Class 16: Phonology-lexicon and phonology-processing interfaces

To do
☐ last homework, phrasal phonology, due Friday

Overview: We'll look at a bunch of phonological phenomena that show frequency effects—including a case from my own research—and consider where in our model of language those effects could reside.

1 Classic frequency effect: English irregular past tense

- There are only about 200 of them, but they are disproportionately likely to be frequent (e.g., Bybee & Slobin 1982).
- Top 25 most frequent verbs (Oxford English Corpus)—irregulars are in bold:

1. be	**8. know**	**15. give**	**22. feel**
2. have	**9. take**	16. use	23. try
3. do	**10. see**	**17. find**	**24. leave**
4. say	**11. come**	**18. tell**	25. call
5. get	**12. think**	19. ask	
6. make	13. look	20. work	
7. go	14. want	21. seem	

- Locus of explanation?

Diachrony
- In order to learn an irregular past tense form, you have to be exposed to it enough times → low-frequency verbs will tend to regularize from one generation to the next (*bode* > *bided*).
- Kirby 2001: simulation study

Processing
- Dual-route model (see Pinker 2000 for overview and application to this case)
  - When you want to say a past tense, there's a race between retrieving a stored form (which might be irregular) and creating the form via the *–ed* rule.
  - The more frequent the stored form, the higher its resting activation → more likely to win the race.
    → low-frequency verbs may get pronounced as regular, even if speaker knows irregular form.

Grammar?
- I don't think anyone has proposed it for *this* case, but it's a logical possibility:
  - Some constraints are sensitive to frequency.

/bowd/, cf. [bajd]	I-O FAITH(hi freq)	O-O FAITH	I-O FAITH(lo freq)
bowd		*!	
☞ bajdɨd			*

or split O-OFAITH by frequency.

  - Or there's just one I-O FAITH constraint, but its ranking is a function of frequency

With these three possibilities in mind, let's look at some more phonological cases and how they've been analyzed.

2 Ng 2010: Singapore English prosodic boundaries

- Singapore English has strong glottalization at prefix-stem, stem-stem, but not stem-suffix boundary
  - *mis-understand* [misʔɑndəstæn] , *stop-over* [stɔpʔovə], *magic-al* [mædʒikØəɯ](p. 8)
  - ʔ Ng analyzes this in terms of p-word structure: let's sketch it out

tone rules: pp. 11-13

- Stress is realized as tone: (L_0M*M_0)H or H
  - last syllable is H, whether stressed or not: *see* ˈH
  - first (non-final) stressed syllable gets M tone: *apple* ˈMH
  - sylls from first stress to penult get M: *elephant* ˈMMH, *Indonesia* ˈMM˛MH
  - syllables preceding first stress get L: *hibiscus* LˈMH, *machine* LˈH, *America* LˈMMH

- Domain of tone assignment ≈ p-word
  - tone pattern generally re-starts in compounds: *century egg* (ˈMH)(˛H)
  - tone pattern may or may not restart at prefix-stem boundary: *un-install* (˛H)-(LˈH) ~ (L-LˈH)
  - tone doesn't restart at stem-suffix boundary: remove-able (LˈMMH)

- Much interesting analysis follows, but let's focus on initialisms (e.g. *NUS* 'National University of Singapore')
  - Initialisms show varying degrees of prosodic merger:

Society for the Prevention of Cruelty to Animals, Anglo-Chinese Junior College, National Registration Identity Card, National Trade Unions Congress (supermarket)

		Least merger			*Most merger*
a.	*SPCA*	((((ˈH)˛H)˛H)˛H)			
b.	*ACJC*	((((ˈH)˛H)˛H)˛H)	(((ˈH)˛H)˛MH)		
c.	*NRIC*	((((ˈH)˛H)˛H)˛H)	(((ˈH)˛H)˛MH)	((ˈH)˛MMH)	
d.	*NTUC*	((((ˈH)˛H)˛H)˛H)	(((ˈH)˛H)˛MH)	((ˈH)˛MMH)	(ˈMMMH)

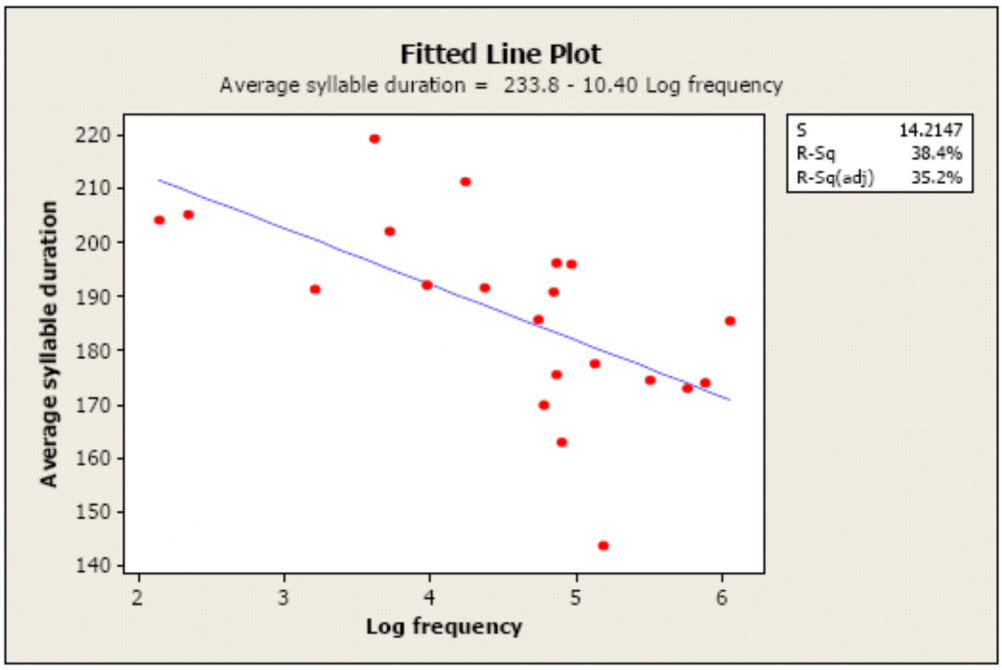
(p. 23)

- Ng finds a correlation between which group an initialism belongs to and its number of Google hits.

Why?

- Ng notes that frequency determines speed of production, perhaps because of faster access (see Bell et al. 2009 for more about possible mechanisms):

Figure 4: Frequency and duration



(p. 31)

- Constraints are then sensitive to speed, e.g. "Grammatical word accessed at speed *n* allows only *n* levels of stress"
  - Result is a prosodification of higher-frequency words that results in fewer stresses.
  - This is an interesting way of removing the need for the grammar to refer to frequency
    - Predicts that if we can manipulate speaking rate independent of word frequency, we'll get similar effects.

(58) *Do not restore faithful stress to destressed initialisms*

[[M][O][E]]$_{S_2}$	WRAP	*SCLASH$_S$	STRESS
☞ a. (('M),OE)			*
b. (('M),O,E)		W*	L
c. (('M)(,O)(,E))		W*	L
d. ('M)('O)('E)	W*		L

accessed at "speed 2" (S_2), so allows only two levels of stress (b and c have tertiary stresses)

(p. 33)

3 Hammond 1999: English rhythm rule

- *thìrteen mén* or *thirtèen mén*?
  - In survey, shift is more likely if adjective is more frequent: *nàive fríend* vs. *obèse chíld*
  - Hammond proposes morpheme-specific faithfulness constraints, whose ranking depends on the word's frequency.

4 (Löfstedt 2010): frequency-specific constraints

- We saw these earlier: Famous paradigm gaps in Swedish result when vowel shortening produces too much of a quality change.

STEM	NEUTER	GLOSS
bl[oː$_T$]	bl[ɔ$_L$] + t:	'blue'
v[iː$_T$]t	v[ɪ$_L$] + t:	'white'
v[iː$_T$]d	v[ɪ$_L$] + t:	'wide'

quality change (from Tense to Lax) is not too big

(p. 152)

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
gr[ɑː]d	INEFFABLE[51]	'straight'	0	7,140
l[ɑː]t	INEFFABLE	'lazy'	0	581,000

quality change (would be from [ɑː] to [a]) is too big

(p. 154)

- But! Sufficiently frequent words don't have a gap

gl[ɑː]d	gl[a] + t:	'happy'	29	2,110,000

(p. 154)

- For each of the vowels that can show a gap, there seems to be a frequency cut-off above which there's no gap. (Löfstedt shows this for some phenomena in other languages too) E.g.,

STEM	NEUTER	GLOSS	ALLÉN (PL)	GOOGLE (-A)
gr[ɑː]d	INEFFABLE[51]	'straight'	0	7,140
l[ɑː]t	INEFFABLE	'lazy'	0	581,000
gl[ɑː]d	gl[a] + t:	'happy'	29	2,110,000

frequency counts from different corpora

(p. 154)

- Löfstedt's solution: faithfulness constraints penalizing vowel changes are indexed to frequency:

	/glad + t:/ 'happy' neut. Cf. [gla:d] (*Freq* /glad / = 2,110,000)	$\sigma_{\mu\mu}$ ↔ [+stress]	[+LONG] ↔ [+TENSE]	IDENT [Long C] /'V_	*MAP (a,a) (7140)	*MAP (a,a) (581,000)	M-PARSE	*MAP (a,a) (2,110,000)
a.	gla:t:	*!						
b.	glat:		*!					
c.	gla:t			*!				
d. >	glat:							*
e.	⊙						*!	

(p. 167)

5 Boersma 1999: lexical-access *constraints*

- The problem: in Dutch, you want to be able to recognize [rɑt] as either /rɑt/ or /rɑd/.
- If you try to use a standard grammar to map perceived form to underlying form, you'll always pick the faithful one:

(7) *Failure to recognize the wheel*

[rɑt]	*VOICEDCODA	MAXVOI
☞ |rɑt| 'rat'		
|rɑd| 'wheel'		*

This is a comprehension tableau: input = perceived phonetic form output = lexical entry

(p. 4)

- So, Boersma proposes a family of constraints *LEX(*x*) "don't recognize any utterance as lexical item *x*" (one for each lexical item).
- <u>Ranking depends on word's frequency</u>:

(10) *A strong tendency to recognize the rat*

[rɑt]	*LEX (|rɑd| 'wheel')	*VOICED CODA	MAXVOI	*LEX (|rɑt| 'rat')
☞ |rɑt| 'rat'				*
|rɑd| 'wheel'	*!		*	

(p. 5)

- Actually, it's a bit more complex: *LEX(*x*/context=*y*) to allow for semantic context to matter

6 (Zuraw 2009): Tagalog tapping

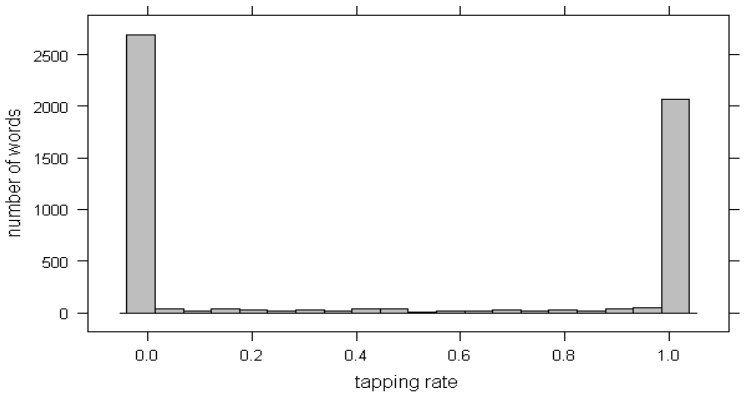
- This is work that Kevin Ryan and I got started on—he did all the phonetic work.

Tapping in prefixed Tagalog words: variable

d →ɾ (spelled *r*) / V__V *dumi* 'dirt' *ma-**r**umi* 'dirty'

but *dahon* 'leaf' *ma-**d**ahon* 'leafy'

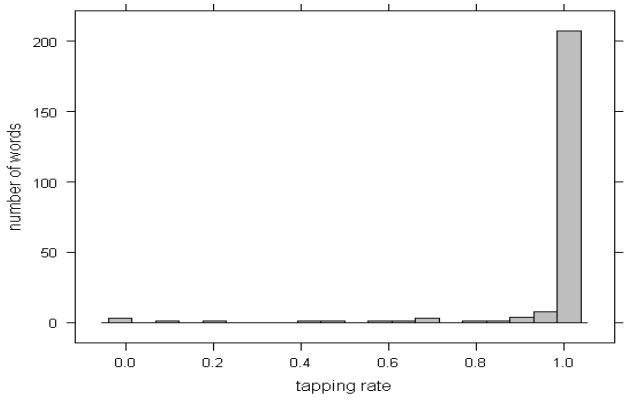
- Each word seems to have a consistent behavior (using spelling data in corpus):



Not shown in this graph: The more frequent the word, the more likely tapping is.

Tapping in suffixed words: obligatory

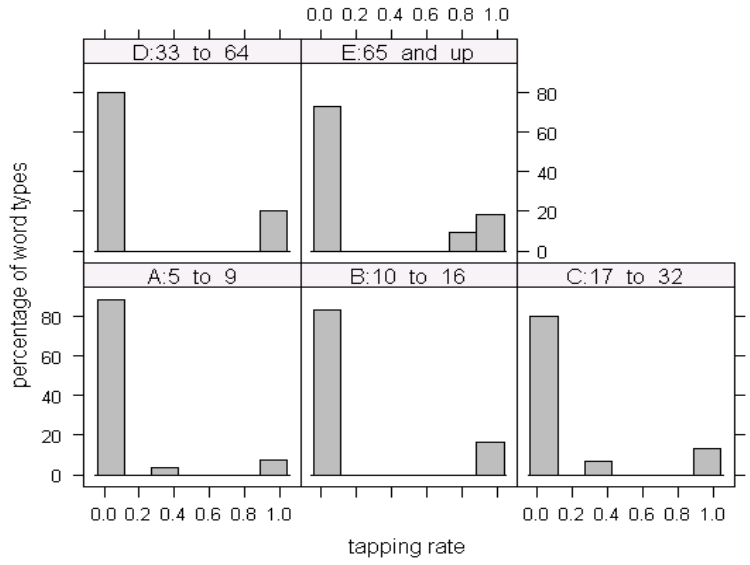
lakad 'walk' *laka**r**-an* 'to be walked on'



The grammar probably has to enforce the change here, since even low-frequency words undergo.

Tapping in p-word reduplication: nearly forbidden

dala 'carry' *dala-**d**ala* 'load carried'



Even high-frequency words (D and E) rarely show tapping. (only 84 word types, though)

→ Maybe grammar should prevent the change from applying in this context.

2009 analysis: grammar refers to outcome of lexical access

- ALIGN(AccU,L; PWd,L): L edge of any accessed lexical unit must coincide with L edge of some p-word.

→ outcome for prefixed word depends on access mode:[1]

(1)

	accessed: maDami	*(...VdV...)	MINIMALITY	STEMISHEAD	ALIGN (AccU,L;PWd,L)	NORECURSION	*r
g	(ma(dami)$_\omega$)$_\omega$					*!	
h	(ma(rami)$_\omega$)$_\omega$					*!	*
i	(madami)$_\omega$	*!					
☞ *j*	(marami)$_\omega$						*
k	(ma)$_\omega$(dami)$_\omega$		*!				
l	((ma)$_\omega$ dami)$_\omega$		*(!)	*(!)		*	

more-frequent word: whole-word retrieval route should tend to win.

- Outcome for suffixed words is fixed, because constraint that refers to access mode is low-ranked:

(2)

	accessed: lakaD, an, (*and maybe* lakaDan)	*(...VdV...)	MINIMALITY	STEMISHEAD	ALIGN (AccU,L,PWd,L)	NORECURSION	*r
a	(lakad(an)$_\omega$)$_\omega$		*(!)	*(!)		*	
b	(lakadan)$_\omega$	*!			*		
☞ *c*	(lakaran)$_\omega$				*		*
d	(lakad)$_\omega$(an)$_\omega$		*!				
e	((lakad)$_\omega$ an)$_\omega$				*	*!	

[1] Access route should depend on more than just word frequency. See (Hay 2003).

- Similarly, outcome for 2-syll reduplicated words is fixed:

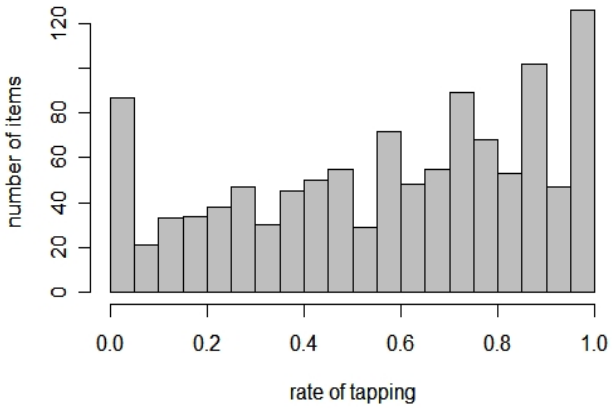
(3)

	accessed: DalaDala	*(...VdV...)	MINIMALITY	STEMISHEAD	ALIGN (ACCU,L,PWd,L)	NORECURSION	*r
h	[(dala(dala)ω)ω]φ			*!		*	
i	[(dalarala)ω]φ			*!			*
☞ *j*	[(dala)ω(dala)ω]φ						
k	[(dala)ω(rala)ω]φ						*!
l	[(dala)ω]φ[(dala)ω]φ						
m	[(dala)ω]φ[(rala)ω]φ						*
n	[((dala)ω dala)ω]φ			*!		*	

(same outcome if *Dala* accessed)

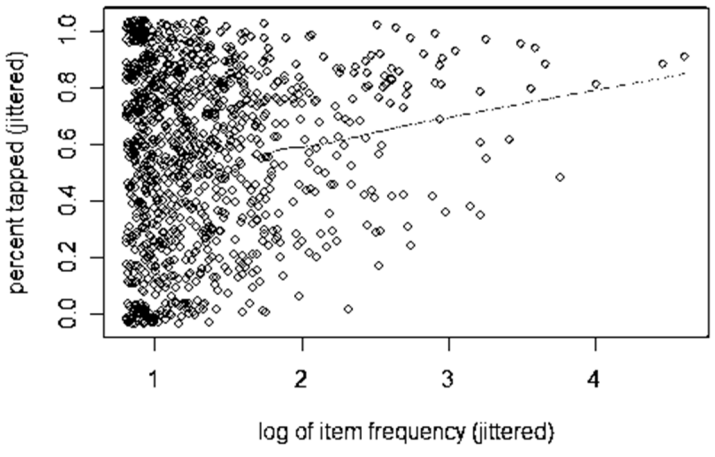
Is any of this really online? Or is it all lexicalized (reflecting diachronic effects)?

- Clitics show real variation: *daw* 'reportedly' *ako **r**aw ~ ako **d**aw* 'me, reportedly'
  din 'also' *ako **d**in ~ ako **r**in* 'me too'.

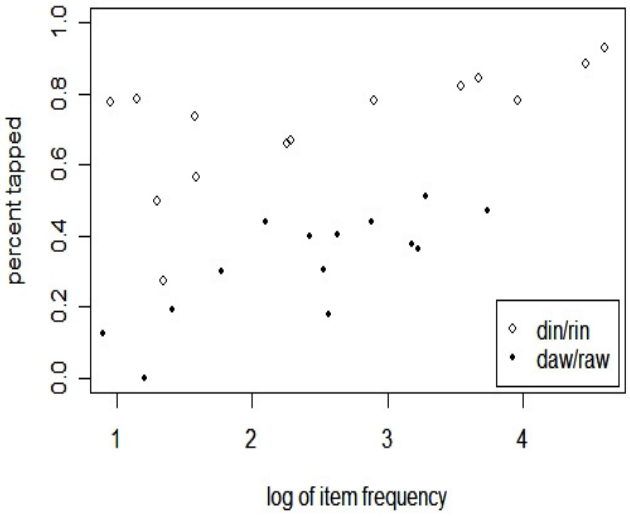


- Weak, non-linear frequency effects:

all word+clitic combinations



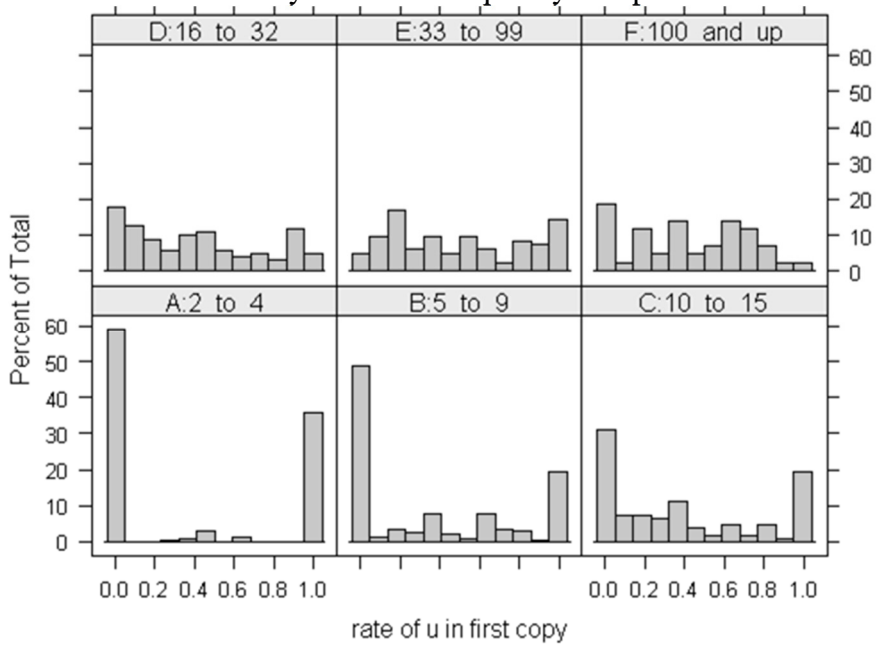
just the clitic+clitic combinations



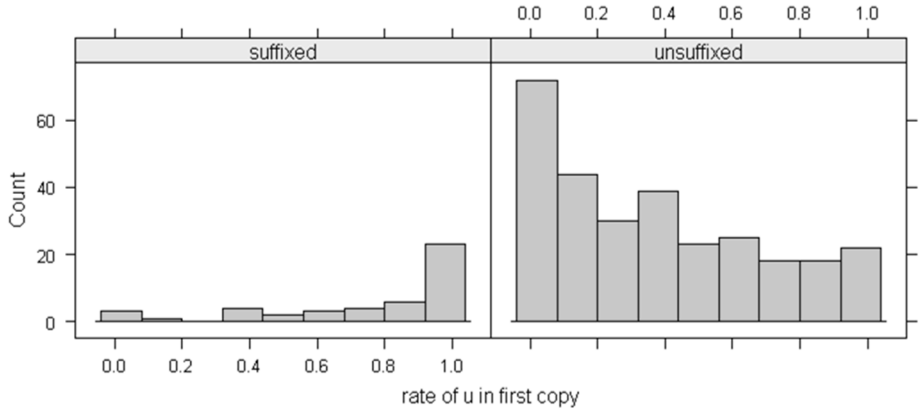
Similar results vowel-height alternation

halo ‘mixture’ hal**o**-halo ~ hal**u**-halo ‘(a dessert)’
(final-syllable [o] alternates with non-final syllable [u])

- ‘o’ forms are mostly in lowest-frequency reduplicated words:



- Grammar matters too: strong reduplicative identity effect
  - if second copy is forced to be [u] by suffixation, first copy is usually [u] too (*ka-tap**u**s-tapus-an* ‘very last’)



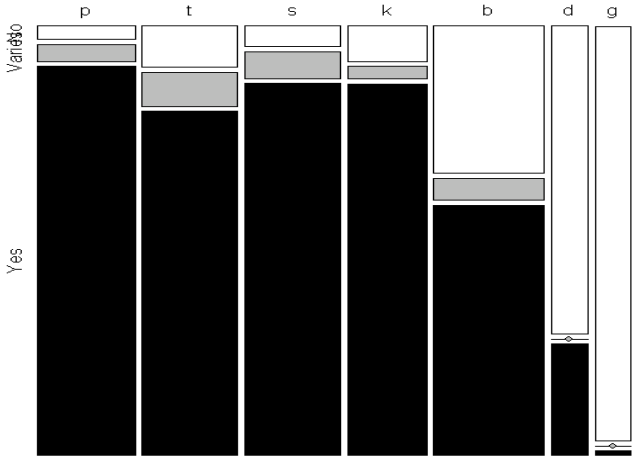
Similar results for nasal substitution

(see (Zuraw 2010) for more on this rule)

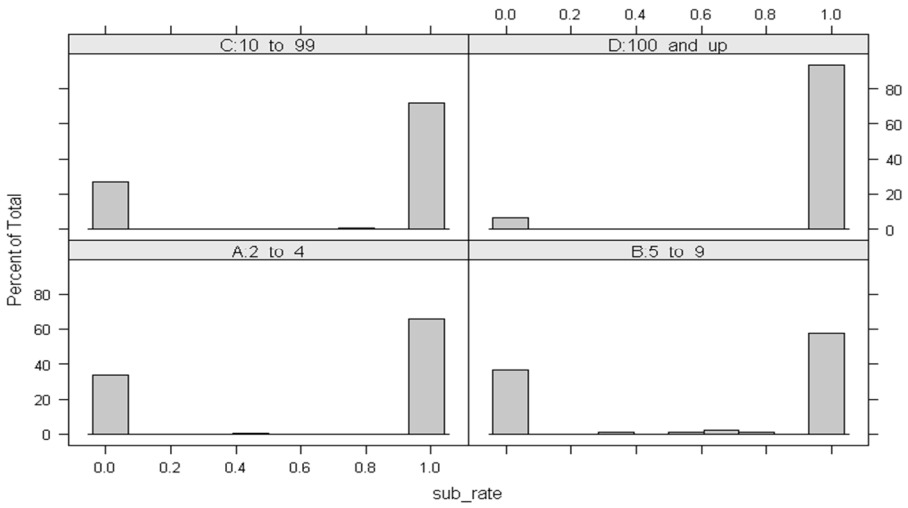
- Prefix-final nasal can fuse (or not) with following obstruent:
  /paŋ+pasko/ 'for Christmas'

a.	non-assimilation	paŋ-pasko	<pang-pasko>
b.	assimilation	pam-pasko	<pam-pasko>
c.	nasal substitution	pamasko	<pamasko>

- Which obstruent it is matters a lot:



- But within the /b/s, where there are plenty of both types, frequency matters:



So where is this effect, really?

- Giving grammar a role seems to work well.
- But what if the grammatical effects be achieved by a diachronic model? Maybe this is all just information stored in lexical entries, perhaps reflecting lexical-access events from long ago.
- If lexical access really is involved, it should be possible to affect a word's pronunciation through priming (temporarily perturbs the item's activation).
  - We think it does! Zuraw, Lin, Yang & Peperkamp (in preparation)

7 More proposals in which grammar refers (at least somewhat) directly to frequency

- Can we think of ways to determine whether grammar makes direct reference to frequency, or sees only to the outcome of lexical access?
  - Coetzee 2008: a lexical item's frequency determines how likely it is to be assigned to a given lexical class on any production occasion
  - Myers 2005: how can lenition be both postlexical and sensitive to lexical frequency?
    - proposes a diachronic solution, where high frequency results in a more lenited lexical entry over time, but plays no synchronic role
    - diachronic and synchronic explanations should make different predictions about effects of priming on production...
  - Alcantara 1998 (English): high-frequency exceptions can be protected by high-ranking idiosyncratic constraints
  - Carlson & Gerfen 2011 (not a proposal about grammar, but a cool case): when a Spanish diphthong loses stress (say, because of suffixation), it should monophthongize. But it's variable:

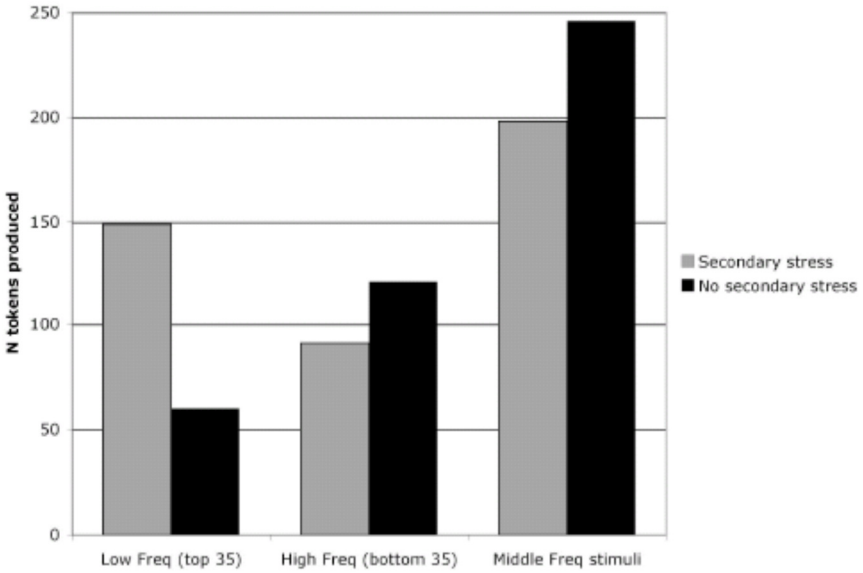
STEM		DERIVED FORM	
n[jé]ve	'snow'	n[e]vóso	'snowy'
verg[wé]nza	'shame'	verg[o]nzóso	'embarrassing'
v[jé]jo	'old'	v[je]jecíto	'little old man'
p[wé]blo	'town, people'	p[we]blíto	'little village'
cal[jé]nte	'hot'	cal[je]ntíto	'warm/cozy'
		cal[e]ntíto	

(p. 512)

The more productive the suffix (by corpus measures), the more likely to keep the diphthong.

  - Gouskova & Roon 2008: in Russian compounds, the constraint requiring each stem to bear a prominence is ranked low, but there's a higher-ranked version of the constraint for low-frequency stems, forcing a secondary stress:

Figure 1: Effect of frequency on secondary stress realization



(p. 56)

If we have time, here's one more proposal I'd like to discuss...

8 Bermúdez-Otero 2012 forthcoming: two types of listing

- **Non-analytic listing**: output of stem level goes into the lexicon (fully prosodified)
  - blocks application of stem-level phonology, e.g. stress assignment, if faithfulness ranked high
  - → allows exceptional stress to survive (*Árabic*)
  - listed form **blocks** morphosyntactic synthesis (you can't just compose *Arab+ic* or *drive+d*)
- **Analytic listing**: output of word level may go into the lexicon, but is listed as a concatenation of inputs to the word level
  - example: <LOAD, PAST> = [WORD LEVEL [p-word (lə$^{\mu}$ʊ$^{\mu}$d)] – d] (p. 23)
  - unable to block application of word-level phonology, e.g. [-d]~[-t]~[-ɨd] allomorphy
  - → no exceptions to word-level phonology allowed
- vs. plain old computation

Illustrated with a classic example

- *-al* is a stem-level suffix
  - so */orígina**l**/* is listed non-analytically
- if you then want to derive *originality* (if you'd never heard it), you have to start with */orígina**l**/*
  - can't start with */origin+al/*
- faithfulness is ranked high: */orígina**l**+ity/* → *orìginálity*, not **òriginálity* (cf. *àbracadábra*)

listed stem-level output: has full prosodification (Σ = foot)

	MAX-Head(Σ)	ALIGN(ω,L;Σ°,L)
[ω o[Σ° rí.gi]nal] - ity		
[ω [Σ° ò.ri]gi[Σ° ná.li]ty]	*!	
[ω o[Σ° rì.gi][Σ° ná.li]ty] ☜		*

(p. 28)

Chung's generalization (from Chung 1983)

- A stem-level process can "cyclically misapply" iff it can have lexical exceptions in monomorphemes
- Bermúdez-Otero's OT interpretation:
  - High-ranking faithfulness are needed to ensure */orígina**l**+ity/* → *orìginálity* (= cyclic misapp.)
  - This means you could have monomorphemic exceptions to the 'abracadabra rule' too : *Epàminóndas*, apparently (ancient Greek statesman)

		MAX-Head(Σ)	ALIGN(ω,L;Σ°,L)	ALIGN(Σ°,R;ω,R)
(a) *default pattern:* σ̆σ̆σ̆[Σ° σ́]σ	[ω σ̆[Σ° σ̆̀σ̆] [Σ° σ́]σ]		1!	2+1=3
	[ω [Σ° σ̆̀σ̆]σ̆[Σ° σ́]σ] ☜			3+1=4
(b) *exception:* [ω a[Σ° pò.the] [Σ° ó]sis]	[ω [Σ° à.po]the[Σ° ó]sis]	1!		3+1=4
	[ω a[Σ° pò.the] [Σ° ó]sis] ☜		1	2+1=3

(p. 27)

Blocking can break down, though, because it happens in processing

- Nonanalytic entry [$_{\text{p-word}}$ (([ˈæᵘ.ɹæᵘ)bɪk)] (*Árabic*) races against synthesis, [$_{\text{STEM LEVEL}}$ æɹæb - ɪk]
- If the whole word isn't frequent enough, the entry isn't accessible enough, so it can lose out to synthesis, resulting in a regularized production.
- And if the exceptional form isn't produced often enough, the next generation won't learn it.

Frequency effects

- Classic cyclicity :

a.	cómp[ə]nsàte	còmp[ə]nsát-ion
	cónt[ə]mplàte	còmp[ə]mplát-ion
b.	cond[ɛ́]mn	còmd[ɛ̀]mn-átion
	imp[ɔ́]rt	ìmp[ɔ̀]rt-átion

(p. 30)

- but :

a.	cons[ɜ́]rve	b.	còns[ə]rv-átion
	tránsp[ɔ́]rt		tránsp[ə]rt-átion

(p. 30)

- The reason is frequency :

(33) (× per 10^6 words in spoken section of COCA)

			base		derivative
a.	*cyclic stress*				
	cond[ɛ́]mn	còmd[ɛ̀]mn-átion	7.09	>	2.57
	imp[ɔ́]rt	ìmp[ɔ̀]rt-átion	5.15	>	0.62
b.	*variable stress*				
	cond[ɛ́]nse	còmd[ɛ̀-ə]ns-átion	0.28	≈	0.22
c.	*noncyclic stress*				
	cons[ɜ́]rve	còns[ə]rv-átion	1.65	<	9.11
	tránsp[ɔ́]rt	tránsp[ə]rt-átion	7.23	<	23.54

(p. 32)

See Collie 2008 for a full study

To sum up today

- We looked at several cases of lexical frequency's influencing phonology.
- We considered putting the explanation in diachrony, processing, and/or grammar.

Next week

- More about phonology and processing
- Getting phonological evidence

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