Online Experiments for Language Scientists

Lecture 8: Iterated learning

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Final chance for questions on undergrad assessment 1 (annotated bibliography)

Drop-in labs for help with final assessment (coding project, due 5th December)

- Times on https://kennysmithed.github.io/oels2024/
- We can help with basic coding stuff
- No questions after 10am on Monday 2nd December (other than in drop-ins)
- **Bring questions about this assessment to next week's lecture (be aware: I am travelling 25th to 30th November, responses to emailed questions may be delayed)**

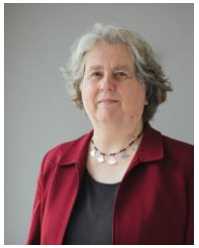
Beckner et al (2017)

Beckner, C., Pierrehumbert, J., & Hay, J. (2017). The emergence of linguistic structure in an online iterated learning task. *Journal of Language Evolution, 2*, 160–176.

An iterated artificial language learning experiment

- Does compositional structure emerge ‘for free’ from person-to-person transmission?

Clay Beckner
(now at Warwick)



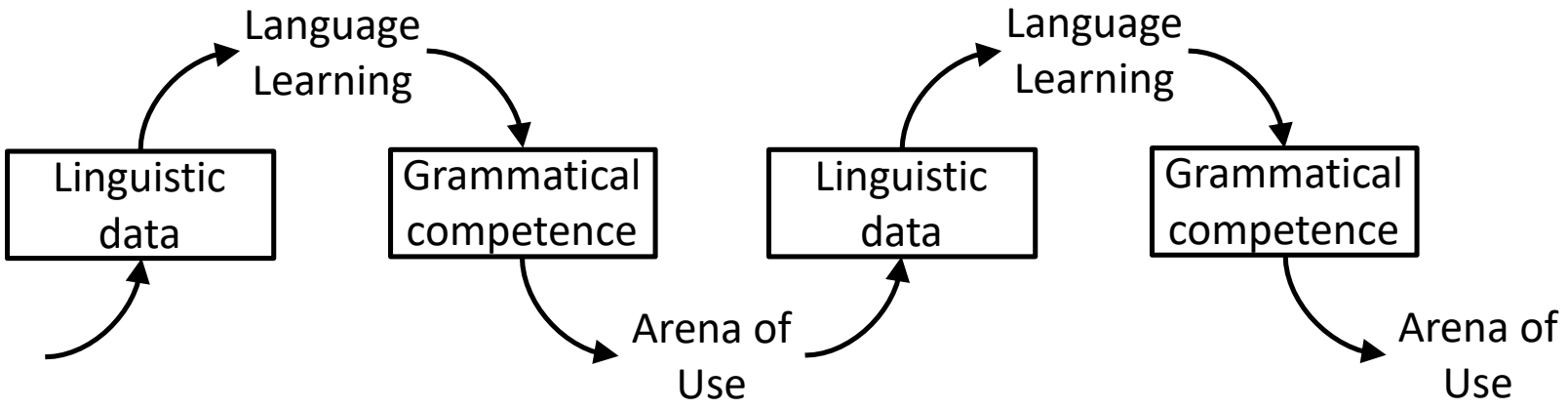
Janet Pierrehumbert
(Oxford)

Jen Hay
(Canterbury, NZ)

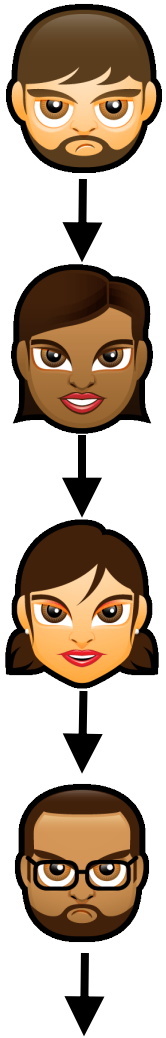
Language is transmitted via repeated **learning** and **use**

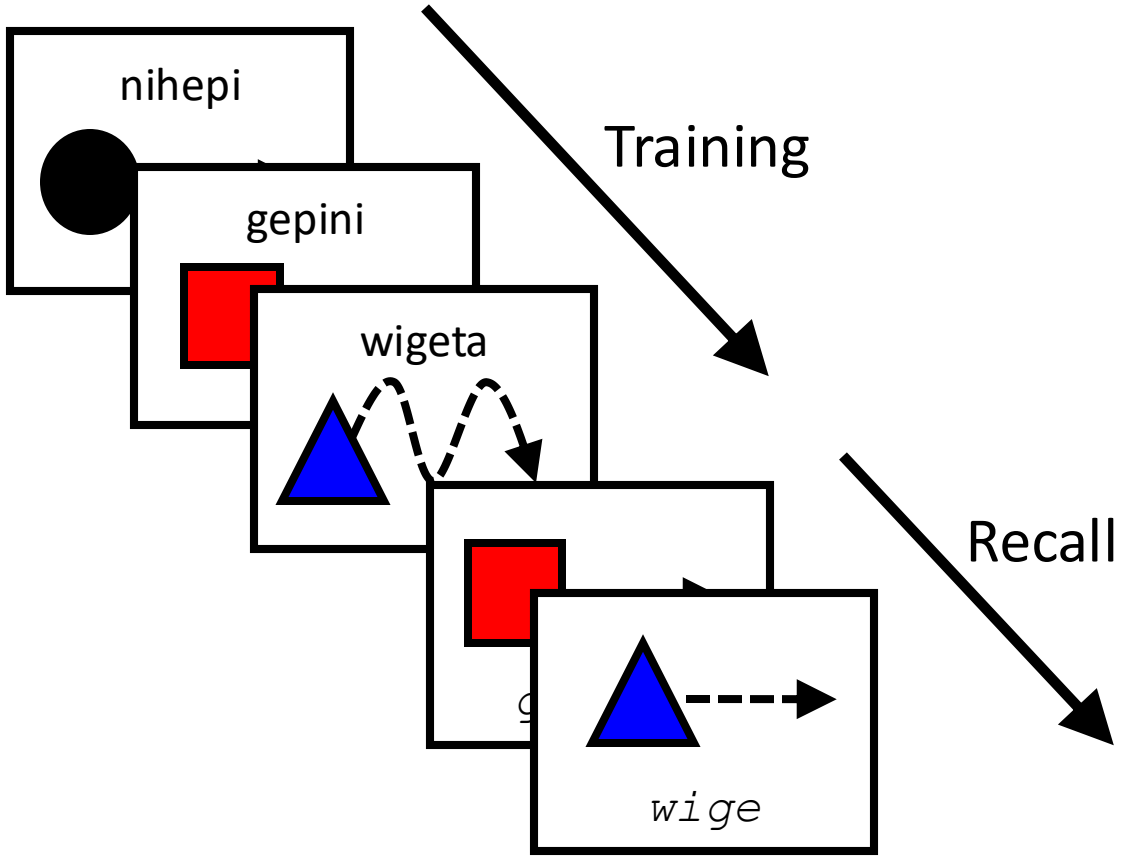
Language is shaped by these processes

The cycle of learning and use produces structure



Iterated learning



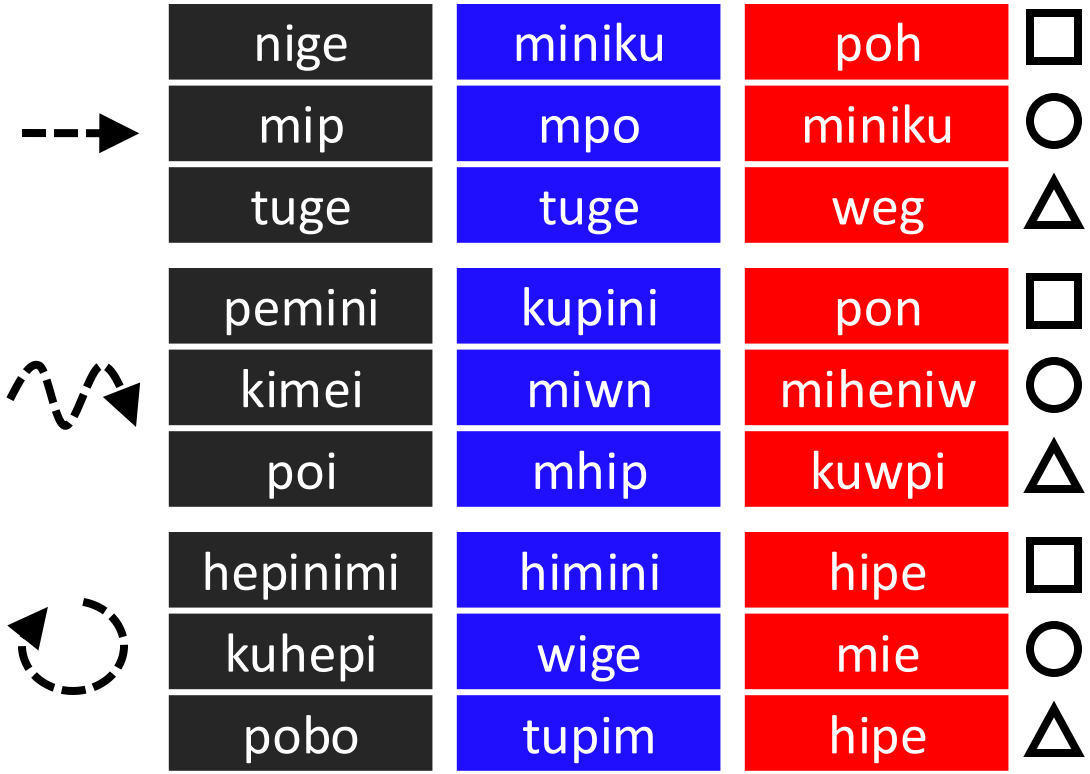


Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *PNAS, 105,* 10681-10686.

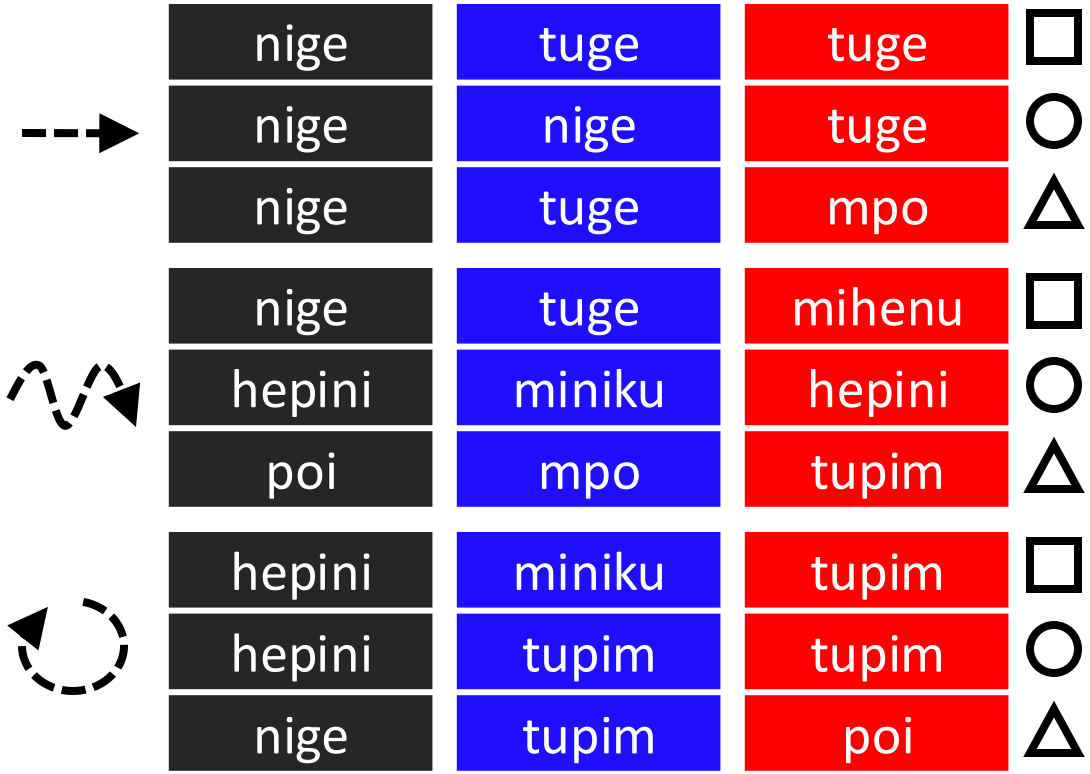
Demo using this week’s practical code

Initial **holistic** language from chain 4

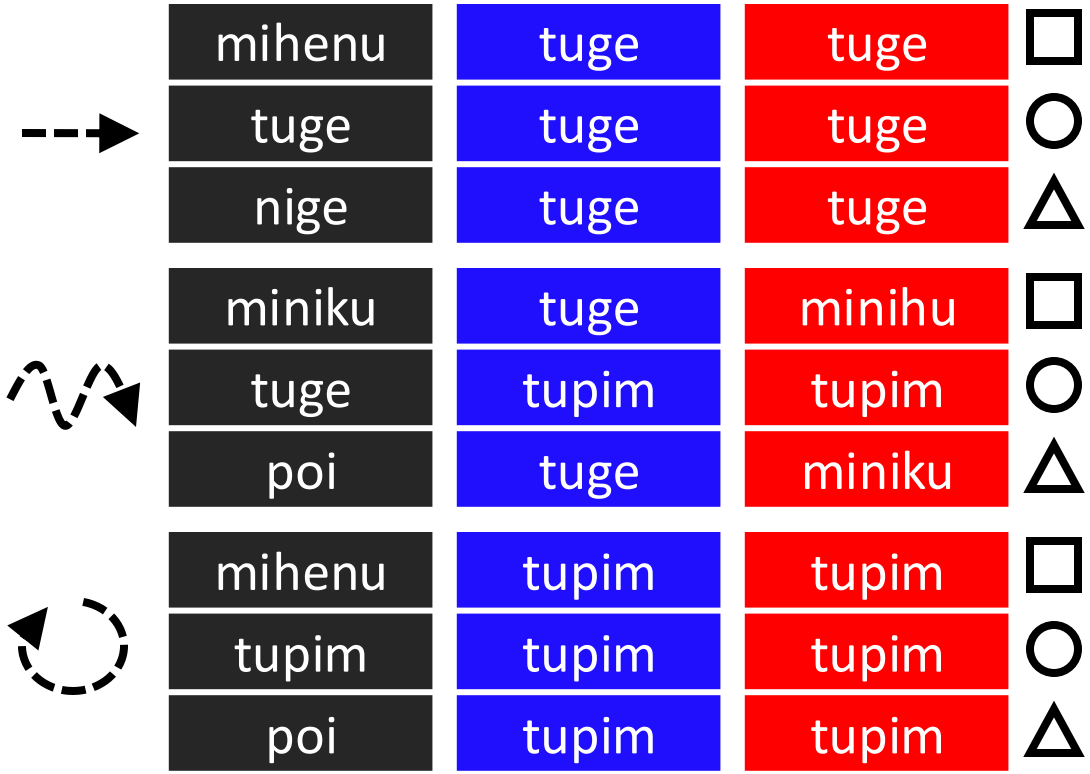
Generation 1 language from chain 4



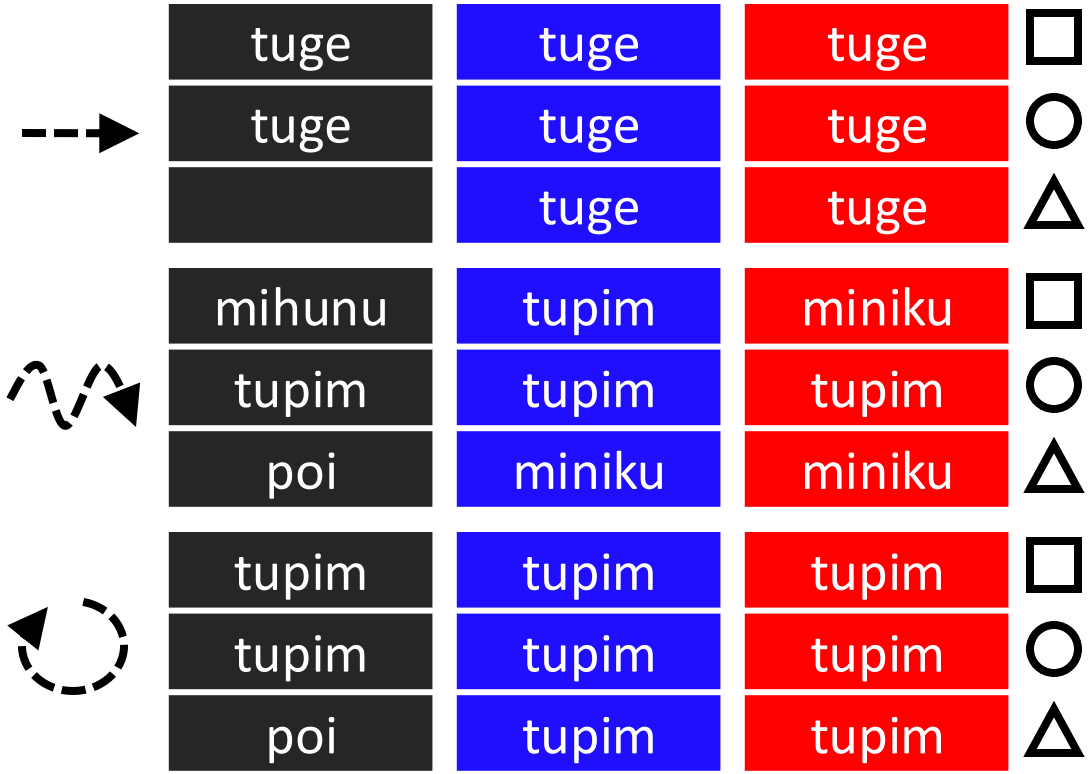
Generation 2 language from chain 4



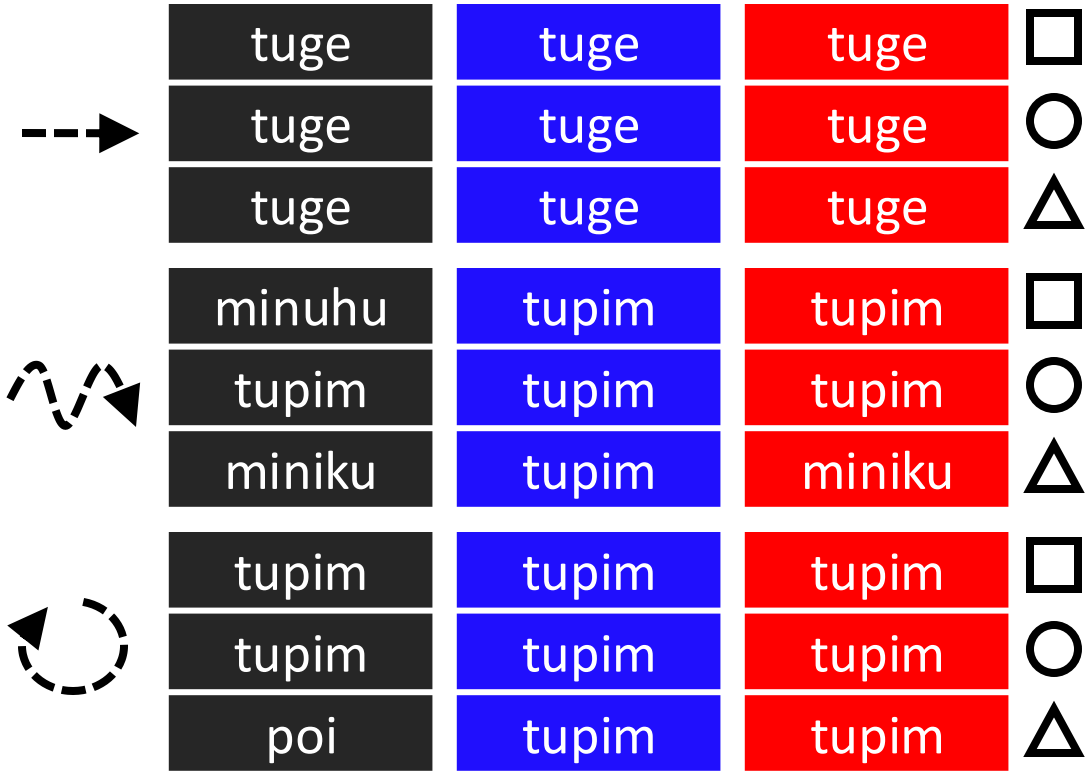
Generation 3 language from chain 4



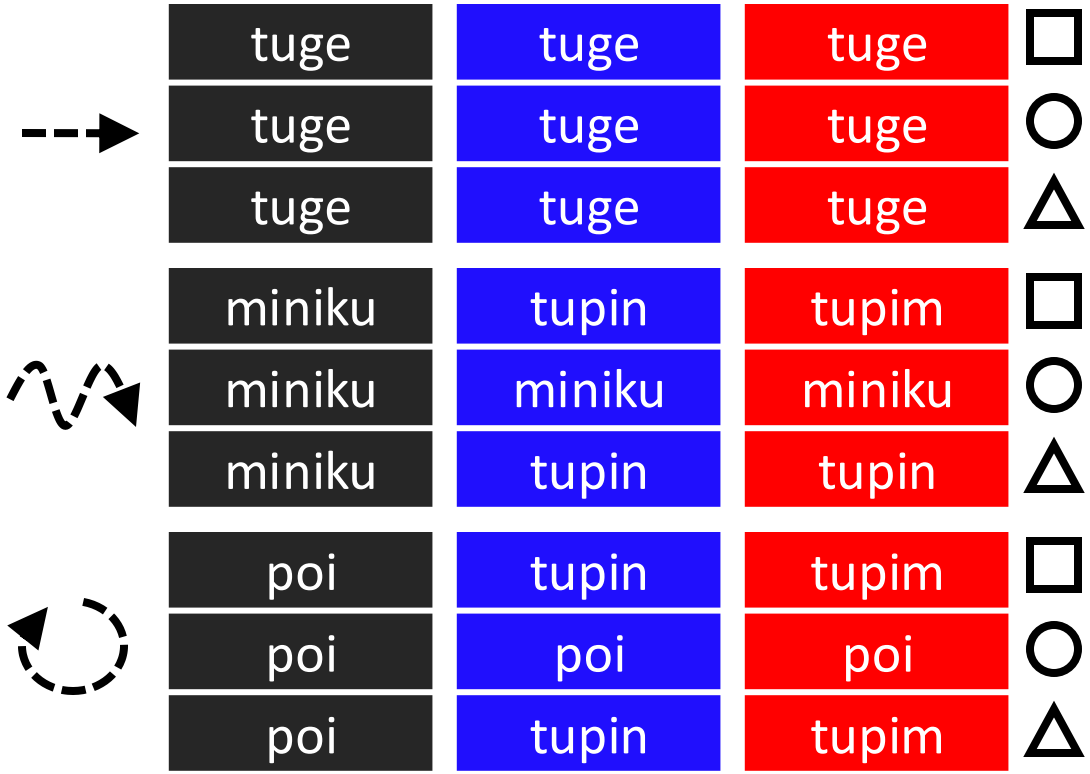
Generation 4 language from chain 4



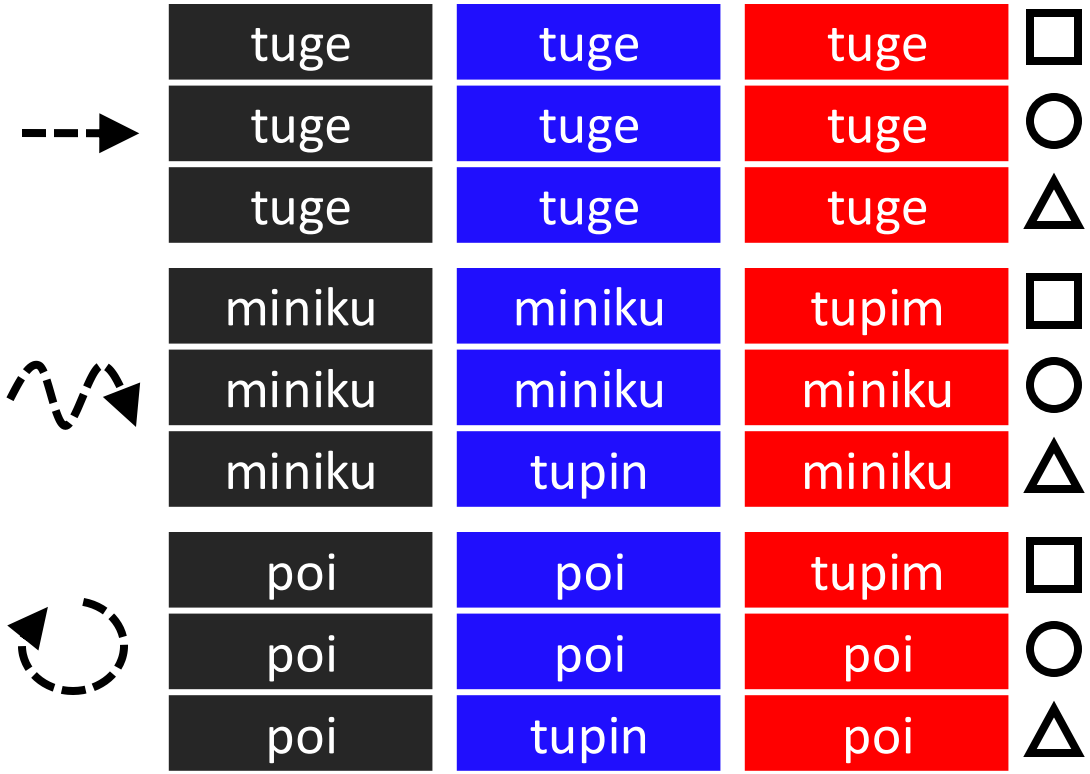
Generation 5 language from chain 4



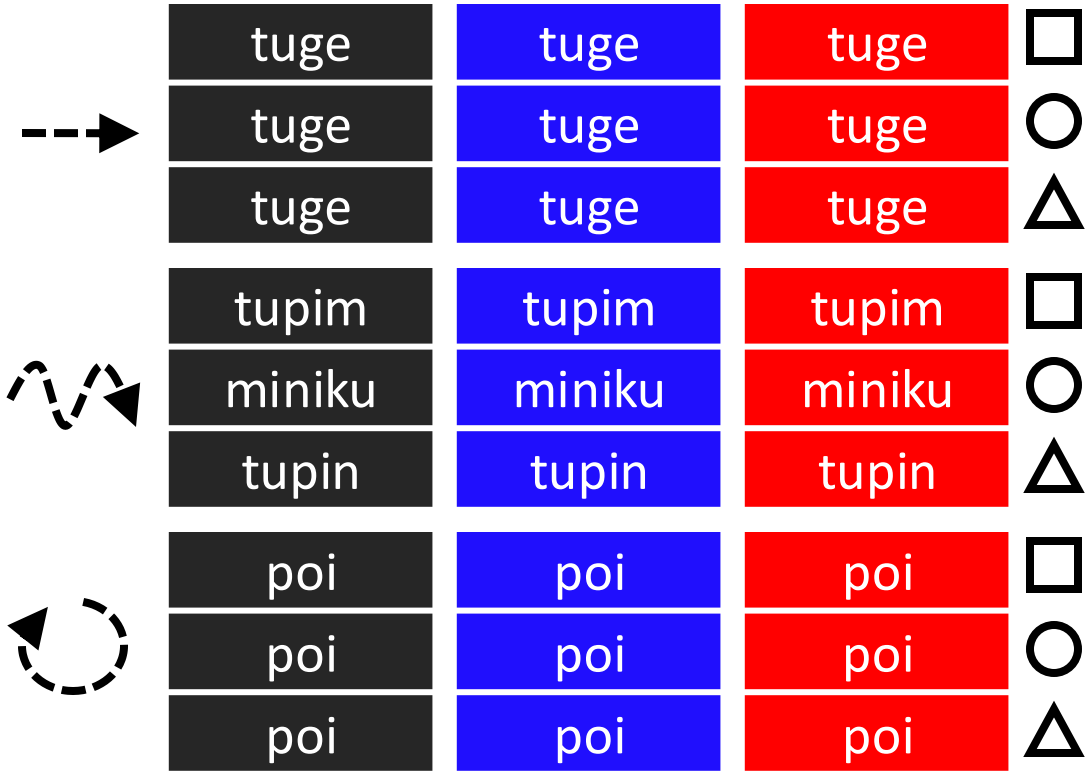
Generation 6 language from chain 4



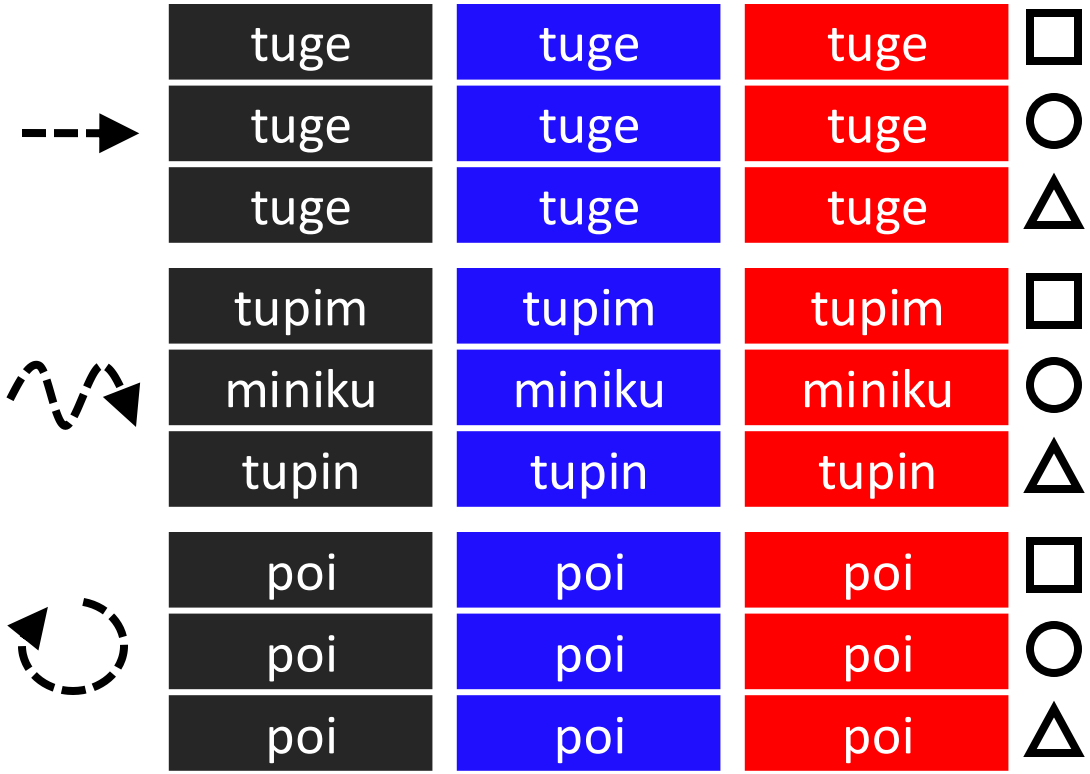
Generation 7 language from chain 4



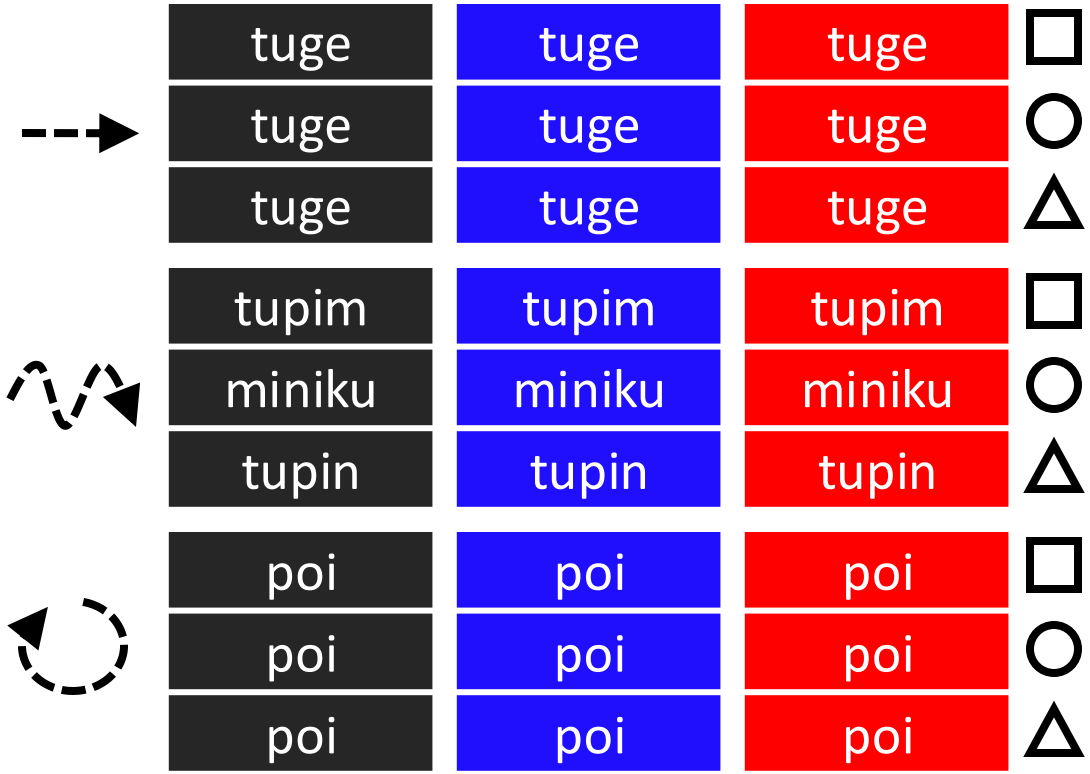
Generation 8 language from chain 4



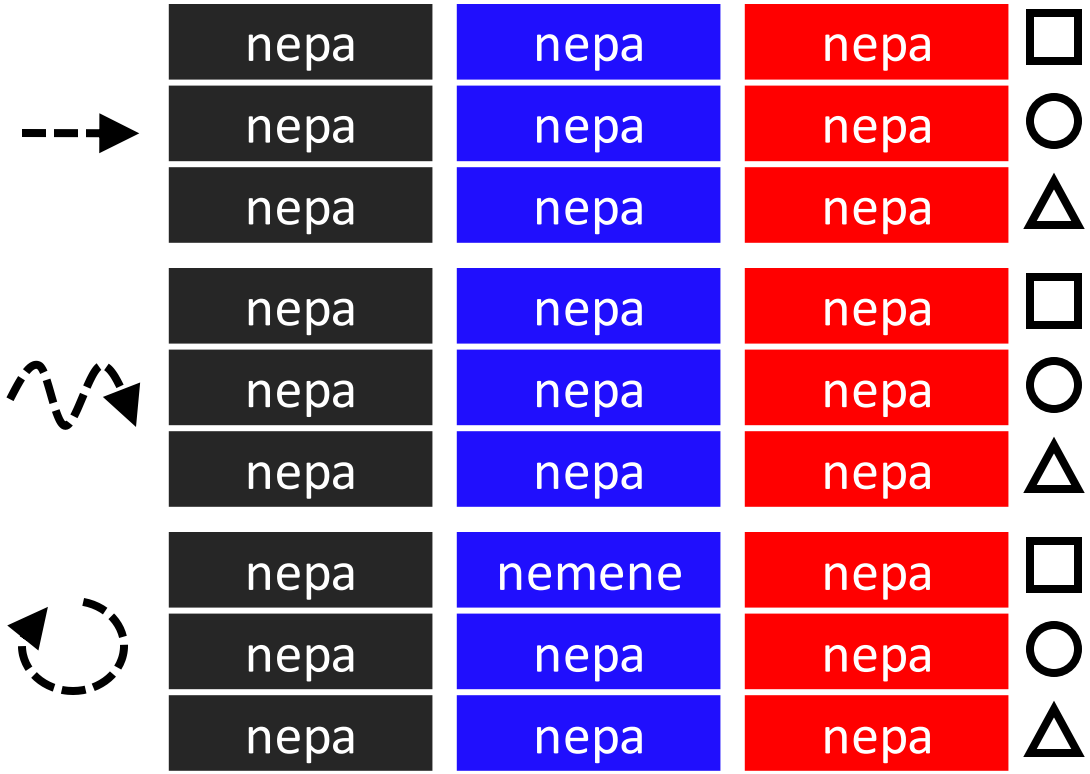
Generation 9 language from chain 4



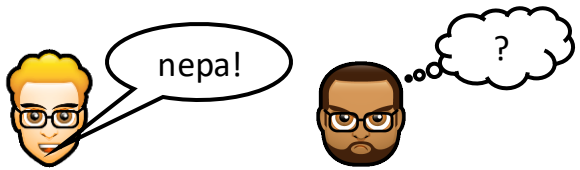
Generation 10 language from chain 4



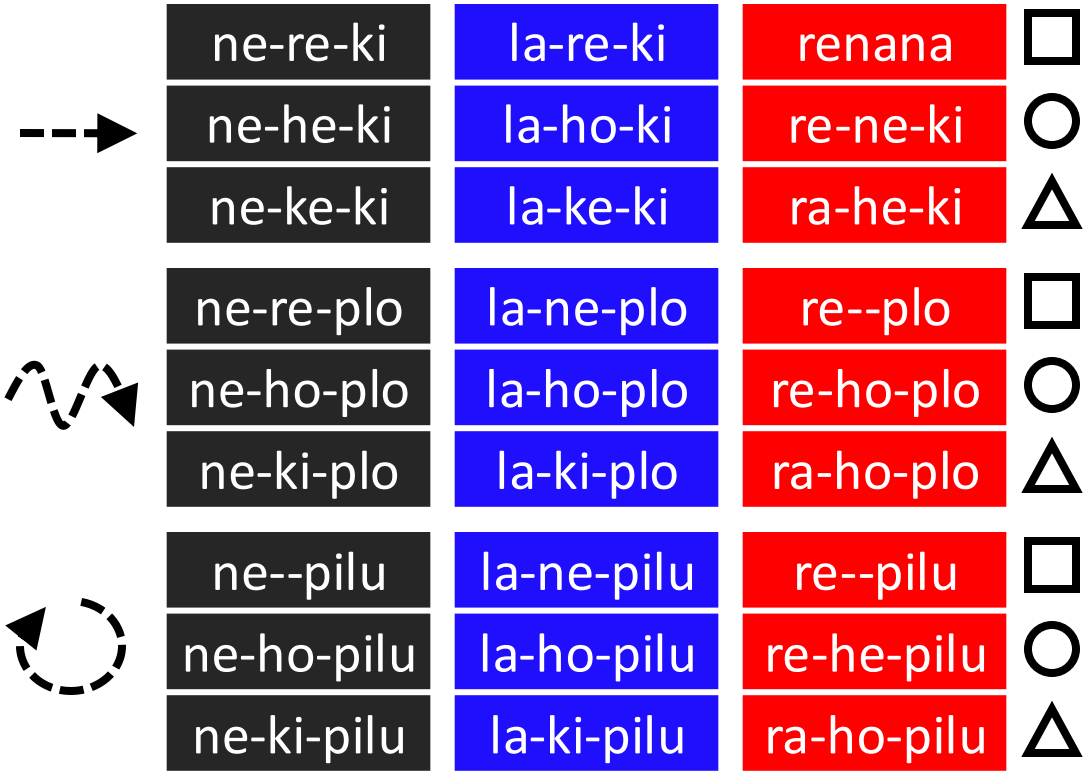
Final language from chain 1 (!)



The languages become **degenerate**



Generation 9 language from chain 5 (with homonymy filter)



Beckner et al. (2017)

Reanalysis/gentle roasting of Kirby, Cornish & Smith (2008)

- Our sample size was tiny
- Our statistics were rudimentary
- They find an interesting (?) difference between semantic dimensions

Replication

- Participants recruited from MTurk
- N=240 (2 conditions, 12 chains per condition, 10 participants per chain)
- 22-25 minutes, paid $3

Measuring structure

“the dog chew-ed the bone” – “the dog lick-ed the bone”

Meaning distance = 1 (predicate)

Signal distance = 1 (verb stem)

“the dog chew-ed the bone” - “the dog lick-s the bone”

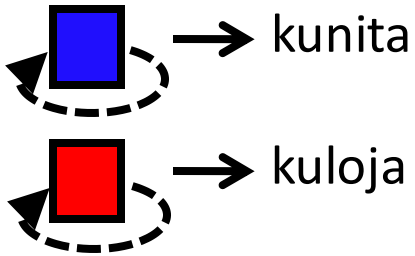
Meaning distance = 2 (predicate, tense)

Signal distance = 2 (verb stem, suffix)

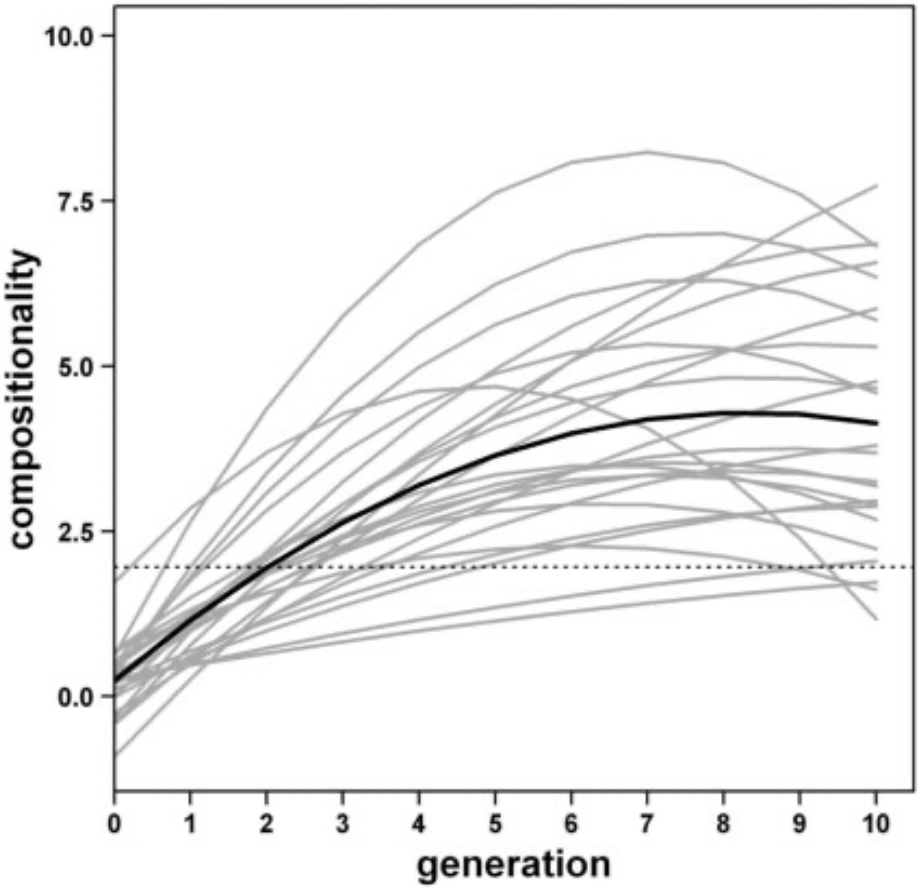
Pairwise meaning and signal distances will be highly correlated in a compositional system: similar meanings map to similar signals (and dissimilar meanings map to dissimilar signals)

Measuring structure

- For every pair of meaning-signal pairs
  - Measure meaning distance (Hamming distance)
  - Measure signal distance (Levenshtein string-edit distance)
  - Correlate these distances
- Evaluate statistical significance of that correlation
  - Randomise label assignments, recalculate measure, repeat 1000 times to give distribution
  - Calculate z-score of veridical correlation



Meaning Distance = 1
Signal distance = 3



	‘red’	‘green’	‘blue’	
‘berry’	shen-to	shen-ta	shen-to	‘1’
	shen-tra	shen-tro	shen-tra	‘2’
	shen-trio	shen-trio	shen-trio	‘3’
‘key’	div-tro	div-tro	div-tro	‘1’
	dev-tro	dev-tro	dev-etrio	‘2’
	dev-stra	div-stra	dev-stra	‘3’
‘phone’	lolni-tro	lolni-tro	lolni-to	‘1’
	lolne-stra	lolni-tro	lolne-stro	‘2’
	lolni-tra	lolni-stra	lolni-stra	‘3’

Beckner et al.’s conclusions

Iterated learning **does** produce structure

- Our 2008 result replicates with a proper sample size
- The method also works online…
- … but for this kind of challenging task, MTurk data is noisier?

Time for Q&A/discussion on this week’s reading

Next up

Lab

- Iterated learning, manipulating CSVs and looping trials

Next week

- Real-time interaction, Zipf’s Law of Abbreviation