Class 17 (Week 8, R)
Learning Models IV: phonologization

To do
- ☐ Read **Hayes & Wilson (2006)** for Tuesday (Nov. 24)
  - presenters, if you e-mail me your handout as a PDF by noon Thurs., I can print
- ☐ Prepare at least one **question or point for discussion** on the reading
- ☐ Computing **homework** using OTSoft is due Tuesday (Nov. 24).
  - I have an extra office hour tomorrow (Friday) from 2 to 3 if questions
- ☐ Negotiate schedule for class on Tuesday of Week 10 (Dec. 1)

Overview: This is getting away from formal models of learning, but an important question about learning is how phonetic effects and properties get turned into phonological ones.

1. Discuss Kirby (2013) and Bang et al. (2015)

2. Beautiful example from Hayes (1999)

- Many factors affect how much aerodynamics favors voicing vs. voicelessness (see Ohala 1983, Westbury & Keating 1986) (Hayes p. 8)
  - <u>place of articulation</u>: fronter closure → bigger oral chamber → more room for the air → airflow from lungs, across glottis, into mouth encouraged
  - <u>closure duration</u>: as time passes during the closure, more air pressure in oral chamber → airflow across glottis discouraged
  - <u>being after a nasal</u>: nasal leak and velar pumping encourage airflow
  - <u>being phrase/utterance-final</u>: subglottal pressure is lower → lairflow across glottis discouraged

- Hayes constructs the following "difficulty landscape" using an aerodynamic model (Keating 1984)
  - 0 means there's no problem having voicing; bigger numbers mean it's difficult.

(2) Landscape of Difficulty for Voiced Stops: Three Places, Four Environments

	b	d	g	
[-son] ___	43	50	52	
# ___	23	27	35	
[+son, -nas] ___	10	20	30	
[+nas] ___	0	0	0	contour line: 25

(p. 9)

- The thing is, there is no language that draws the line at 25. Instead, languages draw vertical or horizontal lines that partly contradict the phonetics:
  - *g (as in Dutch): ignores the fact that initial [g] is easier than post-obstruent [d]

- This can lead to seeming cross-language markedness constradictions in the corners:
  - *p (as in Arabic): even in geminates, you get only [bb], not *[pp]
  - *VOICEDGEMINATE (as in non-loan Japanese): only [pp], not *[bb]

3. Hayes's proposed solution [assumes analytic bias]

The learner...

- ...compiles a difficulty map like the above
- ...constructs constraints according to certain templates (*[αF], *[αF][βG], *[αF,βG], etc.)
- ..evaluates constraints according to how often they correctly predict that one item in the map is harder than another
  - e.g., *g is correct about g/[-son]__ vs. d/[-son]__, but wrong about g/#__ vs. d/[-son]__
  - collect % of pairs for which prediction is correct
- ...to be accepted, a constraint must do better on the above test than all its "neighbors" that are equally or less complex
  - constraints are neighbors if they differ in just one symbol (whatever counts as a symbol in your theory).
  - e.g., *[coronal, +voice] and *[dorsal, +voice] are neighbors, equally complex
  - *g and *#g are neighbors; *g is less complex than *#g

- <u>Result</u>: The learner add complex constraints only if they justify themselves.

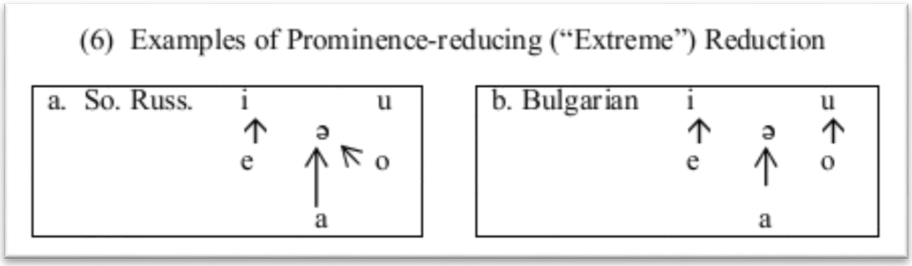
- Echoes of smoothing/regularization: to reduce overfitting, in this model there is a built-in bias against great complexity (which would allow a closer fit to the data).

- In the voicing example, Hayes ends up with constraints like *[dorsal, +voice] and *[+nasal][-voice], but nothing more complex.

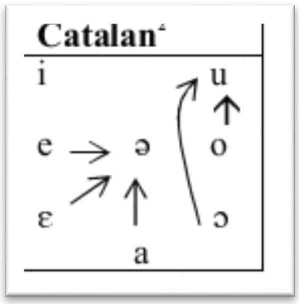
4. Some other cases similar in spirit

- Crosswhite (1999): When stressed syllables have shorter duration, there's less time for jaw opening, so low vowels are disfavored.[1]
  - In some languages, result is actual neutralization with another V category
  - Which category a V is neutralized with can be language-specific (over):

[1] That's not the only type of vowel reduction in unstressed syllables; Crosswhite also discusses the contrast-enhancement type.



(Crosswhite 2000a, p. 4)



(Crosswhite 2000b, p. 3)

⇨ Despite shared phonetic motivation, different faithfulness rankings. These patterns aren't just an automatic result of reduced jaw lowering.

- Zhang (2000): languages with contour tones (falling, rising, dipping) often restrict where those contours can appear, including
  - long vowels only
  - stressed syllables only
  - final syllables only
  - monosyllables only

→ syllables that will "canonically" have longer duration in the sonorous portion of their rime are favored sites for contour tones.

- Moreover, Zhang found that language-specific facts about, e.g., how much features of a coda consonant affect duration, affect where the contour tones can occur in that language.

- But the "**canonically**" is key: based on some typical speech rate and style, or averaged/normalized over speaking rates and style.
  - If we had a constraint like simply

    *CONTOUR/<200 msec

    Then the winning candidate would change according to speech rate.
  - While some contours that are normally acceptable *might* get wiped out in fast speech, extra-slow speech doesn't (I think) allow additional contrasts.

5. Experimental evidence: Myers & Padgett 2014

- It's been proposed that the motivation for final devoicing is motivated by what happens articulatorily at the end of an utterance: drop in sub-glottal pressure, glottal abduction in anticipation of breathing. Discuss: problems/issues for this story?

- Artificial grammar study 1: phonotactic learning
  - Participants hear words in frames *santa* _______ and *santa* _______ *mizupu*
  - Listen and repeat
    - Final devoicing group: words like *pis, pum, pamu*—but *pis* is never utterance-medial
    - Final voicing group: words like *puz, pum, pamu*—but *puz* is never utterance-medial
  - Testing phase: press button to say whether utterance belongs to the language or not
    - novel words of the same types, but now the *s*- and *z*-final words can be utterance-medial

o Discuss results:

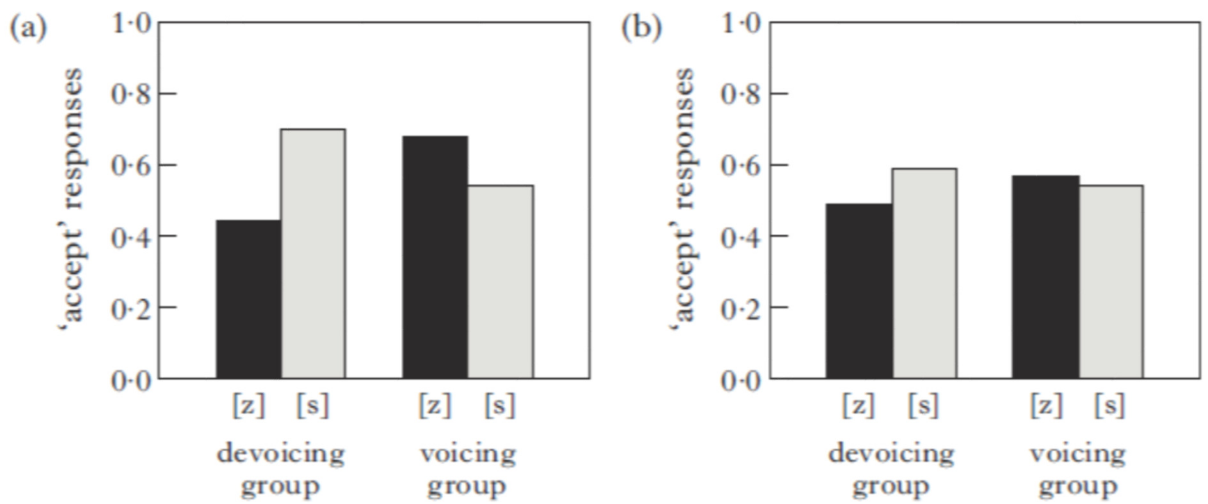


Figure 1
Proportion of 'accept' responses by word-final voicing category and learning group: (a) utterance-final position; (b) utterance-medial position.

(p. 409)

- Artificial grammar study 2: alternation learning
  - Participants hear words in frames *bitomi* _______ and *bitomi* _______ *nama*
  - Words come in singular-plural pairs: *pet, peti; git, gidi; min, mini*
    - Participant gets a pair like *bitomi pet, bitomi peti*, with drawings illustrating singularhood and pluralhood
  - Obstruent-final stems are never utterance-medial
  - Feedback phase
    - Hear an utterance with a plural, produce the utterance with the singular
  - Test phase
    - Includes non-alternating voiced (*teb, tebi*)
    - and reverse-alternating (*teb, tepi*)
    - Participants hear the utterance with the plural, then the singular
    - All singulars can occur in all environments

- Discuss results:

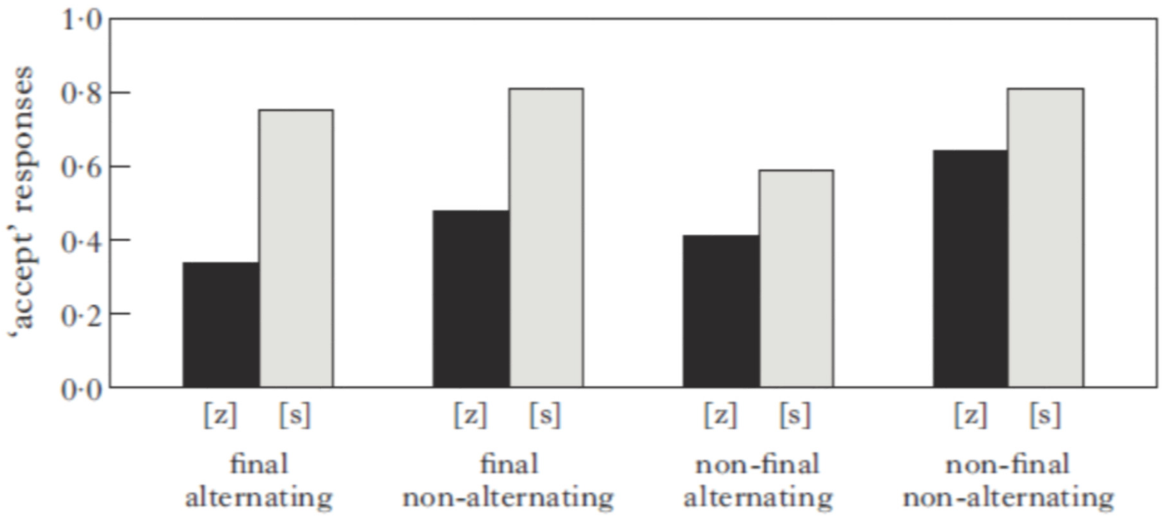


Figure 3
Proportion of 'accept' responses by stem-final voicing category, utterance position and alternation status.

(p. 421)

6. A grab bag of other things to think about

- Hansson (2001): consonant harmony as the phonologization of production-planning effects
- Pierrehumbert (2001): "viable constraints are coarse-grained"
  - Focussed on constraints that could be used by a Fast Phonological Preprocessor that guesses word boundaries
  - Asks how reliable various regularities in the English lexicon are
    - Stress pattern σ́σσ is more common than σσ́σ
    - Some nasal+obstruent clusters are more common than others
    - Statistics of nasal+obstruent clusters between an initial, stressed syllable and a following, unstressed syllable
    - Word-final /gri/ is more common than /kri/
  - The simpler constraints turn out to be more likely to be well represented in a subset of the data → they should be more reliably learned
  - P. concludes that "[p]honological constraints must be coarse-grained because ocmplex and detailed phonological descriptiors are statistically unstable across differences in vocabulary, and cannot be learned reliably" (p. 692)
- Fruehwald (2013): argues that reanalysis of phonetics and phonology occurs *early* in a change, not late
  - The phonological change is the cause, not the effect, of the phonetic change

7. Coming up (on Tuesday—there is no class Thursday)

- What if the learner has to figure out the constraint set, or even the features?

References

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