

# Corpus data vs. experiments in English phonotactics

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# Outline

Syllable onsets in different domains

Syllable onsets and grammar

Syllable onsets and frequency

Syllable onsets and acquisition

Syllable onsets and judgments

A model

Conclusions

# Collaborators

- ▶ Jeff Berry
- ▶ Jordan Brewer
- ▶ Lynnika Butler
- ▶ Jason Ginsburg
- ▶ Ben Tucker

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Are these all in sync with each other? **If not, what story do we tell?**

# English consonants

p		t		k
b		d		g
f	θ	s	ʃ	
v	ð	z	ʒ	
			č	
			ǰ	
m		n		ŋ
		l		
		r		
w			y	h

All of these can be syllable onsets except the ones marked in red (Hammond, 1999); [ŋ] cannot occur at all and [ʒ] is marginal.

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  - ▶ Pig Latin
 

<i>Strom</i> [stram]	→	[am-stre]
<i>Gwen</i> [gwɛn]	→	[ɛn-gwe]
<i>Beula</i> [byulə]	→	[yulə-be]

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▶  $\left\{ \begin{array}{c} \text{stop} \\ \text{voiceless fricative} \end{array} \right\} + \left\{ \begin{array}{c} \text{l} \\ \text{r} \\ \text{w} \end{array} \right\}$

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 e.g. *splash* [splæʃ], *spreed* [spri], *squash* [skwɔʃ], etc.

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For example, in [kw] in *queen*, [k] and [w] are independently onsets, e.g. in *keel* [kil] and *we* [wi], and [k] is less sonorous than [w].

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- ▶ judged more well-formed.

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But there shouldn't be any clusters that violate the Sonority generalization.

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- ▶ Size of clusters

size	tokens
0	302878
1	630175
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- ▶ Meta-analysis of Smit et al. (1993) shows no effect of rising/falling sonority on cluster acquisition. (Again, this comparison may not be apropos, because [s]-clusters are an exception.)
- ▶ **But:** D. Ohala (1996) shows that complex clusters are simplified to their **least** sonorous members.

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- ▶ Are they?
- ▶ Experimental judgment tasks are a way of examining judgments more closely.
- ▶ **Gradient** judgments allow us to look even more closely.

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- ▶ For example, *blick* [blɪk] has these neighbors:

<i>click</i> [klɪk]	<i>flick</i> [flɪk]
<i>lick</i> [lɪk]	<i>slick</i> [slɪk]
<i>brick</i> [brɪk]	<i>black</i> [blæk]
<i>bleak</i> [bli:k]	<i>block</i> [blak]
<i>blink</i> [blɪŋk]	<i>bliss</i> [blɪs]

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- ▶ Both effects also show up in yes-no tasks (Frisch et al., 2000).
- ▶ Both effects show up with auditory or visual presentation (Bailey & Hahn, 2001).

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- ▶ One way to do that is to carefully select materials so these are all balanced and controlled.
- ▶ Match items for neighborhood density and phonotactic probability.

# Previous results presented here

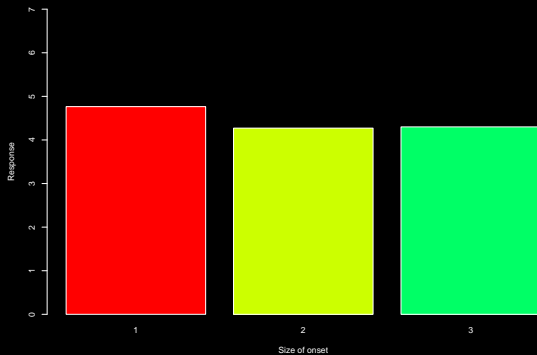
C	CC	CCC
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Items matched as closely as possible for neighborhood density and phonotactic probability.

# Uh-oh!



But the effect appears to go in the **wrong** direction.

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- ▶ Significant by subjects [ $F(2, 19) = 4.31, p < .01$ ], but not by items [ $F(2,18) = 1.27, n.s.$ ].
- ▶ If we add in neighbors and phonotactic probability, then:
  - ▶ there is an effect of neighbors, also in the **wrong** direction. By subjects: [ $F(2, 19) = 7.95; p < .000$ ]; By items: [ $F(2, 18) = 4.87; p < .03$ ]
  - ▶ plus several significant interactions of phonotactic probability and neighbors with onset size.

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- ▶ **A problem:** Did we somehow reverse the scale? Is there some unknown factor that overwhelms the factors we're interested in?
- ▶ **A significant problem:** We can't control neighborhood density or phonotactic probability adequately for this investigation.
- ▶ **Teaser:** There seems to be a typological effect of onset complexity in there somewhere.

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Choose materials that are **impossible** words of English.

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rmzube	rnguke	rntafe	rntheef	rnvizz	rvis	shliz
thliz	thmazz	thmled	thmrass	thnlem	thnreef	tmaz
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pmreeze	rmfeap	rmkoot	rmpeeze	rmthass	rmtofe	rmuke
rmzube	rnguke	rntafe	rntheef	rnvizz	rvisss	shliz
thliz	thmazz	thmled	thmrass	thnlem	thnreef	tmaz
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- ▶ Items have **no** neighbors and have **zero** phonotactic probability.

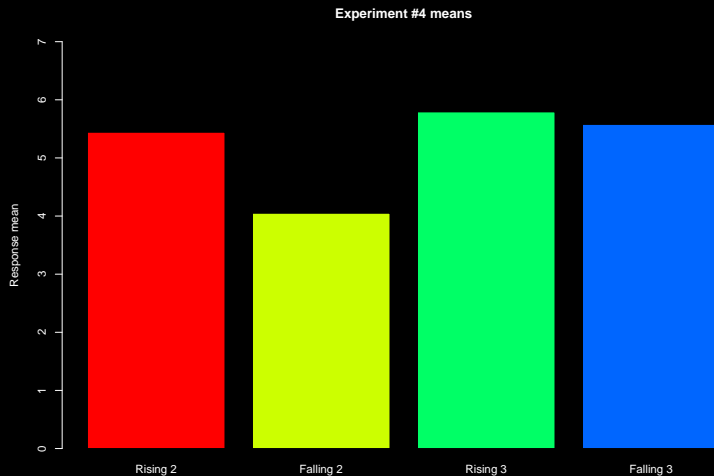
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- ▶ Items have **no** neighbors and have **zero** phonotactic probability.
- ▶ Factors are size **and sonority cline** of onset.

# Results from new experiment



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- ▶ **But** the factors interact. [by subjects:  $F(1, 20) = 47.979, p < .000$ ; by items:  $F(1, 64) = 14.886, p < .000$ ]

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- ▶ Do **other** markedness relations play a role?

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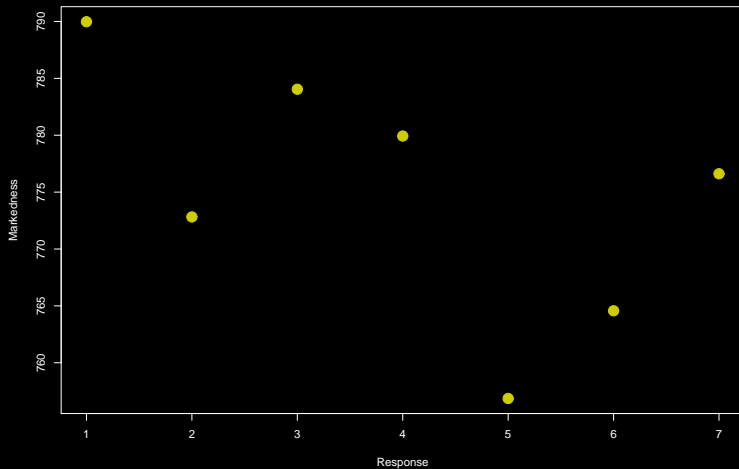
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- ▶ How to calculate segmental markedness: count the number of times each segment occurs in UPSID. Thanks to Natasha Warner!
- ▶ We replicated Bailey & Hahn's visual presentation experiment and found an independent effect of segmental markedness: items containing typologically **more** marked sounds are judged as **less** well-formed in the Bailey & Hahn visual presentation replication. [By subjects: phonotactic probability  $F(1, 17) = 197.33, p < .000$ ; neighborhood density  $F(1, 17) = 46.32, p < .000$ ; markedness  $F(1, 17) = 21.96, p < .000$ ] and [By items: phonotactic probability  $F(1, 254) = 43.98, p < .000$ ; neighborhood density  $F(1, 254) = 10.33, p < 0.001$ ; markedness  $F(1, 254) = 4.89, p < 0.02$ ]

# The effect of markedness



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- ▶ Outputs of machines combined by linear regression.

## Toward a model

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- ▶ Each machine produces a numerical result.
- ▶ Outputs of machines combined by linear regression.
- ▶ What machines?

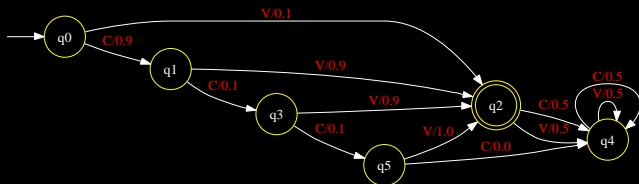
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- ▶ Several (cognitive) machines operating in parallel.
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  - ▶ **Weighted Finite automaton** (WFSA) for language-specific frequency distributions **and** for typological patterns. (Initial weights reflect typological predispositions.)

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- ▶ What machines?
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  - ▶ Something else for lexical items.

## Initial weights for onset size

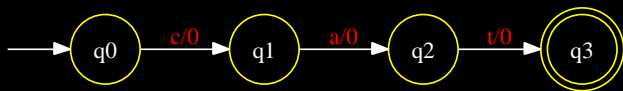


## Reweighting by experience

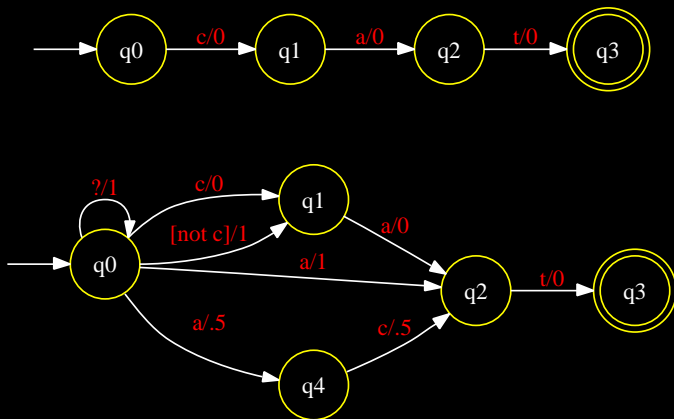
onset	before	after
fV	.009	.09
sfV	.007	.07
sfrV	.005	.05
fnV	.007	.007
fnrV	.005	.005

Weights here are **illustrative**.

# Neighborhood density



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- ▶ Experiments on adults can involve **impossible** words.

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# Conclusions

- ▶ It can be especially informative to look at **impossible** words, rather than just possible words.
- ▶ Segmental and syllabic markedness play a role in gradient judgments.
- ▶ These factors may not play a role in corpus studies or observations of natural acquisition for methodological reasons.
- ▶ Typology and neighborhood density can be incorporated into judgments by using WFSAs and setting initial weights accordingly.