Simulation and evaluation of exemplar theoretic -t/-d deletion

Josef Fruehwald

University of Pennsylvania

NWAV 37, November 8, 2008

Outline

- -t/-d deletion is the well known phenomenon of consonant cluster simplification
  - C{t,d} -> C
- This talk is about possible representation and implementation of grammatical conditioning on -t/-d deletion
  - Exponential Model (Guy 1991a, 1991b)
  - Exemplar Model (Bybee 2002)

Grammatically Conditioned Variability

- Contextual Conditioning
  - Preceding segment
  - **Following Segment**
    - V < C
- Grammatical Conditioning
  - Past < Irregular Past < Monomorphemes
- Etc.

Grammatically Conditioned Variability

- Representation:
  - Decreasing functional load
    - Past > Irregular Past > Monomorphemes
    - Highly informed phonology
  - Variable Factor Weights
    - Past = .3; Irregular Past = .5; Momomorphemes = .7
    - Potentially arbitrary ranking
  - Connection to morphological structure
    - Exponential Model

Exponential Model (Guy 1991a, b)

- Single Variable Rule: Input p
- Cyclic application based on morphological structure

- Variation is based in phonological mechanics

Exponential Model

- Produces an exponential relationship across classes

Level	Past	Irreg	Mono
Stem			50% td
Word		50% td	25% td
Post Lex	50% td	25% td	12.5% td
	p	p^2	p^3

Exponential Model

Philadelphia Corpus; N = 1,555

	Past	Irreg	Mono
Retention	p = 76.6%	55.6%	43.5%
Predicted	p = 76.6%	p^2 = 56.6%	p^3 = 44.9%
CI	2.4%	6.7%	1.7%

Buckeye Corpus; N = 13,414

	Past	Irreg	Mono
Retention	p = 76.8%	58.8%	46.7%
Predicted	p = 76.8%	p^2 = 58.9%	p^3 = 45.3%
CI	1%	2.5%	0.6%

Exponential Model

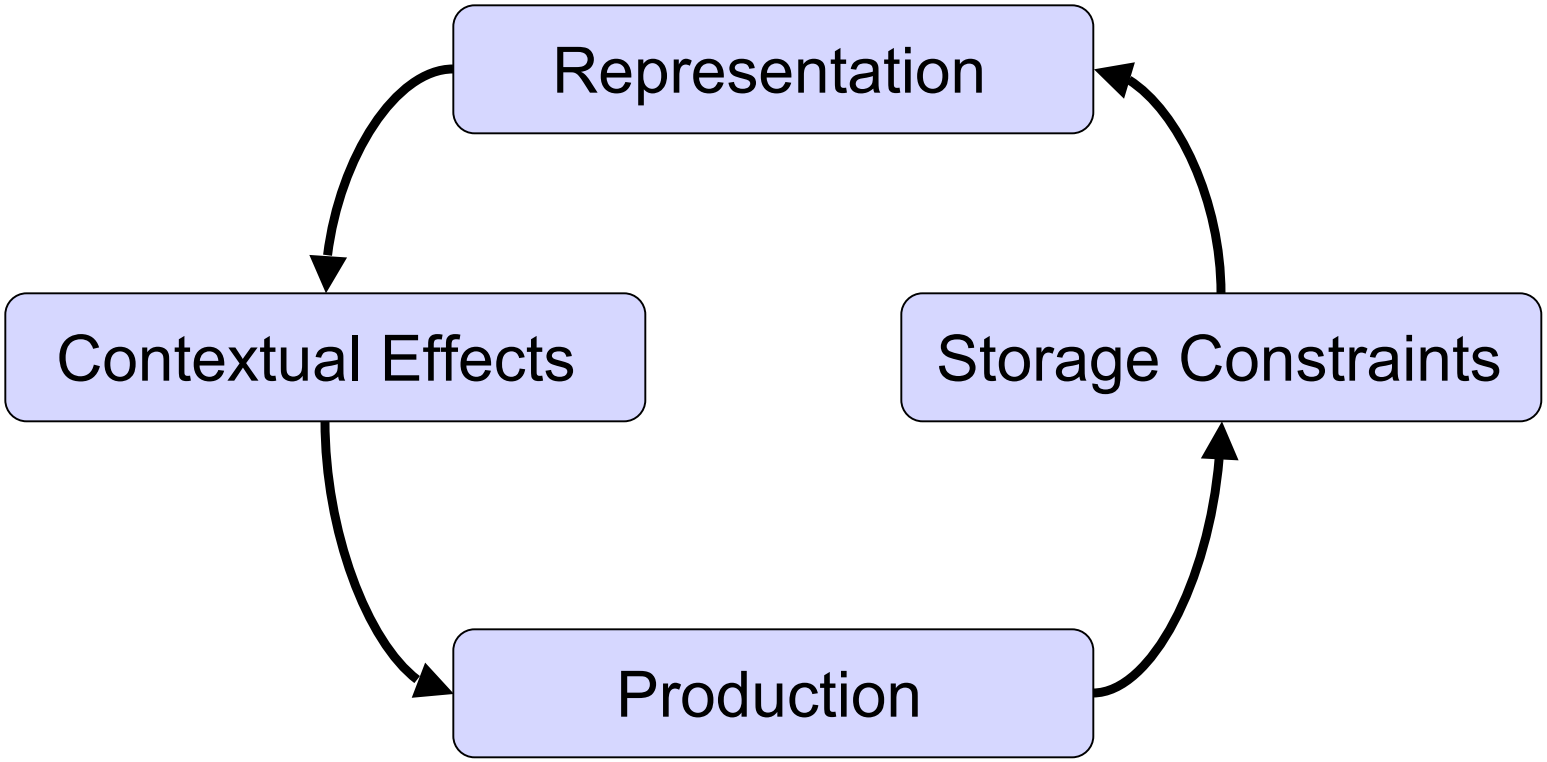
- Delivers:
  - A relationship between retention rates across classes
  - No need for direct morphological information in variable rule
- Dependant upon
  - Cyclicity
    - Lexical Phonology / Stratal OT (Bermuzez-Otero 2003)
  - Morphological composition

Exemplar Model

- Words are represented in phonetic detail
- Phonemic / Morphological categories are emergent (Pierrehumbert 2002, 2007).
- Variability is in the lexical representation (Bybee 2002).

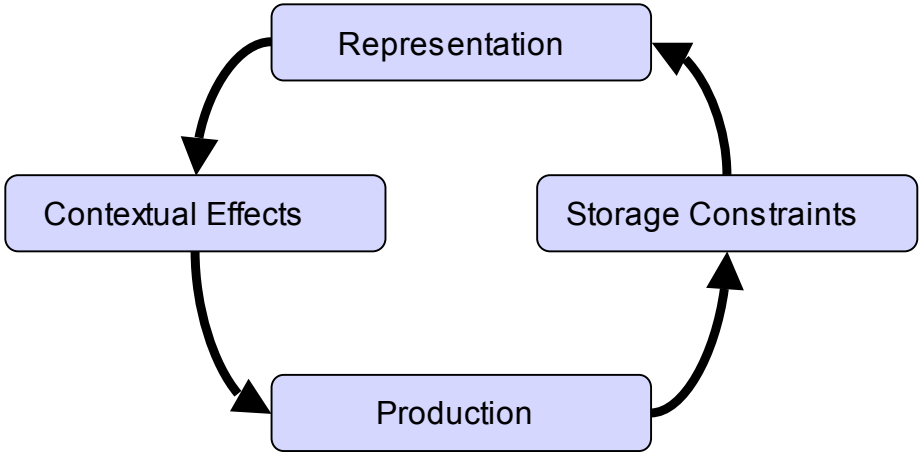
Exemplar Model

- Variation could be introduced by the Production-Representation loop



Exemplar Model

- Reduction is possible in production
- Over time, representations will "accrue more exemplars that are reduced" (Bybee 2002)
- More frequent words will go through this cycle more often, and will have more reduction

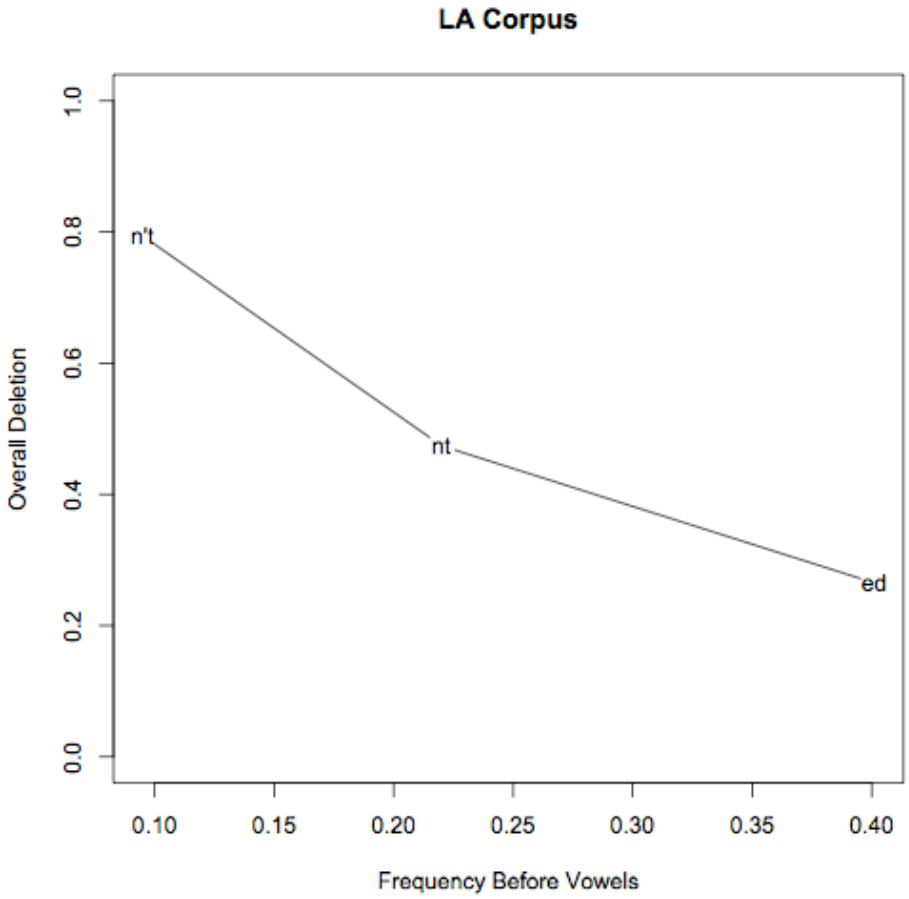


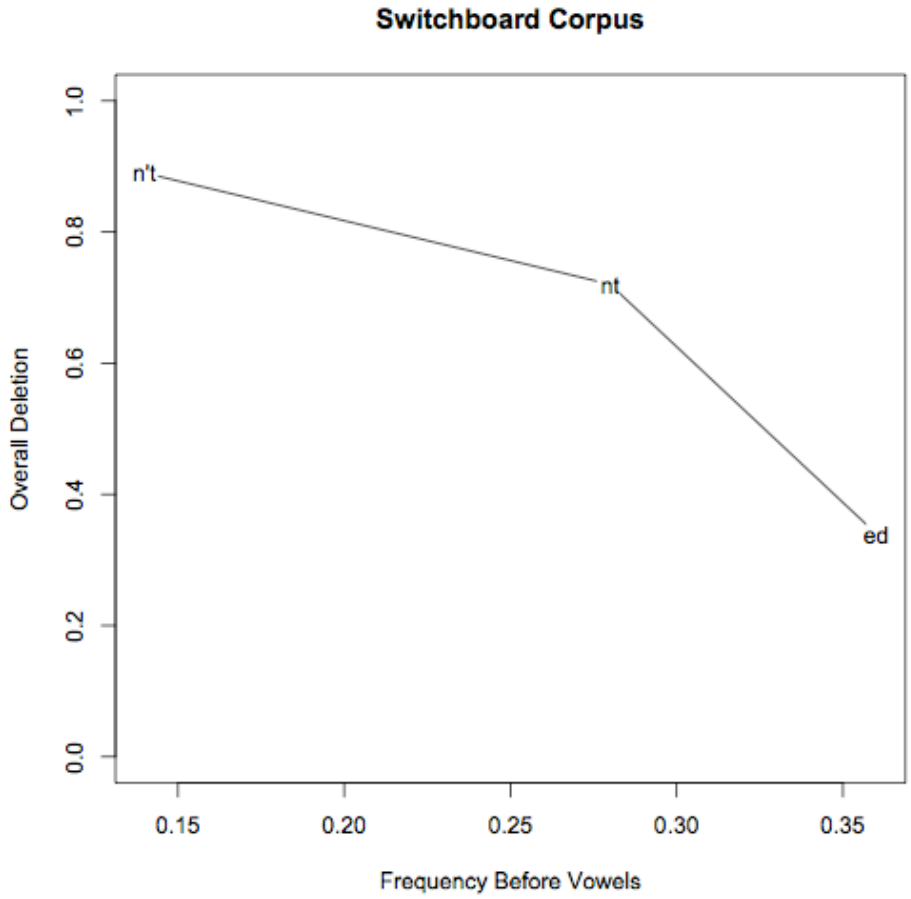
Exemplar Model: Contextual Effects

- Effects of Preceding and Following Segment can be grounded in saliency
  - _V: Audible burst, Formant Transitions
  - _C: Obscured burst, Competing closures
- Differential contextual effect should affect words that vary in their distributions across contexts

Exemplar Model: Grammatical Differentiation

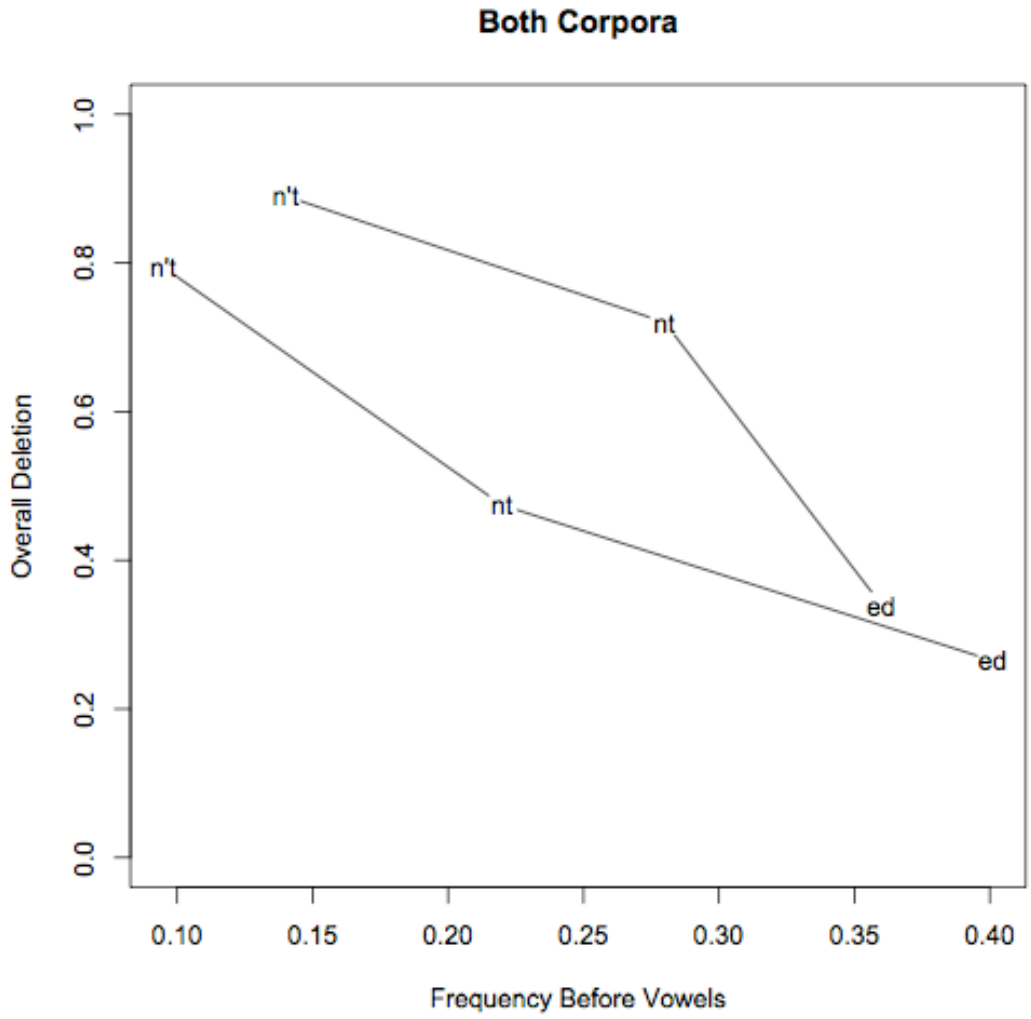
- Correlation between grammatical class' _V distribution and overall deletion (Bybee 2002)





Exemplar Model: Grammatical Differentiation

- The relationship between _V and overall deletion between corpora not the same
  - Possibly due to differences in nasal flap formation



Exemplar Model: Grammatical Differentiation

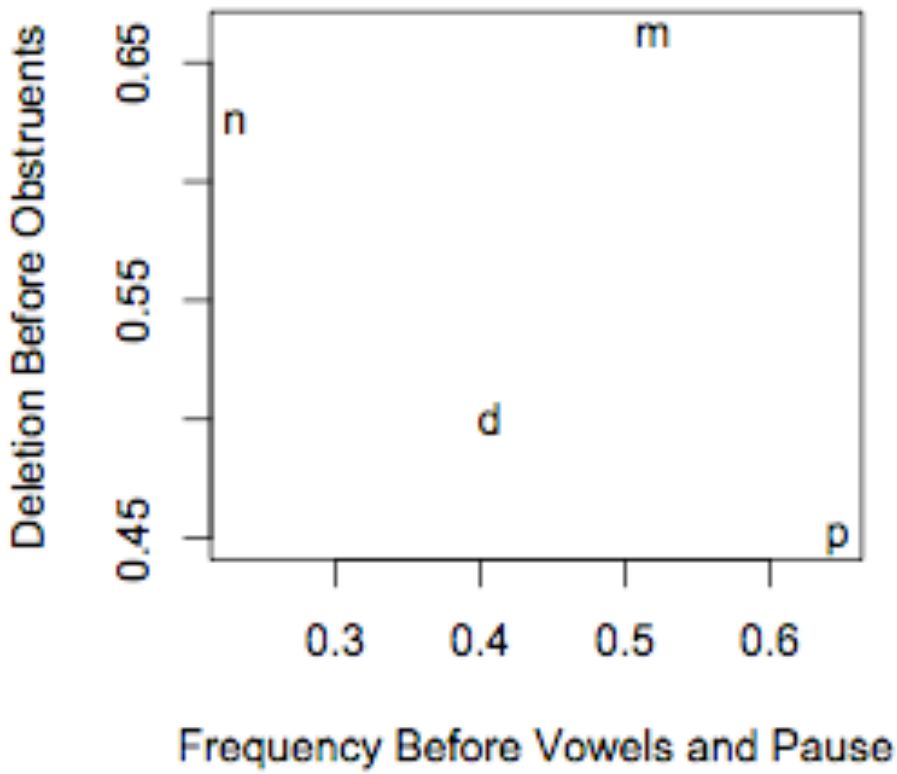
n -- n't contraction

d -- Irregular Past tense

m -- Monomorphemes

p -- Past tense

From Buckeye



Exemplar Model: Grammatical Differentiation

- This model assumes that variable -t/-d deletion is a case of change.
  - Impossible to talk about accumulation of online reduction without this assumption
- Most formulations will produce rapid, complete reduction

Exemplar vs. Exponential

- Apparent exponential relationship between grammatical classes is coincidental
  - Emergent from variable contextual distributions
- Variation is located primarily in the representations, fed by the production-perception loop.

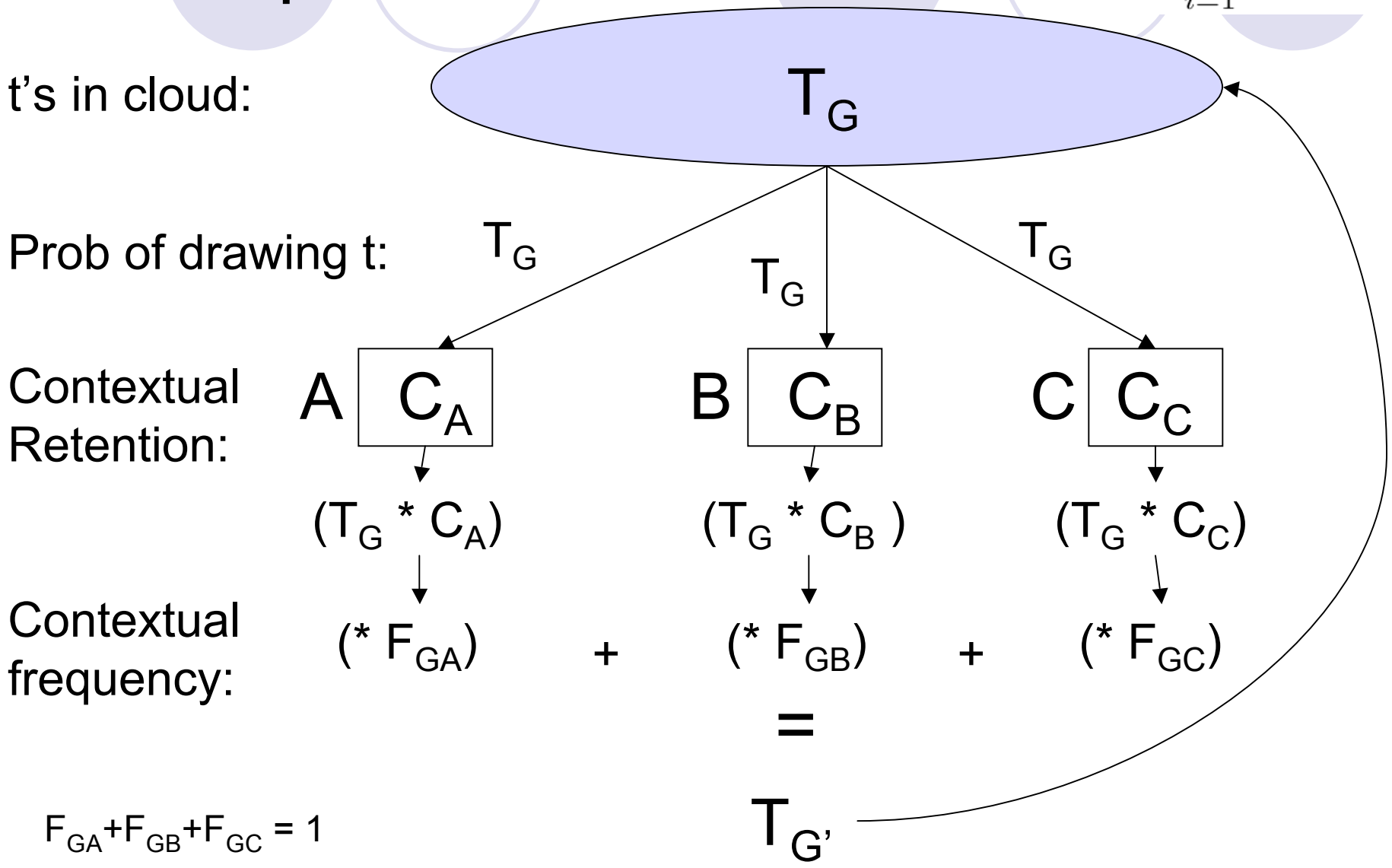
Exemplar Simulation

- 3 Factors of -t/-d deletion in Bybee 2002:
  - -t/-d representation (proportion of t's in the cloud)
  - Contextual Retention (probability of retaining t)
  - Distribution across contexts
- Model
  - Representation feeds contextual retention
  - Contextual retention weighted by frequency
  - Exemplar cloud updated by experience

$$T_{G'} = \sum_{i=1}^{n} T_G F_{Gi} C_i$$

Exemplar Simulation

$$T_{G'} = \sum_{i=1}^{n} T_G F_{Gi} C_i$$



$F_{GA}+F_{GB}+F_{GC} = 1$

Exemplar Simulation--Assumptions

- Probability of t = Proportion of /t/ exemplars in the cloud
- Proportion of t exemplars begins at 100%
- New proportion of T exemplars = Output of production

$$T_{G'} = \sum_{i=1}^{n} T_G F_{Gi} C_i$$

Exemplar Simulation--Data

- Contextual frequency can be determined from a corpus
- Contextual retention can be estimated
  - $\text{Retention}_A = (T_G * C_A)$
  - If $T_G \approx 1$; $\text{Ret}_A \approx C_A$
  - Grammatical class with least deletion will have T_G closest to 1
  - Contextual retention for past tense taken to be C_i

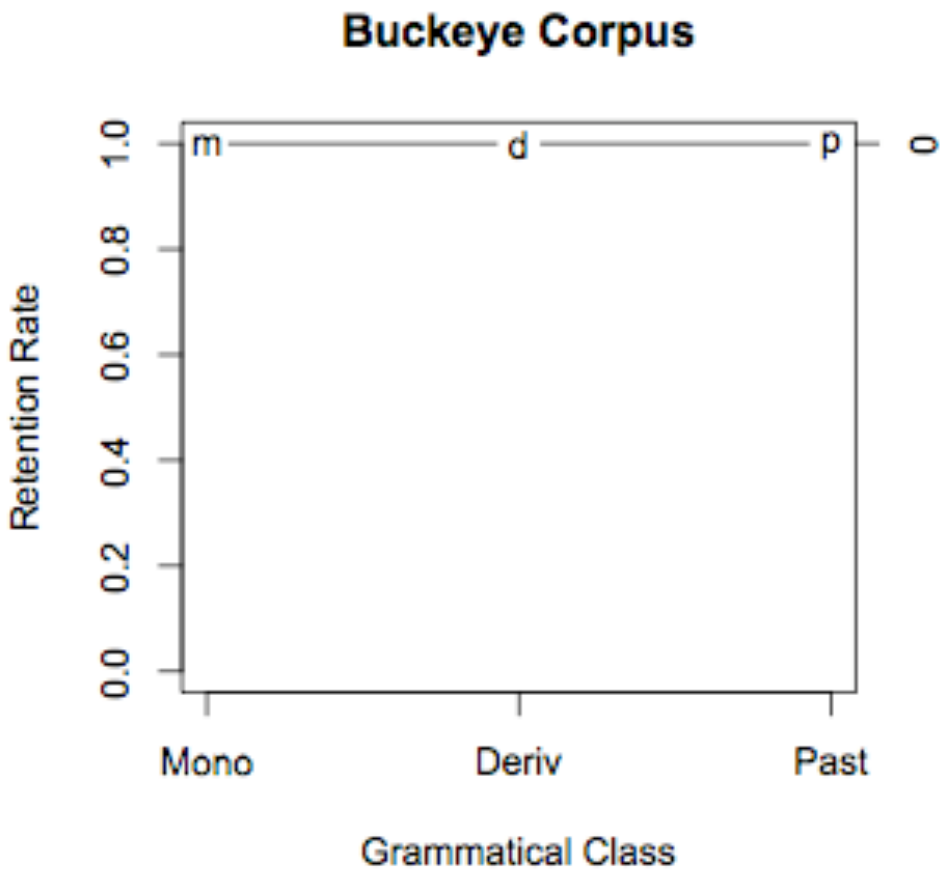
$$T_{G'} = \sum_{i=1}^{n} T_G F_{Gi} C_i$$

Exemplar Simulation -- Corpora

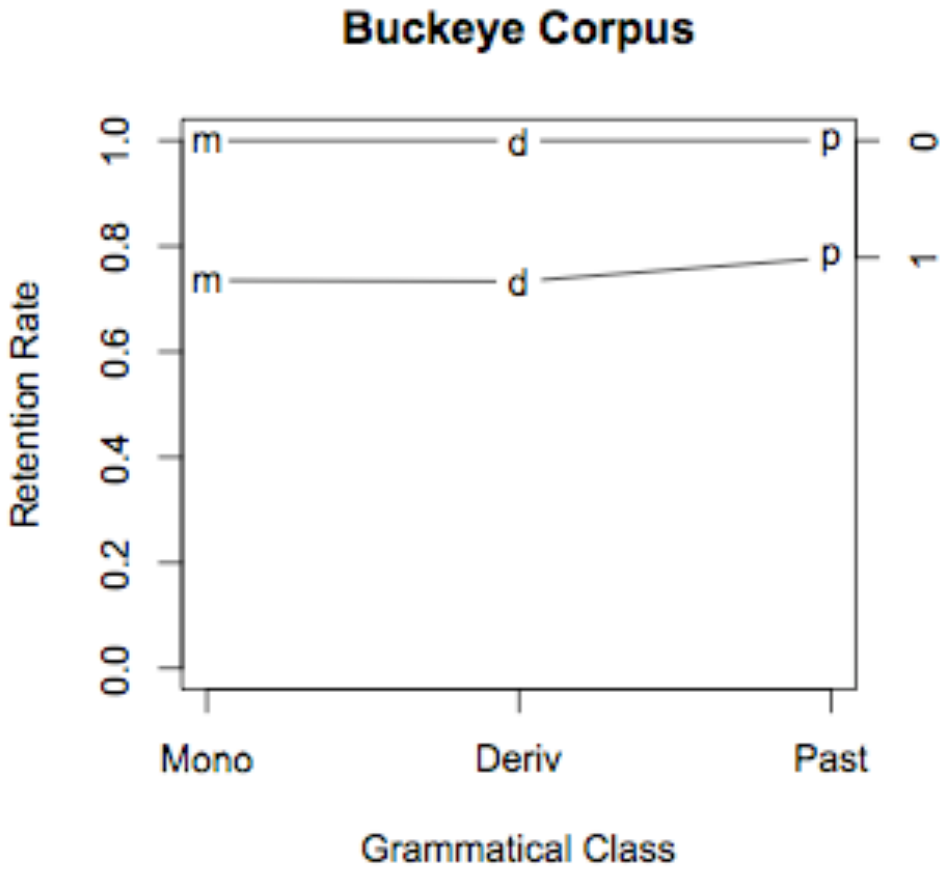
- Buckeye Corpus (Pitt et al 2007)
  - Total N = 12273

Past Tense	Irregular	Mono
1696	351	7172

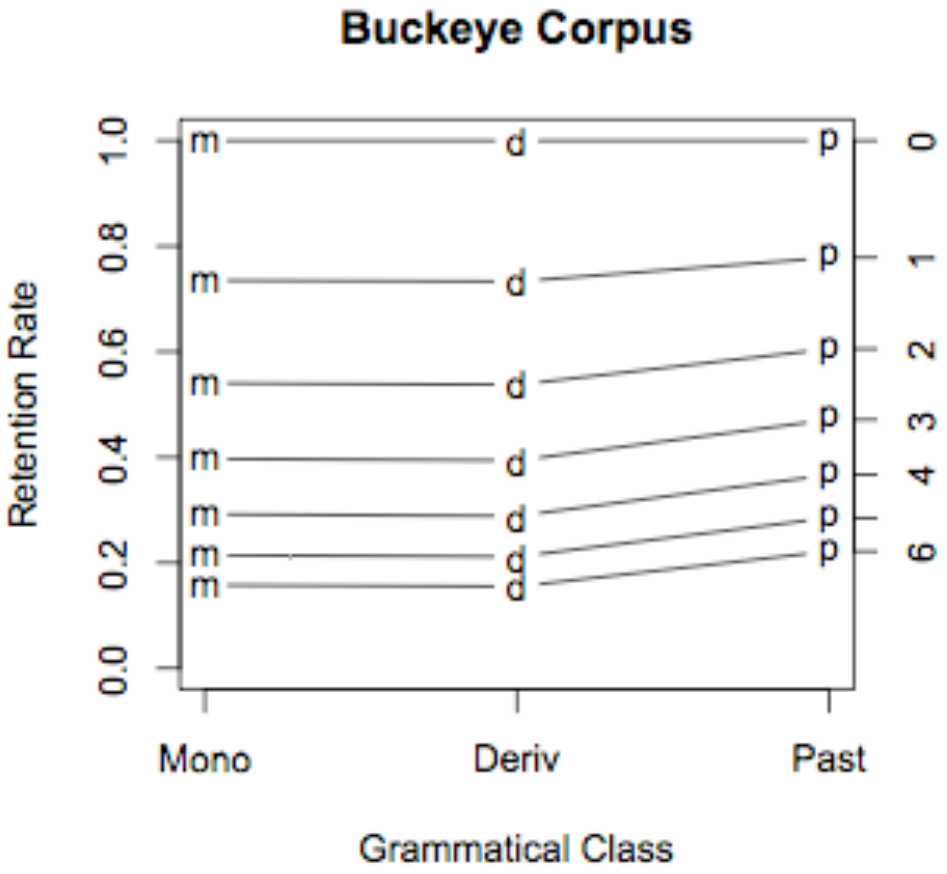
TD: Exemplar Simulation



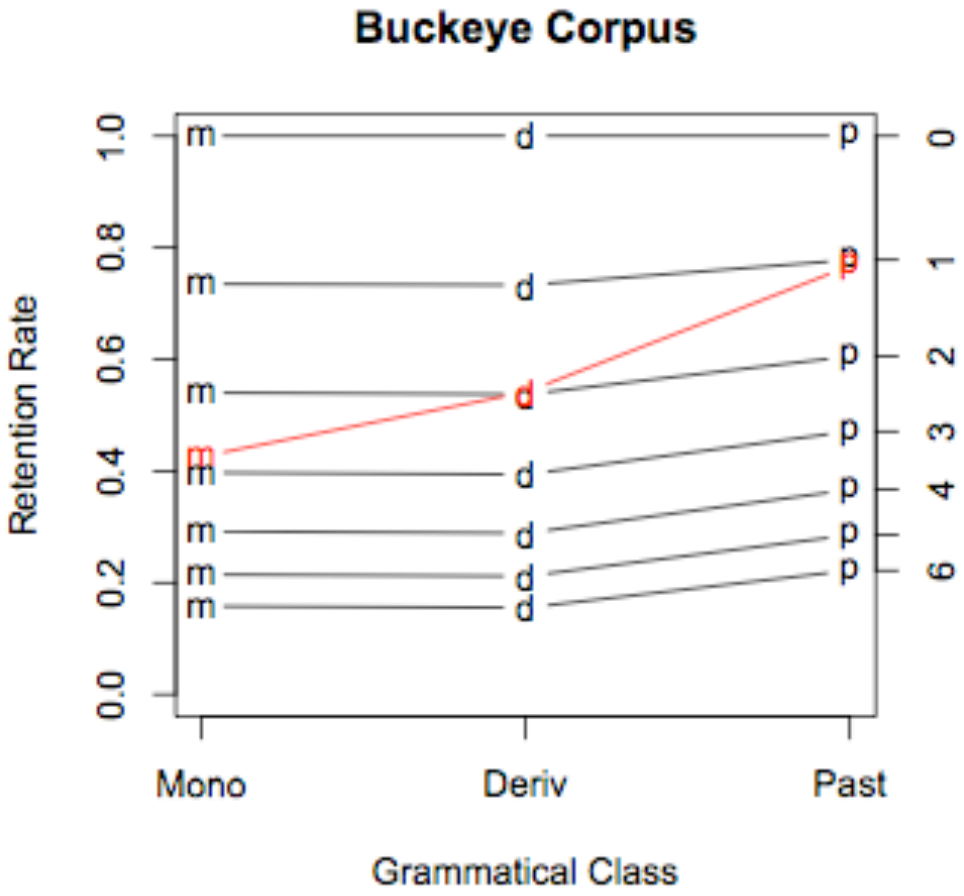
TD: Exemplar Simulation



TD: Exemplar Simulation

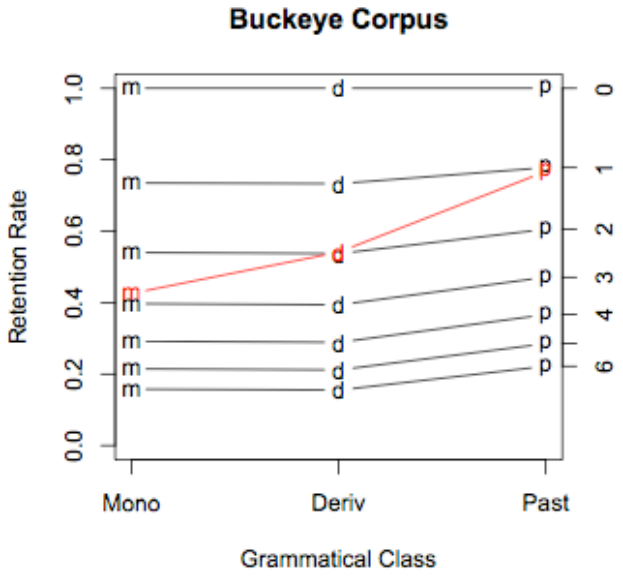


TD: Exemplar Simulation



TD: Exemplar Simulation

- Differences between grammatical classes are rather small
- Quantal jumps between iterations are an idealization
  - Actual retention rates appear to be quantally separated
  - Past tense near first iteration, irregular past near second iteration, monomorphemes near third

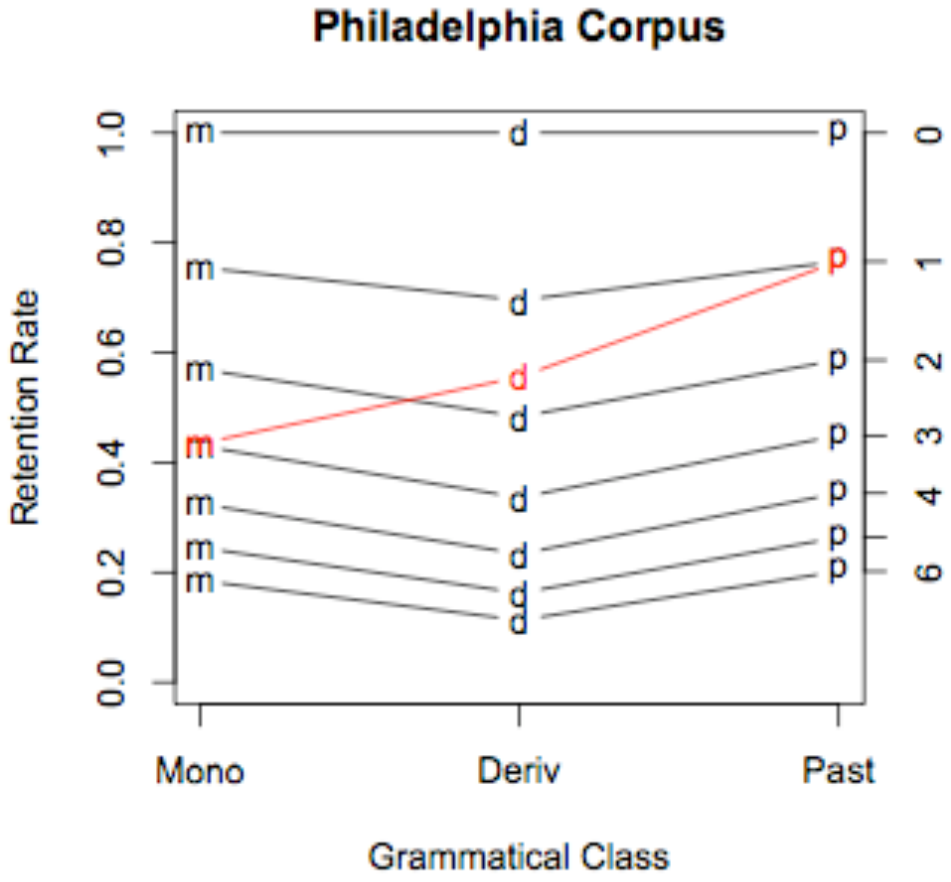


Exemplar Simulation -- Corpora

- The Philadelphia Corpus
  - Sociolinguistic interviews with 7 Philadelphians coded for TD features
  - Total N = 1555

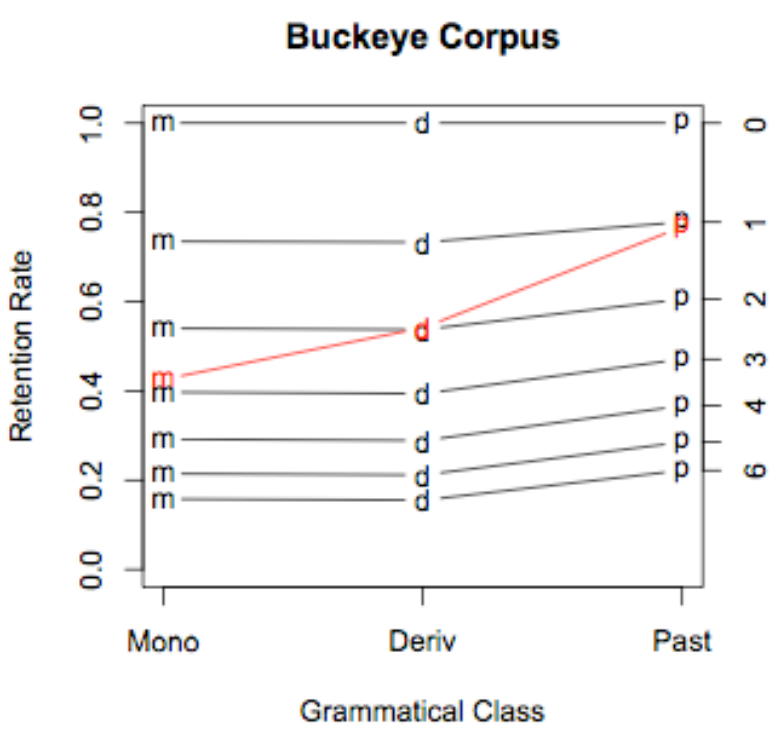
Past Tense	Irregular	Mono
316	54	773

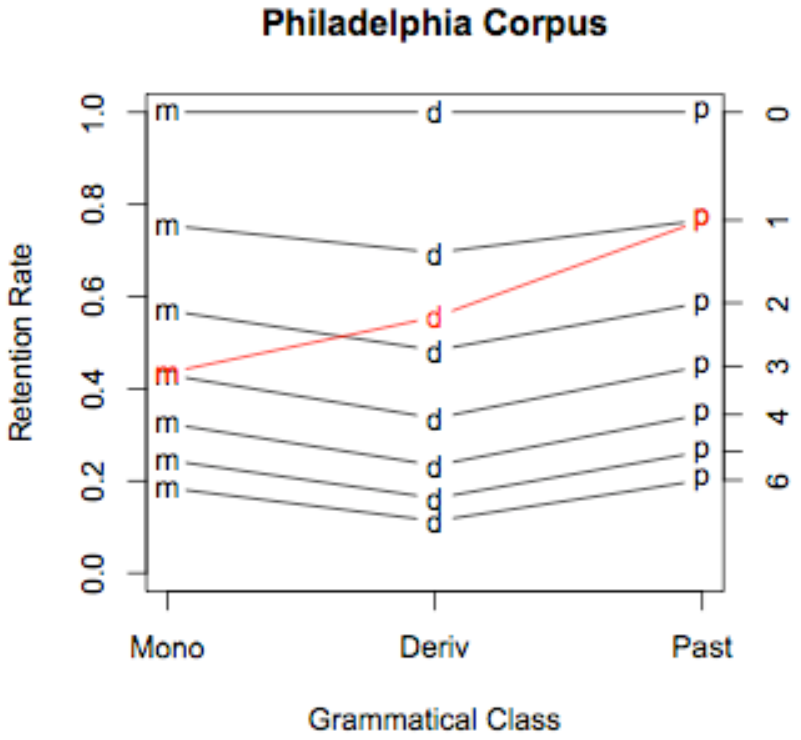
TD: Exemplar Simulation



TD: Exemplar Simulation

- Why this relationship between the simulation and actual rates?

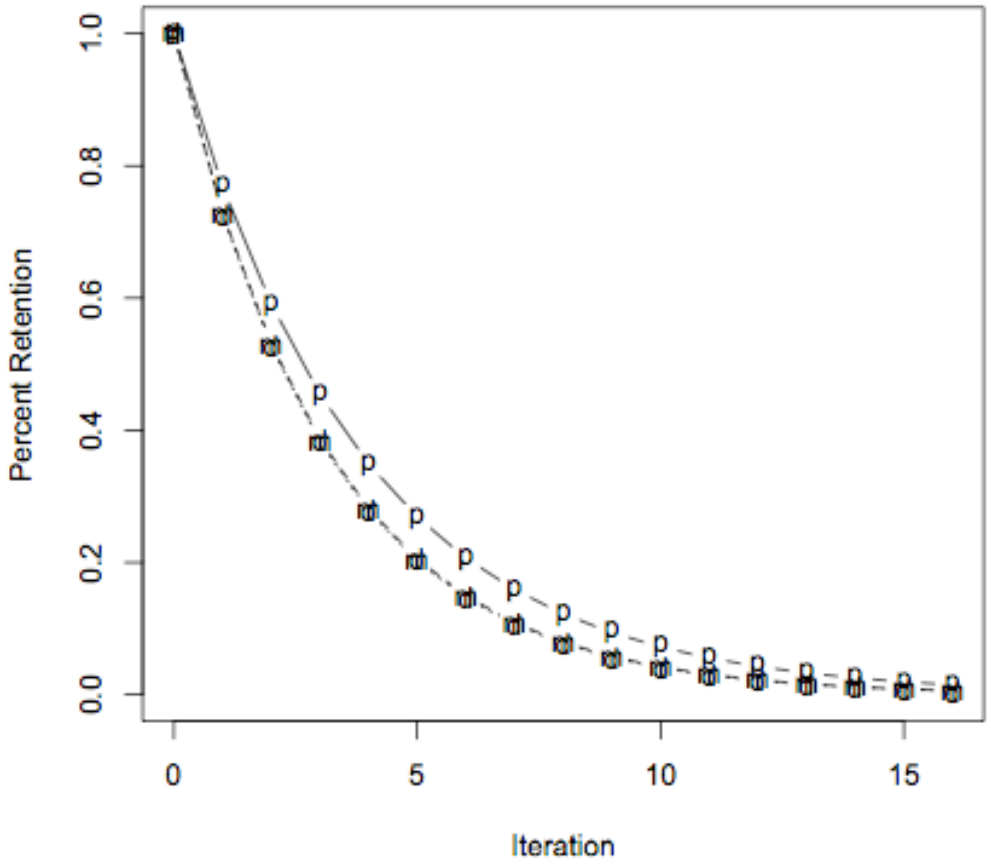




TD: Exemplar Simulation

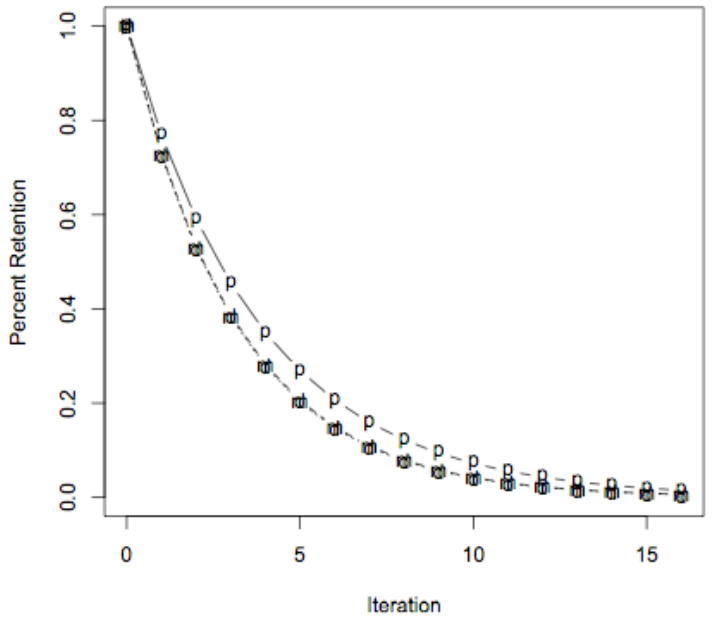
- By taking contextual retention to be retention for past tense
  - $T^0 = 1$
  - $T^1 \approx$ Retention for past tense
- Model is basically one of exponential decay
  - Retention = $(1\text{-Online Reduction})^{Time}$
- Rates of online reduction across grammatical classes are basically equivalent
- Reproduces exponential relationship

Exponential Change



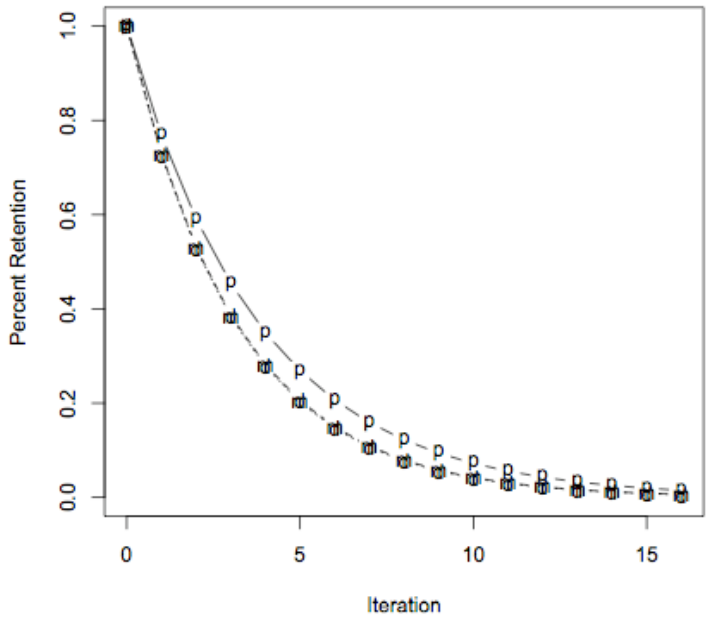
Exponential Change

- Factors like frequency, phonological neighborhood density and lexical competitors will bias rate of decay
- Language change is typically described as taking place over an s-shaped curve (Labov 2001)



Exponential Change

- No countervailing force against reduction
  - Contextual Retention not included in speaker knowledge
  - Perceived forms not checked against expectations



Conclusions

- Lexical distribution across phonetic contexts is insufficient to produce sufficient variability to explain grammatical effect.
- The quantal, exponential relationship between grammatical classes remains to be explained
- To prevent rapid, complete reduction, deletion should be controlled by abstract phonological forms.

References

- Bermudez-Otero, R. 2003. “The acquisition of phonological opacity”. In *Variation within Optimality Theory: proceedings of the Stockholm Workshop in Variation within Optimality Theory* ed. J. Spenader, A. Eriksson, and O. Dahl, pages 25–36, 2003.
- Bybee, J. 2002. “Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change”. *Language Variation and Change*, 14:261–290.
- Guy, G.R 1991a. “Explanation in variable phonology: An exponential model of morphological constraints”. *Language Variation and Change*, 3(1):1-22.
- Guy, G.R., 1991b. “Contextual conditioning in variable lexical phonology”. *Language Variation and Change*, 3(2):223–239.
- Labov ,W. 1994 *Principles of linguistic change. Volume 1: Internal Factors*. Language in Society. Blackwell, Oxford, 1994.
- Labov ,W. 2001 *Principles of linguistic change. Volume 2: Social Factors*. Language in Society. Blackwell, Oxford, 2001.
- Pierrehumbert, J.B. 2002. “Word-specific phonetics”. In *Laboratory Phonology VII*, pages 101-139. Mouton de Gruyter
- Pitt, M.A., Dilley, L., Johnson, K., Kiesling, S., Raymond, W., Hume, E. and Fosler-Lussier, E. (2007) *Buckeye Corpus of Conversational Speech (2nd release)* [www.buckeyecorpus.osu.edu] Columbus, OH: Department of Psychology, Ohio State University (Distributor).