The impact of frequency on the evolution of category systems

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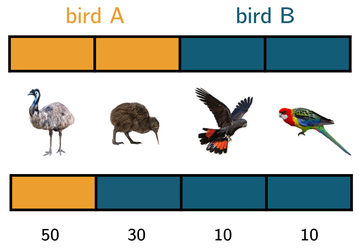
Information theory

Having a category boundary is like getting one question about the structure of the world for free.



A "good" system divides the possibilities in half.

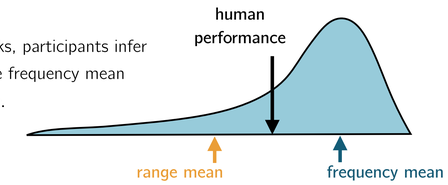
A "bad" system doesn't.

But the underlying frequency distribution affects the optimal placement of category boundaries.

Range-frequency theory

People don't perform at the information-theoretic optimum.

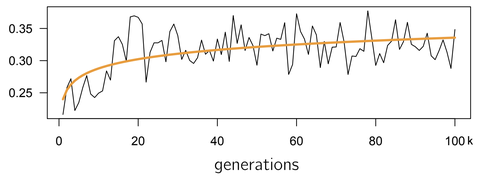
Parducci (1968):
Across a wide variety of categorization tasks, participants infer boundaries located somewhere between the frequency mean and the mean of the category labels' range.
We don't really know why.



Evolution and information

Evolving populations acquire information about their environment via natural selection. (e.g. Bergstrom & Rosvall 2009, Adami 2012, Ferdinand *in prep*)

mutual information between environment and organism types



Learning and evolution are similar: (Harper 2009, Shalizi 2009, Ferdinand 2018) both are methods of extracting information from environments.

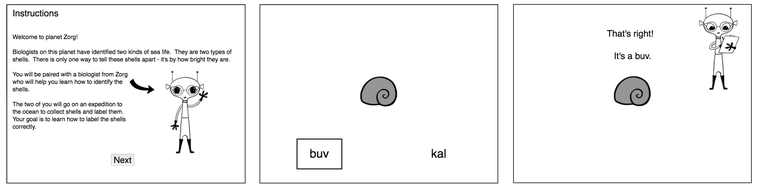
One way environments contain info is in different object frequencies:

$H($  $) = 2.85\ bits$ $H($  $) = 3.32\ bits$

Do individual learning and cultural evolution play different roles in getting environmental information into category systems?

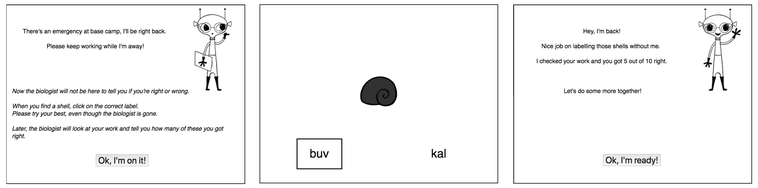
Experimental Design

Training with feedback (30 trials)

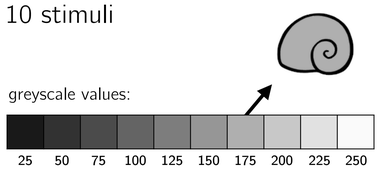


Testing without feedback (10 trials)

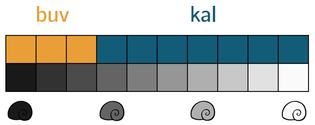
Next round...



10 stimuli

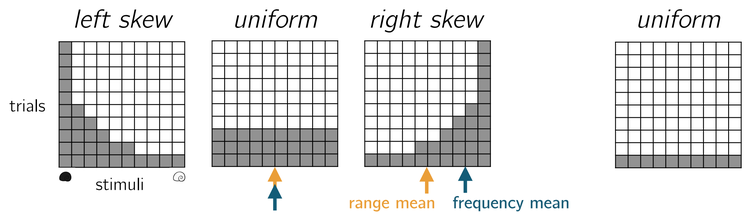


Example test responses

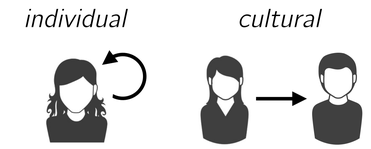


3 training distribution conditions

1 testing distribution



2 transmission conditions



trained on own testing responses from previous round

trained on the testing responses of a previous participant

Participants

297 recruited on Mechanical Turk

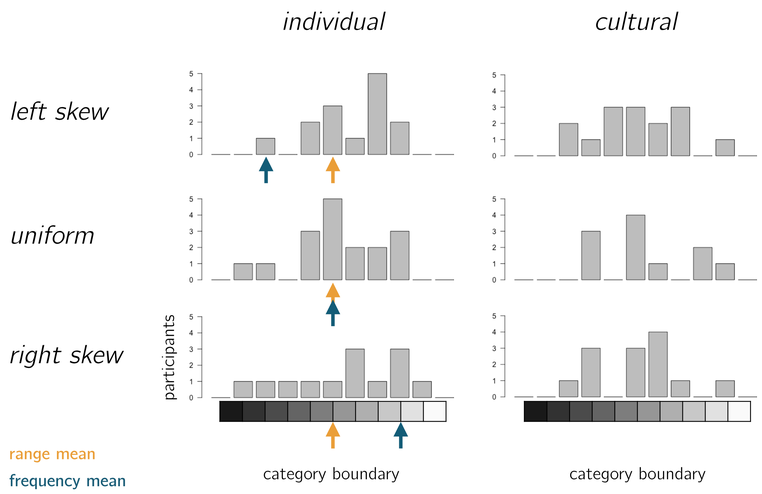
90 *individual* participants
207 *cultural*, in 45 transmission chains

Ran participants until convergence (or until an individual did 8 rounds)

642 mappings (i.e. rounds) obtained
124 of those were converged mappings

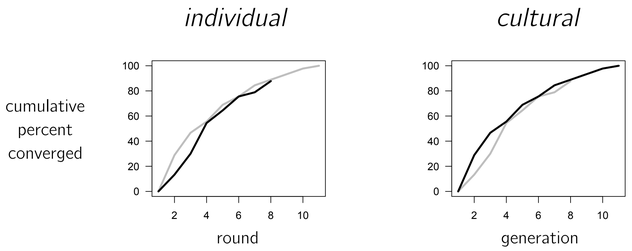
Main question

Do different frequency distributions and type of evolutionary regime affect category boundary location?



Other results

How long did it take participants to converge on a mapping?



What type of mappings did participants converge on?

	total	*individuals*	*chains*
regular 	83	44 (53%)	39 (47%)
irregular 	41	35 (85%)	6 (15%)