Modelling Handedness as a Function of Cooperation and Competition

Or: How I Learned to Bow Down to My Left-Handed Overlords

Meridith Bartley John Ensley

Department of Statistics
The Pennsylvania State University

STAT 590 Presentation, December 2, 2014

PENNSTATE

Outline

History of Handedness

- 10% of population is left-handed.
- Why hasn't this percentage reached equilibrium in populations at either:
  - 50%-50% between left and right-handedness
  - 100% either left or right handed
  - Some other handedness ratio
- This paper proposes that hand preference may be influenced by costs and benefits of cooperation and competition during human evolution.

Building the Model

- We want to model l, the proportion of lefties, over time.

$$\frac{dl}{dt} = (1 - l)P_{RL}(l) - lP_{LR}(l)$$

- Assume P_{RL} and P_{LR} are symmetric.

$$\frac{dl}{dt} = (1 - l)P_{RL}(l) - lP_{RL}(1 - l) \tag{1}$$

- Break $P_{RL}(l)$ into increasing and decreasing components.

$$P_{RL}(l) = cP_{RL}^{\text{coop}}(l) + (1 - c)P_{RL}^{\text{comp}}(l) \tag{2}$$

Video

Using Athletics Data

Ideally

Want to compare predicted equilibria of eq (1) to animal population data where cooperation is present.

- Quantification of cooperation and available data very depending on task

Proxy Situation

Within atheletics, data on handedness and cooperation are readily available.

Baseball Rank Equation

$$l_r = \frac{1}{2} \frac{l_{bg} N \ \mathrm{erfc}(\hat{s}_r - \Delta\hat{s})}{r} \tag{3}$$

Visualizations

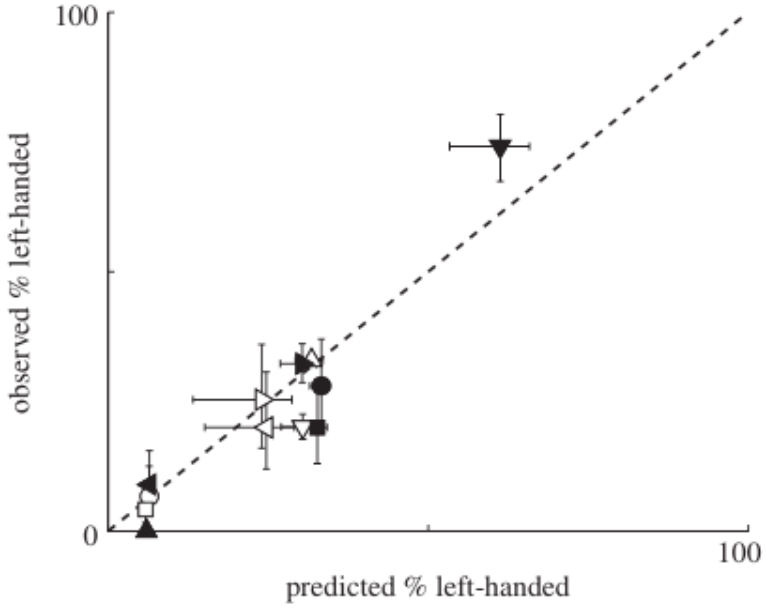

Figure: Predicted vs observed lefty proportions for various sports

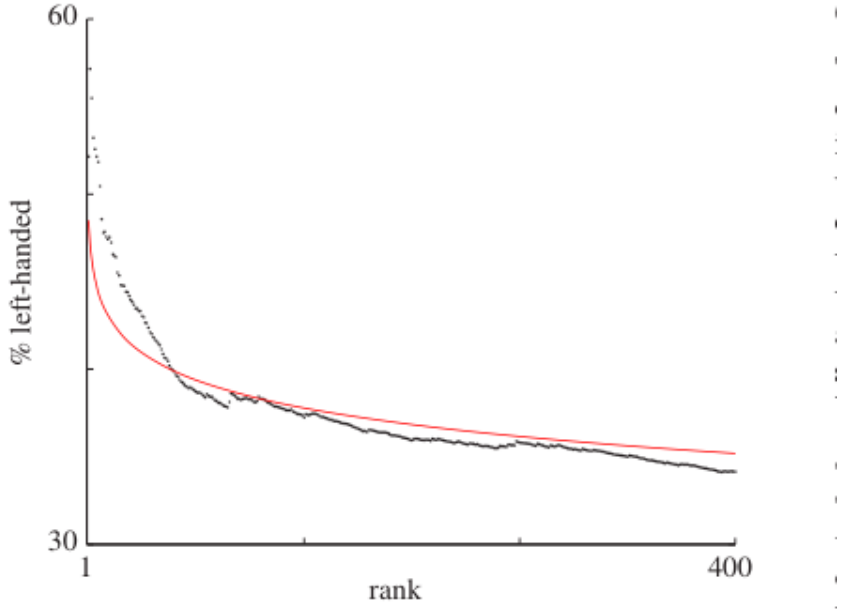

Figure: Lefty proportion as a function of rank in baseball, predicted and observed

Summary

- Sports data may not be analogous to natural world data; further quantitative analysis with social animal groups vital for future research.
- Analysis of athletics provides new insights into evolutionary origins of handedness.
- This model may be applied to any species of animal and may also be used in understanding other physical and/or behavioral lateralized adaptations.

For Further Reading I

Abrams, Daniel M. and Panaggio, Mark J.
A model balancing cooperation and competition can explain our right-handed world and the dominance of left-handed athletes
Journal of The Royal Society Interface, 2012.