Class 2, 4/4/13: Knobs; Checking out the Law of Frequency Matching

1. Current assignments

- Reading that was for today:
  - Andries Coetzee and Joe Pater. The place of variation in phonological theory. In *Handbook of Phonological Theory*, Goldsmith, Riggle and Yu (eds.).
- New reading:
  - Hayes, Bruce and Paul Boersma (2001) "Empirical tests of the Gradual Learning Algorithm," *Linguistic Inquiry* 32: 45-86.
  - Do a one-page, perhaps bullet-pointed summary of the article to hand in on Tuesday.

TOKEN VARIATION: THE QUESTION OF KNOBS

2. Background

- Kie laid out the basis patterns, discovered by Labov and other sociolinguistics, in token variation.
- I'd like to follow up with some discussion/rank speculation about "knobs".

3. Knobs, and the question of how many there are

- "Knob" = some mechanism, often expressible formally with a single parameter value, that governs process-application frequency.
- How many knobs control token variation?

4. The maximal-knob theory

- Knobs are **process-specific**
  - (a knob for Tapping, a knob for /æ/ Diphthongization, etc.)
  - OT doesn't recognize processes; but we might have knobs for particular Markedness or Faithfulness constraints — see below.
- There are knobs for **what kind of speaker you are**:
  - male-female
  - social class
  - So, although I have learned to speak as a late-middle-aged, lower-fringes-of-upper-middle-class educated male, if I suddenly and magically
    — changed gender
    — reverted to age 18 … and joined the Marines
    … I would instantly know what to do, since it's in my grammar (????)

- There is a knob for **word frequency**, perhaps even word identity (*Pentium* example)
- There is a knob for **speaking rate**, perhaps also for clarity-effort (we can speak rapidly but clearly with extra effort).

5. Labov's work

- His presentations suggest he is a **maximal-knob theorist**, but perhaps this only reflects his wish to get across the data in fullest possible detail.

6. Radically-minimal knob theory

- There is only one knob, the **style knob**.
  - let's suppose: formal is high setting, informal is low
- It applies uniformly across processes; e.g. turning it down (direction of casual style) demotes all Faithfulness constraints in the Postlexical Phonology by a uniform amount.

7. Handling other data in one-knob theory

- **Who you are**: People possess a rich knowledge of the social structure of their society
  - Lower-middle class people know to turn up the knob a lot when others are attending to their speaking style ("lower-middle-class crossover")
  - Women know to keep their knobs turned higher than men in any given context.
- **Word frequency**: Everyone tacitly knows to turn the knob down in communicating low-probability words (*Pentium* example).
- **Clear speech** might somehow be relegated to the phonetic rather than the phonological component. I don't know how clear-speech is related to formal-speech.

8. Some data that work fairly well with one-knob theory

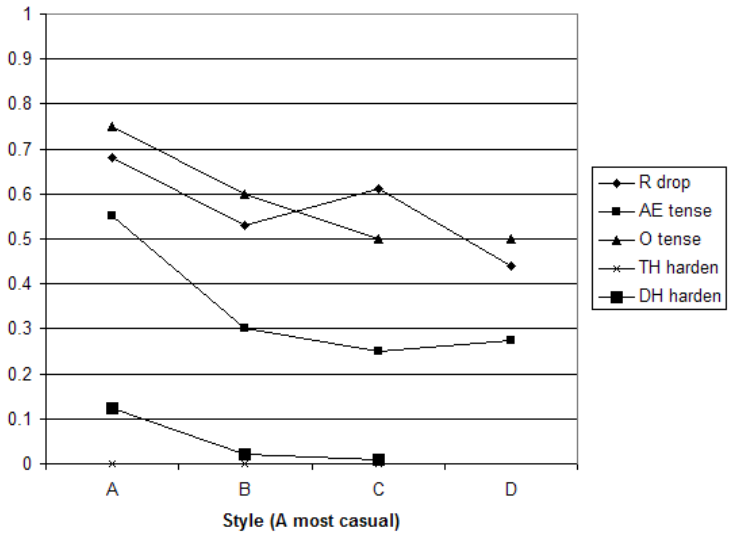
- Labov, *Sociolinguistic Patterns* (1974)
- Five processes:
  - ɹ → ∅ in codas (*car* [kɑɹ, kɑː])
  - /æ/ → [æə] - [ɛə] - [eɛ] - [ɪə] before a batch of various consonants (*man* [mæn], [mæən], [mɛən], [meən], [mɪən])
  - /ɔ/ → [ɔə] - [oə] - [ʊə] everywhere (*coffee*)
  - /θ/ → [t̪θ], [t̪] (*thin*)
  - /ð/ → [d̪ð], [d̪ð] (*this*)
- Four contexts:[1]
  - A: overheard talking with peers
  - B: interview
  - C: reading (a colloquial passage)

[1] There are actually five (read minimal pairs is fifth) but only r-drop data are available for the fifth context.

- D: word lists

9. Miriam's phonological variables are more or less in lockstep

- Miriam is 35 years old, graduated Hunter College and St. John's law school, works as lawyer.



- … and we should cut this hypothesis some slack, because data are sparse in some parts of this chart.

10. Can we do this with a knob? A quickie simulation[2]

- Markedness constraints (not formalized):
  - DROP R
  - PREFER[ɪə]
  - PREFER[ʊə]
  - PREFER STOPPED T̬
  - PREFER STOPPED D̬
- Knob-based Faithfulness constraints; valid *across processes*:[3]
  - USE MOST FORMAL VARIANT IN STYLE A
  - USE MOST FORMAL VARIANT IN STYLE B
  - USE MOST FORMAL VARIANT IN STYLE C
  - USE MOST FORMAL VARIANT IN STYLE D

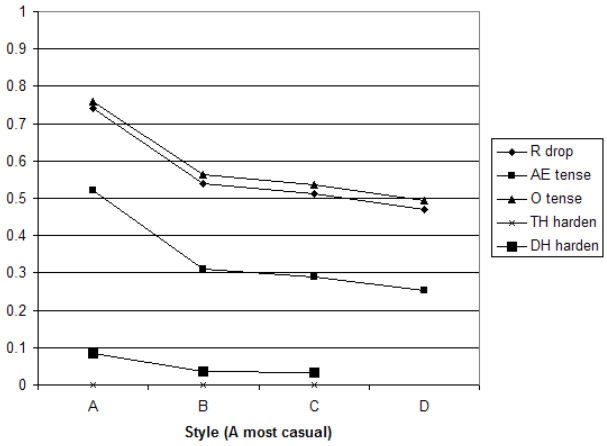
[2] Caveat: the Labovian phonetic continua above are reduced to simple binary choices, with a probability attached to the choice. To get the continua we would need to replace the PREFER X constraints with something more elaborate.

[3] I could imagine these constraints as OO-Faithfulness to the "Sunday best" pronunciation, which is itself derived in the main phonology.

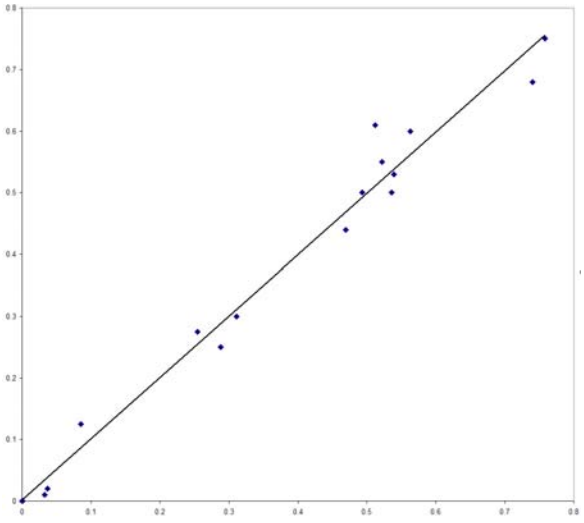
- Method used: fit mean values with a **maxent grammar** (which we are about to cover)

Constraint	*Weight*
USEFORMALA	7.28
USEFORMALB	8.17
USEFORMALC	8.28
USEFORMALD	8.45
DROPR	8.33
PREFERIE	7.37
PREFEROE	8.42
PREFERT	0.00
PREFERD	4.91

- Fit is not too bad:



  - Scattergram of model fit:



11. Interpretation

- Under this model, the "knob" has values for all four styles:

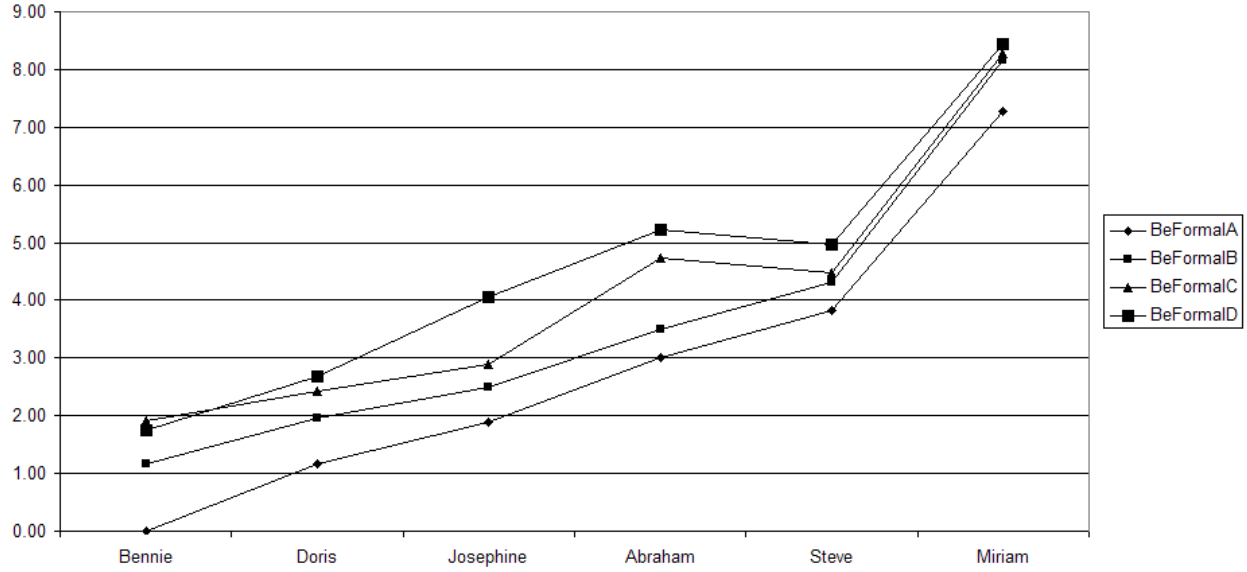
A	7.28
B	8.17
C	8.28
D	8.45

- Plainly, we can only read in a relative value; the overall range balances against the overall range of the markedness constraints.

12. Freedom allowed in the model

- How you set the Faithfulness weights in contexts A-B-C-D (< theory of social psychology)
- How much each Markedness constraints wants you to move toward the casual variants.

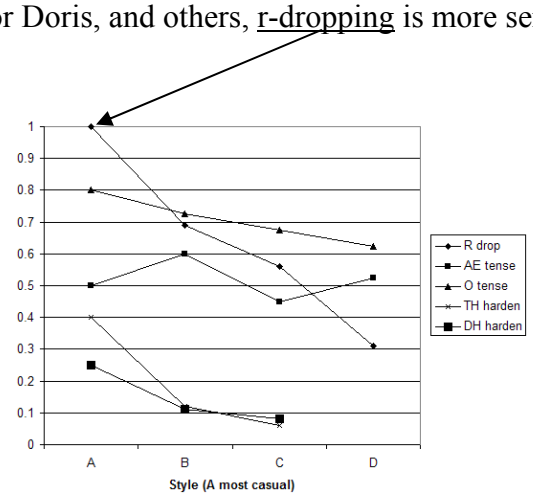
13. The knob seems fairly consistent across six New Yorkers



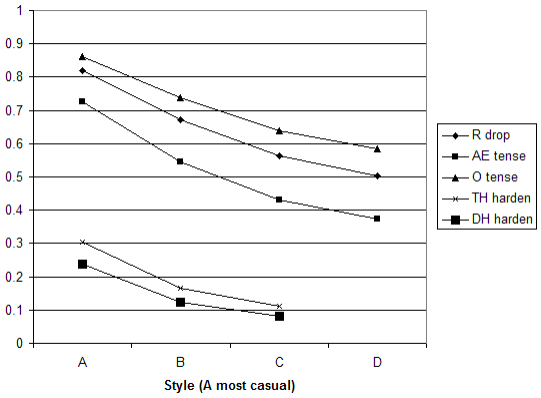
- The interviewees, sorted by average [Faithfulness − Markedness] weights:
  - Bennie, 40, finished only one semester of high school, drives a truck
  - Doris, 39, high school graduate, homemaker, African-American
  - Josephine, 35, almost four years of college, receptionist at Saks
  - Abraham, 47, taxi driver, high school grad
  - Steve, 25, four years at Brooklyn college but no degree, copyreader's assistant
  - Miriam, 35, law school, lawyer
- Caution: the real slope across speakers is moderated; Miriam (and to some extent, Bennie) have higher Markedness weights as well.

14. Grounds for pessimism for single-knob theory

- Labov thinks that for Doris, and others, r-dropping is more sensitive to style than other processes.



cf. maxent model prediction:



15. Grounds for pessimism for single-knob theory, from Kie's handout

- New trends are felt (?) to be casual and are led by women; but existing trends involve men speaking more casually.
- Word frequency effects: is pressure to speak intelligibly actually the same as formal style?

16. Upshot

- Theories with fewer knobs are more interesting to us because they make more predictions.
- But I'm pessimistic about maintaining a really tight few-knobs theory.

LEXICAL VARIATION

17. Lexical variation (from last time)

- Different stems or words behave differently in the phonology (but each stem or word usually behaves more or less consistently).
  - ➢ exception: you can have a (usually small) set of vacillator forms
- Confession: this field seems to be much easier to work in! Corpora are available, experiments are feasible; no pounding the pavements for years, endless phonetic transcription …

WHERE DOES LEXICAL VARIATION COME FROM? THE DIACHRONIC PICTURE

18. Absolute neutralization

- Spanish had [ɛ], [ɔ], which diphthongized to [je], [we] under stress, reduced to [e, o] when stressless.
- It had (and has) [e], [o], which didn't alternate.
- It acquired some [je], [we] in stressless position.
- Now, when you hear [pleˈgamos], you can't predict whether the 1st sg. will be [ˈpljego] or [ˈplego].

Alternation:	[n**e**ˈgamos]	'we deny'	[ˈn**je**go]	'I deny'
	[seˈgamos]	'we blind'	[ˈs**je**go]	'I blind'
	[k**o**nˈtamos]	'we tell'	[ˈk**we**nto]	'I tell'
	[poˈblamos]	'we populate'	[ˈp**we**blo]	'I populate'
No alternation A:	[p**e**ˈgamos]	'we hit'	[ˈp**e**go]	'I hit'
	[l**e**ˈbamos]	'we weigh'	[ˈl**e**bo]	'I weigh'
	[m**o**nˈtamos]	'we mount'	[ˈm**o**nto]	'I mount'
	[d**o**ˈblamos]	'we bend'	[ˈd**o**blo]	'I bend'
No alternation B:	[d**je**sˈmamos]	'we decimate'	[ˈd**je**smo]	'I decimate'
	[arr**je**sˈgamos]	'we risk'	[aˈrr**je**sgo]	'I risk'
	[am**we**ˈbamos]	'we furnish'	[aˈm**we**blo]	'I furnish'
	[desk**we**ˈramos]	'we flay'	[desˈk**we**ro]	'I flay'

- This pattern was part of the data for the theory of abstract segments (e.g., /ɛ/, /ɔ/ for alternators).
- But there's also a modest amount of frequency matching: see Bruce Hayes, Adam Albright and Argelia Andrade (2001, ms.) "Segmental environments of Spanish

diphthongization",
http://www.linguistics.ucla.edu/people/hayes/SegEnvSpanDiph/index.htm

19. Phonological processes in partial retreat

- The **life cycle of phonological rules** (work of Baudouin de Courtenay (19th c.), Steven Anderson, Ricardo Bermudez-Otero)
- Sound change starts low-level/phonetic, is fairly regular, reaches neutralizing status.
- Resistance to alternation, especially when phonetically severe, kicks in.
- Where predictability is imperfect, lexical listing kicks in
- And where lexical listing is possible, the cases of individual variation tend to settle into one category or the other — Kie's histogram of d → r in Tagalog, very heavy on the ends.
- Kie's example from last time; Tagalog tapping

- d → ɾ / V__V :

dunoŋ	'knowledge'	ma-**ɾ**unoŋ	'intelligent'
dinig	'heard'	ma-**ɾ**inig	'to hear'
dupok		ma-**ɾ**upok	'fragile'

- But, there are also words like this

daʔig	'beaten'	ma-**d**aʔig	'beaten'
dulas	'slipperiness'?	ma-**d**ulas	'slippery'
daʔan	'road'	ma-**d**aʔan-an	'passable'

- and like this

duŋis	'dirt on face'	ma-**ɾ**uŋis ~ ma-**d**uŋis	'dirty (face)'
dumi	'dirt'	ma-**ɾ**umi ~ ma-**d**umi	'dirty'

- I conjecture that d → ɾ / V__V was once regular.
- I conjecture that there was an earlier stage with *many* examples like ma-**ɾ**uŋis ~ ma-**d**uŋis 'dirty (face)'[4]; these settled mostly into single categories.
- The phonology that persists with lexical variation can be very old indeed.
  - Kie's Nasal Mutation example (below)—5000 years?
  - English *slinked ~ slunk* reflects the vowel ablaut alternations of Indo-European, of comparable vintage.

[4] Ito and Mester (2003) give a nice example with Japanese g → ŋ / V ___ V, where *every* compound word of the form *xxx* + g*yyy* has free variation between [*xxx*ŋ*yyy*] and [*xxx*g*yyy*]. Source: Ito, Junko and Armin Mester (2003) On the sources of opacity in OT: coda processes in German. In Caroline Féry and Ruben van de Vijver (eds.), The Syllable in Optimality Theory, Cambridge University Press. 271-303.

20. Undoing neutralization

- Speakers seem to be able to take "reverse wug tests", using lexical statistics to help them "guess the underlying form".
- Example from Ernestus and Baayen (2003) "Predicting the unpredictable: Interpreting neutralized segments in Dutch", *Language*
- Dutch has standard Final Obstruent Devoicing

verwijden	[vɛrʊɛidən]	'widen-INF'
verwijten	[vɛrʊɛitən]	'reproach-INF'
verwijd	[vɛrʊɛit]	'widen'
verwijt	[vɛrʊɛit]	'reproach'

- Most surface [x] are derived from underlying [ɣ], few from underlying /x/.
- When wug-tested, speakers guess /ɣ/ when they hear a novel [x] stem — more on this below.
- So the source of lexical variation is simply the phonemic distinction of voicing, present underlyingly.

THE LAW OF FREQUENCY MATCHING AND ITS EMPIRICAL SUPPORT

21. The Law restated (from last time)

- When a speaker of a language with lexical variation is tested on novel items, "[t]heir responses aggregately match the lexical frequencies"

22. Outline

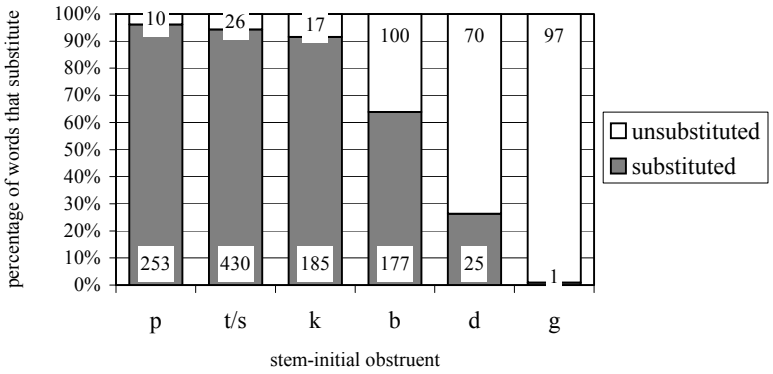
- Some cases
- Theory
- Subtleties and controversy

23. Zuraw's work on Tagalog

- Zuraw, Kie (2000) *Patterned exceptions in phonology*, UCLA dissertation.
- Zuraw, Kie (2010). A model of lexical variation and the grammar with application to Tagalog nasal substitution. *Natural Language and Linguistic Theory* 28(2): 417-472.

24. Lexical study of percent application of Nasal Substitution in Tagalog: N+obstruent → {m,n,ŋ}

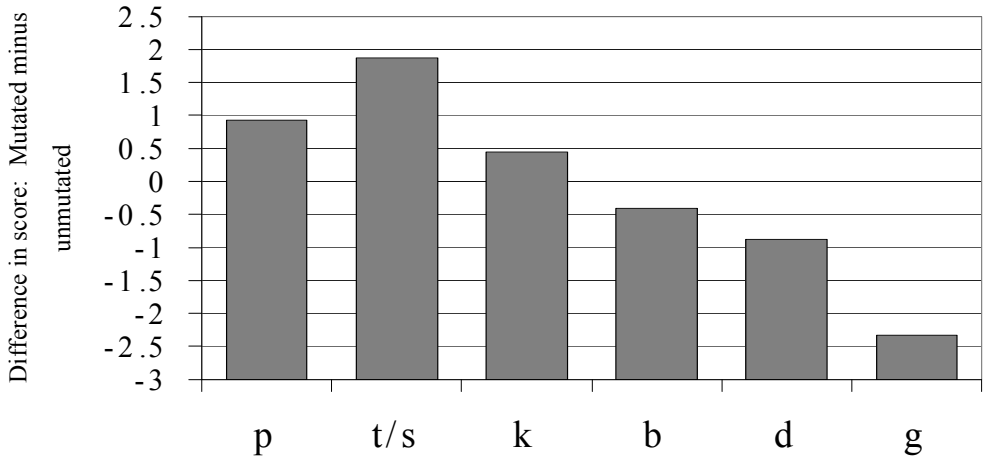
mag-bigáj 'give', but
/maŋ-bigáj/ → mamigáj 'distribute'



- Frequency of Nasal Substitution varies in the lexicon according to the stem-initial consonant
- The variation is mostly lexical; there are few doublet forms (both substitution and non-substitution are legal).[5]
- Cf. the [d]-[ɾ] alternation

25. Native speakers are tacitly aware of this pattern

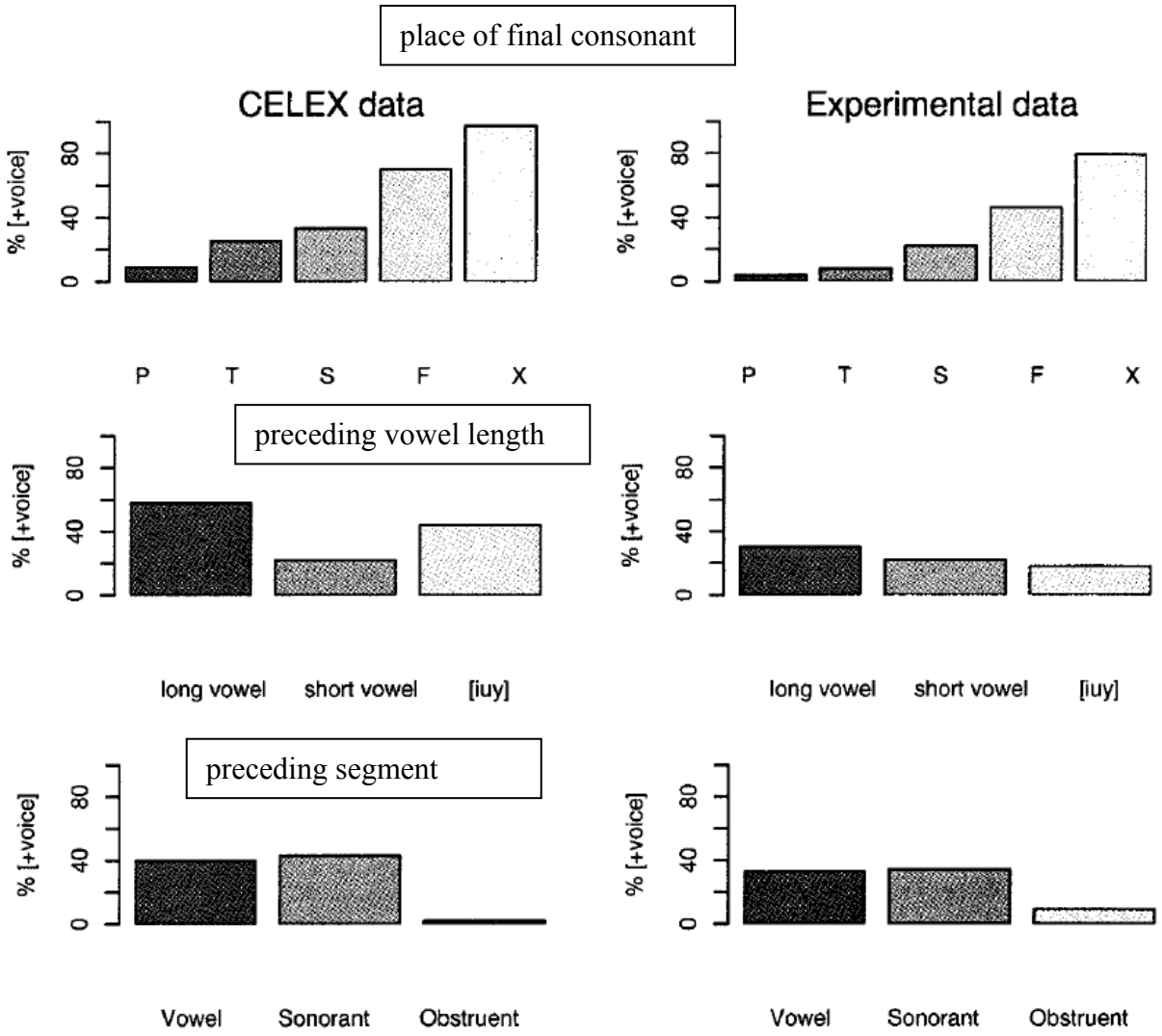
- Again Zuraw, a "wug" test (following Berko 1958). Preference for the nasally-mutated form (difference between both options, each rated on 1-10 scale)



[5] Zuraw 2010: "Although the variation pattern documented here is mainly lexical—most words have a fixed pronunciation—there is also some free variation even in some frequent words and words that are established enough to be listed in a dictionary."

26. The Dutch final devoicing case (Ernestus/Baayen) again

- They find good agreement between the Dutch lexicon (CELEX) and their wug-test data on "undoing Final Devoicing".



- Ernestus and Baayen try out quite a few learning models to match their data; several work well.

HUNGARIAN VOWEL HARMONY

27. Sources

- Hayes, Bruce and Zsuzsa Cziráky Londe (2006) Stochastic phonological knowledge: the case of Hungarian vowel harmony. *Phonology* 23: 59-104.
- Hayes, Bruce, Kie Zuraw, Péter Siptár, and Zsuzsa Londe (2009) Natural and unnatural constraints in Hungarian vowel harmony. *Language* 85: 822-863.

28. Hungarian vowels

Back	[u, uː, o, oː, ɔ, aː]	abbreviated "B"
Front rounded	[y, yː, ø, øː]	abbreviated "F"
Front unrounded, often called "neutral"	[i, iː, eː, ɛ]	abbreviated "N"

29. *Dative suffix*

- Is representative in its behavior
- Allomorphs: back [-nɔk] and front [-nɛk]

30. Closest vowel back: back suffixes

B**B**	[ɔblɔk-nɔk]	'window-dat.'
N**B**	[biːroː-nɔk]	'judge-dat.'
F**B**	[glykoːz-nɔk]	'glucose-dat.'

31. Closest vowel front rounded: front suffixes

F	[yʃt-nɛk]	'cauldron-dat.'
N**F**	[sɛmøltʃ-nɛk]	'wart-dat.'
B**F**	[ʃoføːr-nɛk]	'chauffeur-dat.'

32. F + N*: front suffixes

FN	[fyːsɛr-nɛk]	'spice-dat.'
FNN	[øːrizɛt-nɛk]	'custody-dat.'

33. Zones of Variation

- Individual stems vary in the kind of harmony they take—you must memorize.
- There are also "vacillators": stems for which either front or back suffixes are acceptable, and occur in various proportions.
- The zones: words ending in BN or BNN, plus [N] and marginally, [NN]

34. Examples: lexical arbitrariness of harmony within the zones of variation (BN)

Word ([o]+[eː])		*Gloss*	*Google hits (Sept. 2008)*	*Percent*
doménnak	[domeːn-nɔk]	'domain (on Web)-dat.'	5	2.1
doménnek	[domeːn-nɛk]		234	97.9
bohémnak	[boheːm-nɔk]	'easy-going-dat.'	433	24.4
bohémnek	[boheːm-nɛk]		1,340	75.6
honvédnak	[honveːd-nɔk]	'Hungarian soldier-dat.'	8,820	74.1
honvédnek	[honveːd-nɛk]		3,084	25.9
poénnak	[poeːn-nɔk]	'punch line-dat.'	56,400	99.9
poénnek	[poeːn-nɛk]		36	0.1

- N.B., just as Kie pointed out with Tagalog Tapping, the number of forms that have free variation is small — most settle on the ends of the frequency spectrum.

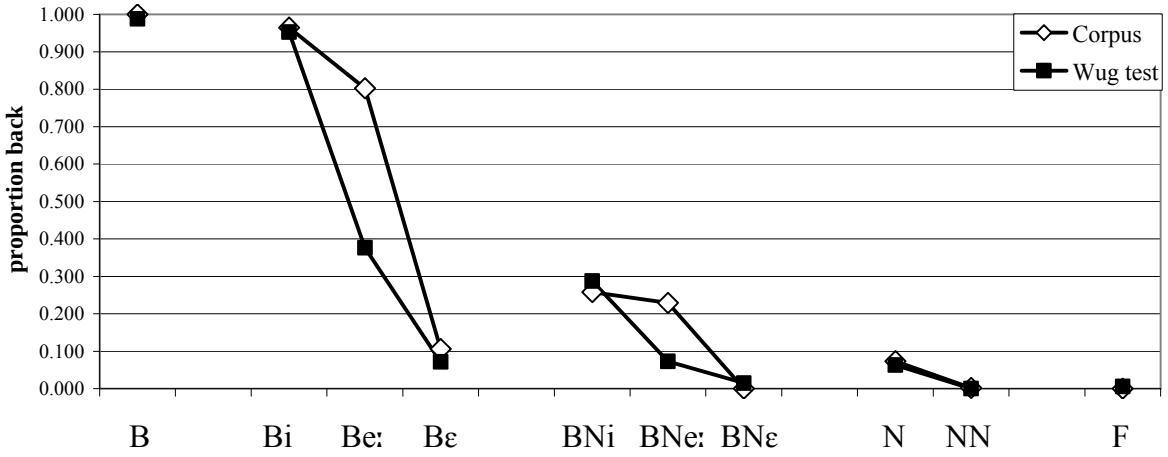
35. Corpus study

- Hayes and Londe (2006) did a Google survey, about 9,000 words, counting both -nɔk and -nɛk

36. Statistical patterns within the zones of variation

- **Height Effect**: the higher the last N vowel in BN, BNN, the more you get front harmony.
- **Count Effect**: more front harmony in BNN than BN.

37. Productivity of Height and Count Effects: Hayes and Londe's wug test



38. The Law in (much) broader perspective

- Frequency-matching is known to be a common ability in animals (Gallistel 1990, ch. 11)[6]; and in humans for nonlinguistic tasks (Hasher and Zacks 1984).[7]
- The Story of the Ducks and the Fish (Gallistel)

39. The Zurovian analysis in outline: Desiderata

- For particular invariant forms like *poénnak*, we want Faithfulness to force their use.
- For novel forms (e.g. never heard with suffix, or wug), we want a stochastic grammar to generate frequency-matching behavior.
- Listing cannot in general ride roughshod over grammar, since some possibilities aren't even listable. Examples: B-stem with -nek, F stem with -nak, datives that change consonants of the stem.
- Say something about the (relatively few) doublet forms, where there is variation within a single stem.

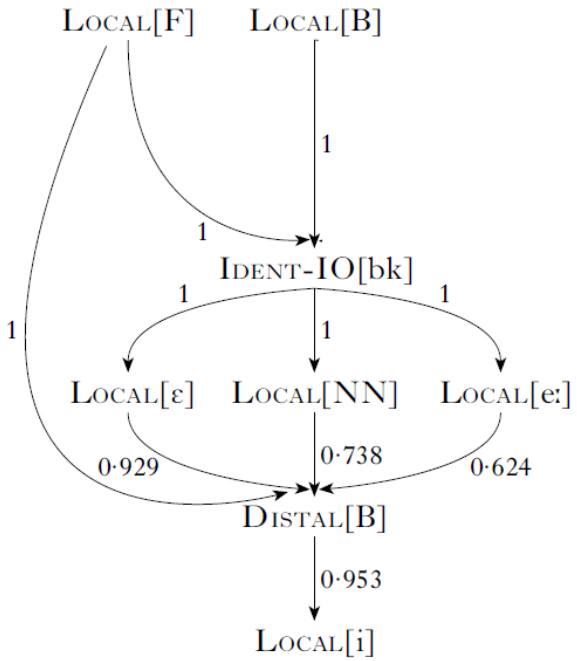
40. Zuraw's theory: the dual listing/generation model

- Words are memorized—even inflected ones—as they are heard.
  - See Baayen, Harald, Robert Schreuder, Nivja De Jong, and Andrea Krott "Dutch inflection: The rules that prove the exception," in Sieb Nooteboom, Frank Wijnen and Fred Weerman (eds.), Storage and computation in the language faculty (2002, Kluwer)
- But a stochastic grammar is created from them — treating them "as if" they were free variation data.
- I.e.: memorize, but be ready to project.

[6] Gallistel, Charles (1990) The Organization of Learning, MIT Press.

[7] Hasher L. and R. T. Zacks (1984) "Automatic processing of fundamental information: the case of frequency of occurrence," American Psychologist 39:1372-1388.

41. Hayes and Londe's (2006) ranking diagram (partial), applying the theory to Hungarian



- LOCAL F and LOCAL B require agreement with an adjacent front-rounded or back vowel — never violated (and wug-test confirms their strength).
- Ident-IO(back) will force use of a listed form.
- LOCAL[ɛ], LOCAL[NN], LOCAL[e:], DISTAL[B], LOCAL[i] are all violable harmony constraints. DISTAL[B] conflicts with the others, and the probabilities of ranking (arrows) are set (using Stochastic OT; Boersma/Hayes readings) to frequency-match the lexicon.

42. What about doublets?

- It would be natural to assign them doublet lexical entries.
- These entries must themselves be somehow probabilistic, to reflect the variation seen above in (34).

LAW OF FREQUENCY MATCHING: EXCEPTIONS AND CONTROVERSIES

43. Candidates for exceptions

- Don't frequency-match if this involves a hypothesis that is **too complex**.
- Don't frequency-match if this involves a hypothesis that is **phonetically unnatural**.
- Don't frequency-match if this involves a hypothesis that is not supported by **the constraint set of UG**.

44. Hayes/Zuraw/Siptar/Londe

- Source:
  - Hayes, Bruce, Kie Zuraw, Péter Siptár, and Zsuzsa Londe (2009) "Natural and unnatural constraints in Hungarian vowel harmony". *Language* 85: 822-863.
- A second wug-test study on Hungarian.
- We were curious about some "dumb" environments: front suffixes favored when stem ends in a bilabial stop.
- Upshot of the paper: relative to the lexicon, wug-testees devalued:
  - Phonetically-unnatural constraints, like "use front after bilabial stop"
  - Complicated constraints, like the agreement constraints based on vowel height.

A TINY BIT MORE ON THE LAW OF FREQUENCY-MATCHING

45. Becker and Nevins's research program

- They're interested in deviations induced by traditional generativist principles of phonological markedness.

46. Initial-syllable faithfulness

- source: Michael Becker, Andrew Nevins, and Jonathan Levine (2012) Asymmetries in generalizing alternations to and from initial syllables. *Language* 88:2, pp. 231–268.
- Lots of languages suppress alternation in initial syllables, e.g.

Monosyllables protected from nasal assimilation in Tamil

SINGULAR	PLURAL	
mi:**n**	mi:**n**-gə	'fish'
ma:n	ma:n-gə	'deer'
makə**n**	makə**ŋ**-gə	'son'
paj:ə**n**	paj:ə**ŋ**-gə	'boy'

- English, by historical accident, favors [f]-[v] alternation in monosyllables; like *leaf ~ leaves.*
  - The accident: English was rather monosyllabic when these alternations came to be.
- Wug test on English f-Voicing: subjects prefer alternation in polysyllables; i.e. obeying UG rather than the lexicon.

47. VC interactions

- Source:
  - Michael Becker, Nihan Ketrez, and Andrew Nevins (2011) The surfeit of the stimulus: Analytic biases filter lexical statistics in Turkish laryngeal alternations. **Language** 87:1, pp. 84–125.

- Doctrine: C can affect neighboring C, V can affect neighboring V, but it's disfavored for C and V to interact.
- A priori support for doctrine
  - typology (??? palatalization, nasality assimilation, spirantization)
  - Moreton's 2008 artificial-grammar learning study (Phonology 25: 83–127)
- Data: "undoing" final devoicing in Turkish, just like in Ernestus and Baayen's Dutch
- Lexicon: height of preceding vowel has a significant effect
- Wug test: height of preceding vowel has no significant effect
- Conclusion: speakers can't notice a factor that UG forbids them to notice

48. Controversies concerning the Turkish result

- Hayes/Zuraw/et. al (2011), working on Hungarian, found robust C-V effect (e.g., stem-final bilabials taking front harmony).
- Kevin Ryan (2009) notes that in the lexicon height is very asymmetrically distributed relative to consonant place, and that this may have led to a falsely-negative conclusion re. the height effect.