Explaining lexical frequency effects: a critique and an alternative account

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29 May 2014

Outline

Introduction

- lexical frequency effects (e.g. Schuchardt 1972; Bybee 2001; Pierrehumbert 2001):
  lexical frequency (partly) determines the speed at which lexical items undergo sound changes
- in this talk: only looking at phonetically gradient sound change
- rapidly growing literature → many different explanations & findings

Introduction

- different sources for frequency effects:
  - exposure (Pierrehumbert, 2001)
    high-frequency items 'erode' faster
  - independence (Bybee, 2001)
    high-frequency items are more independent $\rightarrow$ *more resistant to change*

    ...

Introduction

- problem:
  many different explanations $\rightarrow$ predictions not clear and not sufficiently distinct
- main goal:
  clarify the predictions of the exposure-based and independence-based accounts
- solution:
  computational and mathematical modelling

Outline

Exposure

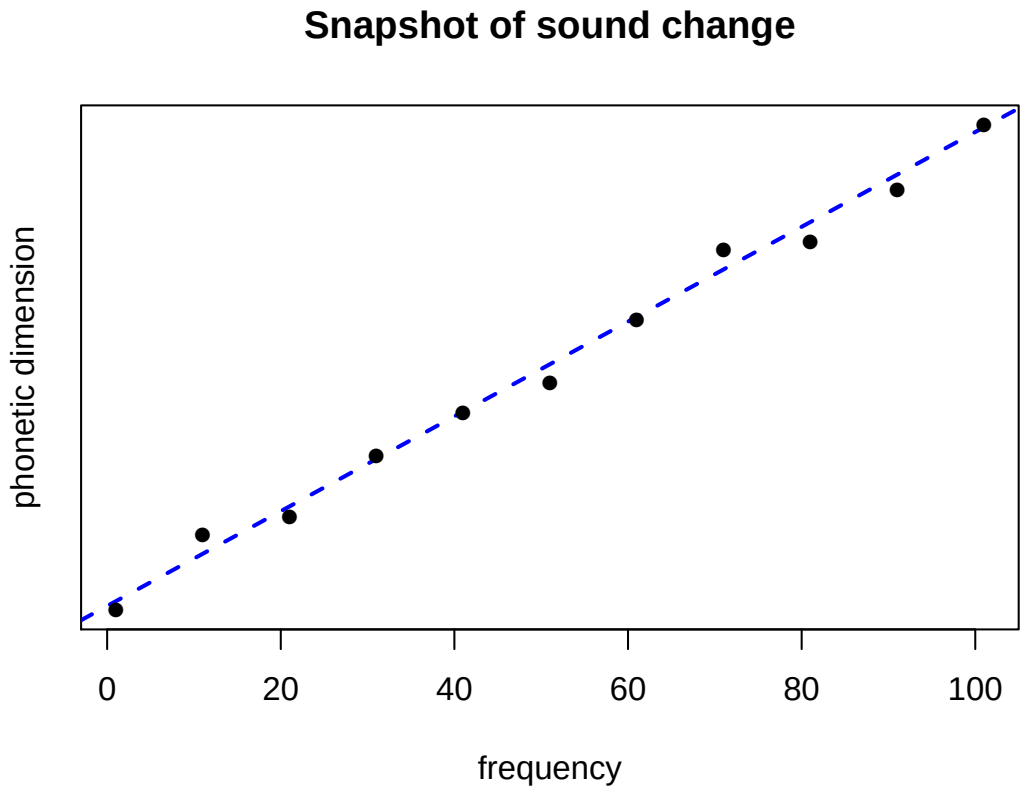
Prediction

- high-frequency forms are exposed to phonetic biases more often $\rightarrow$ they change faster
- Pierrehumbert (2002):
  '[...H]igh frequency words are affected more because they are produced more often and so more memories of them in their lenited form accrue, once the lenition gets underway.'

Exposure

Prediction

- apparent prediction: positive linear frequency effect (e.g. Pierrehumbert 2001)



Exposure

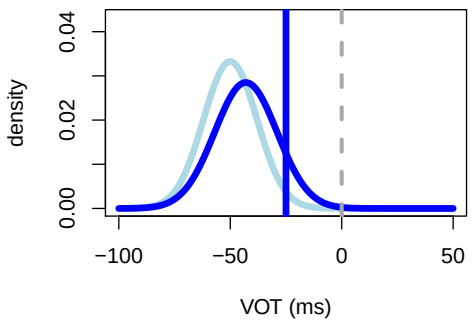
Simulation architecture

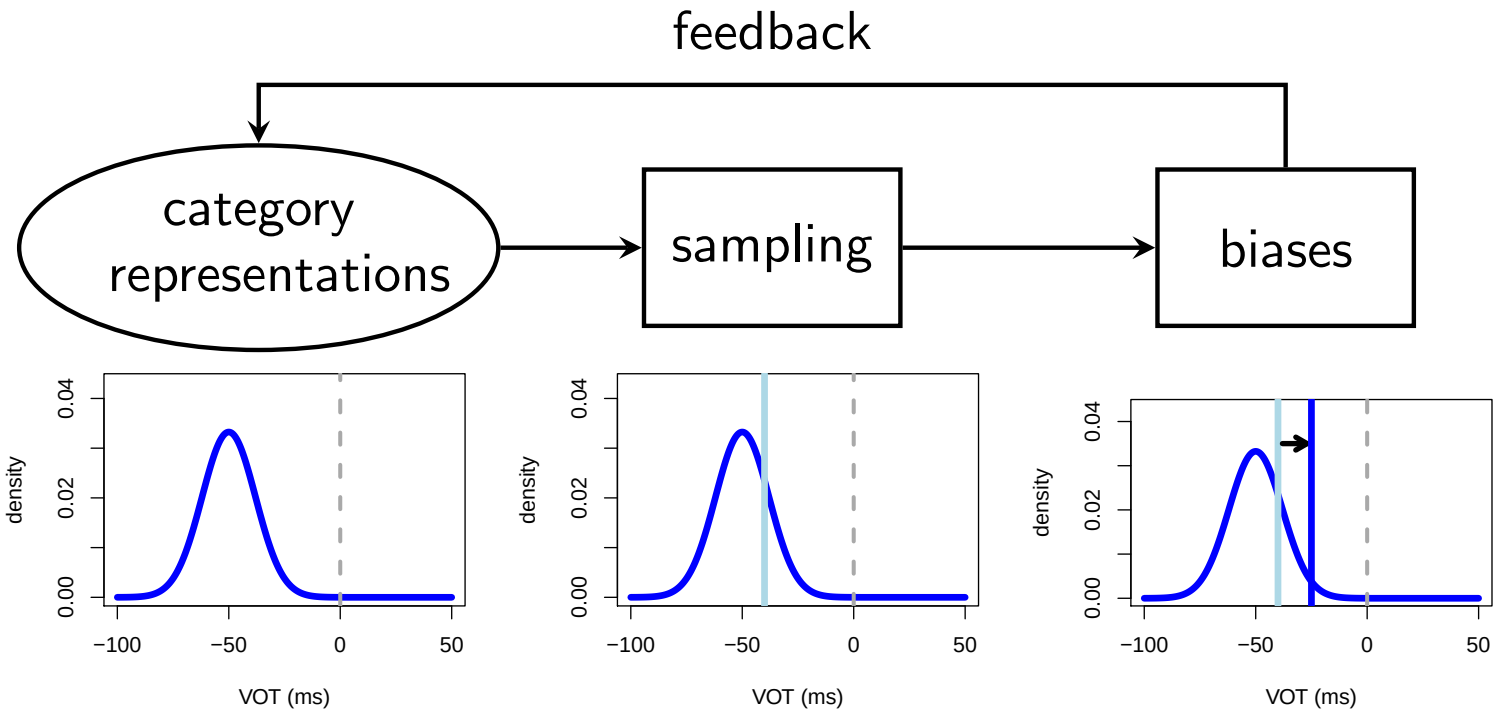
- modelling framework: simplified version of Pierrehumbert (2001)
- each word has a separate representation
- looking at how those representations evolve as a function of frequency
- parametric (prototype-based) representations

$\rightarrow$ the results hold for the original model as well

Exposure

Simulation architecture





Exposure

Simulation architecture

- in exemplar models:
  - memory activation of exemplars decreases with time
  - memory activations summed (MASS) $\propto$ frequency
- current model also includes MASS
- words with higher MASS (i.e. high frequency categories) are more resistant to incoming stimuli

Exposure

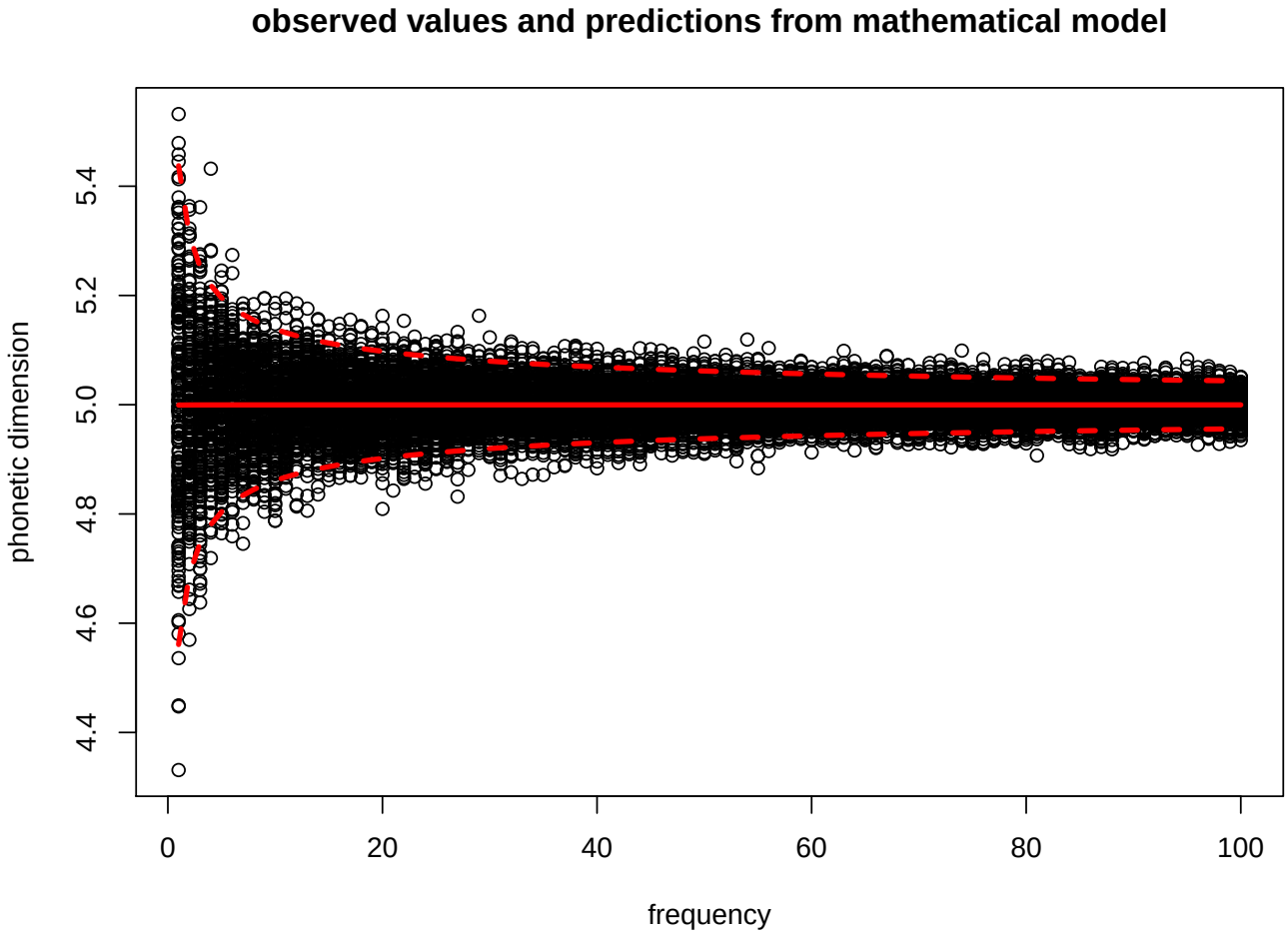
Simulation architecture

- a single phonetic dimension
- each word initialised at 0
- 20,000 simulated word categories
- word frequency varies between 1 and 100 per time unit
- constant positive bias
- 500 time units for each word
- looking at means for each word

Exposure

Results

- word frequency vs word means after 500 time units



Exposure

Results

1. frequency has no effect on the expected values of the means
   - the effect of MASS cancels out the effect of exposure
2. the mean values vary more for low frequency words
   - consequence of the algebra of random variables...
   - this is an empirically testable prediction!

Outline

Independence

Prediction

- instances of the same sound category in different words are not completely independent
- high-frequency forms more independent than low-frequency forms (cf. Bybee (2001))
  - $\rightarrow$ they resist analogical change more
  - $\rightarrow$ they can also stray further from the rest of the category?

Independence

Simulation architecture

- modelling framework: simplified version of Pierrehumbert (2002)
- each word represented separately
- category representation, bias and update same as previously
- sampling is different:
  - samples from a weighted mixture distribution
  - frequent words $\rightarrow$ heavier weight
  - target word $\rightarrow$ heavier weight

Independence

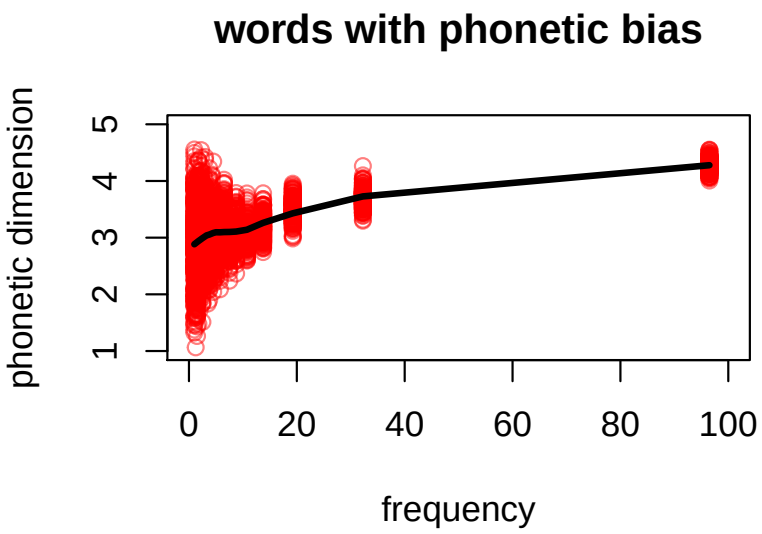
Simulation architecture

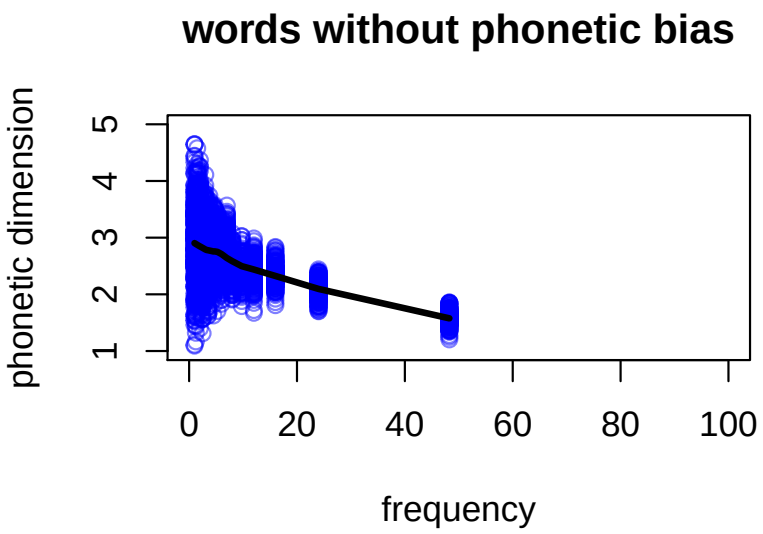
- same as before, except:
- only half of the words are affected by the bias
  - otherwise, results would be identical to prev. sim.
  - similar to e.g. /u/-fronting: *tube* → biased; *cool* → not biased
- 100 word categories (frequencies: Zipf distribution)
- simulation repeated 100 times with same parameters
- looking at one word from each frequency bin

Independence

Results

- word frequency vs word means
  (pooled results from 200 simulations)





Independence

Results

1. frequency has a positive effect for biased words (*tube*-type)
2. frequency has a negative effect for non-biased words (*cool*-type)
3. the mean values vary more for low frequency words in both groups

Outline

Conclusion

- careful modelling is crucial to unpack the predictions of theories of sound change
- exposure:
  - no effect on expected value of mean
  - the evolution of infrequent words is less predictable
- independence:
  - positive frequency effect in trigger environment
  - negative frequency effect in elsewhere environment
  - the evolution of infrequent words is less predictable

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Conclusion

Simulation architecture for independence simulations