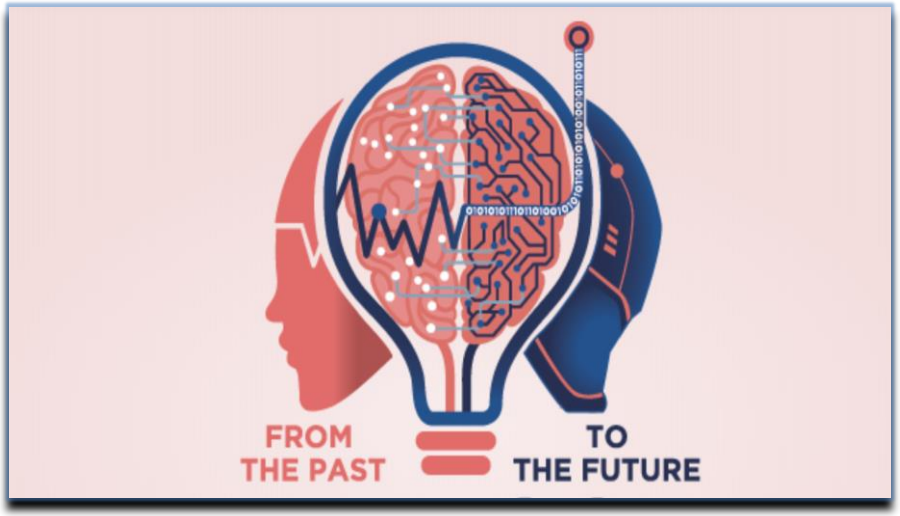
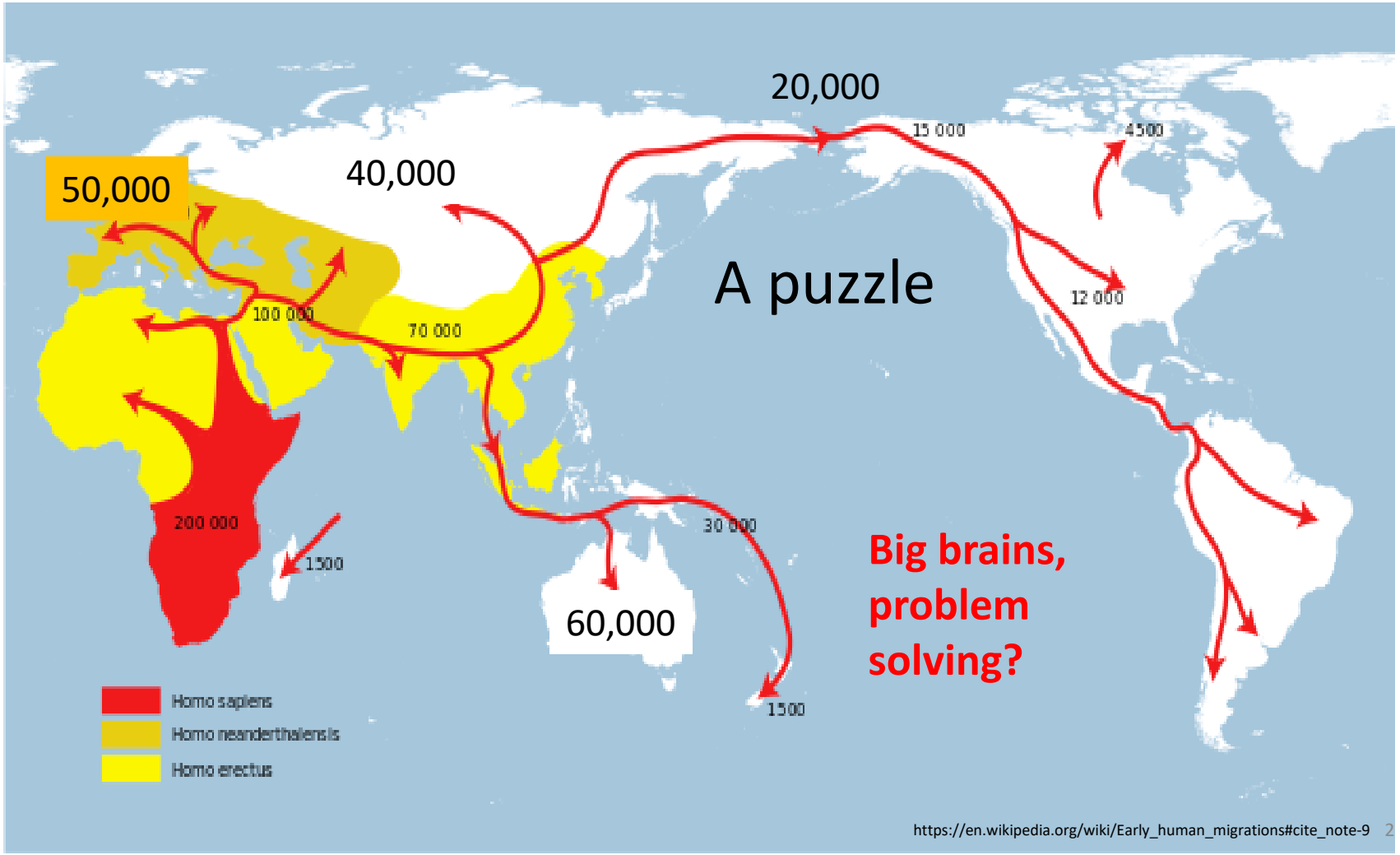
Evolving the Collective Brain



Joseph Henrich
Department of Human Evolutionary Biology
Harvard University



https://en.wikipedia.org/wiki/Early_human_migrations#cite_note-9

LOST EUROPEAN EXPLORERS

Escaped

Aboriginal Processing

- Grind, leach, heat and use mussel shell spoon
- Grind, leach, bake in ash

Poisoned and starved on a full stomach

60,000 years

What are those big brains for?

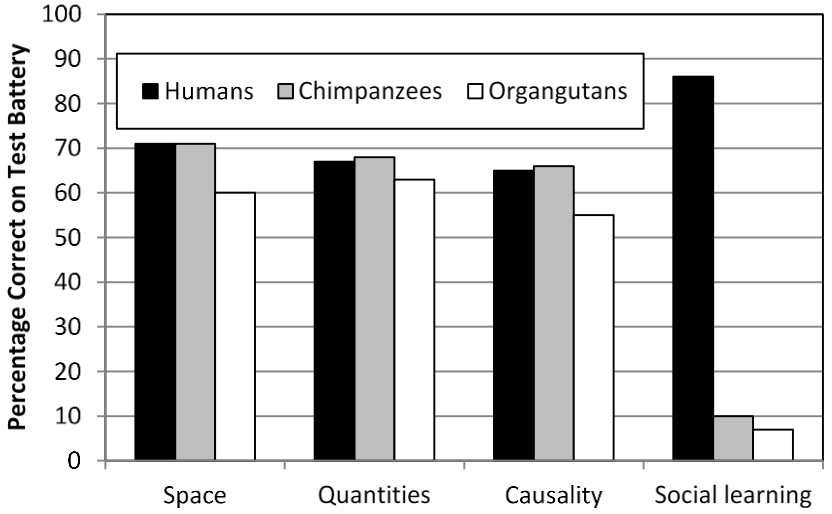
Morton Bay Chestnut

Why could any local adolescent survive easily, but Burke and Will could not?

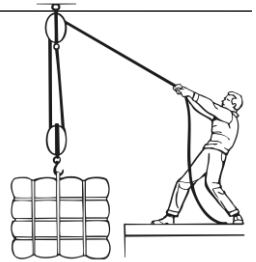
Success of humans not explained by “intelligence” relative to other apes

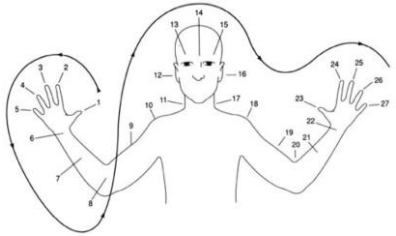
We humans get much smarter from 2.5 to 25. Apes do not. Why?

Figure 3.1: Performance on four sets of cognitive test with chimpanzees, orangutans and toddlers (data from Herrmann et. al. 2007)



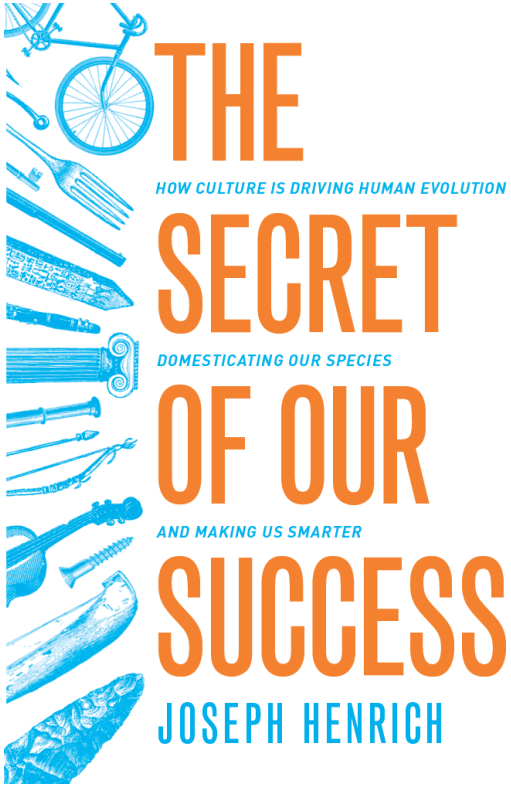
Culture makes us ‘smarter’



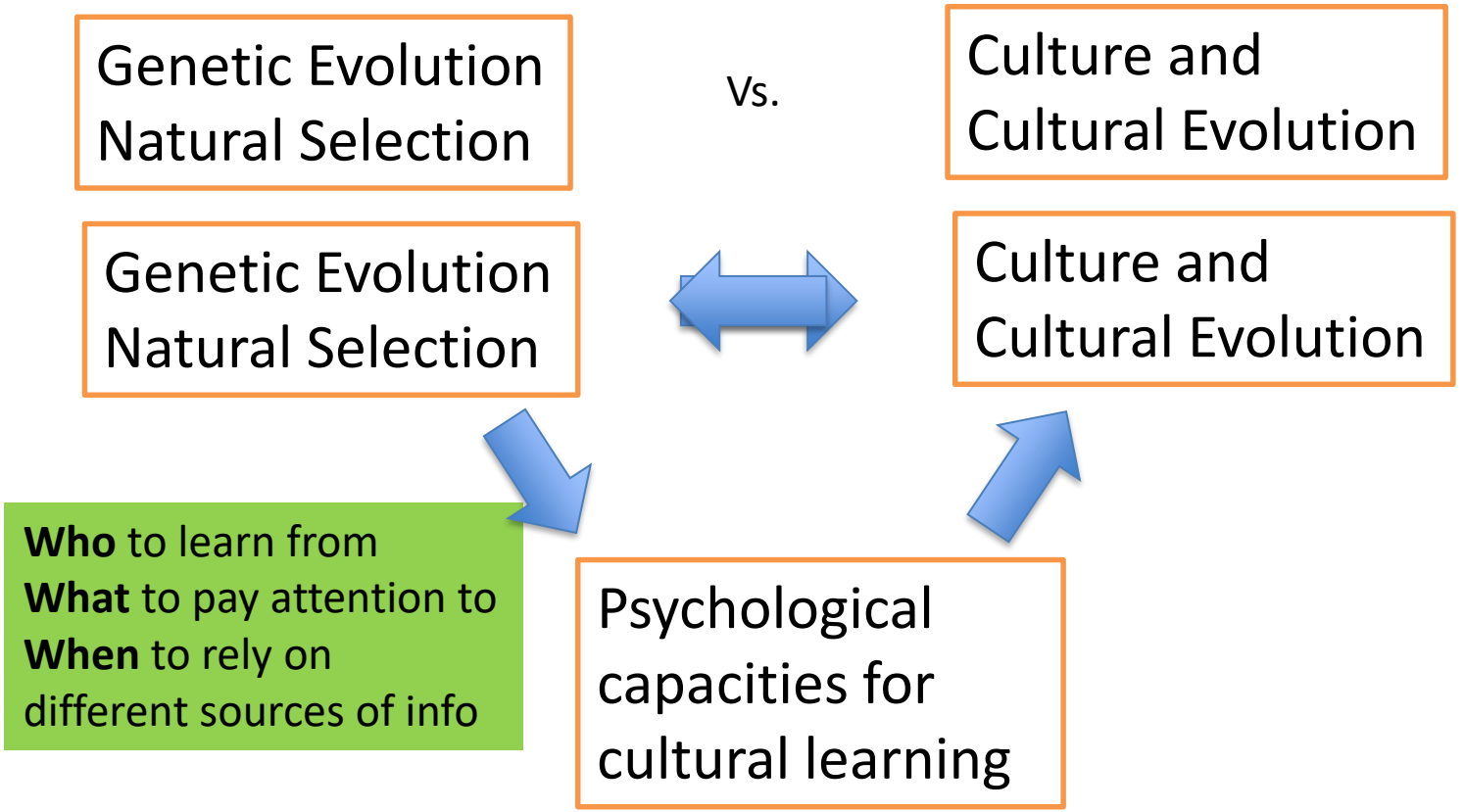


Oksapmin count to 27

Pink, circle, freedom



- It’s not our intelligence.
- Culture: we depend on cumulative bodies of cultural information—*cultural adaptations*.
- Collective Brains: larger, more interconnected populations generate more complex repertoires and larger toolkits
- Culture-driven genetic evolution


Genetic Evolution
Natural Selection
Vs.
Culture and
Cultural Evolution
Genetic Evolution
Natural Selection
Culture and
Cultural Evolution
Who to learn from
What to pay attention to
When to rely on
different sources of info
Psychological
capacities for
cultural learning

Cultural Adaptations

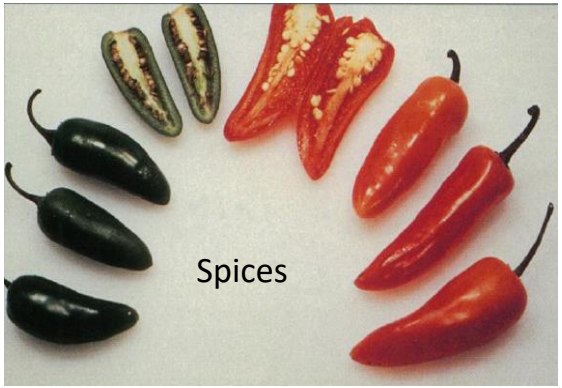
Genetic Evolution
Natural Selection

↓

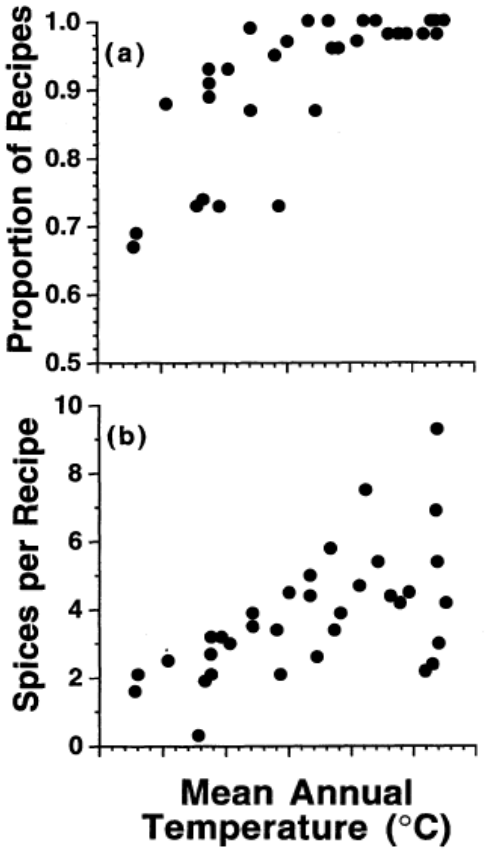
Psychological capacities for cultural learning

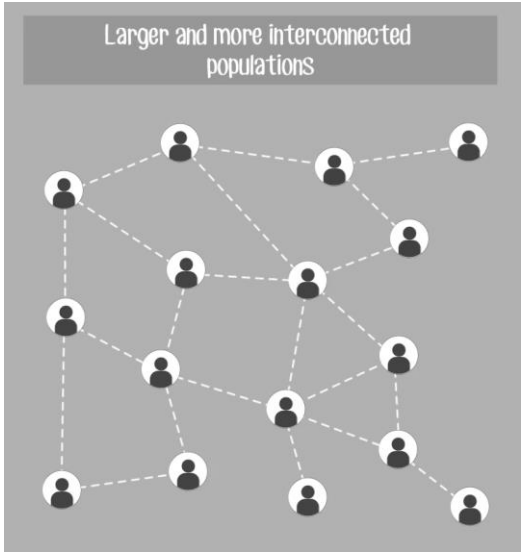
↓

Cultural Adaptations

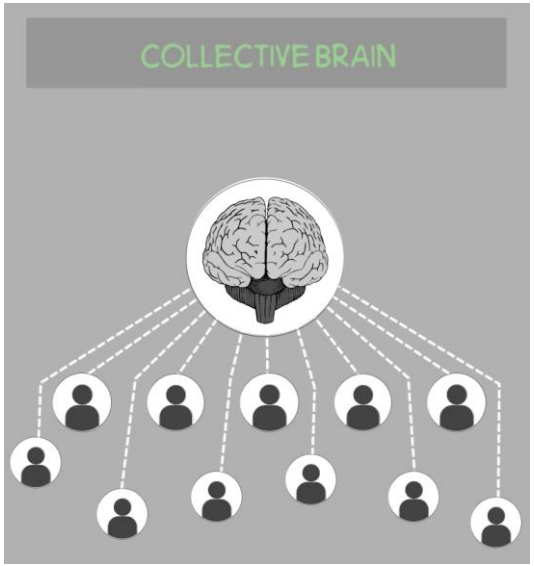


- Non-conscious
- No causal understanding
- Causal understanding negative



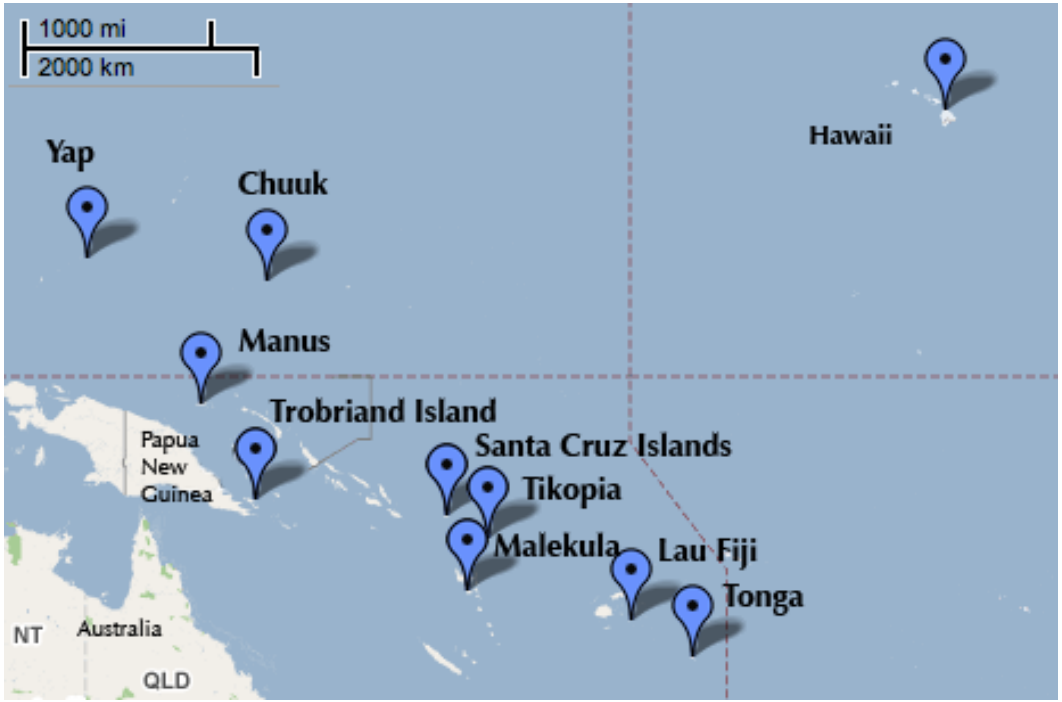


Our cultural and social natures give rise to our **collective brains**



- Collective Brains: larger, more interconnected populations generate more complex repertoires and larger toolkits
  - High fidelity cultural transmission
  - Sociality

Population Size and Tool Complexity



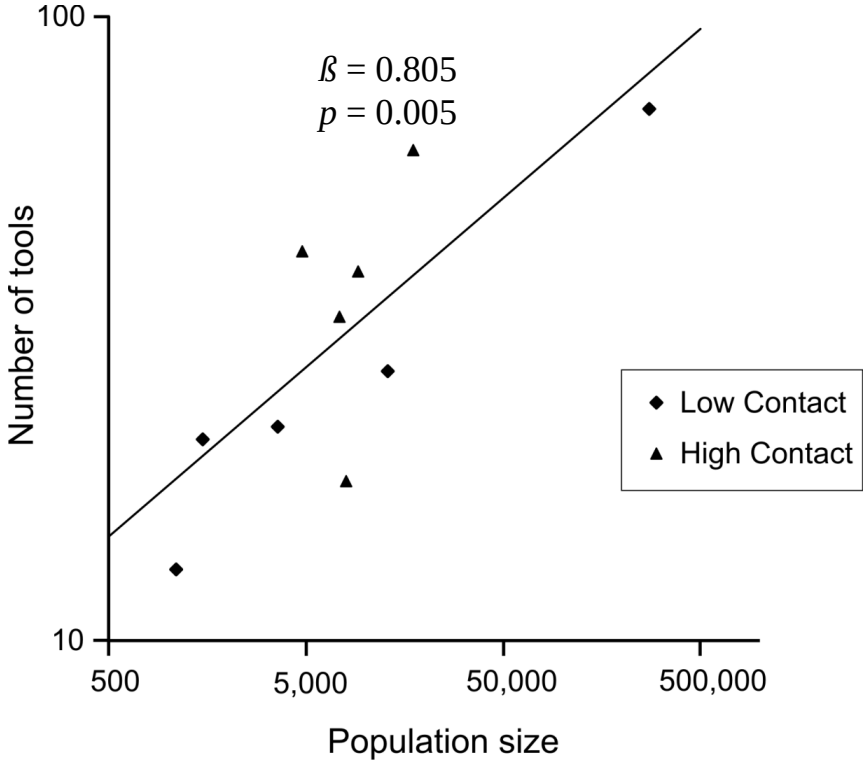
Kline and Boyd 2010

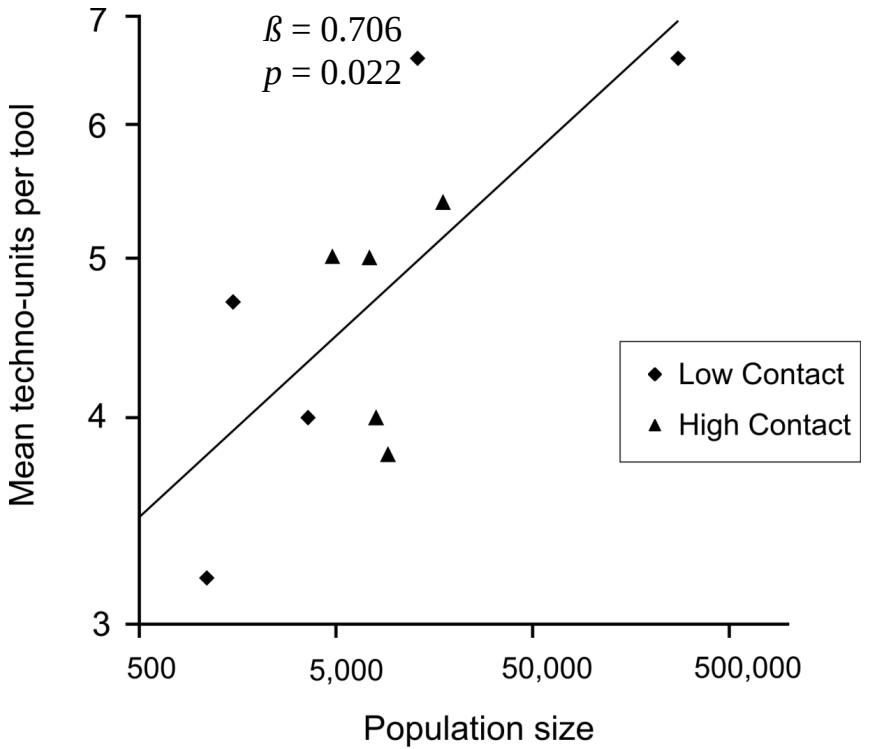
Does population predict the size and complexity of toolkits?

<u>Marine foraging</u> tool complexity

10 societies, Oceania

Technological variety and complexity



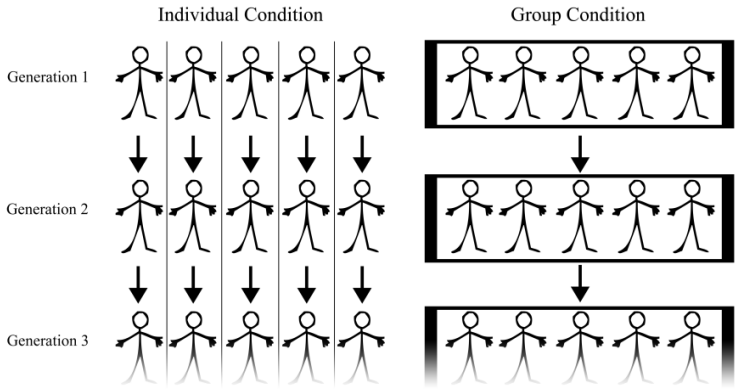


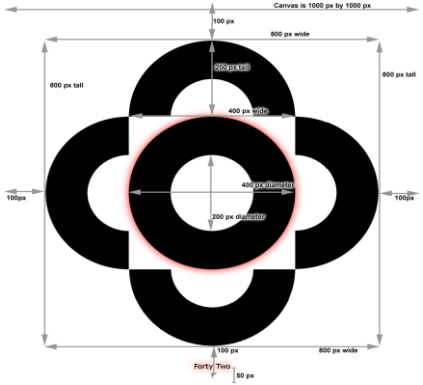
Cities in the U.S.A.

Bigger cities—>more innovations
Super-linear: each person is more likely to innovate when they live in a bigger cities

Can sociality influence skill?

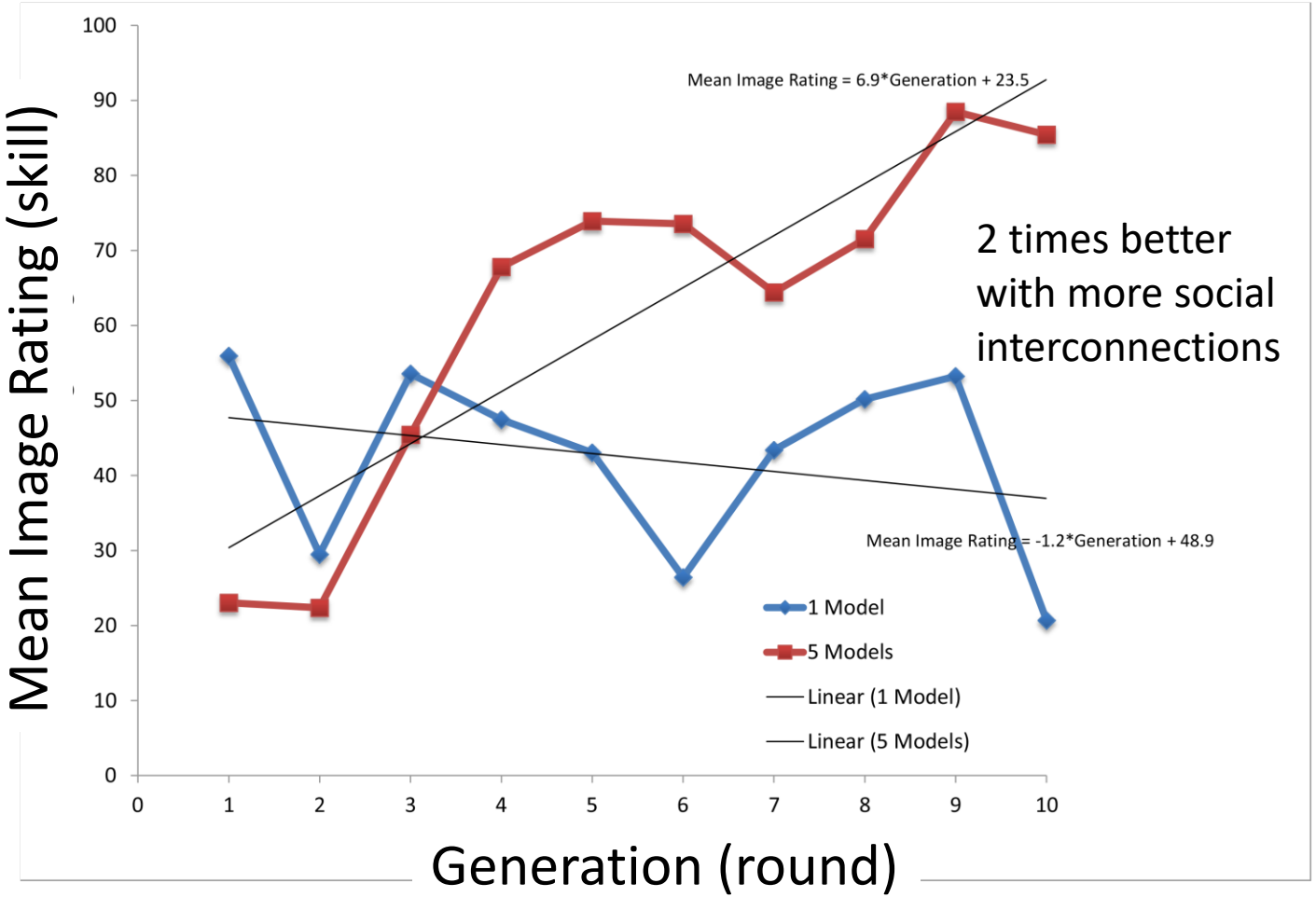
- Replicate target image
- Time limit
- Paid for own and student's performance.
- Access 1 or 5 models
- After task: can write up to 2 pages for "student"
- Next generation gets the (1) model's product, (2) write-up and (3) target



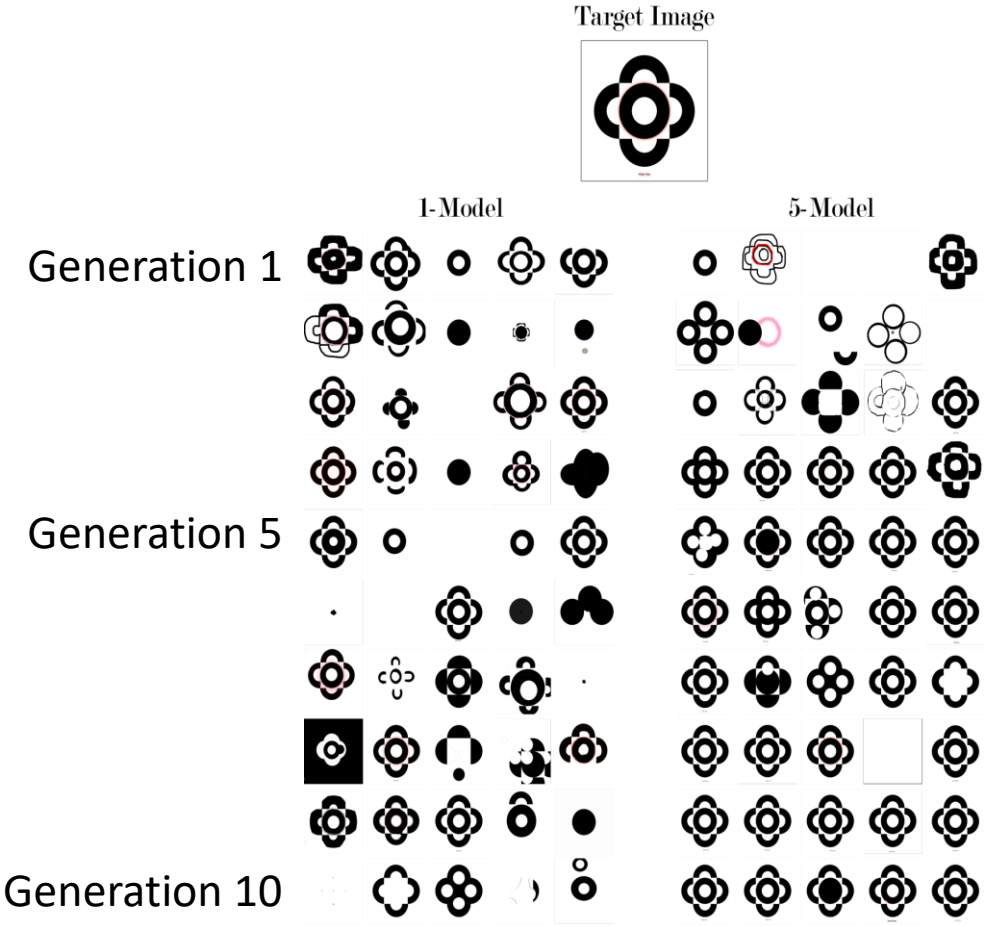


Target Image

Muthukrishna et. al. 2013


Mean Image Rating (skill)
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Generation (round)
Mean Image Rating = 6.9*Generation + 23.5
Mean Image Rating = -1.2*Generation + 48.9
1 Model
5 Models
Linear (1 Model)
Linear (5 Models)
2 times better with more social interconnections

The raw data



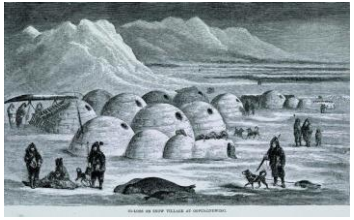
In Generation 10

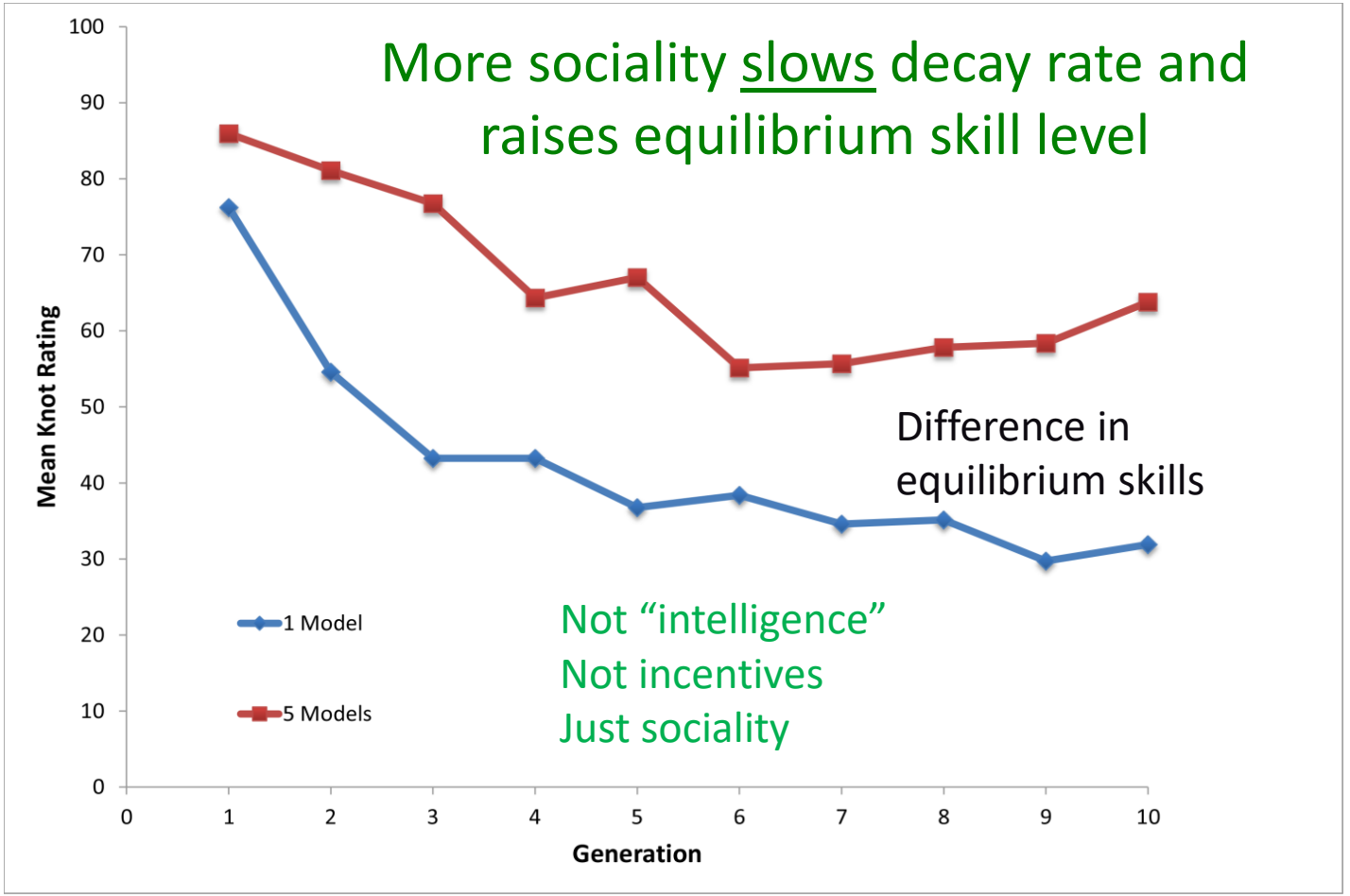
Everyone in 5-Model treatment is more skilled than the best guys in the 1-Model treatment.

Just copying the best?

- For 5 model treatment:
- Broke image down in binary elements
- Use t-1 generation ‘teachers’ elements to predict presence of elements in learners.
- Learners copied according to skill level, which meant that all ‘teachers’ had some influence except the worse.

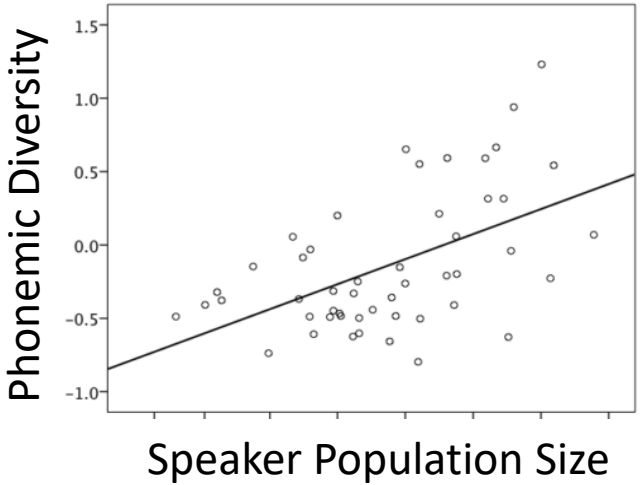
Recombination from multiple models → innovation without invention




More sociality slows decay rate and raises equilibrium skill level
Mean Knot Rating
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Generation
1 Model
5 Models
Difference in equilibrium skills
Not “intelligence”
Not incentives
Just sociality

Tools and rules for communication

- Languages are products of cultural evolution, sets of tools and rules.
- Ergo, the same predictions apply
  - Larger speaker communities have
    - ✓*More words—gain & loss*
    - ✓*More phonemes*
    - ✓*Informationally more efficient*

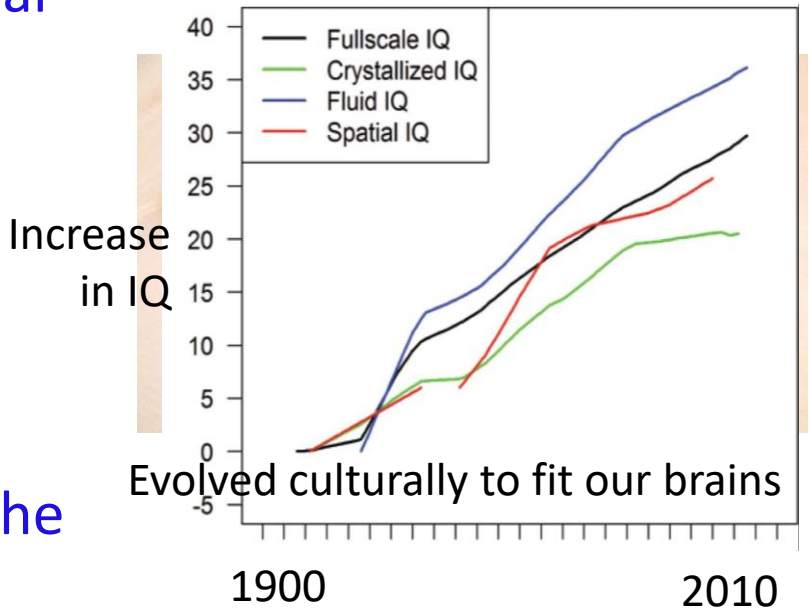


Phonemes vary from 11 to 140 across languages

Larger collective brains makes us individually smarter

Cultural practices harness innate mental capacities to yield specialized cultural-cognitive abilities.

- Spatial reference & technology
  - Left vs. Right.
  - Mental abacus—extraordinary computation abilities
- Rise in IQ in many societies over the last century.



Evolved culturally to fit our brains

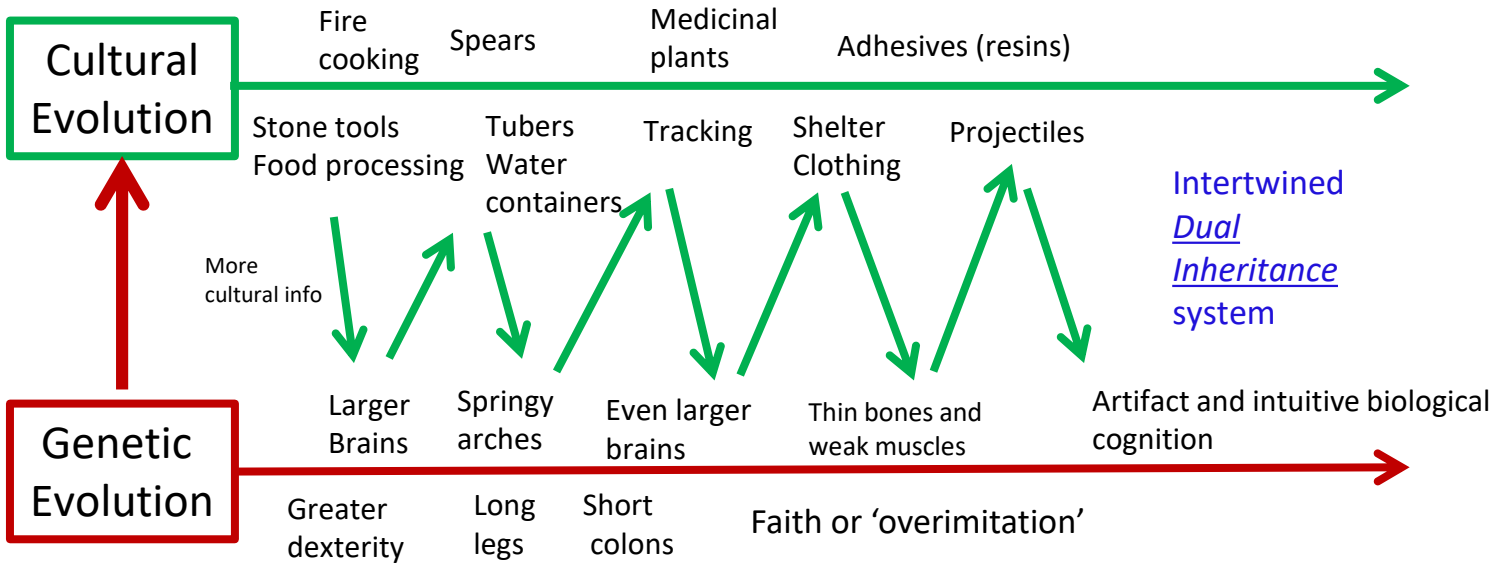
Evolving the Collective Brain

Innovation is driven by:

- The **recombination of ideas,** fueled the interaction of diverse minds
- Broader social interconnectedness and relational flexibility
- More trust in strangers, and willingness to share ideas

Culture-driven genetic evolution

Products of a long-running and ongoing culture-gene interaction



Brains for acquiring, organizing, storing and re-transmitting cultural information

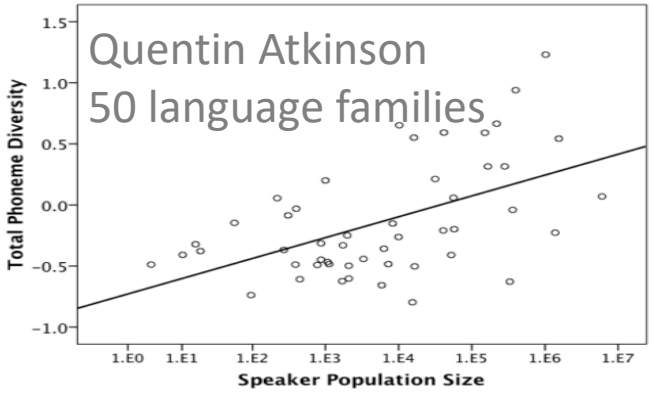
Thanks for listening

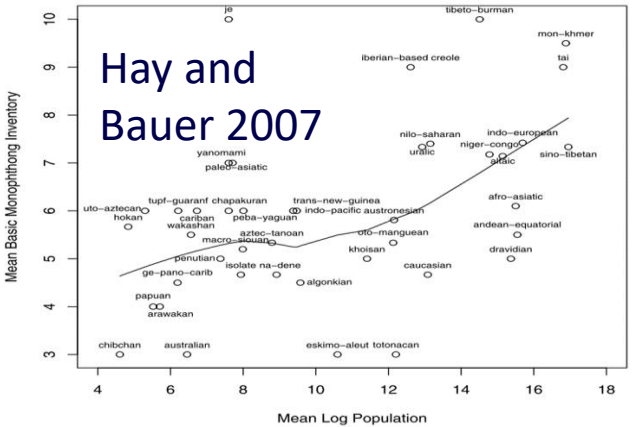
Field Evidence

- Tasmania
- Polar Inuit
- Banks Islanders

Tasmania watercraft (no paddles)

Sound (phonemes) Inventories

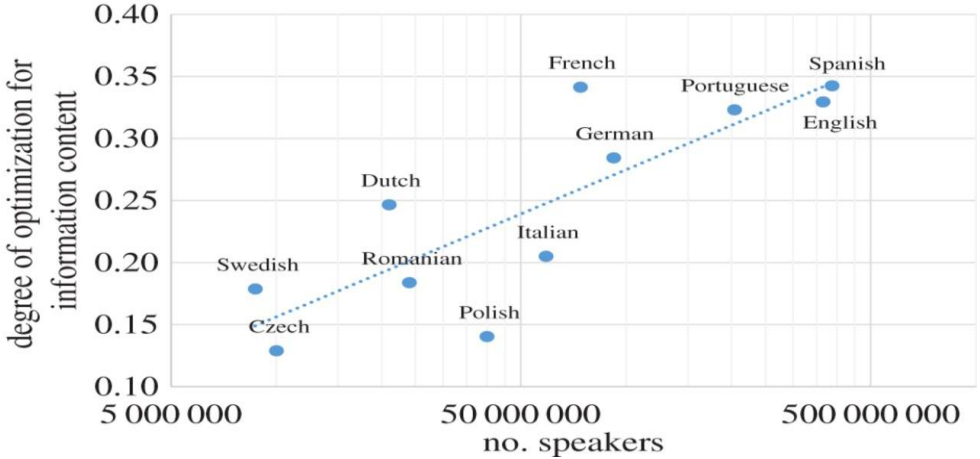




Phonemes vary from 11 to 140 across languages

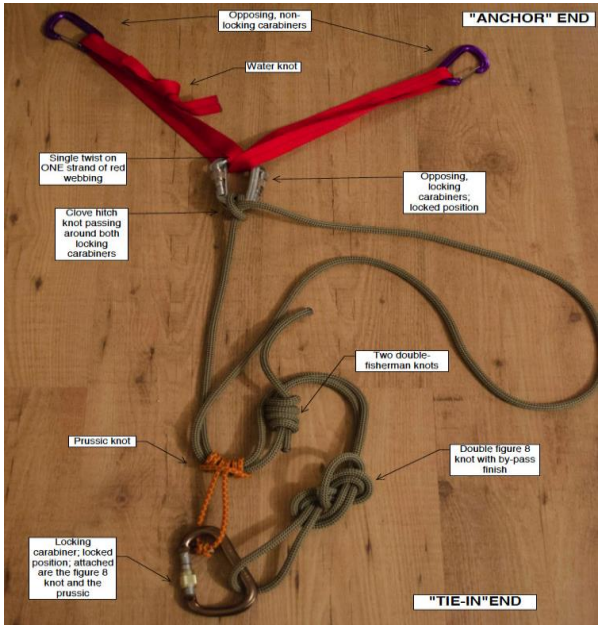
More phonemes → shorter words

WEIRDist Language: English
(most words, high IE, morpho-simple)



Experiment 2:
Experts in Generation 1

- Goal: replicate a complex series of rock climbing knots
- Time limit
- Paid for own and student's performance.
- Access 1 or 5 models
- After task: make video demonstration
- Next generation gets model score and video
- Skill = similarity to target



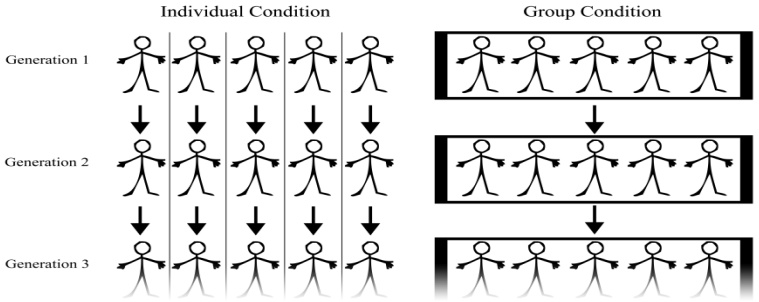


Table 3. Each row gives the standardized regression coefficients and significance values for a multiple regression in which the dependent variable is the logarithm of average number of techno-units per tool and the independent variables are the logarithm of population size and one of the alternative variables. (The coefficients for population size are large and mostly significant, whereas the coefficients for the control variables are smaller and none are close to significant. Significance values based on bootstrap analysis are larger, but show a similar pattern (see the electronic supplementary materials for detail). Models are arranged in order of best fit according to the AICc information theoretic statistic. The AICc value for a regression with only the constant is −2.91.)

	β	significance		β	significance	AICc	AICc weight
population	0.514	0.143	standard deviation rainfall per year	−0.321	0.337	−4.33	0.05504
population	0.727	0.026	mean maximum cyclone wind speed	−0.205	0.453	−4.27	0.05355
population	0.907	0.048	mean rainfall per year	0.274	0.494	−4.26	0.05317
population	0.798	0.029	effective temperature	0.201	0.511	−4.25	0.05301
population	0.828	0.038	sum of maximum wind speeds for all cyclones	−0.203	0.551	−4.24	0.05270
population	0.715	0.030	contact	−0.144	0.600	−4.23	0.05238
population	0.702	0.033	importance of fishing	−0.103	0.710	−4.22	0.05215
population	0.732	0.030	latitude	−0.127	0.652	−4.22	0.05209
population	0.757	0.036	total cyclones	−0.120	0.694	−4.21	0.05189
population	0.632	0.093	fish genera	0.128	0.705	−4.21	0.05186
population	0.670	0.052	mean number of rainy days per year	−0.096	0.747	−4.20	0.05171
population	0.722	0.039	publications	−0.044	0.883	−4.19	0.05137

Effect of Log (N) on mean techno-units holds up to many controls