

Evolutionary models of choice

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Theoretical considerations: the background

- Consumers now face a stupendous proliferation of choice – over 10 billion – billion! – choices are available in New York City alone
- Many of these products are complex, hard to evaluate
- We are **far** more aware than ever before of the behaviour/opinions/choices of others
- In 1900, most of the world's population lived in villages. Now, over half live in cities
- The internet is transforming the world like the printing press did in the 15th century
- The preferences of agents are **not** fixed, they evolve in many ways. Specifically, they can be altered *directly* by the behaviour of other agents

Cultural and creative markets

- A large and rapidly growing part of the world economy
- ‘social network markets’: a connected group of individual agents who make production and consumption decisions based on the actions (signals) of other agents on the social network (J Potts, S Cunningham, J Hartley, P Ormerod, *J Cultural Economics*, 2008)
- consumer tastes and preferences are continually evolving in symbiosis with the producer offers

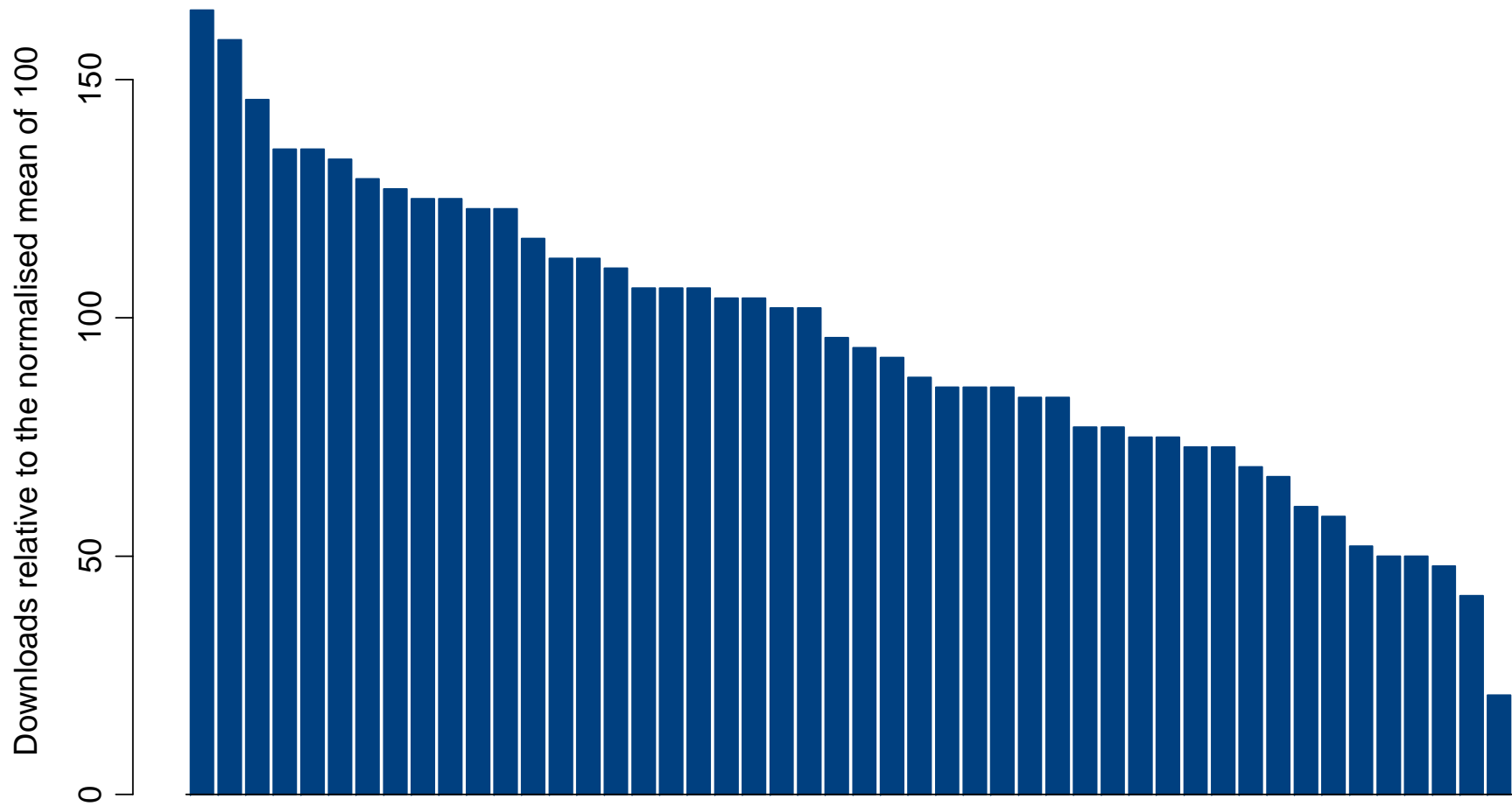
The social network markets sector

- systems that build and maintain social networks (e.g., advertising, architecture, media, ICT software, etc.)
- systems that create value on these social networks through content (e.g., film, TV, music, fashion, design, etc)
- **These require different rules of agent behaviour**
- **Copying/imitation is more important than the attributes of the alternatives on offer**
- AL Barabasi and R Albert, 'Emergence of scaling in random networks', *Science*, 1999
- R Bentley, P Ormerod and M Batty, 'Evolving social influence in large populations', *Behavioral Ecology and Sociobiology* , 2011

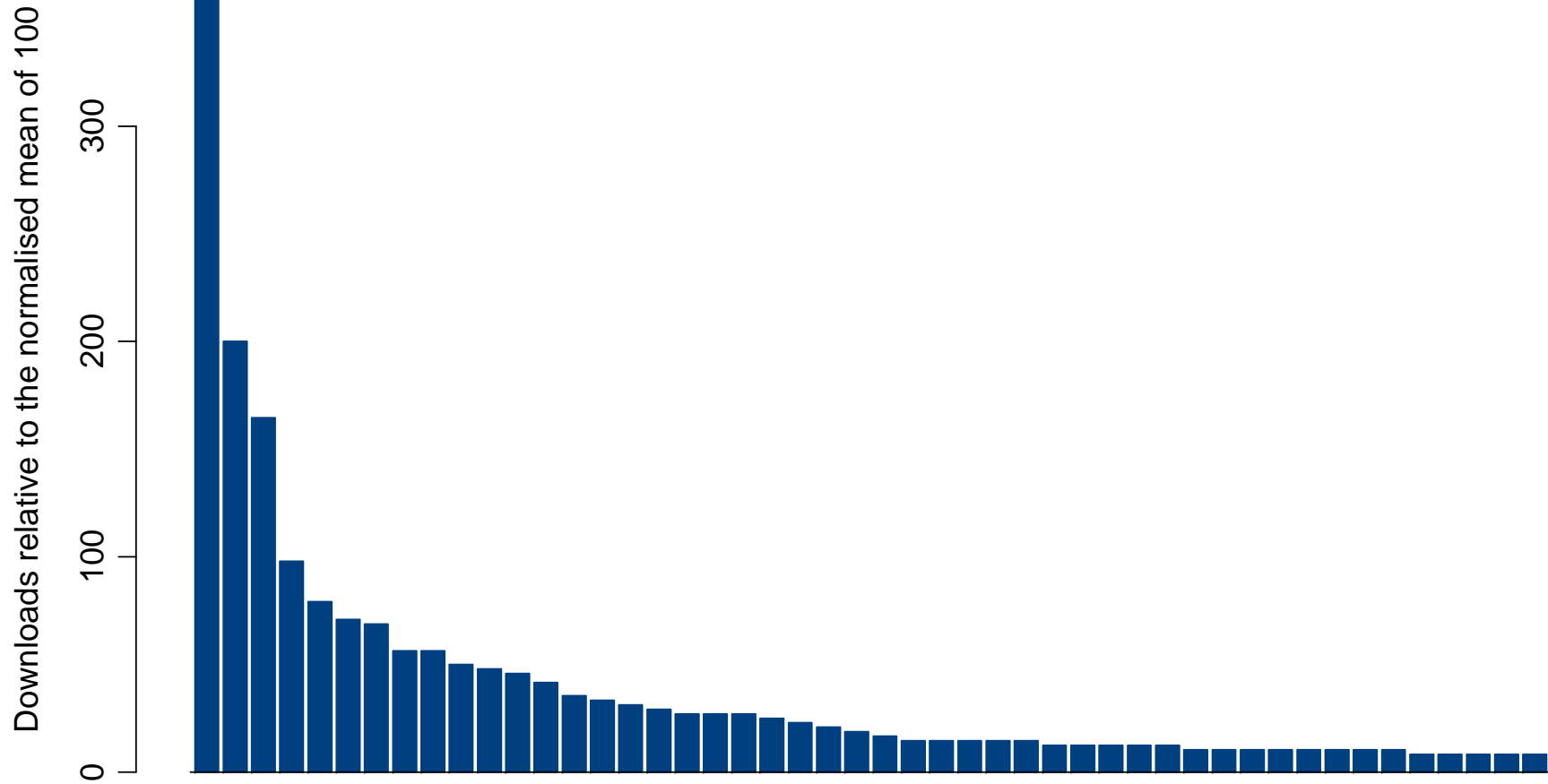
The music download experiment: an example of copying

- Salganik, Dodds, Watts, 'Experimental study of inequality and unpredictability in an artificial cultural market', *Science*, 2006
- Students downloaded previously unknown songs either with or without knowledge of previous participants' choices
- This information was both ranked and unranked
- Students also gave the songs a rating

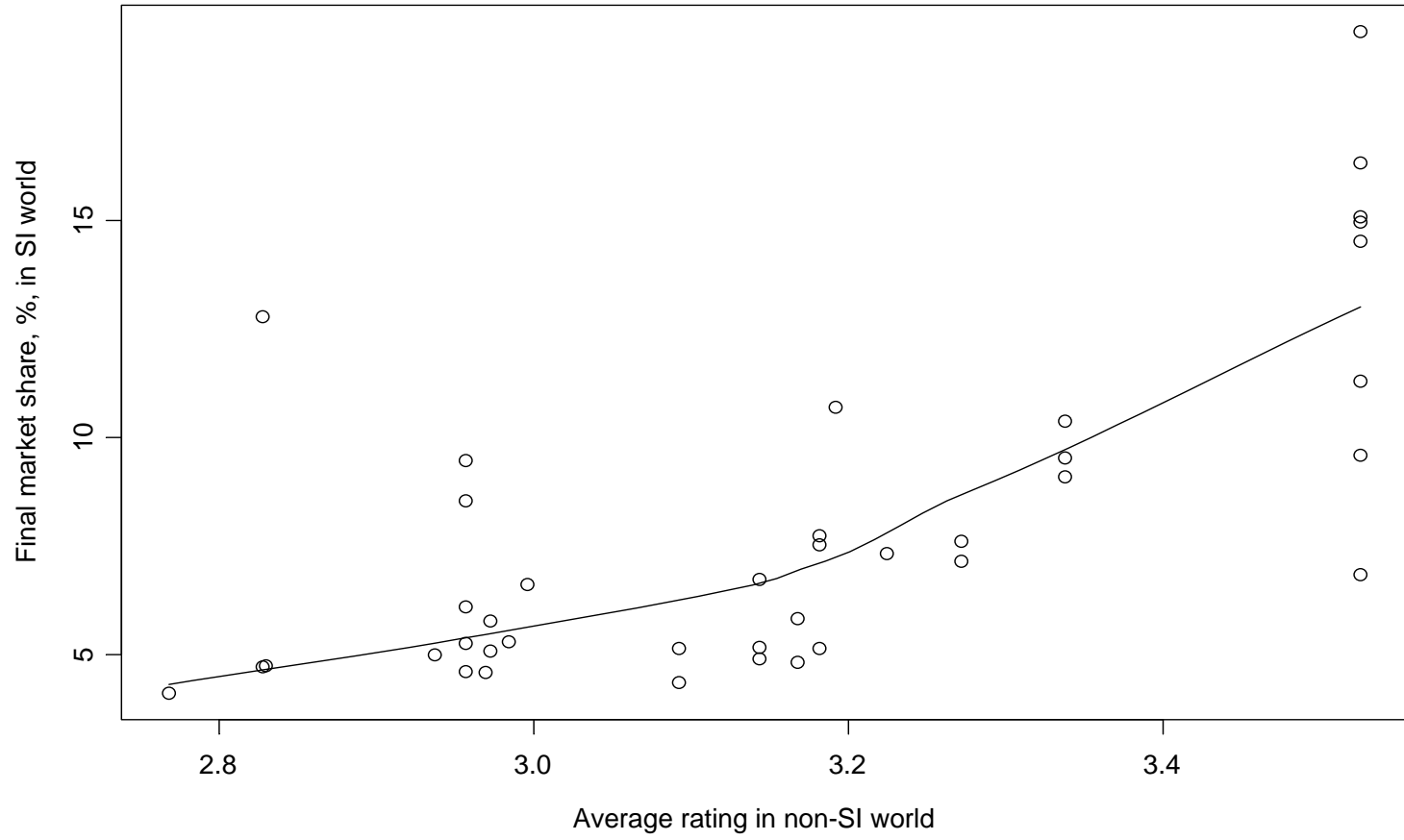
Number of downloads of each of the 48 songs No social influence



Number of downloads of each of the 48 songs Strong social influence



Final market share in SI world and average rating non-SI world



Social and economic outcomes are typically non-Gaussian

- downloads on YouTube
- film producers' earnings
- the number of sexual partners people have
- the size of price changes in financial assets
- crowds at soccer matches
- firm sizes
- the size and length of economic recessions
- unemployment rates by county in America and the UK
- deaths in wars
- the number of churches per county in William the Conqueror's *Domesday Book* survey of England in the late 11th century

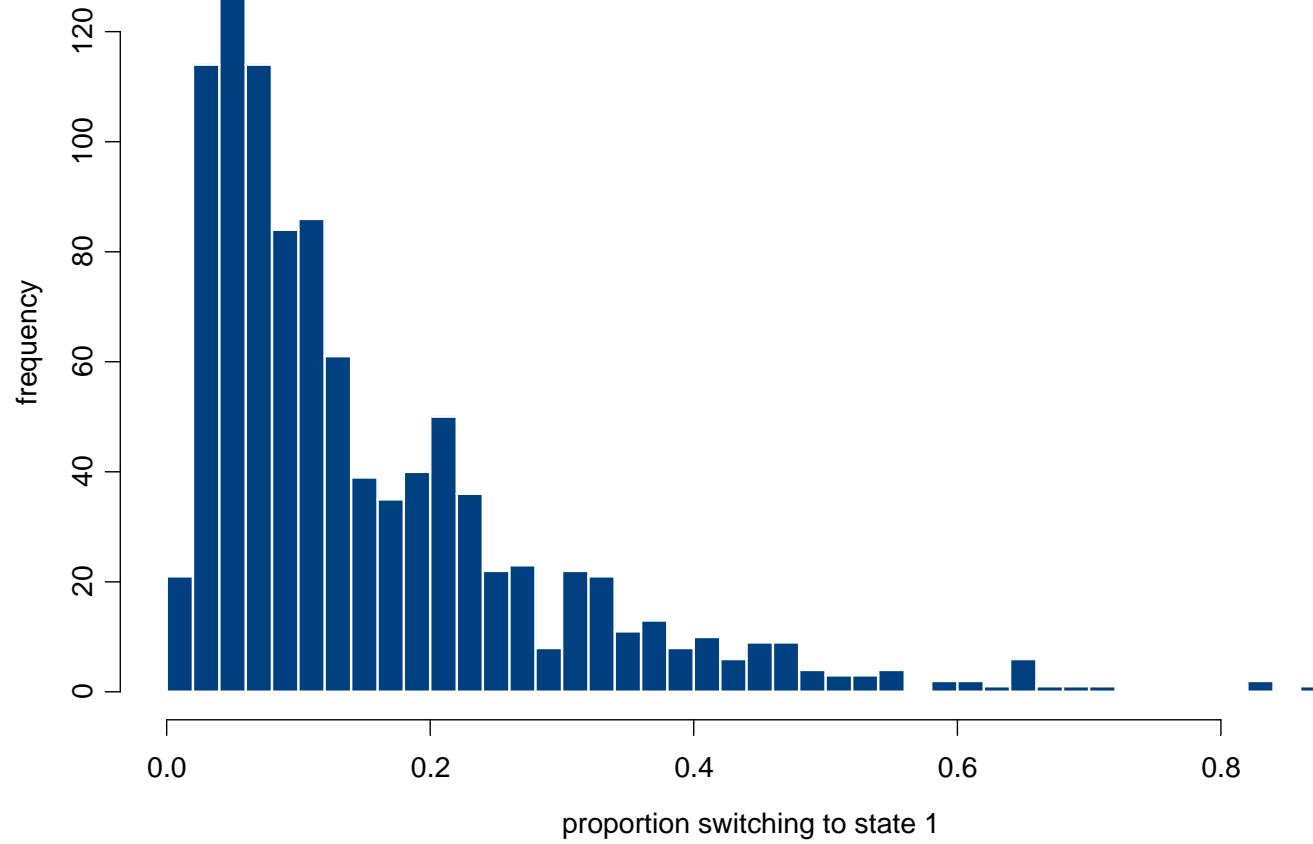
Two key empirical features

- Non-Gaussian distribution at a point in time
- Turnover in rankings within the distribution over time

Binary choice with externality

- Much of the agent based/network literature which focuses on the spread of ideas/behaviour, essentially involves 'binary choice with externalities' (Schelling 1973, Watts 2002)
- Heterogeneous agents are connected on a network and can be in one of two states of the world
- Agents switch depending upon their individual threshold (propensity to switch) and the states of the world of their neighbours
- With this model, the process of 'adoption' of new norms or shared conceptions is essentially one of copying (imitation)

Distribution of size of cascade: identical initial shock
1000 solutions, small world network



Preferential attachment

- The process of preferential attachment (Yule 1925, Simon *Biometrika*, 1955, Barabasi and Albert 1999) involves agents choosing amongst a fixed number (which may be large) of alternatives
- Agents choose probabilistically in proportion to the number of times each alternative has already been chosen by other agents
- We can think of this as corresponding to agents having complete information about the choices made by all other agents
- A drawback of preferential attachment in its basic form is that as the process of selection unfolds and more and more agents make choices, the relative rankings amongst the alternatives becomes fixed.

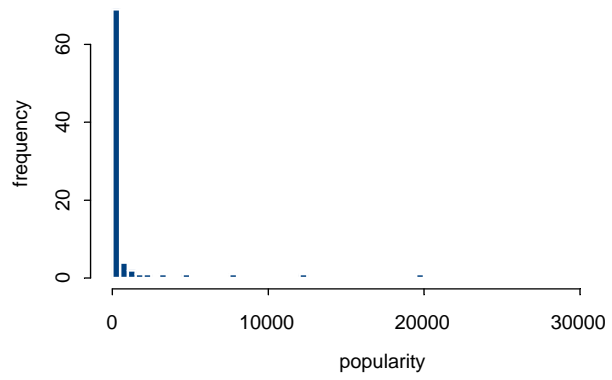
Cultural evolution (1)

- Cultural evolutionary theory retains preferential attachment as the basis for individual decisions amongst alternatives
- But it allows agents to innovate and select something which no agent has previously done before (Shennan and Wilkinson 2001 Lieberman et al. 2005, Bentley and Shennan 2007)
- Agents select amongst existing alternatives using preferential attachment with probability $(1 - \mu)$ and make an entirely new choice with probability μ
- There is a substantial amount of evidence from a variety of contexts that μ is small, not greater than 0.1 (for example, Eerkens 2000, Larsen 1961, Rogers 1962)

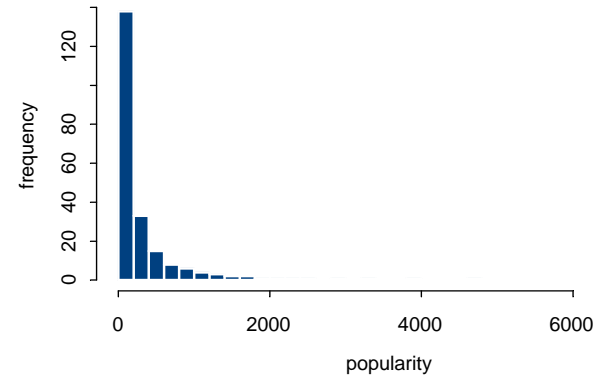
Cultural evolution (2)

- In the basic version of the model, the attributes of the various choices do not matter – agents are ‘neutral’ between them
- The model is known for $m = 1$ and for $m = \text{‘all’}$, where m is the number of previous steps back an agents looks at i.e. how many previous decisions of other agents?
- m can be allowed to take any value between 1 and all
- Turnover in rankings is a natural feature of this model
- As μ increases, the outcome becomes more egalitarian
- As m increase, the outcome becomes more egalitarian

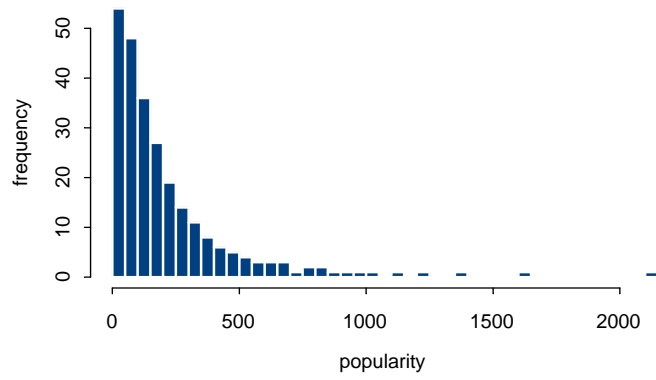
Very low innovation



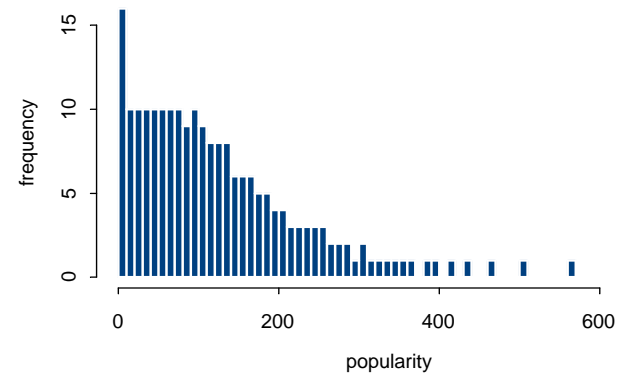
Moderate innovation



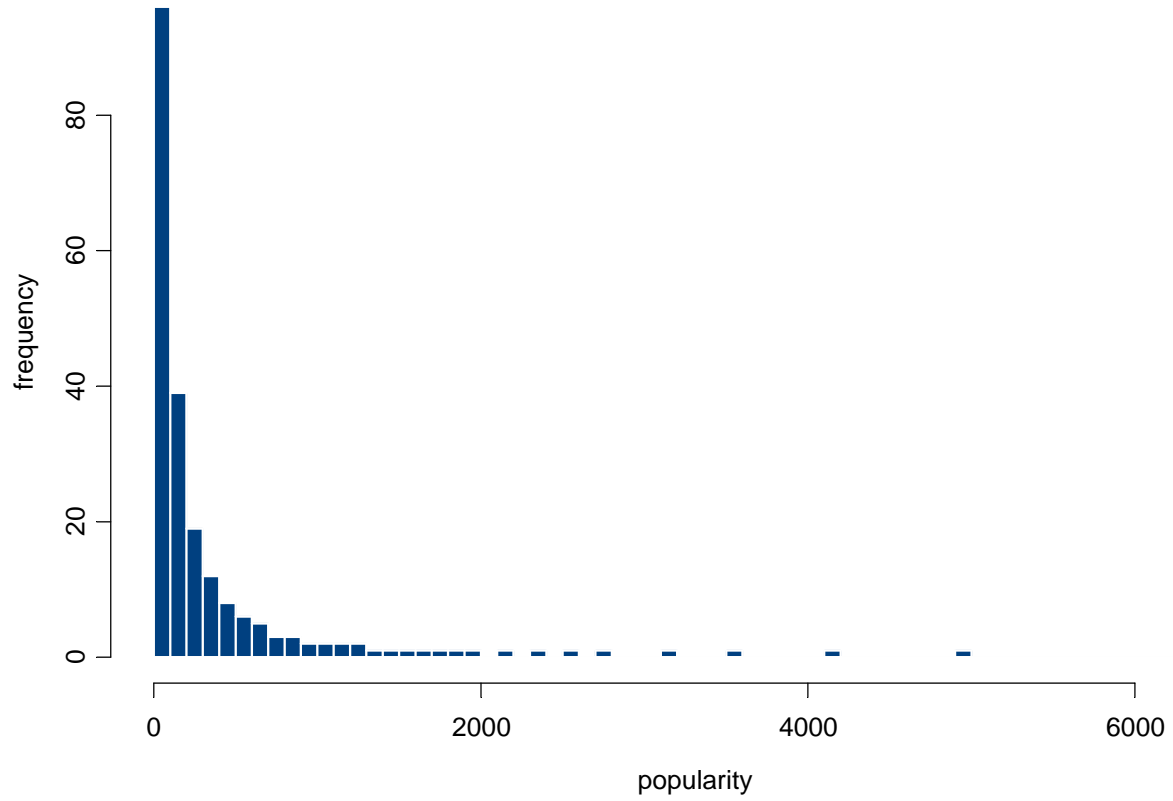
Faster innovation



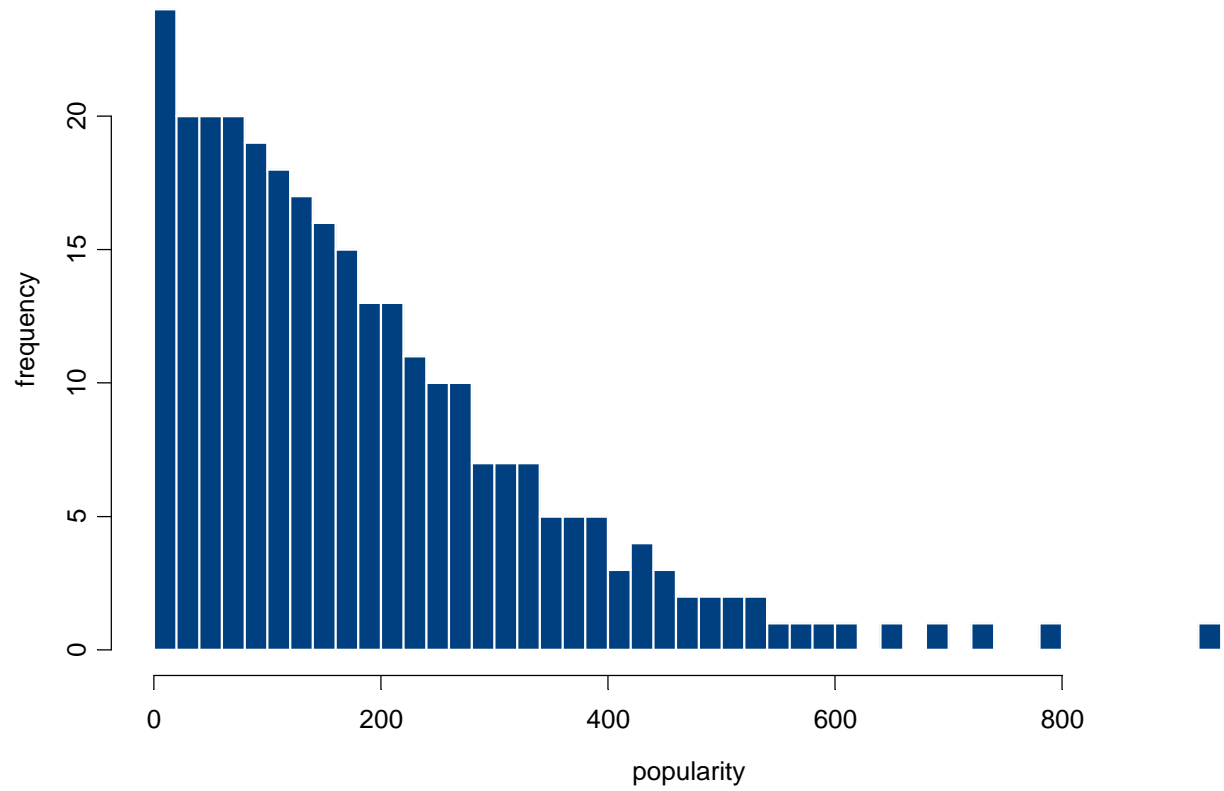
Rapid innovation

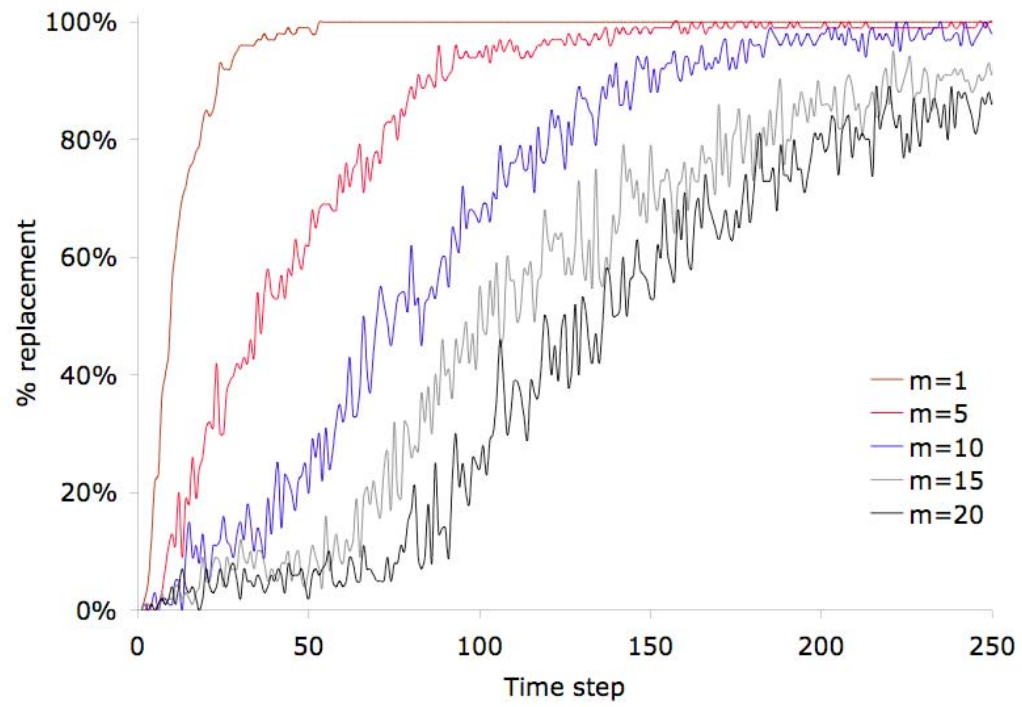


Agents copy very recent choices of others



Agents copy many past choices of others

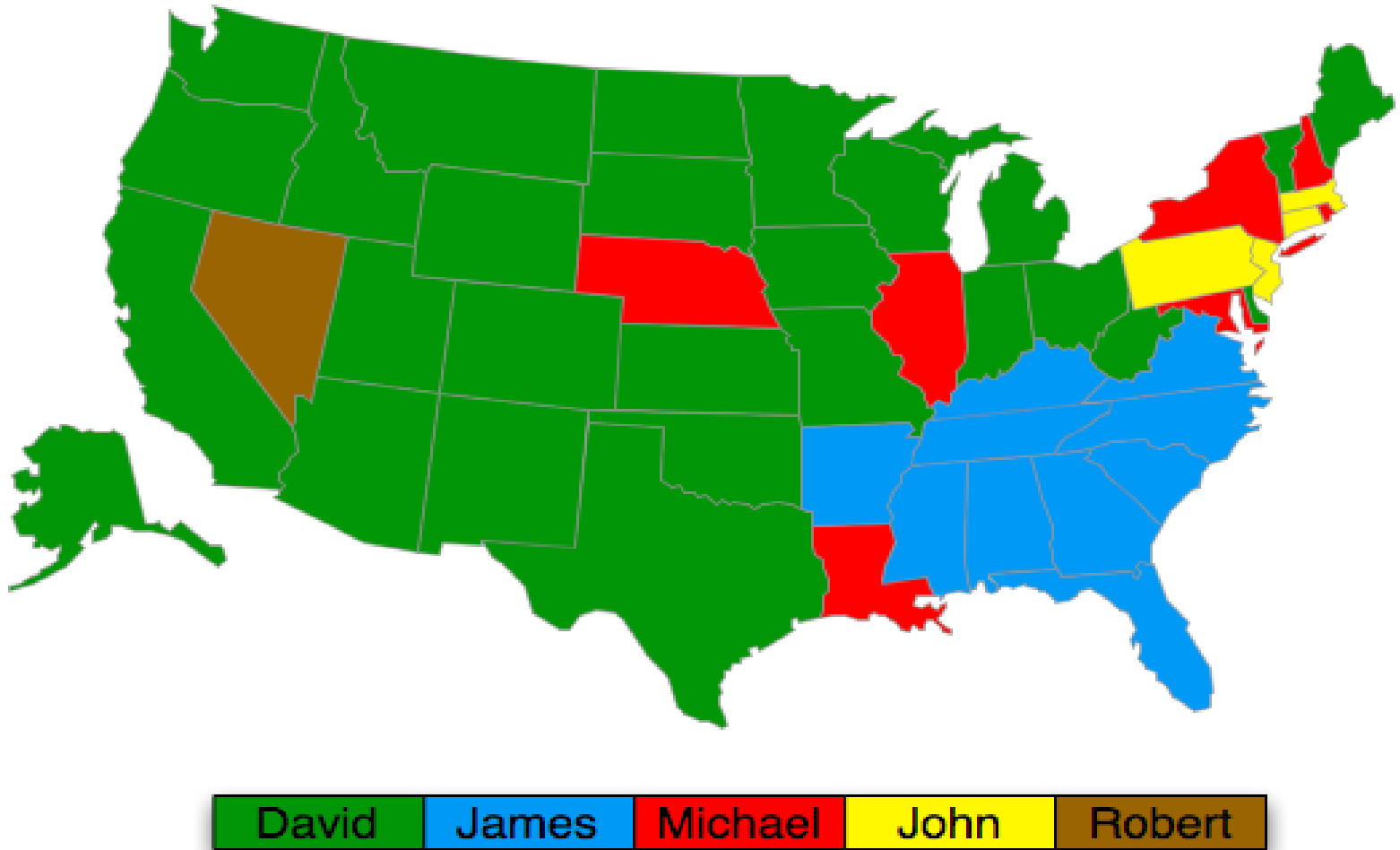




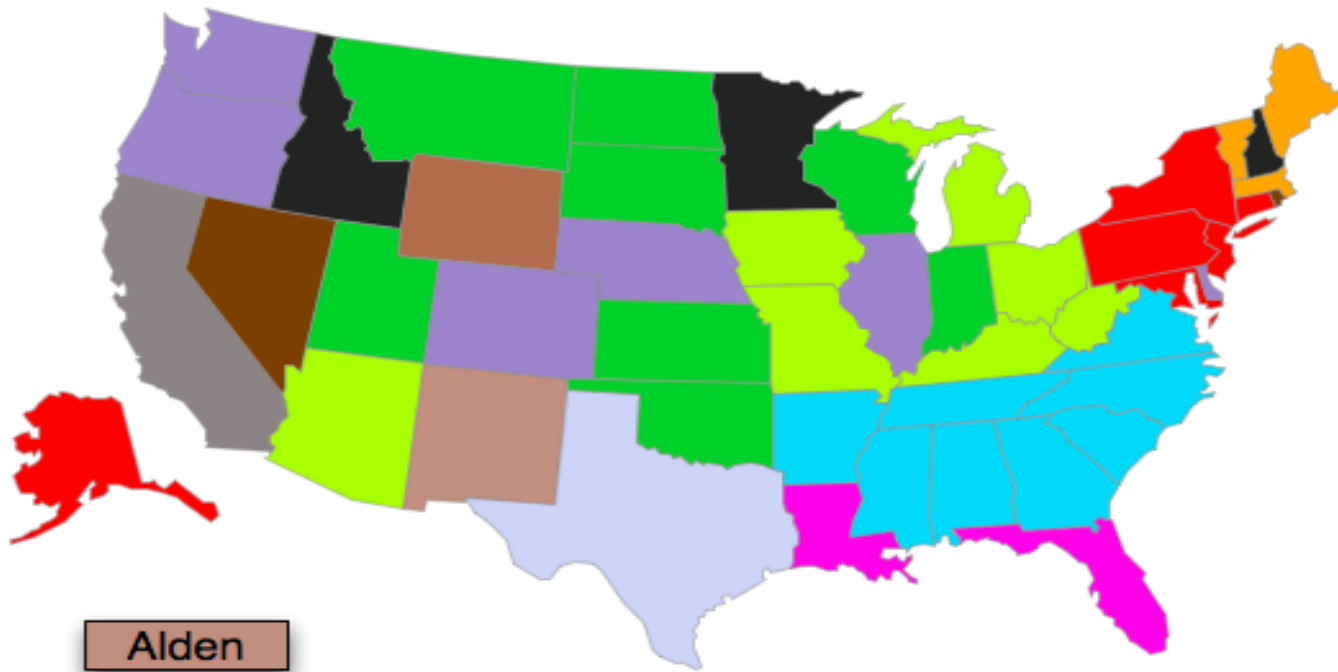
Baby names (1)

- Choices of first names reflect 3 general principles of collective behaviour that apply to fashion/popular culture
- They involve a number of people carrying out the same or similar activity at the same time
- The behaviour exhibited is transient or continually changing
- There is some kind of dependency amongst individuals, they are not acting independently
- 'the choice of a name 'connects us to society in a way that encapsulates the great contradiction in human social life: between the desire to fit in and the desire to be unique' Stephen Pinker

(c) Boys 1960



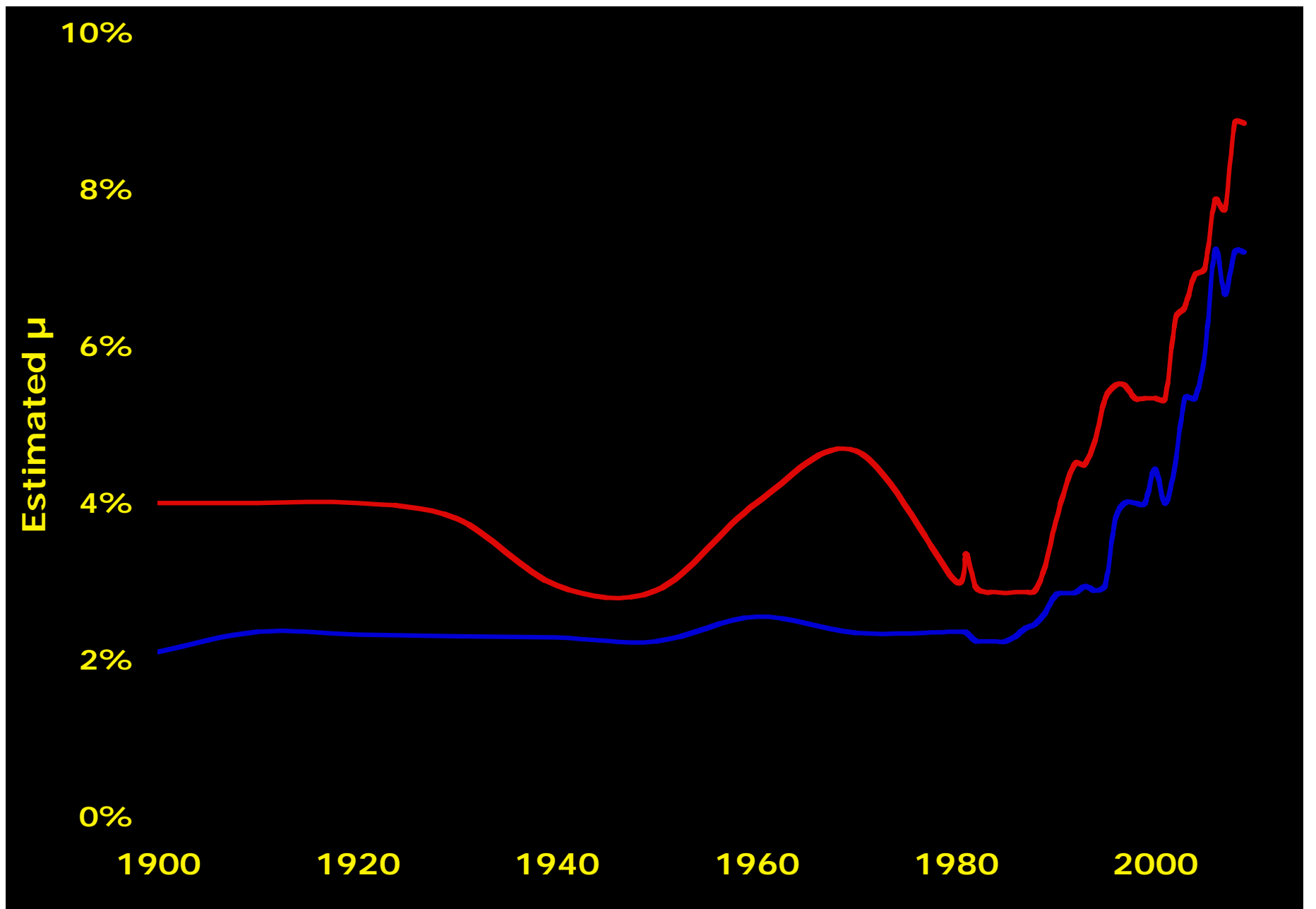
(d) Boys 2009



Alden

Ethan Jacob Alexander Anthony Daniel Jayden

William Michael Logan Noah Jose Wyatt



Other examples

- database of ceramic bowls from two successive phases of occupation of Bogazköy-Hattusa, capital of the Hittite empire and the largest Bronze Age settlement in Turkey in 14th century BC. The bowls differ in features such as size and the type of fabric used
- J Steele, C Gatz, A Kandler, *Journal of Archaeological Science* , 2010
- Three key features of linguistic evolution: i) power law at a point in time ii) inverse power law in word frequency versus replacement rate iii) S-curves for proportion of words in the top N replaced over time
- R Bentley and P Ormerod, *Proceedings of the Royal Society (B)*, 2011