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With Lauren Eby Clemens, Jon Levine & Andrew Nevins February 10, 2011

Universal Grammar protects Initial Syllables*

Overview:

- Phonological alternations (e.g. *naɪf* ∼ *naɪvz*) are costly, particularly in prominent positions (root, onset, stressed syllable, initial syllable).

- In Turkish, Portuguese, & French, monosyllables are protected from alternations, and speakers apply this protection to novel words.

- English goes the other way, with more protection in polysyllables. But English speakers protect novel monosyllables and polysyllables equally.

- Given a chance to acquire a new language, English speakers prefer to protect initial syllables, as in Turkish.

- Our experimental methods reveal the speaker's unwillingness to learn a pattern that violates their expectations, ignoring the **surfeit of the stimulus** (Becker et al. 2011).

1 The typology of initial syllable protection

In Slovenian, the adjectival suffix [-ən] causes palatalization on the preceding root, without exception and regardless of size (Jurgec p.c.):

(1) 'bók ∼ 'bótʃ-ən 'hip'/'lateral'
     'znák ∼ 'znátʃ-ən 'sign'/'marked'
     ba'rók ∼ ba'rótʃ-ən 'Baroque'/'baroque'
   o'trók ∼ o'tròtʃ-ən 'child'/'childish'

In Tamil, [n] becomes [ŋ] before the plural suffix [-gə], but [n] is protected from change in the initial syllable (Christdas 1988; Beckman 1997, 1998):

(2) miːn ∼ miːn-gə 'fish SG/PL'
     maːn ∼ maːn-gə 'deer SG/PL'
     makən ∼ makəŋ-gə 'son SG/PL'
     pajːən ∼ pajːəŋ-gə 'boy SG/PL'

We never find the "anti-initial language" that protects non-initial syllables:

(3) pak ∼ patʃ-i 'impossible'
     suk ∼ sutʃ-i 'no way'
     tirak ∼ tirak-i 'not in a million years'
     funak ∼ funak-i 'on the Greek calends'

(4) Alternations in initial syllables imply alternations in non-initial syllables:
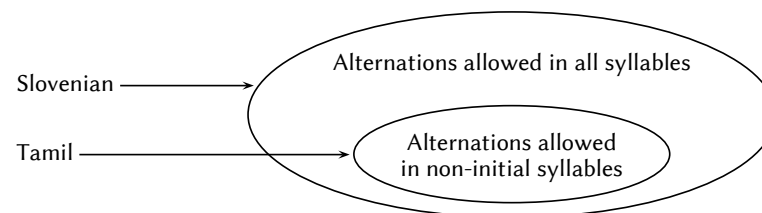
(5) The Logic of the subset principle (Berwick 1985; Manzini & Wexler 1987)

- Learners start with the most restrictive grammar, moving outwards only with positive evidence.

- The superset grammar includes everything in the subset grammar.

- If the speaker is exposed to alternations in initial syllables, they must allow alternations in all syllables.

2 Gradient protection of Initial syllables

2.1 Turkish (Becker et al. 2011)

In Turkish, the voiceless (aspirated) stops [p, t, tʃ, k] become voiced [b, d, dʒ, g] before the possessive suffix in some short words,

(6)   tatʃ ~ tadʒ-ɨ   'crown NOM/POSS'
      satʃ ~ satʃ-ɨ   'hair NOM/POSS'
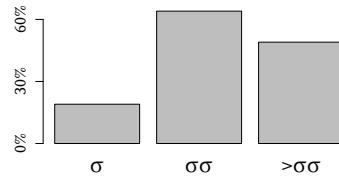
and some long words:

(7)   amatʃ ~ amadʒ-ɨ   'goal NOM/POSS'
      anatʃ ~ anatʃ-ɨ   'cub NOM/POSS'

Long words are more likely to alternate (Lees 1961; Inkelas & Orgun 1995; Inkelas et al. 1997; Hayes 1995; Pycha et al. 2007). Data from Inkelas et al. (2000):

(8)   **The Turkish lexicon**

size	n	% voicing
σ	238	19%
σσ	454	64%
longer	806	49%

Experiment 1: Projection from the Turkish lexicon ("wug test", Berko 1958)

(9)   Materials: 72 final-stress nouns that we created, e.g. ˈtup, guˈjup.

(10)   Participants: 24 native speakers of Turkish.

(11)   Noun presented in orthography <tup>, forced choice between two auditory possessives: [tup-u] vs. [tub-u].

(12)   Results: Alternations are chosen significantly less often in monosyllables (40% vs. 66%, mixed-effects logistic regression with lmer, $p < .0001$).

(13)   Monosyllables protected from voicing altenrations:
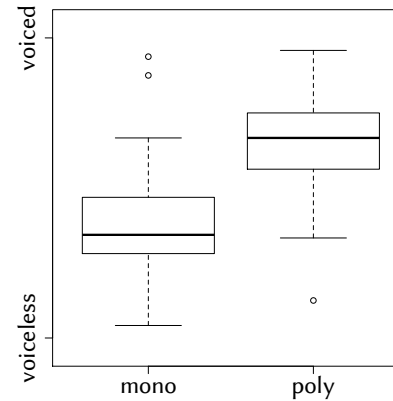
2.2 Portuguese (Becker, Clemens & Nevins, forthcoming)

In Brazilian Portuguese, word-final [w] changes to [j] (Gomes & Manoel 2010) before the plural suffix in some short words,

(14)   ˈsaw ~ ˈsajs   'salt SG/PL'
      ˈpaw ~ ˈpaws   'stick SG/PL'
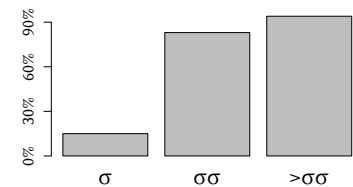
and in some long words:

(15)   deˈdaw ~ deˈdajs   'thimble SG/PL'
      kaˈkaw ~ kaˈkaws   'cocoa SG/PL'

Real [w]-final words:

(16)   **The Brazilian Portuguese lexicon**

syllables	n	%[w]→[j]
σ	23	15%
σσ	87	83%
longer	107	94%

Experiment 2: Projection from the Brazilian Portuguese lexicon

(17) Materials: 63 [w]-final nouns that we created, e.g. *'daw, ma'haw, 'ʃantaw.*
We only report the final-stress items today.

(18) Participants: 35 native speakers of Brazilian Portuguese.

(19) Noun presented auditorily only, forced choice between two auditory plurals
on a scale of 1–7.

(20) Results: Alternations are rated significantly less acceptable in monosyllables
(3.97 vs. 4.99, mixed-effects regression with lmer, $p < .0001$).

(21) Monosyllables protected from backness alternations:
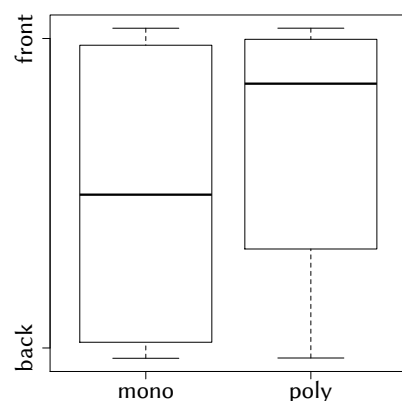
Conclusion: Turkish speakers and Brazilian Portuguese speakers prefer alterna-
tions in polysyllables, and extend this preference to novel words.

2.3 French (Becker, Clemens & Nevins, forthcoming)

In French, word-final [al] changes to [o] in the plural in some short words,
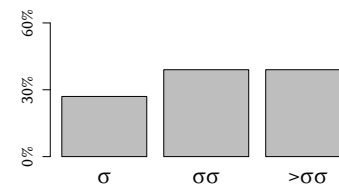
(22) mal ∼ mo 'evil SG/PL'
bal ∼ bal 'ballroom SG/PL'

and in some long words:

(23) ʒuʁ'nal ∼ ʒuʁ'no 'newspaper SG/PL'
festi'val ∼ festi'val 'festival SG/PL'

Real [al/aj/ɛl/ɛj]-final masculine words:

(24) **The French lexicon**

syllables	n	%[al/aj/ɛl/ɛj]→[o]
σ	15	27%
σσ	46	39%
longer	14	39%

Experiment 3: Projection from the French lexicon

(25) Materials: 50 [al/aj/ɛl/ɛj]-final nouns that we created, e.g. *'ʒal, ʒi'stal.*

(26) Participants: 115 native speakers of French.

(27) Noun presented in orthography, forced choice between two auditory plurals
on a scale of 1–7.
Frame sentence assures that the noun is treated as masculine, e.g.:
"Ce mec a eu un jal gris. Puis, ses amis lui ont donné trois [ʒal/ʒo] blancs."

(28) Online presentation using Experigen (Becker & Levine 2010).

(29) Results: Alternations are rated significantly less acceptable in monosyllables
(3.72 vs. 4.75, mixed-effects regression with lmer, $p < .0001$).

(30) Monosyllables protected from [al/aj/ɛl/ɛj]→[o] alternations:
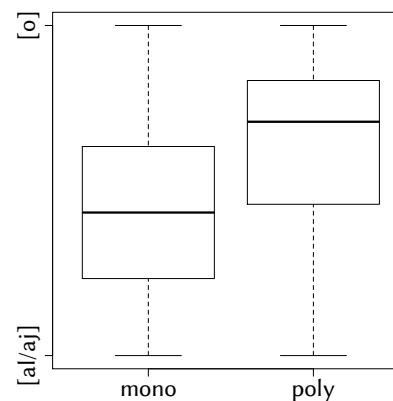
Conclusion: French speakers prefer alternations in polysyllables, especially in
novel words, even with meagre evidence from their real words.

2.4 Monosyllabicity as the best theory of size effects

Three approaches that can make ʒistal ~ ʒisto more acceptable than ʒal ~ ʒo:

(31) Monosyllabic ʒal ~ ʒo incurs a violation of initial syllable faithfulness, polysyllabic ʒistal ~ ʒisto doesn't.

(32) Word-recognition/processing (Wedel 2002; Ussishkin & Wedel to appear; Stausland Johnsen to appear):

    a. High probability words (=words with frequent sound combinations) are at high risk of confusion with others (trɪk, trɛk, træk, trʌk, trɪp, trɪm, etc.). Low probability words are at lower risk (θwɑrt, θwæk).

    On average, monosyllables have higher probability than polysyllables, simply by having fewer sound combinations. So alternations in monosyllables are risky.

    b. Words with few segments are at high risk of confusion with others words (mæs → pæs, mɛs, mɪs, mæp). Words with many segments are at lower risk (mæsətʃusəts → ...).

    On average, monosyllables have fewer segments than polysyllables, so alternations in monosyllables are risky.

(33) Phonetically long elements resist alternation (Barnes 2006):

In long words, segments are compressed and pronounced more quickly. Shorter segments are less resistant to change.

The [al] of [ʒal] resists alternation because it is longer than the [al] of [ʒistal] (monosyllables 75 ms longer, two-tail t-test: *t(35.4) = 6.6, p < .001*).

(34) The three approaches are very strongly correlated:
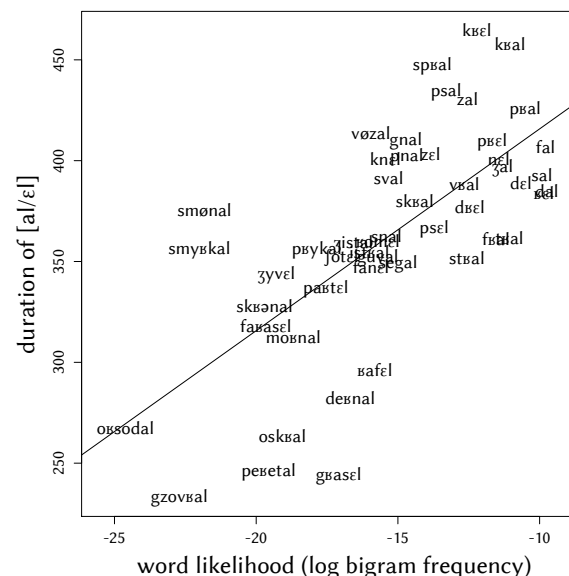
We let these three approaches compete for predicting the responses of our participants, using comparison of nested `lmer` regression models.

(35) Competing explanations in French: Monosyllabicity wins

	$\chi^2(2)$	*p*-value
Monosyllabicity	6.98	<.05
Number of segments	4.01	>.1
Word likelihood	2.11	>.1
Phonetic duration	1.48	>.1

Similar results obtain for Turkish (Becker & Nevins 2009).

Conclusion:

- Monosyllabicity, a binary grammatical factor, is the best predictor of the experimental results. It performs significantly better than all the other approaches in the literature *combined*.

- Other factors don't make a significant contribution to the model
  → no evidence that speakers take these into account.

3 English Speakers ignore an anti-Universal trend

Becker, Nevins & Levine (forthcoming)

Final [f/θ] alternate with the voiced [v/ð] in some nouns, but not others (Jespersen 1909; Berko 1958; Hayes 2009; Honeybone & Spaargaren 2011):

(36) naɪ**f** ∼ naɪ**v**z   'knife'
      pæθ ∼ pæ**ð**z   'path'

(37) gu**f** ∼ gu**f**s, *gu**v**z   'goof'
      dɛθ ∼ dɛθs, *dɛ**ð**z   'death'

Do English voicing alternations pattern *grammatically*?

(38) They go beyond spelling:

   - Spelling doesn't help at all with [θ].

   - <roofs> is about 100 times more common than <rooves> in Google, but [rʊvz / ruvz] is very common.

   - [dʒəˈɹævz] is spelled with <ff>, which is not expected to alternate.

(39) They go beyond history, since the patterns changed quite a bit over time:

   - Alternations present in non-Germanic roots (scarf, handkerchief, giraffe, carafe, psychopath)

   - Post-[r] voicing is new: [dwoɹf] 'dwarf', [woɹf] 'wharf', [skɑɹf] 'scarf'.

   - Loss of most vowel alternations: [stæf] ∼ *[steɪvz] 'staff'

   - Alternations lost for many speakers (completely or in some contexts).

The *grammatical* generalizations:

(40) Segmental context:

   - More voicing with long vowels (leaves vs. cliffs).

   - More voicing with complex codas (shelves vs. chefs).

(41) Prosodic shape (monosyllabicity and stress)

   - Voicing is best in monosyllables: [ˈnaɪvz] 'knife', [ˈpæðz] 'path'

   - Voicing is okay in polysyllables with final stress: [dʒəˈɹævz] 'giraffe', [vɚˈmuðz] 'vermouth'

   - Voicing is worst in polysyllables with non-final stress: *[ˈʃɛɹɪvz] 'sheriff', *[ˈmæmɪðz] 'mammoth'

3.1   Experiment 4: The English lexicon

(42) Materials: 126 f/θ-final existing nouns: Monosyllables (ˈhæf, ˈpæθ), and polysyllables with final stress (dʒəˈɹæf, ˈsaɪkəˌpæθ), taken from the CMU dictionary.
      We also used polysyllables with non-final stress, but we only report the final-stress items today.

(43) Participants: 120 English-speaking Mechanical Turkers
      Amazon's Mechanical Turk is a web application that provides access to an arbitrarily large number of potential participants for survey-based experiments; see also Sprouse (2010).

(44) Noun presented in orthography, forced choice between two auditory plurals on a scale of 1–7.

(45) Results: Alternations are rated significantly *more* acceptable in monosyllables (3.56 vs. 3.22, mixed-effects regression with lmer, $p < .05$).

(46) Monosyllables alternate significantly more than polysyllables:
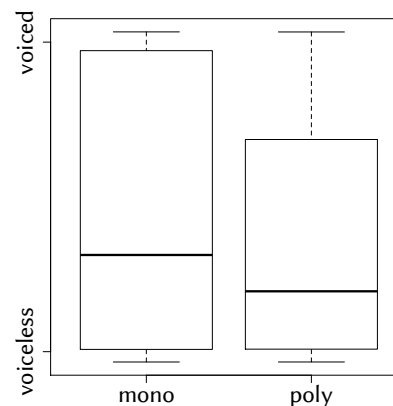
(47) **The real words of English exhibit the "anti-initial" effect that we predicted shouldn't exist.**

3.2 Experiment 5: Projection from the English lexicon

(48) Materials: 132 f/θ-final nouns that we created: Monosyllables (ˈsmaf, ˈwaθ) and polysyllables with final stress (glɪˈnaf, ʤɪˈzaθ).
We also created polysyllables with non-final stress, but we don't report them today.

(49) Participants: 120 English-speaking Mechanical Turkers.

(50) Noun presented in orthography, forced choice between two auditory plurals on a scale of 1–7.

(51) Results: Alternations are equally acceptable in monosyllables and polysyllables (4.35 vs. 4.84, mixed-effects regression with lmer, $p > .1$).
The "anti-initial" effect from the lexicon is gone.

(52) Monosyllables and polysyllables alternate at the same rate.
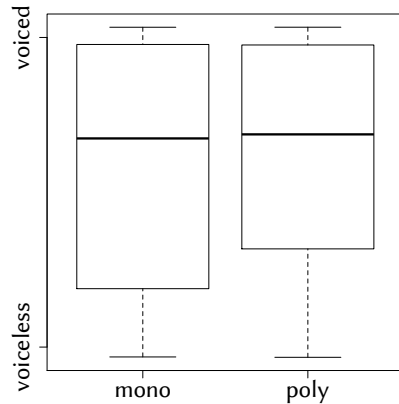
(53) **Speakers of English do not extentd the typologically anomalous "anti-itinial" pattern from their lexicon to novel words.**

(54) "Surfeit of the stimulus" (Becker et al. 2011): The speakers are given ample evidence in the lexicon, yet fail to form a generalization.

4 Learning alternations with a blank slate

4.1 Experiment 6: Artificial Turkish

(55) Materials: 60 p/t/k-final nouns that we created: Monosyllables (ˈmip, ˈstut) and polysyllables with final stress (təˈgep, gəˈʃut).

(56) Participants: 80 English-speaking Mechanical Turkers. Each person is randomly assigned to monosyllabic or polysyllabic training.

(57) Method: Artificial grammar setup (à la Wilson 2006)

	monosyllabic training		polysyllabic training	
Training	*10 stop-final monos*		*10 stop-final polys*	
	ˈmip	ˈmibni	təˈgep	təˈgebni
	ˈstut	ˈstudni	gəˈʃut	gəˈʃudni
	ˈprok	ˈprogni	ləˈʃok	ləˈʃogni
Testing		*10 stop-final monos*		
		ˈgaɪp	_____	
		ˈklet	_____	
		ˈdok	_____	
		10 stop-final polys		
		fəˈʧop	_____	
		bəˈgit	_____	
		ʧəˈpak	_____	

(58) Monosyllabic training looks like a fragment of English.
Polysyllabic training looks like a fragment of Turkish/Portuese/French.

(59) The Subset Principle
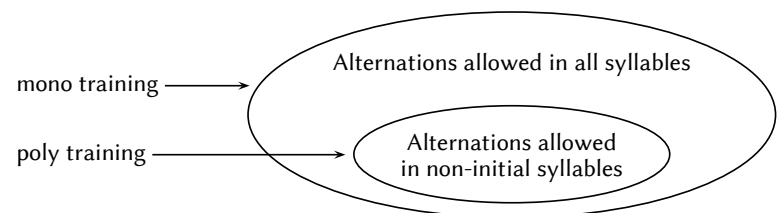
(60) Results: People trained on monosyllables voiced both monos and polys (54% vs. 56%, $p > .1$). People trained on polysyllables voiced monos significantly less (51% vs. 65%, $p < .001$, mixed-effects logistic regression with `lmer`).
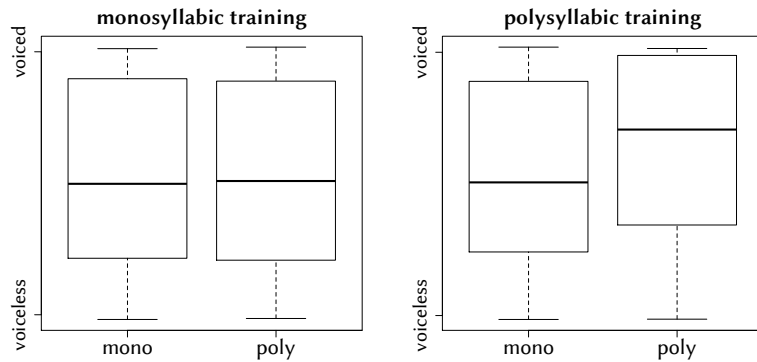
Conclusion: Given a chance, English speakers ignore the anti-initial syllable effect of their language, and prefer a Turkish/Portuguese/French initial syllable effect.

4.2 Experiment 7: Beyond monosyllables

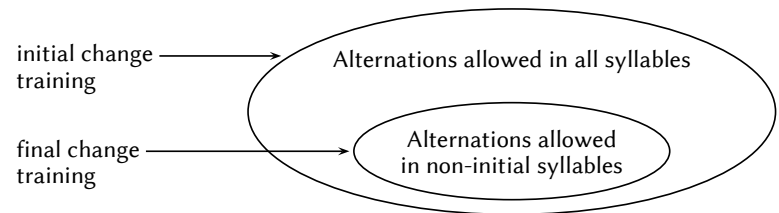So far, we used initial syllable faithfulness to separate monosyllables from polysyllables.
The next step: Show that initial syllable faithfulness distinguishes among polysyllables as well.

(61) Materials: 60 disyllabic nouns that we created: Initial stress (ˈzuməp, ˈbrezəl) and final stress (səˈfup, trəˈmel).
Vowel backness is switched ("umlaut") in the stressed syllable.

(62) Participants: 66 English-speaking Mechanical Turkers. Each person is randomly assigned to initial stress or final stress training.

(63) Method: Artificial grammar setup (à la Wilson 2006)

	initial change training		final change training	
Training	10 initial change		10 final change	
	ˈzuməp	ˈziməp	səˈfup	səˈfip
	ˈbrezəl	ˈbrozəl	trəˈmel	trəˈmol
Testing		10 initial change		
		ˈfunəl	_____	
		ˈʃebəf	_____	
		10 final change		
		pəˈdul	_____	
		kəˈzem	_____	

(64)

(65) Everybody applied the alternation significantly more cautiously to the position they haven't been trained on ($p < .005$), but significantly more so with final change training ($p < .001$, mixed-effects logistic regression `lmer`).
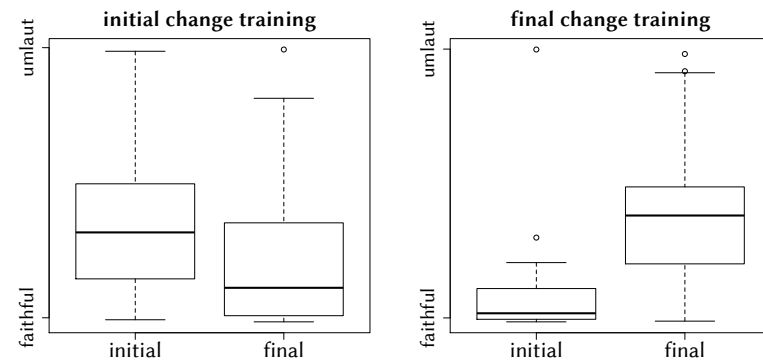
Conclusion:

- English speakers take alternations in the initial syllable as a license to impact later syllables.
  Alternations in non-initial syllables do not license violations of initial syllable faithfulness.

- Initial syllables are protected in monosyllables and in polysyllables →
  There is no need for special protection of monosyllables.

5   Generating the typology of initial faithfulness

From Beckman (1997, 1998):

(66)   In Tamil, codas keep their place of articulation only in the initial syllable.

/makən + gə/	Faith-σ1	Markedness	Faith
a. ma.kən.gə		*!	
b. ☞ ma.kəŋ.gə			*

/mi:n + gə/	Faith-σ1	Markedness	Faith
a. ☞ mi:n.gə		*	
b. mi:ŋ.gə	*!		*

Similarly in other languages (Steriade 1994; Casali 1998; Barnes 2006; Jesney 2009).
The factorial typology:

(67)   Faith-σ1 ≫ Markedness ≫ Faith
       Initial syllables are protected, later syllables are not.

(68)   Markedness ≫ Faith, Faith-σ1
       The change is observed in all roots.

(69)   Faith ≫ Markedness ≫ Faith-σ1
       Faith, Faith-σ1 ≫ Markedness
       No change observed (the speaker's default, Tessier 2006, Coetzee 2009).

There is no ranking that generates the "anti-initial language", thanks to the exclusion of constraints like "Faith-non-initial" and "Faith-polysyllabic".

The English speaker's lexicon & grammar

(70)   Polysyllables aren't affected by Faith-σ1:

/ʤɹæf + z/	Faith-σ1	Markedness	Faith
a. ☞ ʤɹævz			*
b. ʤɹæfs		*!	

/bəlif + z/	Faith-σ1	Faith	Markedness
a. bəlivz		*!	
b. ☞ bəlifs			*

(71)   Monosyllables rely on the ranking of Faith-σ1

/hʊf + z/	Markedness	Faith-σ1	Faith
a. ☞ hʊvz		*	*
b. hʊfs	*!		

/kʌf + z/	Faith-σ1	Markedness	Faith
a. kʌvz	*!		*
b. ☞ kʌfs		*	

The grammar/lexicon, with cloning (Pater 2006, 2009; Coetzee 2008; Becker 2009):

(72)   Faith-σ1$_{kʌf}$ ≫ Faith$_{bəlif}$ ≫ Markedness ≫ Faith$_{ʤɹæf}$, Faith-σ1$_{hʊf}$

A fuller grammar/lexicon:

(73)   Faith-σ1$_{30\ items}$ ≫ Faith$_{90\ items}$ ≫ Markedness ≫ Faith$_{10\ items}$, Faith-σ1$_{70\ items}$

Applying the grammar to a novel polysyllable:

(74)   ~~Faith-σ1$_{30\%}$~~ ≫ Faith$_{90\%}$ ≫ Markedness ≫ Faith$_{10\%}$, ~~Faith-σ1$_{70\%}$~~

Applying the grammar to a novel monosyllable:

(75)   Faith-σ1$_{30\%}$ ≫ Faith$_{90\%}$ ≫ Markedness ≫ Faith$_{10\%}$, Faith-σ1$_{70\%}$

Individual items can be learned, but the anti-initial generalization cannot be projected to novel items.

6 Conclusions

Languages with less alternations in initial syllables:

- Turkish, Portuguese, and French protect monosyllabic lexical items from alternations more than polysyllabic items.

- The trend is projected from the lexicon onto novel items ("wug test").

- The monosyllabicity criterion offers a significantly better account of the observed patterns than accounts based on frequency or duration.

Language(s) with more alternations in initial syllables:

- English protects monosyllabic lexical items less than polysyllables.

- No projection of the trend from the lexicon onto novel items.

Simulated language learning:

- Given a chance, English speakers protect initial syllables.

- Initial syllables are protected both in monosyllables and in polysyllables.

Initial syllable faithfulness shows up without any evidence from the ambient language = doesn't need to be learned.
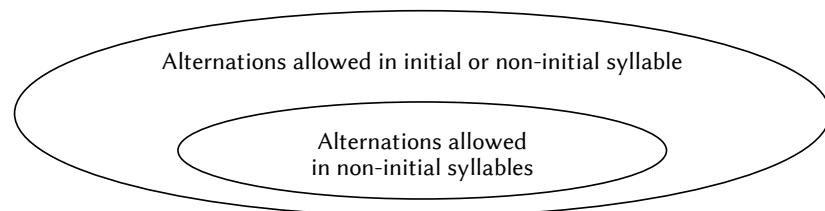
Future questions:

- A fuller study of alternations in prominent positions, which in turn will inform our understanding of prominence.

- Novel word tasks and artificial grammars simulate the language acquisition process with adult participants. We need to go directly to the kids to find out what they do.

- A large-scale alternation learner is in the works; would be the first since the Minimal Generalization Learner (Albright & Hayes 2002, 2003, 2006).

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