Predicting lexical stability in an artificially learnt language

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Overview

- Lexical stability

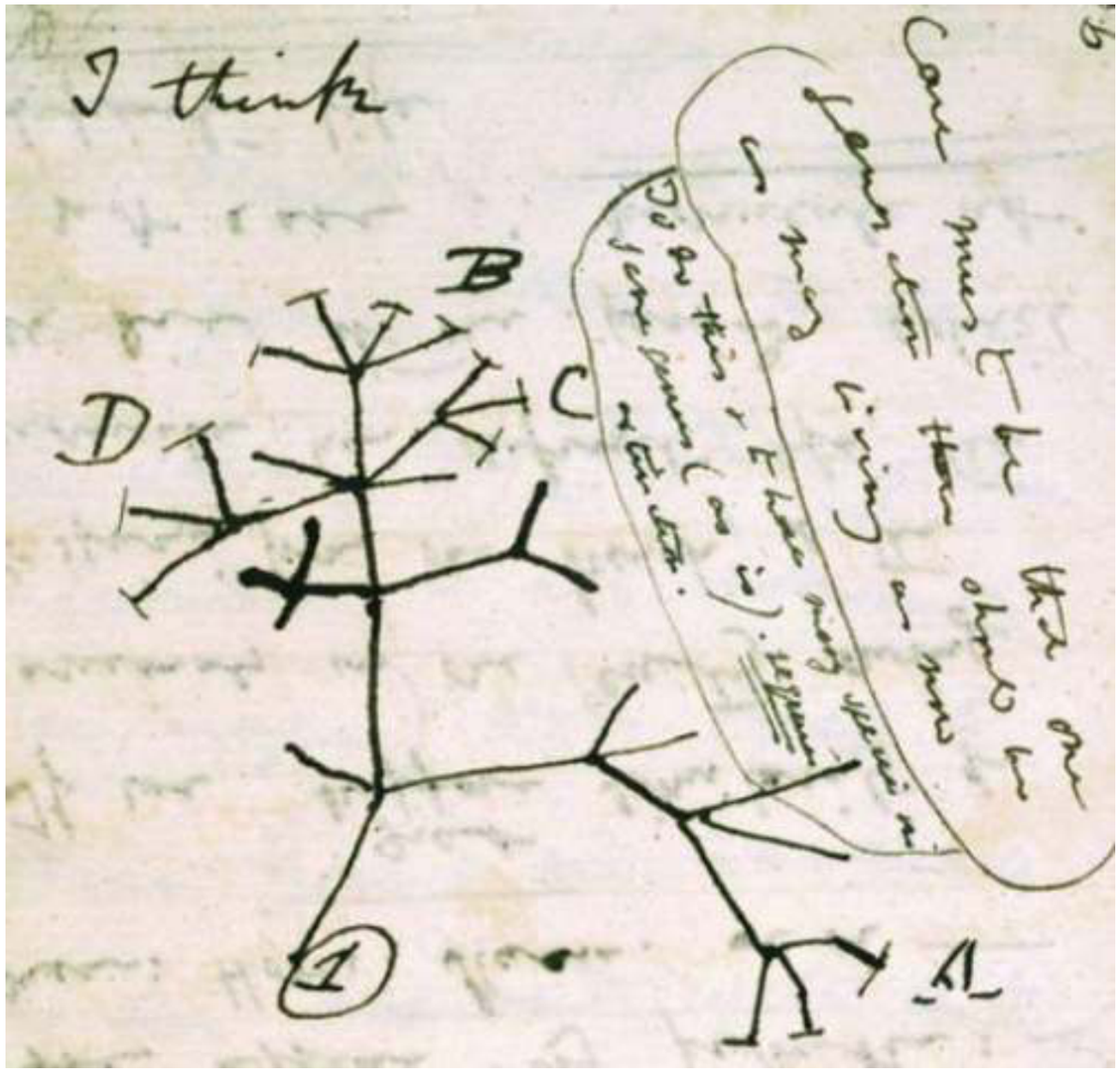
- Background

- Experiment 1
  - One shot learning
  - Types of change

- Experiment 2
  - Cultural transmission
  - Structural change

- Conclusions

Background



Background

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Background

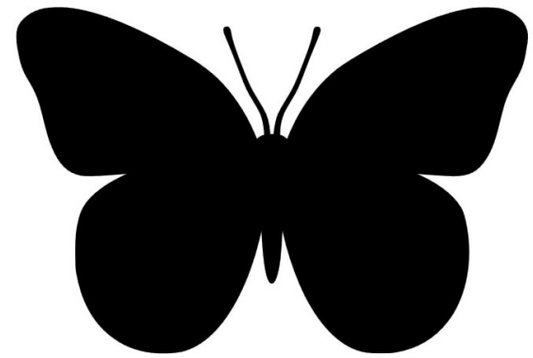
butterfly

πεταλούδα

Schmetterling

papillon

mariposa



Background

- Evidence
- Using Swadesh list of fundamental lexical items to measure rates of cognate replacement in Indo-European languages

	Less stable	More stable	
Frequency	Low	High	Pagel, Atkinson & Meade (2007) Monaghan (2014) Vejdemo & Hörberg (2016)
Phonological length	Long	Short	Monaghan (2014)
Age of Acquisition	Later	Early	Monaghan (2014)

Background

- Evidence
- Diachronic studies
- Lieberman et al (2007) high frequency verbs tend not to adopt regular past tense suffix –*ed*, whilst low frequency verbs undergo more dramatic changes
- Bybee & Thompson (1997) dropping of final phonemes in high frequency words

Hypotheses

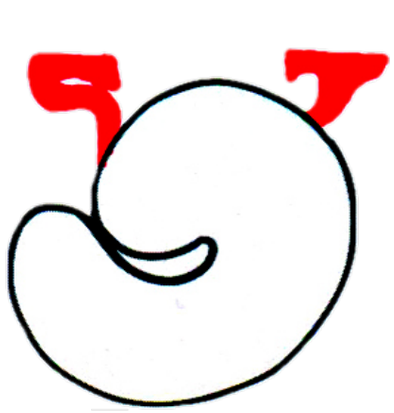
- Higher frequency words will be more accurately recalled than lower frequency words
- High frequency words will experience small adjustments
- Low frequency words will experience dramatic replacement

Experimental design

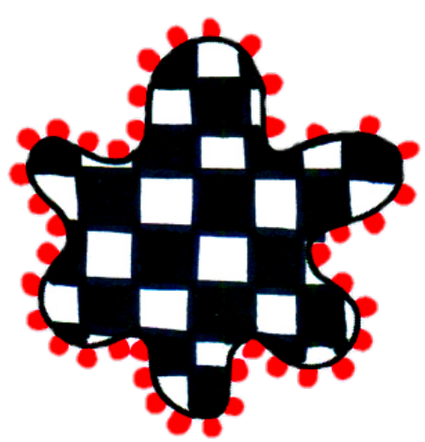
- Artificial language learning experiment
- Participants trained on a set of non-sense words, each paired with a unique meaning
- Manipulate the frequency of exposures during training
- After training, they are tested on production

Experimental design

- Non-words generated from 8 consonants and 5 vowels
- No duplicated syllables within a word
- Meanings vary along two dimensions - shape and texture fill

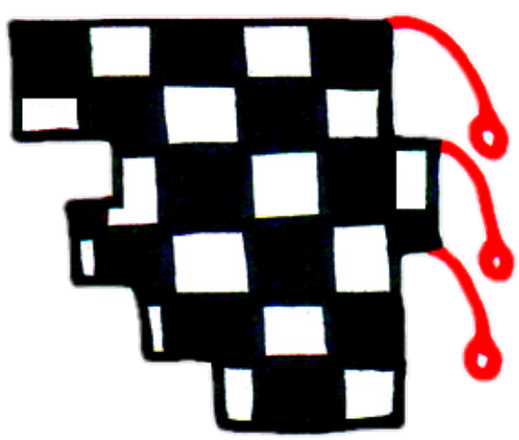


gahemi



hekipo

kilonu



lenoga

Experimental design

- Each frequency condition has 4 form-meaning mappings, each word is 6 letters long

Block	Low	Medium	High
1	1	3	6
2	1	3	6
3	1	3	6
Total	3	9	18

120 presentations

Analysis

- Dependent variable – Levenshtein distance:

- Error measurement based on the difference between two sets of words, matching characters in each position

- Example

Input = Antwerp
Response = Antwerk

Levenshtein distance = 1

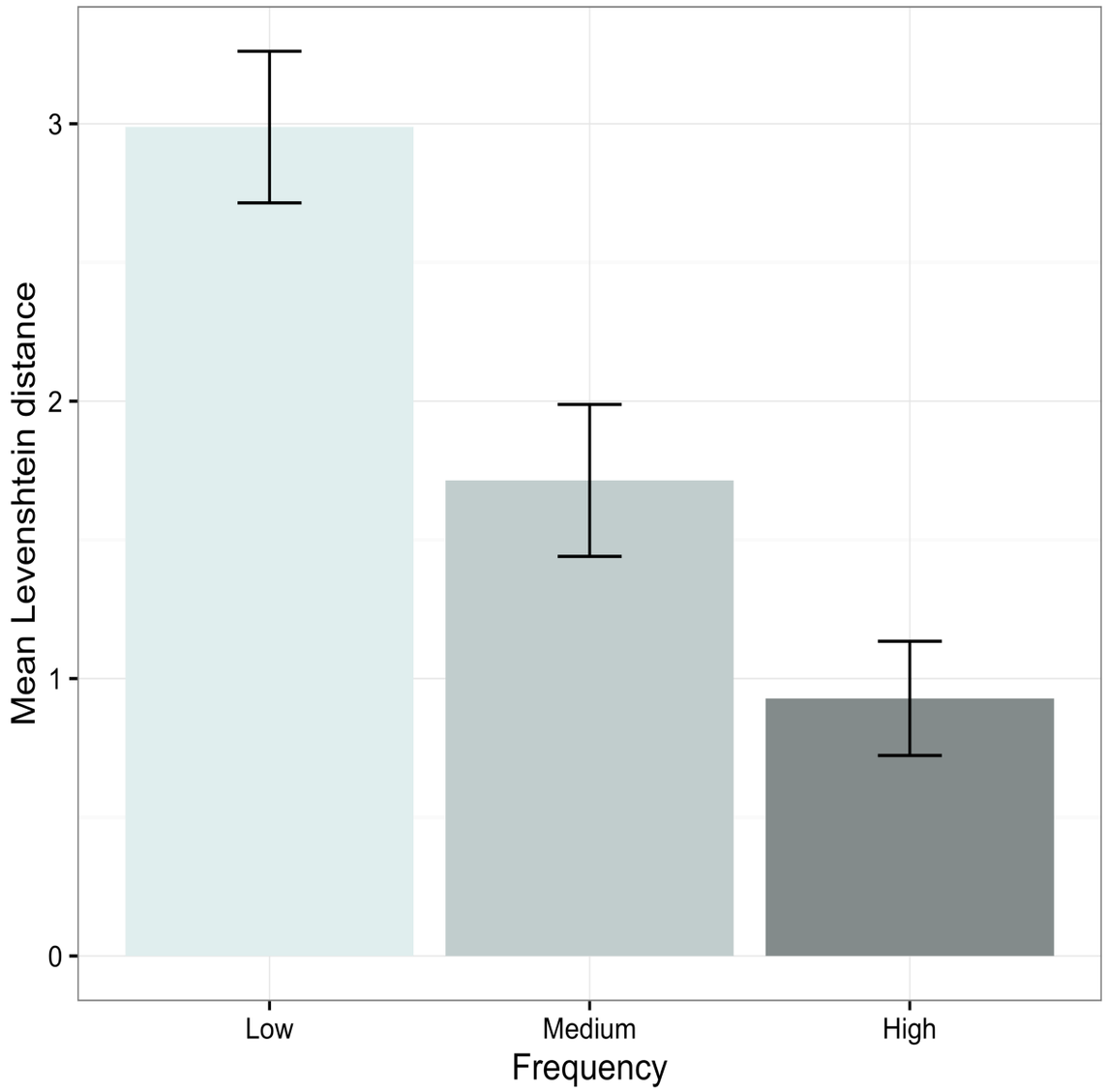
Results

- Lmer Results:

Significant linear relationship for frequency

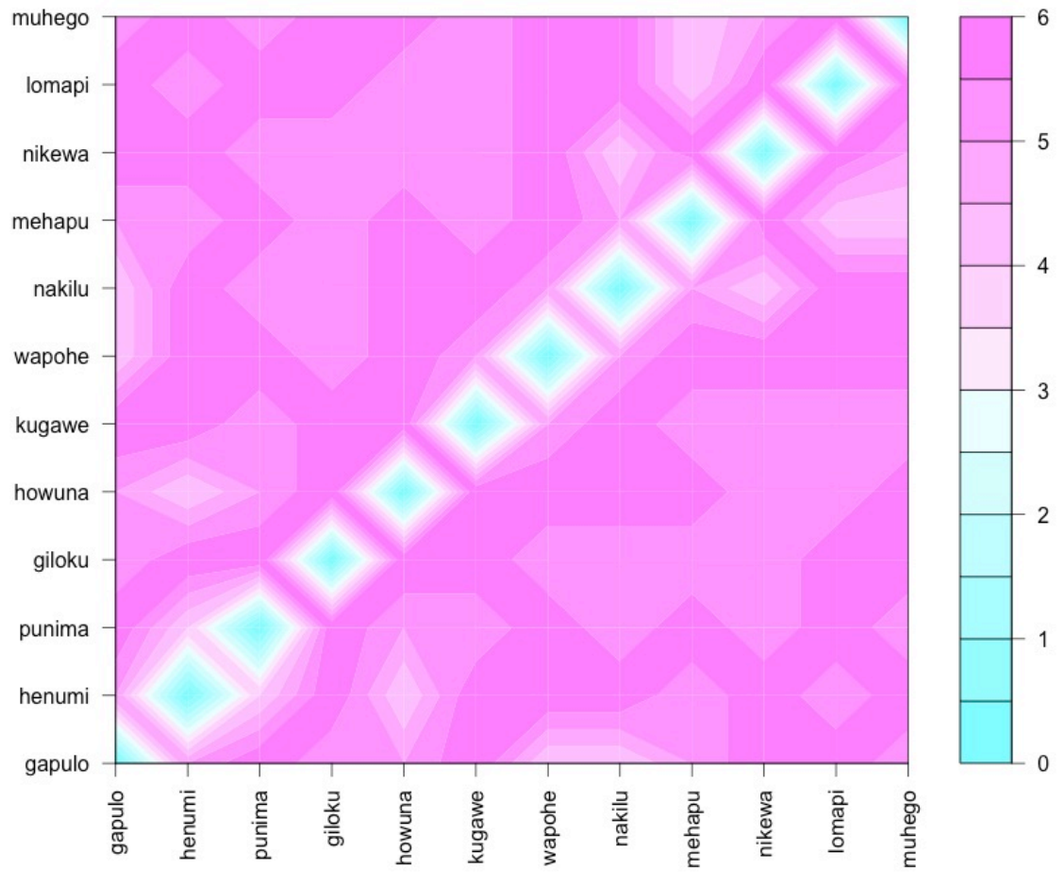
$\chi^2(2) = 45.5, p = 1.317 \times 10^{-10}$ ***

estimate = -1.46, $SE = 0.21$, $t = -6.996$



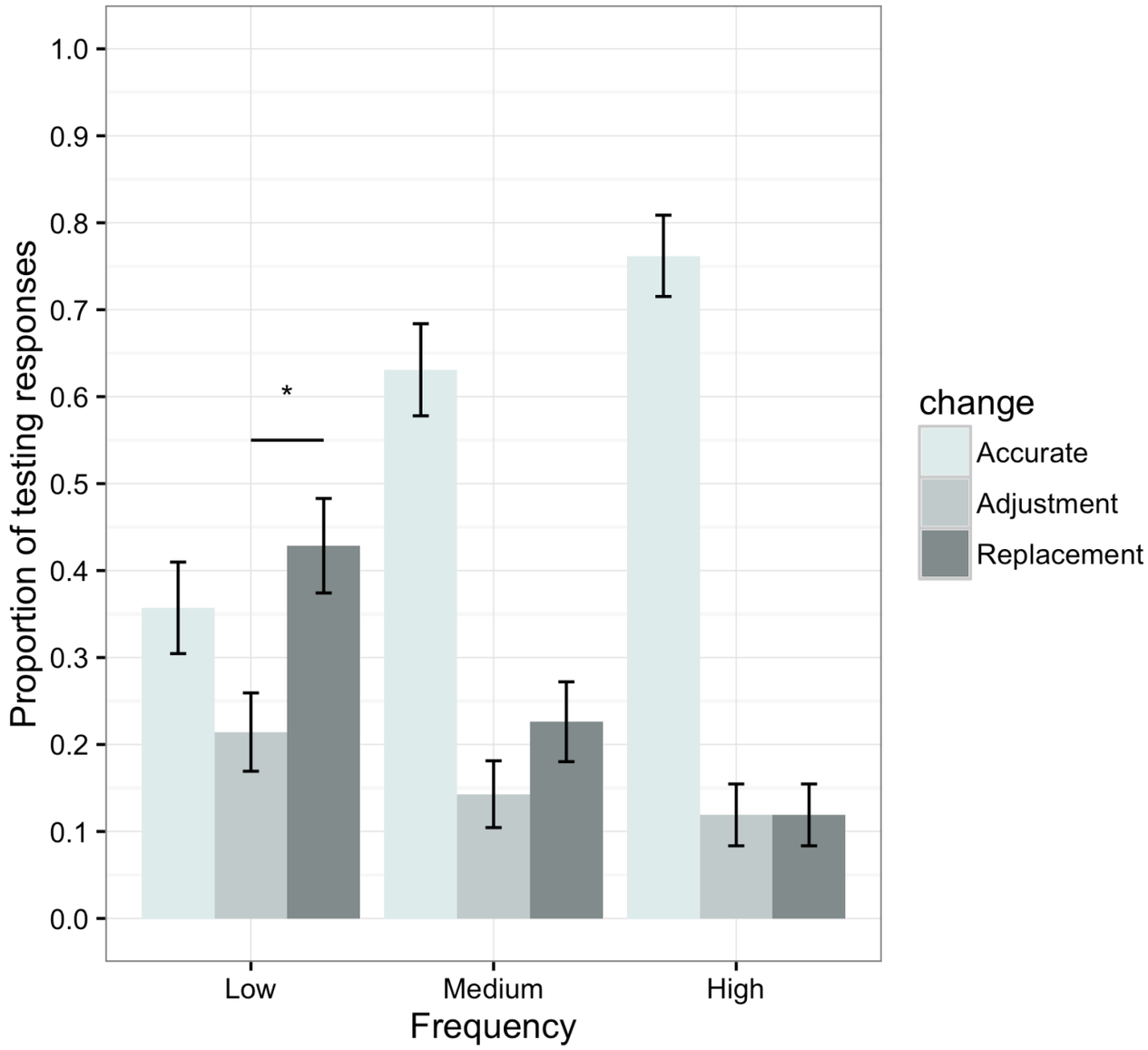
Analysis 2

- Replacement/adjustment
- Calculate the average Levenshtein distance between all input words, round to nearest full value to get threshold
- If participants output response is greater than this value -> replacement
- If smaller than the value -> adjustment
- If 0 then -> accurate



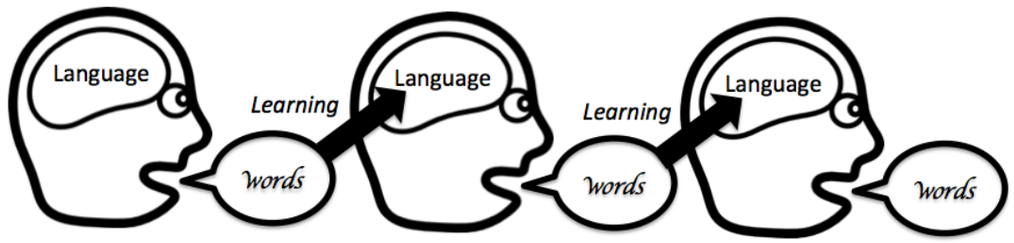
Results 2

- Adjustment/replacements:
- Significantly more replacements in low frequency condition than adjustments
- Number of replacements decreases as frequency increases
- No difference between number of adjustments across frequency conditions



Background

- Model the cultural transmission of the language
- Iterated learning paradigm (Kirby, Cornish & Smith, 2008)
- Pass the output language from one participant to the next participant
- Simulating what happens during learning over generations of learners
- This amplifies weak cognitive learning biases, that influence the structure of the language



Hypotheses

- Higher frequency words will retain their forms (or undergo small adjustments)
- Low frequency words will become more learnable
- Low frequency words will become structured, explaining the greater learnability

Experimental design

- 4 chains of learners
- 8 participants/generations in each chain
- Communicative pressure introduced to remove homonyms

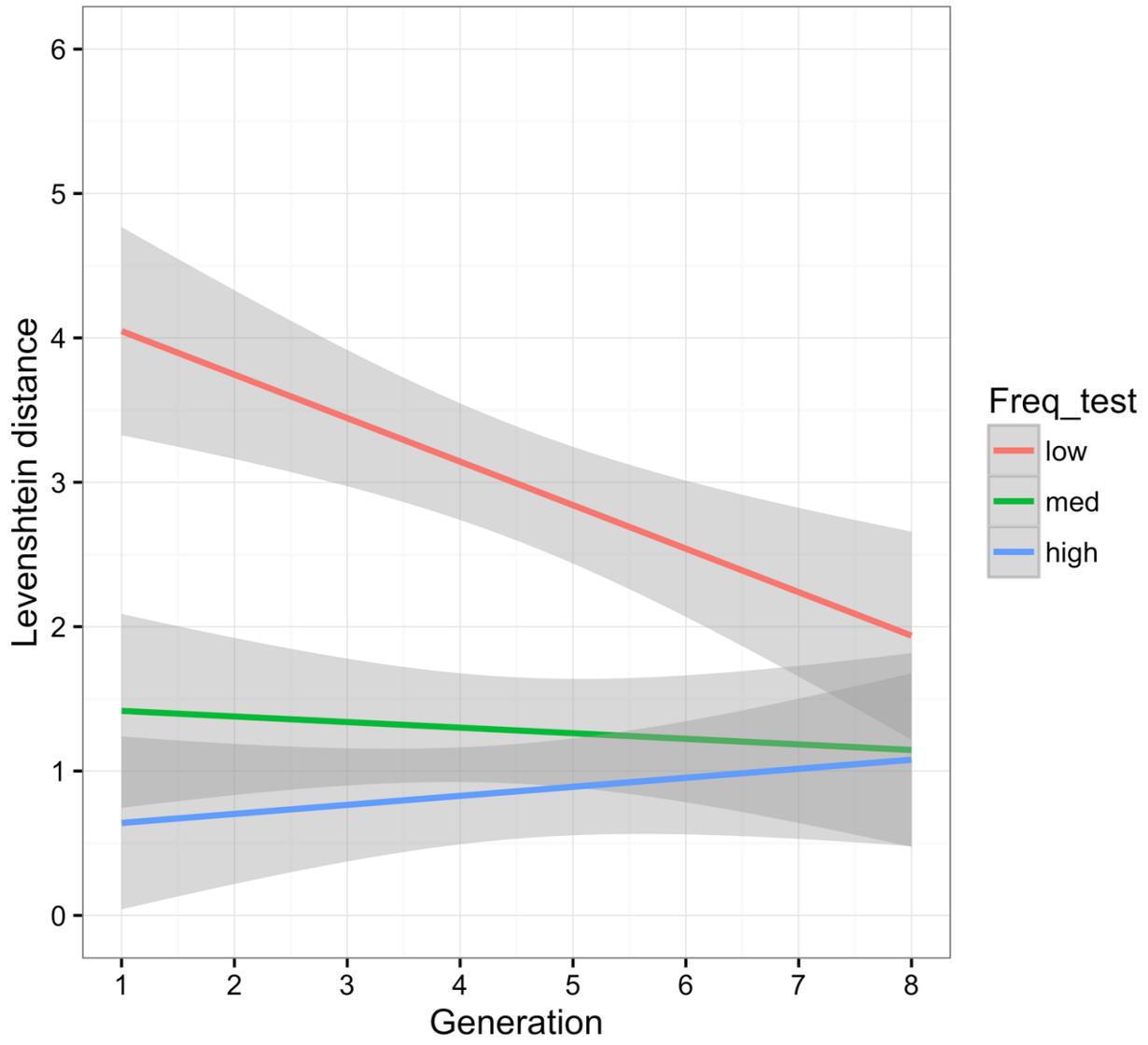
Results

- Lmer Results:

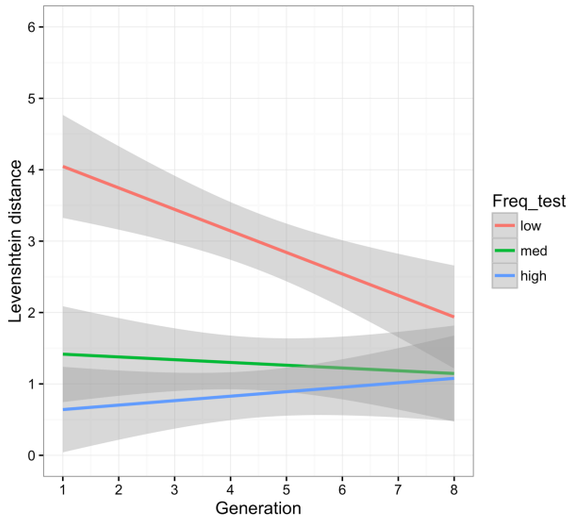
Significant linear relationship for low frequency

$\chi^2(1) = 6.12, p = 0.01$ *

estimate = -0.30, $SE = 0.12$, t = -2.541



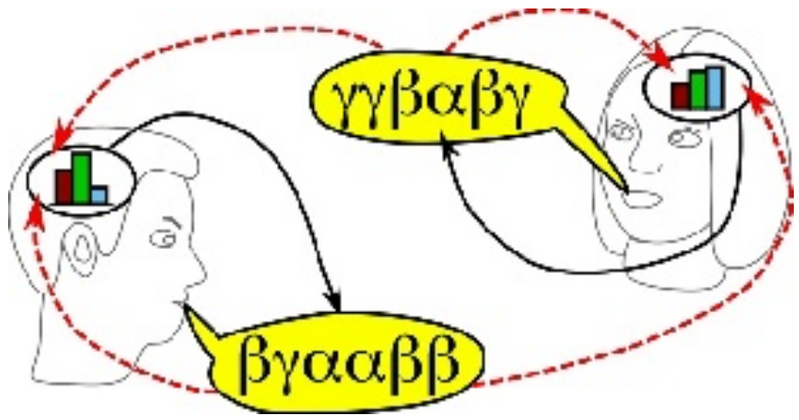
Results



Frequency	Generation 1	Generation 7
low	giloku	mihewu
low	howuna	mihuge
low	kugawe	napiwa
low	lomapi	nokiwa
med	nakilu	lilipe
med	wapohe	lamupo
med	muhego	hewino
med	punima	wopehu
high	henumi	punima
high	gakulo	logopi
high	nipewa	henumi
high	mehapu	gakulo

Conclusions

- Replicating results in the laboratory
- Frequency affects rate and type of change
- Low frequency words (may) be more structured to improve learnability



Thank you!

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Word length condition

- Hypothesis: Shorter words will be more accurately recalled than longer words in the vocabulary
- Present a set of form-meaning mappings with different word lengths, consisting of:

small - 4 letters
medium - 6 letters
long - 8 letters

Block	Short	Medium	Long
1	5	5	5
2	5	5	5
Total	10	10	10

120 presentations

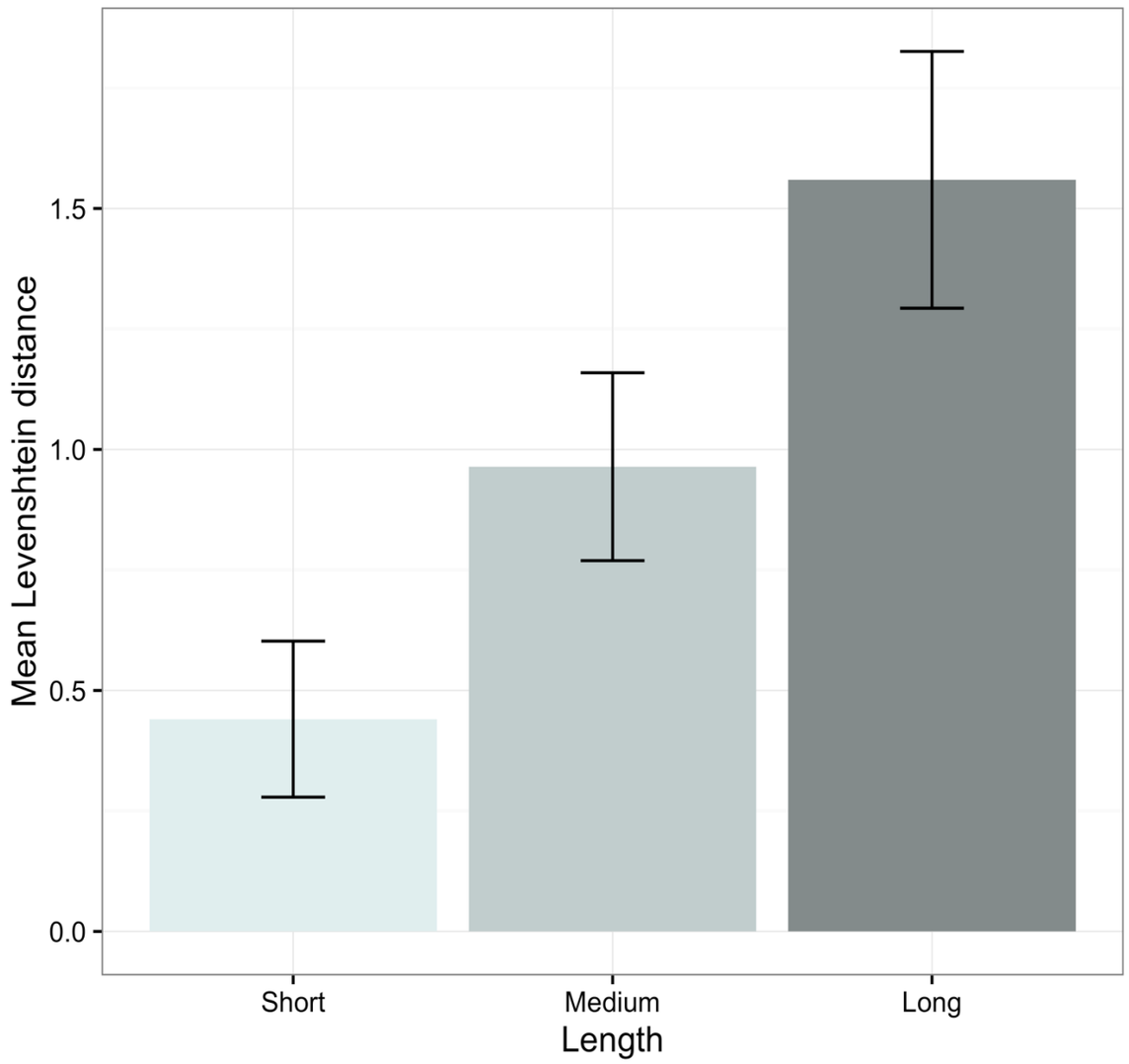
Word length condition

- Lmer Results:

Significant linear relationship for word length

$\chi^2(2) = 18.2, p = 0.0001$ ***

estimate = 0.79, $SE = 0.18$, $t = 4.324$



AoA condition

- AoA condition
- Hypothesis - Early acquired words will be more accurately recalled than late acquired words in the vocabulary
- Present a set of form-meaning mappings with different weightings for the stage at which they are presented during the training phase, early (EA) and late acquired (LA)
- Each acquired condition has 6 form-meaning mappings, each word is 6 letters long

Block	Early	Late
1	6	0
testing phase		
2	1	3
3	1	3
4	1	3
5	1	1
Total	10	10

120 presentations

AoA condition

- Lmer Results:

No significant difference for AoA

$\chi^2(1) = 1.6, p = 0.2037$

estimate = -0.27, $SE = 0.22, t$ = -1.271