Exceptions

Class 7: Predictability without alternations

Adam Albright

CreteLing 2024

creteling2024.phonology.party

So far

- Focused on predictability of alternating features
- K&K hierarchy also implicitly focuses especially on alternating features
    - What values a UR may contain, when surface allomorphs differ from each other
    - Wang and Hayes learning model mainly explores abstraction for alternating properties
- Wording is quite general, however: "idiosyncratic (unpredictable) properties"
- Question: to what extent do speakers predict 'static' properties of morphemes?

Place in English

- In general, English allows coda clusters ending in labials, coronals, and dorsals

limp	lɪmp	*lisp*	lɪsp
lint	lɪnt	*list*	lɪst
link	lɪŋk	*risk*	ɹɪsk

- However, after tense vowels and diphthongs, only coronals are allowed
  - *paint* [peɪnt], *pint* [paɪnt], *point* [pɔɪnt]
  - *least* [list], *roost* [ɹust], *paste* [peɪst], *roast* [roʊst], *hoist* [hɔɪst]
- Predictability: C $\rightarrow$ [+cor] / [+tns]C_
- Exceptions: *oink*, *boink*, *yoink*

Place in English

- More generally: place is predictable to varying extents, depending on…
  - Manner
  - Position
  - Segmental context
- A grammar that encoded these regularities could do (much) better than chance at predicting place
  - Parallel to Ernestus & Baayen (2003), Becker et al. (2011), etc. for voicing
- Morphemes that go against these general trends are exceptions

Albright, Fullwood and Jun (2016)

- Employed the Minimal Generalization Learner (Albright & Hayes, 2002) to learn grammars predicting features of morphemes in Dutch, English, and Korean
- Tested grammar on existing words, to determine which are correctly derived, and which are exceptions
- Hypothesis: exceptional words will have higher token frequency

Applying the MGL to phonological features

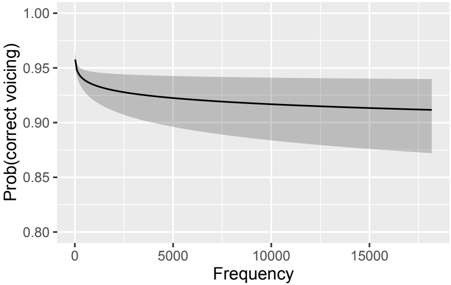
- Given a pair: [ʋeːrəl$T_{[\varnothing \text{ voice}]}$], [ʋeːrəl$T_{[+\text{voice}]}$] ‘world’
- Learn a word-specific rule: [$\varnothing$ voi] $\rightarrow$ [+voi] / ʋeːrəl $\begin{bmatrix} \text{t} \\ \_ \end{bmatrix}$ #
- Comparison with [xɛl$T_{[+\text{voice}]}$] ‘money’, [beːl$T_{[+\text{voice}]}$] ‘image’, [sxʏl$T_{[+\text{voice}]}$] ‘fault’, etc.
  - [$\varnothing$ voice] $\rightarrow$ [+voice] / [+lat] $\begin{bmatrix} \textit{-son} \\ \textit{-cont} \\ \textit{+cor} \\ \_ \end{bmatrix}$ #
  - This rule works in 186/209 = 89% of cases
- By contrast: in general, only 7779/15553 = 33% of final obstruents are voiced in Dutch
- Wug testing the model: [ʋeːrəl$T_{[+\text{voice}]}$] has higher reliability, so is preferred output

Albright, Fullwood and Jun (2016)

- Trained Minimal Generalization Learner on 5151 obstruent-final Dutch nouns, from CELEX (Baayen et al., 1993)
- ‘Wug tested’ the resulting grammar on all 5151 nouns, compared output to actual output
- Model accuracy: is the model more likely to be correct for low frequency words?
  - That is, are low frequency words more regular w.r.t. final obstruent voicing?

Albright, Fullwood and Jun (2016)

Result for Dutch: significant effect of frequency ($p < .0001$)



- As Ernestus and Baayen observe, final obstruent voicing is overall very predictable (>90%)
- Significantly more predictable at lower frequencies
- Expected pattern of regularization of low frequency items, if rules concerning final voicing are in the grammar

Alternations vs. static phonotactics

- Albright, Fullwood and Jun (2016) compared three languages, with three patterns of word-final neutralization

	Place	Continuancy	Laryngeal
English	✓	✓	✓
Dutch	✓	✓	*
Korean	✓	*	*

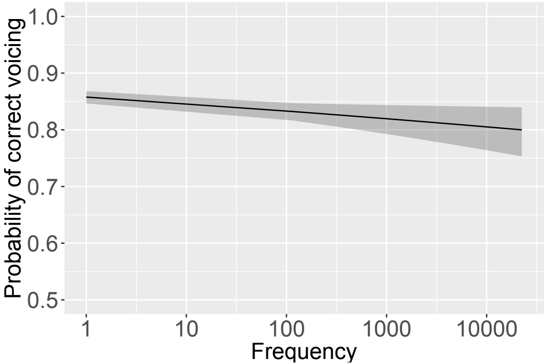
- Dutch and Korean neutralize features categorically in final position, with alternations
    - Korean: alternating features show same freq effect as Dutch
- Both languages also show gradient restrictions with no alternations for other features–e.g., place
- English: gradient phonotactic restrictions for all features finally
- All three lgs show gradient static restrictions in initial position
- Question: similar effects for static phonotactics?

Modeling English

- Trained the Minimal Generalization Learner on all obstruent-initial/final words found in the OANC
    - Excluded clusters of obstruents
    - 7,896 items with final obstruents, 11,093 with initial obstruents
- Learning task: given all properties of the word except the voicing/continuancy/place of the final segment, try to predict that feature
- Tested the model on all existing words, tallying correct vs. incorrect
- Test: is probability of being correct greater at lower (or higher) frequencies?

Features of obstruents in final position: English

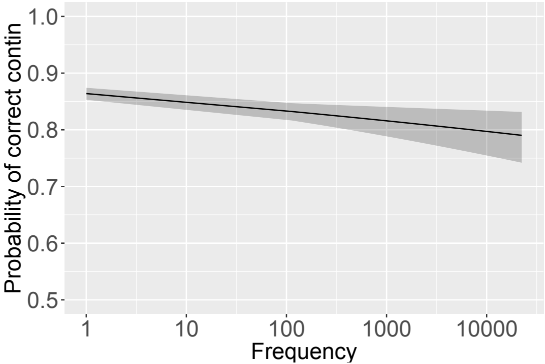
Voicing (two-way anova: $p = .014$)



- All features are surprisingly(?) predictable
- Consistent effect: low frequency words are more predictable

Features of obstruents in final position: English

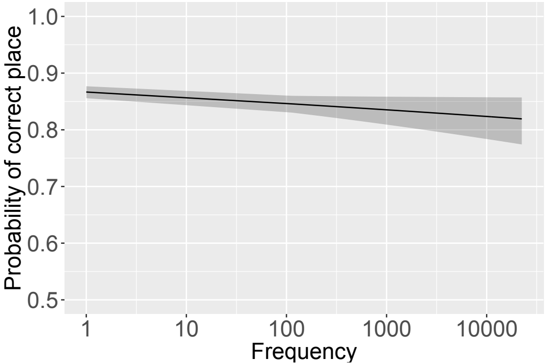
Place: (three-way anova: $p = .037$)



- All features are surprisingly(?) predictable
- Consistent effect: low frequency words are more predictable

Features of obstruents in final position: English

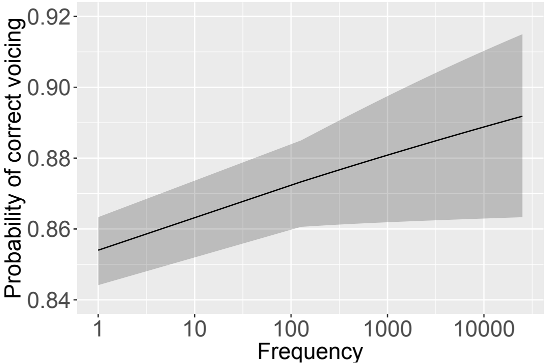
Continuancy: (two-way anova: $p = .002$)



- All features are surprisingly(?) predictable
- Consistent effect: low frequency words are more predictable

Features of obstruents in initial position: English

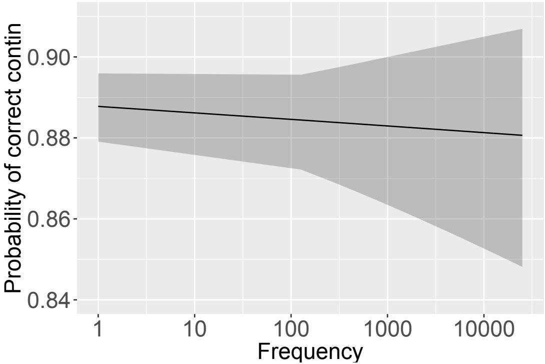
Voicing (two-way anova: p = .033)



- No consistent effect, and to the extent that anything significant effects emerge, they go in the opposite direction
    - Low frequency words are *less* predictable

Features of obstruents in initial position: English

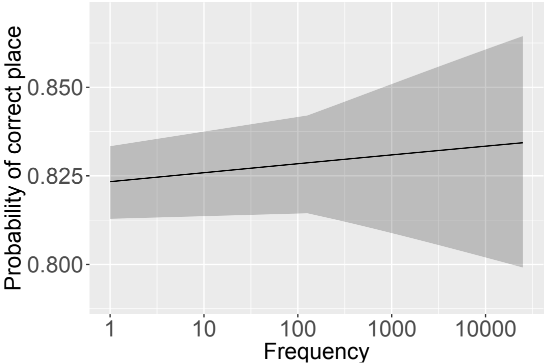
Place: (three-way anova: $p = .598$)



- No consistent effect, and to the extent that anything significant effects emerge, they go in the opposite direction
  - Low frequency words are *less* predictable

Features of obstruents in initial position: English

Continuancy: (two-way anova: $p = .682$)



- No consistent effect, and to the extent that anything significant effects emerge, they go in the opposite direction
  - Low frequency words are *less* predictable

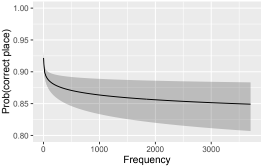
Equivalent test for Korean

- Ran MGL on 5018 Korean nouns (Sejong corpus, dialect forms and errors removed by hand; Kim & Kang, 2000)
- Tested predictability of place, continuancy, and laryngeal features in stem-initial and stem-final position

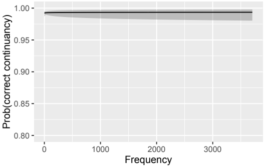
Initial vs. final position: Korean

Stem-final: systematic frequency effects, where not at ceiling

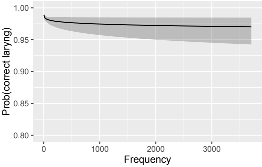
Place ($p < .0001$)



Contin. ($p = .81$)

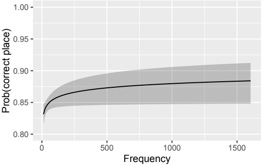


Laryngeal ($p < .05$)

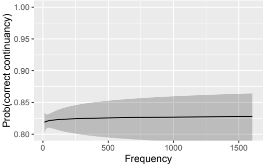


Stem-initial: significant inverse effects(!!)

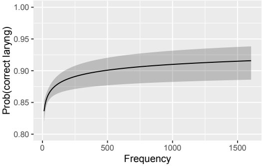
Place ($p < .0001$)



Contin. ($p = .729$)



Laryngeal ($p = .03$)



Local summary

- In initial position, no real effect, but perhaps a trend towards greater predictability in high frequency words
- Something is special about morpheme-final position
  - Greater predictability in low frequency words, as expected through regularization
- Interestingly, this is where I do know of some historical changes over time (though often potentially involving morphological reanalysis)
  - Famously so, for Korean
  - Examples: *ostri*[tʃ] $\sim$ *ostri*[dʒ], *Texa*[s] $\sim$ *Texa*[z]

Exceptions to constraints

From whole grammars to individual constraints

Two different theories of exceptionality

- Listed exceptions (e.g., Zuraw, 2000)
  - If the grammar is unable to select the correct output candidate for a form, the form is listed in ‘pre-compiled’ form
- Rule or constraint indexation (Pater, 2000; Becker, 2009)
  - If a specific highly ranked constraint selects the wrong output candidate for a form, the form is listed as an exception to that constraint

Both approaches predict a relation between frequency and the likelihood of listing a form as an exception, but the latter allows us to examine the distribution of exceptions on a constraint-by-constraint basis

Strategy

- Identify violable (exceptionful) constraints
- Compare frequency distributions of forms that obey vs. exceptionally violate
- Hypothesis: exceptional forms should be skewed towards higher frequency

Again: English vs. Korean (nouns, verbs/adjectives)

Violable constraints of English

- Used Wilson's phonotactic constraint learner on the English lexicon
  - Similar to UCLA Phonotactic Learner (Hayes & Wilson, 2008)
  - Learns grammar of weighted constraints, penalizing underattested sequences
  - Uses likelihood ratio criterion instead of observed/expected ratio (Wilson and Obdeyn 2009)
- Training: 19,367 lemmas from OANC (all lengths)
  - Phonetic transcriptions from CMU, as above
  - Automated syllabification
  - Feature system from Hayes & White (2013), including feature for 'coda consonants'
- Cut off learning after 500 constraints

Finding informative constraints

- Many of the 500 constraints rarely/never violated in the lexicon
  - 46 have 0 violations, 102 have 10 or less violations
  - E.g. *Coda *h*, $*\begin{bmatrix} +\text{strid} \\ +\text{ant} \end{bmatrix}[-\text{ant}]$, …
  - Not sensible to ask how violations are distributed by frequency
- Others are weak and general, violated many times
  - $*\begin{bmatrix} -\text{cont} \\ +\text{voi} \end{bmatrix}$: 9,660 violations
  - $*\begin{bmatrix} +\text{stress} \\ -\text{back} \\ -\text{tense} \end{bmatrix}$: 9,663 violations
  - Not strong enough to create much of an effect
- Sorted constraints by descending weight, searched for constraints with 50 or more violations
  - Ignored a handful of constraints ruling out sequences that arose to handle erroneous transcriptions and syllabification

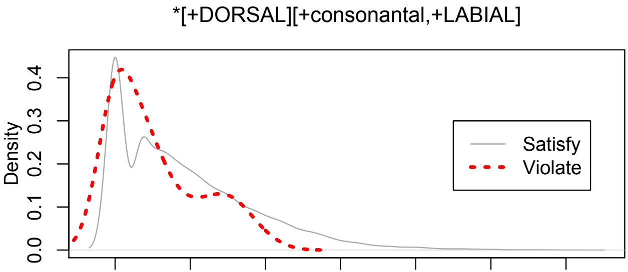
An example

- $*[+\text{dorsal}]\begin{bmatrix}+\text{consonantal}\\+\text{labial}\end{bmatrix}$ (=*[k,g,ŋ][p,b,m,f,v])
    - 64 violations, weight = 3.909
    - Most exceptions are compounds or derived forms
    - Most monomorphemic exceptions are /gm/

eggplant, bagpipe, bagpipes, backbone, backfire, backfield, backpacker, backpack, backpack, backpedal, bookmobile, blackberry, blackball, blackmail, blockbuster, breakfast, dogfish, jackpot, embankment, figment, fragment, gangbuster, gangplank, hummingbird, kickback, kingpin, cookbook, quagmire, lakefront, logbook, magpie, meaningful, milkman, augment, pigment, pickpocket, ping-pong, pigmentation, pragmatic, wrongfully, rugby, segment, sigma, springboard, stockbroker, stigma, checkbook, checkmate, workbench, workman, workmanship, workplace, workplace, wingback, walkman, thankfully, thankful

Are exceptional words more frequent?

- Goal: compare frequency distribution of violating (‘irregular’) vs. satisfying (‘regular’) constraints
- Calculated kernel density estimates over log OANC frequencies for violators and satisfiers
- Result: for this constraint violators tend to have somewhat lower than average frequency
    - Possibly also related to the fact that violators tend to be compounds?



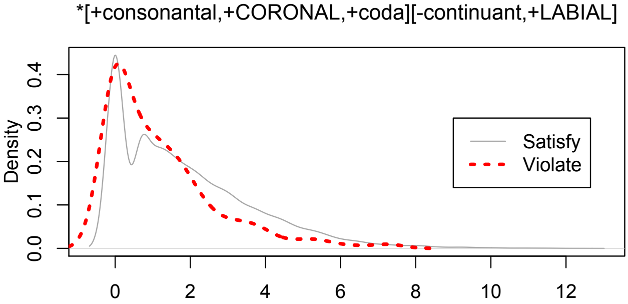
Another cluster constraint

- $*\begin{bmatrix} +\text{consonantal} \\ +\text{coronal} \end{bmatrix} . \begin{bmatrix} -\text{continuant} \\ +\text{labial} \end{bmatrix}$ (=*[COR].[p,b])
  - 216 violations, weight = 3.406

album, icebox, outback, output, oddball, oxbow, able-bodied, ex-boyfriend, elbow, eastbound, inboard, input, unborn, alpaca, asbestos, basketball, baseball, bedpan, billboard, bullpen, bulb, busboy, dashboard, downpour, disbelief, unplug, fastball, feedback, fishbowl, fallback, foolproof, football, footprint, full-blown, floodplain, frisbee, frostbite, gallbladder, gunpoint, good-bye, grandparent, grasp, hatchback, houseboat, hodgepodge, hardback, heartburn, hotbed, headband, help, henpecked, hornbill, husband, cardboard, cornbread, culprit, cusp, crisp, kielbasa, lesbian, mailbox, needlepoint, needlepoint, nitpick, newsprint, nonprofit, albeit, pocketbook, potpie, pulp, raspberry, rainbow, roadblock, rollback, rosebush, sandbagged, sandpaper, sagebrush, sailboat, setback, seatbelt, softball, sunburn, scalp, sculpture, smallpox, smorgasbord, standby, switchblade, tidbit, tollbooth,

Another cluster constraint

- $*\begin{bmatrix} +\text{consonantal} \\ +\text{coronal} \end{bmatrix}.\begin{bmatrix} -\text{continuant} \\ +\text{labial} \end{bmatrix}$ (=*[COR].[p,b])
  - 216 violations, weight = 3.406
- Again, violators tend to have lower frequency, contrary to the 'frequent exceptions' hypothesis
  - Reduction in high-frequency exceptions involving /d/: *goodbye*



More disagreeing clusters

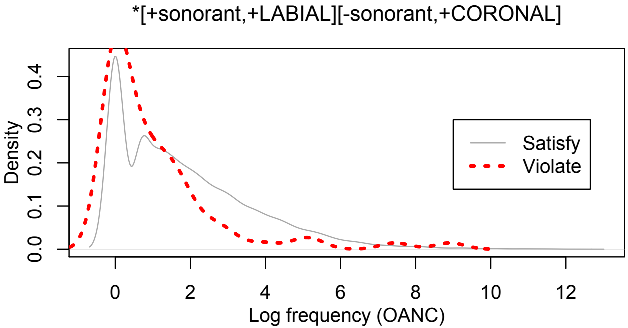
- $\begin{bmatrix} +\text{sonorant} \\ +\text{labial} \end{bmatrix} \begin{bmatrix} -\text{sonorant} \\ +\text{coronal} \end{bmatrix}$
  - 70 exceptions, weight $= 2.612$

armed, armchair, informed, unaccustomed, uninformed, bmw, bummed, bloomed, damned, dammed, damsel, doomsday, themself, drummed, accustomed, acclaimed, unarmed, unharmed, assumed, ashamed, farmed, fumes, flimsy, flimsiest, gummed, groomed, hamster, hamstring, hamstring, hemmed, homesick, homesteaded, homestead, hometown, humdinger, humdrum, himself, inflamed, uniformed, camshaft, clumsy, lambda, limestone, monogrammed, maimed, malformed, perfumed, plumbed, proclaimed, circumspect, circumstance, seamstress, seems, someday, sometime, sometime, something, circumstantial, sometimes, skimmed, storms, swimsuit, times, tamed, temptation, charmed, volumes, whimsical, warmth

- Violations are largely affixed (-*ed*) or compounds

More disagreeing clusters

- $\begin{bmatrix} +\text{sonorant} \\ +\text{labial} \end{bmatrix} \begin{bmatrix} -\text{sonorant} \\ +\text{coronal} \end{bmatrix}$
  - 70 exceptions, weight $= 2.612$



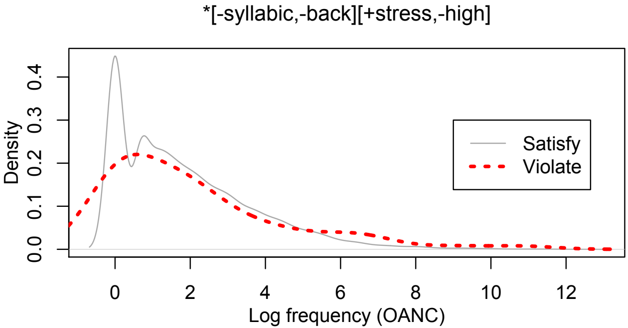
A glide/vowel constraint

- $*\text{j}\begin{bmatrix} +\text{stress} \\ -\text{high} \end{bmatrix}$
  - 64 exceptions, weight $= 3.146$

backyard, *barnyard*, *dossier*, *junkyard*, *familiarity*, *graveyard*, *yeah*, *yack*, *yam*, *yang*, *yankee*, *yank*, *yap*, *ya*, *yadda*, *yahoo*, *yon*, *yonder*, *yardage*, *yard*, *yarn*, *yacht*, *yay*, *urine*, *urethane*, *yellow*, *yell*, *yep*, *yesterday*, *yet*, *yo*, *yodel*, *yogurt*, *yoyo*, *yolk*, *yawn*, *yaupon*, *your*, *yuck*, *yummy*, *yum*, *young*, *yuppie*, *yup*, *urinalysis*, *carryover*, *courtyard*, *seniority*, *schoolyard*, *vignette*

A glide/vowel constraint

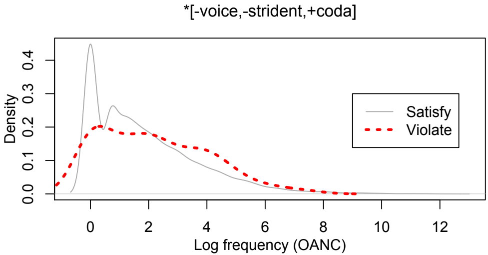
- $*\text{j}\begin{bmatrix} +\text{stress} \\ -\text{high} \end{bmatrix}$
  - 64 exceptions, weight = 3.146



More generally: weight>1.5, violations>50

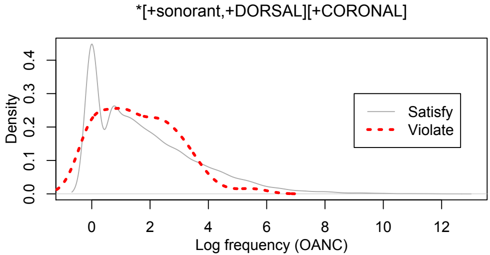
- A small number of constraints show slight skewing of violators to higher frequencies
- No constraint shows anything like a frequency distinction like English irregulars for violators vs. satisfiers

More generally: weight>1.5, violations>50



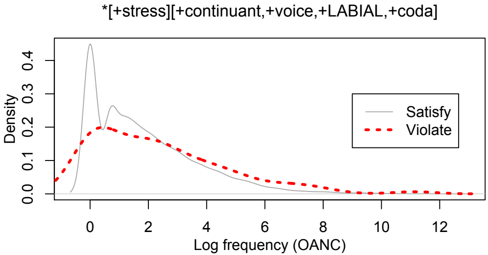
- A small number of constraints show slight skewing of violators to higher frequencies
- No constraint shows anything like a frequency distinction like English irregulars for violators vs. satisfiers

More generally: weight>1.5, violations>50



- A small number of constraints show slight skewing of violators to higher frequencies
- No constraint shows anything like a frequency distinction like English irregulars for violators vs. satisfiers

More generally: weight>1.5, violations>50



- A small number of constraints show slight skewing of violators to higher frequencies
- No constraint shows anything like a frequency distinction like English irregulars for violators vs. satisfiers

The same exercise for Korean

- Same datasets as for bigrams
  - 1–2σ nouns, all verbs/adjectives
  - Syllabified phonetic transcriptions
- Submitted to MaxEnt Phonotactic Learner, to learn grammars of 500 constraints
- Examined resulting grammars for constraints with $>$50 violations, and weights > 1

Results: Korean nouns

Numerous violable constraints reflecting gradient trends

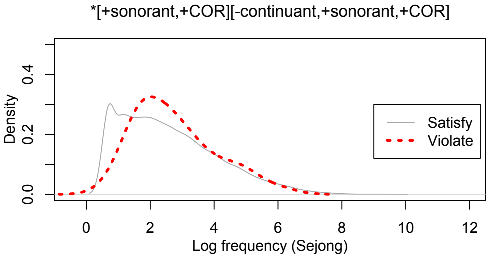
- *[-continuant,+sonorant][+tense]
    - No tense obstruents after nasals (w=2.92, 62 violations)
- *#[-continuant,+tense]
    - No initial tense stops (w=2.58, 203 violations)
- *[-high,-back][+coda,+sonorant,+COR]
    - No e/ɛ before l,r,n (w=1.84, 103 violations)

(Related to constraints observed by Cho, 2012 and others)

Distribution of violators: Korean nouns grammar

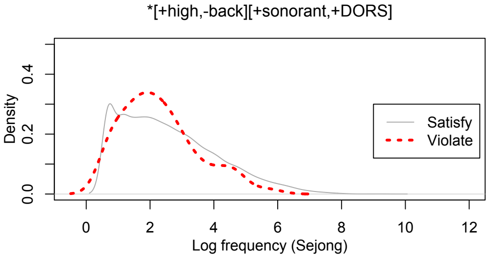
- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Distribution of violators: Korean nouns grammar



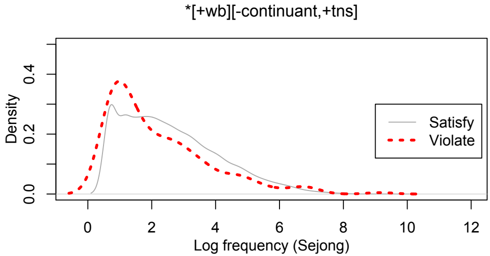
- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Distribution of violators: Korean nouns grammar



- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Distribution of violators: Korean nouns grammar



- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Results: Korean verbs

Numerous violable constraints reflecting gradient trends

- *[-consonantal][-continuant,+sonorant][-coda]
  - No medial nasal onsets, *VNV (w=2.985, 601 violations)

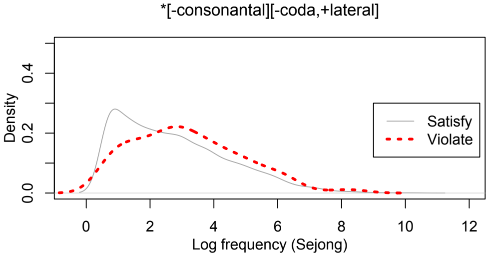
  (Similarly, no medial fricative onsets, w=2.75, 358 violations)
- *[-syllabic][-sonorant,+LAB]
  - No labial obstruents as the second member of a cluster (w=1.271, 136 violations)
- *#[+syllabic]
  - No initial vowels (w=1.131, 375 violations)

  (Same constraint is weaker for nouns; w=0.32)

Distribution of violators: Korean verbs grammar

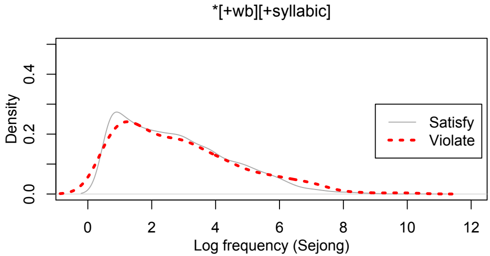
- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Distribution of violators: Korean verbs grammar



- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Distribution of violators: Korean verbs grammar



- As for English, a few specific constraints do show skewing towards higher frequencies, but no general trend

Discussion

- Final segments show a fairly reliable frequency effect
  - For features that alternate (neutralization)
  - And also, features that don’t (phonotactics)
- By contrast, non-final segments don’t show a reliable frequency effect
  - Initial segments, specific features: trend towards reverse effect, items with dispreferred value are rarer
  - Throughout the word, constraint violations: similar tendency for exceptions in rarer words

Interpretation?

- Not consistent with the idea that all predictable features are removed from the lexicon and predicted by grammar
  - At least, not gradiently predictable features
- Perhaps an effect of position, not predictability
  - Final segments more weakly represented than initial segments?
- Not strictly linked to alternations, either
  - Final segment predictability high across languages, regardless of neutralization
  - Consistent frequency effect in final position, regardless of neutralization

Lower frequency for exceptional items

- Perhaps an avoidance effect?
- Frisch (1996): learners are reluctant/slower to learn improbable words
- Martin (2007): speakers produce phonotactically dispreferred items less frequently than expected

References

ALBRIGHT, ADAM, and BRUCE HAYES. 2002. Modeling English past tense intuitions with minimal generalization. *Sigphon 6: Proceedings of the sixth meeting of the acl special interest group in computational phonology*, 58–69. ACL.

BAAYEN, R. HARALD; RICHARD PIEPENBROCK; and HEDDERIK VAN RIJN. 1993. *The celex lexical data base on cd-rom*. Philadelphia, PA: Linguistic Data Consortium.

BECKER, MICHAEL. 2009. *Phonological trends in the lexicon: The role of constraints*. UMass Amherst dissertation.

BECKER, MICHAEL; NIHAN KETREZ; and ANDREW NEVINS. 2011. The surfeit of the stimulus: Analytic biases filter lexical statistics in Turkish laryngeal alternations. *Language* 87.84–125.

References (*cont.*)

Cho, Hyesun. 2012. Statistical learning of Korean phonotactics. *Studies in Phonetics, Phonology and Morphology* 18.339–370.

Ernestus, Mirjam, and R. Harald Baayen. 2003. Predicting the unpredictable: Interpreting neutralized segments in Dutch. *Language* 79.5–38.

Frisch, Stefan. 1996. *Similarity and frequency in phonology*. Northwestern University dissertation.

Hayes, Bruce, and James White. 2013. Phonological naturalness and phonotactic learning. *Linguistic Inquiry* 44.45–75.

Hayes, Bruce, and Colin Wilson. 2008. A maximum entropy model of phonotactics and phonotactic learning. *Linguistic Inquiry* 39.379–440.

References (*cont.*)

KIM, HEUNG-GYU, and BEOM-MO KANG. 2000. Frequency analysis of Korean morpheme and word usage. Tech. rep., Institute of Korean Culture, Korea University, Seoul.

MARTIN, ANDY. 2007. *The evolving lexicon*. UCLA dissertation.

PATER, JOE. 2000. Nonuniformity in English stress: The role of ranked and lexically specific constraints. *Phonology* 17.237–274.

ZURAW, KIE. 2000. *Patterned exceptions in phonology*. UCLA dissertation.