “Comparative methods to detect correlated evolutionary change”  
Chapter 8, “Using trees to study biological and cultural diversification”

Chang, Will, Chundra Cathcart, David Hall, and Andrew Garrett. 2015. Ancestry-Constrained Phylogenetic Analysis Supports the Indo-European Steppe Hypothesis. *Language* 91 (1): 194244. doi:10.1353/lan.2015.0005.

Fitch, W Tecumseh. 2011. Genes, Language, Cognition, and Culture: Towards Productive Inquiry. *Human Biology* 83 (2). Wayne State University Press: 32329.

Henn, Brenna M, L L Cavalli-Sforza, and Marcus W Feldman. 2012. The Great Human Expansion.. *Proceedings of the National Academy of Sciences of the United States of America* 109 (44). National Acad Sciences: 1775864. doi:10.1073/pnas.1212380109.

Holden, C J. 2002. Bantu Language Trees Reflect the Spread of Farming Across Sub-Saharan Africa: a Maximum-Parsimony Analysis. *Proceedings of the Royal Society of London* 269 (1493): 79399. doi:10.1098/rspb.2002.1955.

Nichols, Johanna. 1992. *Linguistic Diversity in Space and Time*. University of Chicago Press. Chicago. (excerpts)

Reesink, G, R Singer, and M Dunn. 2009. Explaining the Linguistic Diversity of Sahul Using Population Models.

Scheinfeldt, L B, S Soi, and S A Tishkoff. 2010. Working Toward a Synthesis of Archaeological, Linguistic, and Genetic Data for Inferring African Population History. *Proceedings of the National Academy of Sciences* 107 (Supplement 2): 893138. doi:10.1073/pnas.1002563107.

## Case Study: Evolution of Color Terms

Paul Kay, Brent Berlin, Luisa Maffi, and William Merrifield (1997). “Color naming across languages”, in C. L. Hardin and Luisa Maffi (eds) *Color categories in thought and language*. Cambridge University Press, Cambridge, U.K. pp. 21-56.

Kimberly Jameson and Roy G D’Andrade (1997). “It’s not really red, green, yellow, blue: An inquiry into perceptual color space”, in C. L. Hardin and Luisa Maffi (eds) *Color categories in thought and language*. Cambridge University Press, Cambridge, U.K. pp. 295-319.

Vittorio Loreto, Animesh Mukherjee, and Francesca Tria. 2012. “On the Origin of the Hierarchy of Color Names. *Proceedings of the National Academy of Science (PNAS)*, 109(18). 6819-6824.

Plus material in progress on information theory, coding and color terms.