Workshop on "Redefining Elicitation: Novel Data in Phonological Theory"
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Diachronically inaccessible grammars:
A diachronic-phonetic study of the English /ai/ alternations

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1. Introduction[1]

(1) Why are some phonological processes common, while others are rare or nonexistent?

(2) "Three Brands of Impossible" in phonology:
a. Unknowable: Universal Grammar won't permit it (or at least discourages it). First-resort explanation in most generative linguistics.
Exx.: *SPE* (Chomsky & Halle 1968:4–5, Feature Geometry (McCarthy 1988, Clements & Hume 1995:245), phonological Optimality Theory (Prince & Smolensky 1993:1–3).
b. Unlearnable: Speaker's output will drive learner to a different grammar.
Ex.: Hypothetical OT case in Boersma (2004).
c. Diachronically inaccessible: Historical change won't lead to it, or is very unlikely to do so.
Exx.: Hale & Reiss 2000, Hyman 2001, Barnes 2002, Blevins & Garrett in press.

(3) Main point of this talk: Synchronically possible—indeed, synchronically natural—processes can be systematically unattested due to diachronic inaccessibility (S. Myers 2003).

Other side of the "crazy rules" problem (Bach & Harms 1972): Why do languages systematically lack *sane* rules?

(4) Outline
§2. Typology of English /ai/ allophony. Multiple independent re-innovation. Half of the logical possibilities are missing...
§3. ...but they aren't "unknowable". Two possible synchronic bases for CR. The missing rules are "natural" according to both, and a very similar alternation is actually attested.
§4. Proposed diachronic basis for CR ("asymmetric assimilation"). Review of supporting evidence from synchronic phonetics. Predicted course of CR innovation.
§5. Conflict with current diachronic accounts of CR.
§6. Case study: Development of CR in Cleveland area, 1880–1977. Corroborates asymmetric-assimilation hypothesis.
§7. Consequent diachronic inaccessibility of the missing alternations.
§8. General discussion.

[1] The work reported here is part of a collaboration with Erik R. Thomas of the Department of English at North Carolina State University (ethomas@social.chass.ncsu.edu). Thanks are due to Misha Becker, Randy Hendrick, Craig Melchert, Jennifer Smith, and Paul Smolensky for comments and suggestions, to Gary Musselman of the City Club of Cleveland and Joanne Cornelius of the Cleveland State University library for tracking down and providing archival recordings, and to the NYU Linguistics Department and the conference organizers. Any remaining errors or omissions are mine.

(5) Relevance to "Redefining Elicitation: Novel Data in Phonological Theory":

a. Arguments from diachrony are ordinarily based on synchronic phonological, diachronic phonological, and synchronic phonetic evidence.

b. This study adds diachronic phonetic data.

2. Canadian Raising and related alternations

(6) Classic Canadian Raising (CR) pattern for /ai/ (Chambers 1973, Paradis 1980):

a. [ʌɪ] before voiceless codas: *ice*

b. [aɪ] elsewhere: *eyes, eye, I'm, isosceles*

(7) Nearly paradigmatic example of rule-governed alternation.

a. Regular and productive, extending to proper names, loan words, and acronyms.

b. Alternations when syllabfication changes (*psychology* vs. *psych*)

c. Native speakers have clear intuitions about which alternant is appropriate to a given context (Lass 1981, Kilbury 1983, Vance 1987).

d. Has lexical exceptions.

e. Opaque interaction with flapping (*writer ≠ rider*).

(f. In many dialects, there is a parallel alternation in /au/. This talk focuses on /ai/.)

(8) "Canadian" raising not limited to Canada; part of a larger family of allophonic rules: /ai/ differs depending on whether obstruent coda is voiced or voiceless. (Other environments vary from dialect to dialect, and were not always reported by our sources.)

(9) Allophonic height variation in /ai/ conditioned by voiceless (–) versus voiced (+) coda obstruents.

/ai/ allophones				
ʌɪ	aɪ	aɛ	a	Dialects
–	+			Canada (Joos 1942, Chambers 1973, Paradis 1980)
				North-central U.S. (Dailey-O'Cain 1997, Thomas 2000)
				East coast of U.S. (Labov 1963, 2001)
				South Atlantic islands (Trudgill 1986)
				English Fens (Britain 1997)
–		+		Southeastern U.S. (Kurath & McDavid 1961)
–			+	—
	–	+		Southeastern U.S. white (Greet 1931, Edgerton 1935, Hall 1942, Sledd 1966)
	–		+	Detroit AAVE (B. Anderson 2002)
				Southeastern U.S. white (Evans 1935, Sledd 1966, Bailey et al 1991, Bernstein 1993)
				Devonshire (P.Anderson 1987)
				Humberside (Trudgill 1999:72)
		–	+	Texas AAVE (Bailey & Thomas 1998)
±				Hertfordshire, Worcestershire, Norfolk (Orton et al. 1978)
	±			Texas Mexican-American (Thomas 1995, 2000)
		±		Texas Anglos (Bailey et al. 1991)
			±	Western North Carolina white (Anderson 1999b)
				Texas Anglos (Bernstein 1993)

(10) Descriptive generalization:

a. Any of [ʌɪ aɪ aɛ a] can occur in either environment, but ...

b. ... the pre-voiceless allophone is *higher*, in the nucleus, offglide, or both, and is lower nowhere.

(11) Independent re-innovations

a. English Fens not cognate with Canada (Pringle & Padolsky 1983, Britain 1997)

b. Cleveland area not cognate with Canada (this talk)

c. No common British source (Britain 1997) ⇒ Canada, Southeastern U.S., South Atlantic islands probably not cognate

d. No known connections between Southern U.S., AAVE—Devonshire/ Cornwall—Humberside.

3. Synchronic admissibility of the attested and unattested alternations

(12) Claim: The missing alternations are within the representational capacity of the synchronic grammar. In fact, they are synchronically "natural".

a. The necessary constraints exist synchronically.

b. A close parallel to the missing alternations is attested in Shetlandic Scots.

(13) What the grammar needs in order to make the missing alternations happen:

a. Context-free inventory constraints ruling out all but the two allophones in question. (Also needed for the corresponding attested alternations.)

b. A contextual markedness constraint favoring the *lower* allophone in the pre-voiceless environment. There are at least two known phonetic and phonological effects of coda voicing which could furnish it.

(14) Pre-voiceless shortening:

a. Vocoids are shorter (i.e., in duration) before voiceless codas (House & Fairbanks 1953, Peterson & Lehiste 1960, and many subsequent studies).

b. Shorter diphthongs are less diphthongal (Gay 1968, Gottfried, Miller, & Myer 1993).

c. Proposed as basis for Canadian Raising (Joos 1942, Chambers 1973, J. Myers 1997, Britain 1997, Bermúdez-Otero 2003).

> It is plausible to speculate that when the Shortening rule was introduced into the grammar, it placed pressure on the low tense (that is, diphthongized) vowels, since the 'distance'—to use the term employed in the Linguistic Atlas—between the low central onset and the peak of the upglide ... is the greatest for these vowels. Several dialects consequently show a tendency to modify these glides in the direction of optimizing the distance... (Chambers 1973:120).

d. ⇒ "Natural" = "Less-diphthongal articulation before voiceless codas"

e. Constraints: *aɪ/VL≤*x* (J. Myers 1997), CLIPDIPH (Bermúdez-Otero 2003)

(15) Pre-voiceless lowering:

a. General association of voiced obstruents (preceding and following) with larger pharyngeal cavity, lower larynx, higher vowels (for reviews see Denning 1989, Trigo 1991)

b. Association between high F1 and following voiceless C in English (Wolf 1978, Mermelstein 1978, Fujimura & Miller 1979; Revoile, 1982; Summers 1987, 1988, Kingston & Diehl 1993, Nearey 1997), Arabic (de Jong & Zawaydeh 2002), Hindi (Lampp & Reklis 2004), non-native English (native Arabic, Japanese, or Mandarin Chinese (Crowther & Mann 1992, 1994).

c Phonologically lower monophthongs and diphthongs before voiceless in Lungtu (Fujien) Chinese (Denning 1989:51), Polish (Gussman 1980, but see Sanders 2002 on non-productivity), Czech (Tobias Scheer p.c. 2003), Shetlandic Scots /ɛ/=[ɛ(ː)] or [æ(ː)] before voiceless sounds, [ɛ̝ɪ] or [eɪ] before voiced ones e.g., *bet* [bæt], *bed* [bɛ̝ɪd] (Johnston 1997:471, p.c. 2003); see also Lass (1981).

d. ⇒ "Natural" = "Lower vocoids before voiceless codas"

(16) Synchronic naturalness of /ai/ alternations

Higher before voiceless (Table (9))			Higher before voiced (unattested)		
Alternation	Pre-voiceless shortening	Pre-voiceless lowering	Alternation	Pre-voiceless shortening	Pre-voiceless lowering
a. ʌɪs aɪz	√	*	*g. aɪs ʌɪz	*	√
b. ʌɪs aɛz	–	*	*h. aɛs ʌɪz	–	√
c. *ʌɪs az	*	*	*i. as ʌɪz	√	√
d. aɪs aɛz	*	*	*j. aɛs aɪz	√	√
e. aɪs az	*	*	*k. as aɪz	√	√
f. aɛs az	*	*	*l. as aɛz	√	√

(17) Problem: Attested alternations less "natural", synchronically, than unattested.

a. Presence of "crazy" (i.e., synchronically unnatural) b, d, e, f. Could result from domination by as-yet unidentified constraint. But:

b. Absence of "sane" (i.e., synchronically natural) h–l.

(18) Reasons to think the unattested patterns are "knowable" (the synchronic phonology can handle them):

a. Factorial typology of existing analyses of Canadian Raising based on pre-voiceless shortening (see Appendix).

b. A constraint embodying pre-voiceless lowering would have the same effect (see Appendix).

c. Shetlandic Scots differs only in nuclear backness:

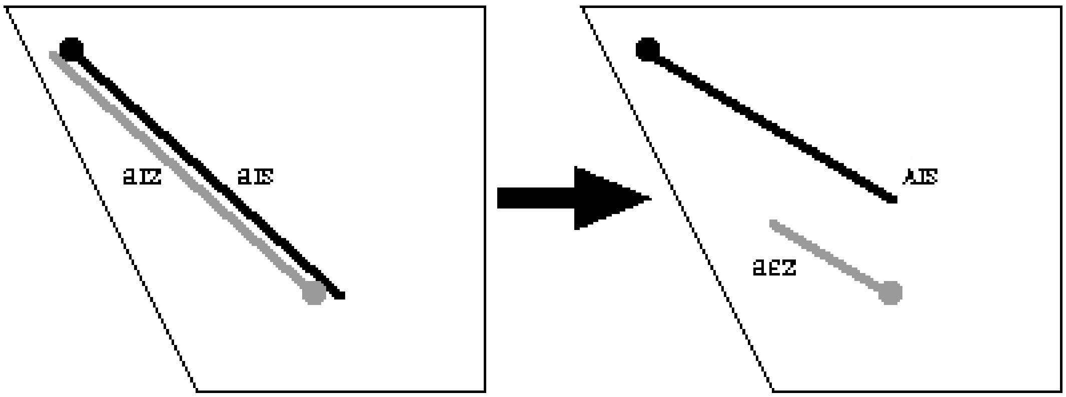
<u>Shetlandic</u>		<u>Unattested</u>	
bæt	*bet*	bat	*bite*
bɛ̝ɪd	*bed*	bʌɪd	*bide*

4. Diachronic phonetic basis: asymmetric assimilation

(19) Proposal:

a. Voiceless codas promote assimilation of the /ai/ nucleus to the offglide, while voiced ones promote assimilation of the offglide to the nucleus.

b. Since the offglide is high and the nucleus low, assimilation creates higher pre-voiceless allophones and lower pre-voiced ones.



(20) /ai/ nucleus and offglide make conflicting demands on the tongue body ⇒ either or both can suffer undershoot (phonetic assimilation)

(21) The undershoot is asymmetric, and coda voicing affects it.

(22). English diphthongs in general undershoot the offglide more than the nucleus (Gay 1968, Gottfried, Miller, & Meyer 1993).

(23) Voiceless codas protect the offglide against undershoot in two ways.

a. Pre-voiceless shortening affects the nucleus more than it does the offglide (Lehiste & Peterson 1961, Gay 1968, Thomas 2000).

b. Pre-voiceless offglides are acoustically more peripheral than pre-voiced ones

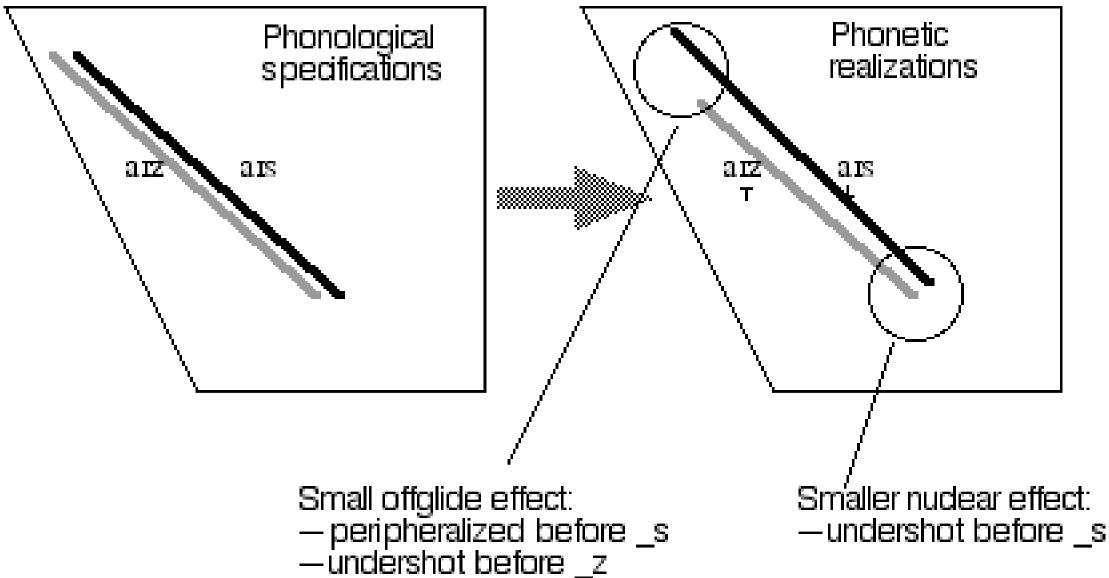
i. in dialects which have no phonological CR, such as Mexican-American English (Thomas 2000), and

ii not just in /ai/, but in /oi ei au/ as well (Moreton 2004).

(24) As a result, there is relatively

a. more undershoot in /ai/ **offglide** before **voiced** (favors *lowering*)

b. more undershoot in /ai/ **nucleus** before **voiceless** (favors *raising*)



(25) Creates conditions for phonologization by "hypocorrection" (Ohala 1981, 1993): differences in phonetic realization are misconstrued by learner as differences in phonological specification.

(26) Ex.: (Hypothetical) phonologization of Canadian Raising by hypocorrection

	Speaker A			Speaker B (learner)	
	UR	SR	Realized	Parsed SR	Parsed UR
ice	/aɪs/	[aɪs]	"a̝ɪs"	[ʌɪs]	/aɪs/
eyes	/aɪz/	[aɪz]	"a̞ɪz"	[aɪz]	/aɪz/

(27) Same asymmetric assimilatory pressures continue to act on new allophones and may change them further.

(28) Result: Pre-voiceless allophones get higher, pre-voiced ones get lower, as seen in Table (9).

(29) Predictions of asymmetric-assimilation theory:

a. Earliest speakers have subtle voiced-voiceless difference in *offglides*, smaller (or no) parallel difference in *nuclei* (i.e., same pattern as in /ei oi/, or in /ai/ of non-CR dalects).

b. Over time, both differences may grow, and the nuclear difference may overtake the offglide difference (but also may not).

c. Pre-voiceless allophone in early stages is *more diphthongal* than pre-voiced allophone (higher offglide, same nucleus).

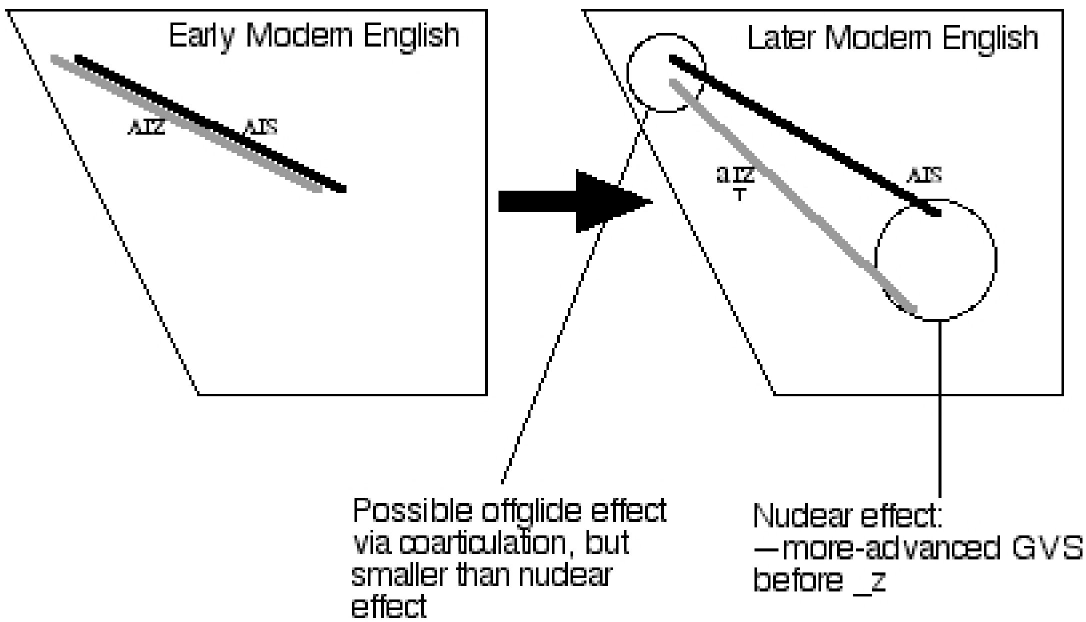
5. Diachronic alternative: CR as consequence of Great Vowel Shift

(30) These predictions are very different from those of the leading historical theories of CR, which are based on Great Vowel Shift:

a. ModE /ai/ in most cases descends from ME /i:/ through intermediate stage with mid nucleus (Wolfe 1972).

b. Pre-voiceless /ai/ allophone represents earlier stage of GVS.

(31) Alternative 1: Failure to Lower. Successive stages in the GVS reach the pre-voiceless environment late, perhaps because the short pre-voiceless environment is less hospitable to more demanding articulations (King 1972; Gregg 1973; Picard 1977; Donegan 1993; Stockwell & Minkova 1997).



(32) Alternative 2: Contact, Focusing, and Reallocation. The allophones come from two different non-alternating dialects at different stages of the GVS (Trudgill 1984, 1986; Britain 1997). Speakers intermingle; learners "rationalized the situation by redistributing the variants according to ... natural phonetic tendencies" (Trudgill 1986:159).

(33) Predictions of the GVS theories:

a. Main difference between earlier and later ME /i:/ reflexes is in nucleus ⇒ alternation should appear first in the nucleus

b. Over time, nuclear difference should grow. Coarticulation may create a parallel offglide difference, but nuclear difference should be bigger.

c. Pre-voiceless allophone is *less diphthongal* than pre-voiced allophone (same offglide, higher nucleus).

(34) Predictions compared:

	Asymmetric assimilation	Great Vowel Shift
Allophony first appears in	Offglide	Nucleus
Voicing effect is bigger in	Offglide (initially)	Nucleus (always)
More-diphthongal allophone	Pre-voiceless (initially)	Pre-voiced (always)

6. Case study: Cleveland area, 1880–1977

(35) Canadian Raising found in younger speakers from the Western Reserve area of Ohio (northeastern Ohio, around Cleveland), by Thomas (2001:81–82).

(36) Independent re-innovation, rather than borrowing:
a. U.S. dialects resist a range of Canadian variants (Labov et al. forthcoming Ch. 11, Zeller 1993)
b. Documented innovations in the Western Reserve have not come from Canada (Drake 1961, Thomas 2001)
c. Major sources of migrants to the Cleveland area have not been Canadian Raising areas (Grabowski 1996)
d. No direct entry point from Canada (unlike Detroit, Buffalo).

(37) Aims of study:
a. Quantify effect of obstruent-coda voicing on F1 and F2 in Cleveland-area /ai/
b. Track over time

6.1. Speakers

(38) Selection criteria:
a. Adult white native speakers
b. Born in Cuyahoga, Summit, Lake, or Geauga counties in Ohio
c. Living in one of those counties at time of recording
d. Birth year known

(39) Data sources:
a. Dictionary of American Regional English (DARE) interviews
b. City Club of Cleveland (CCC) archives
c. Interviews by Erik R. Thomas, NCSU Dept. of English

(40). Speakers.

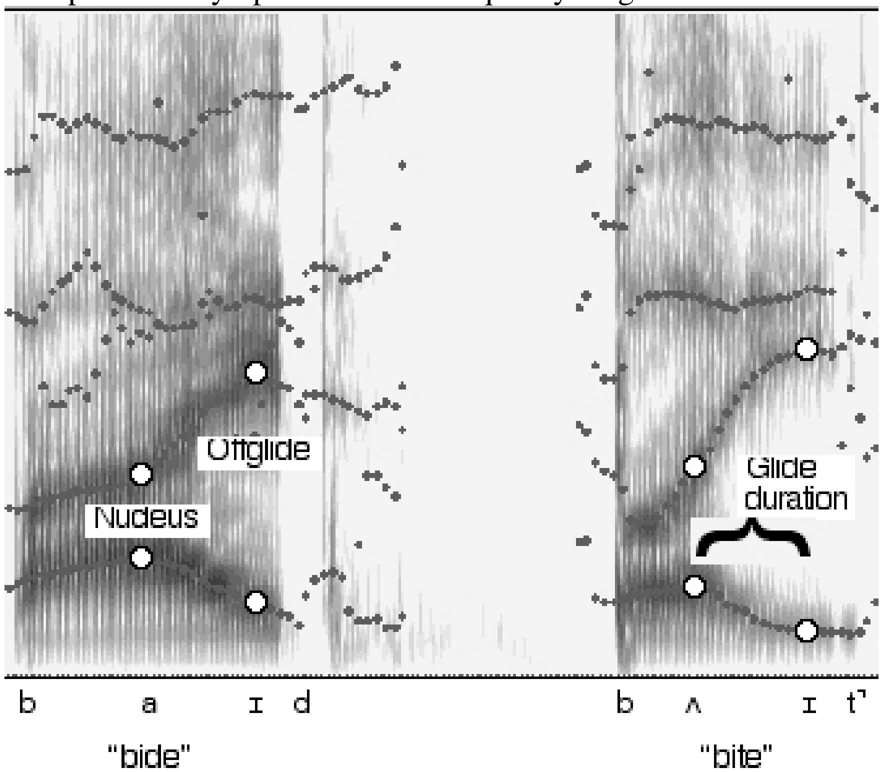
Code/ Year	Place of birth	Sex	Source	Tokens Voice-less	Voiced
1880	Hudson	m	DARE	5	10
1884	Norwalk	f	DARE	23	14
1898	Chagrin Falls	f	DARE	11	19
1905	Lakewood	m	City Club	18	19
1911	East Cleveland	m	City Club	11	19
1913	Cleveland	m	City Club	28	53
1914	Cleveland	m	City Club	24	55
1915	Cleveland	m	City Club	13	28
1918	Akron	m	ERT	23	17
1924	Chagrin Falls	f	DARE	28	16
1927	Cleveland	m	City Club	7	39
1934	Cleveland	m	City Club	25	29
1946	Mentor	m	ERT	18	20
1948	Bainbridge	m	ERT	19	18
1952	Solon	f	ERT	19	19
1960	Cleveland	f	ERT	22	22
1967a	Cleveland	m	ERT	56	44
1967b	Cleveland	f	ERT	61	44
1969a	Euclid	f	ERT	57	53
1969	Lakewood	f	ERT	45	40
1970	Lakewood	m	ERT	54	44
1977	Brunswick	m	ERT	38	28
			TOTAL	605	650

6.2. Measurement procedure

(41) Token selection criteria
- a. /ai/ had primary or secondary stress
- b. Followed by labial or coronal obstruent C
- c. C syllabified with /ai/ (C precedes pause, another C, or an unstressed V)
- d. C not /t/ or /d/ in a flapping context

(42) Measurement points (Moreton 2004):
- a. Nucleus measured at F1 maximum
- b. Offglide measured at F2 maximum
- c. "Glide duration" = interval between those two

(43) Measurement points (nuclear F1 and F2, offglide F1 and F2, and glide duration) for "bide" and "bite" produced by Speaker 1977. Frequency range shown is 0 to 5000 Hz. The window is 1.00 s wide.



(44) Measurement points were located, and measurements made, using supervised automatic procedure (Praat + Perl script). Hand corrections made to 14% of 1255 tokens (1/3 of these were a single speaker, 1913).

6.3. Speaker and duration normalization

(45) Speaker normalization

a. Want to compare across speakers with different vocal-tract lengths.

b. Standard techniques won't work—they compare with the speaker's other vowels, which may change over time. Same problem as with cross-language comparisons (Nearey 1989).

c. <u>Solution</u>: Compare allophones *within* a speaker. Use log-transformed Hz values, and compute voiced-voiceless differences (corresponding to ratios—not affected by changes in VT scale).

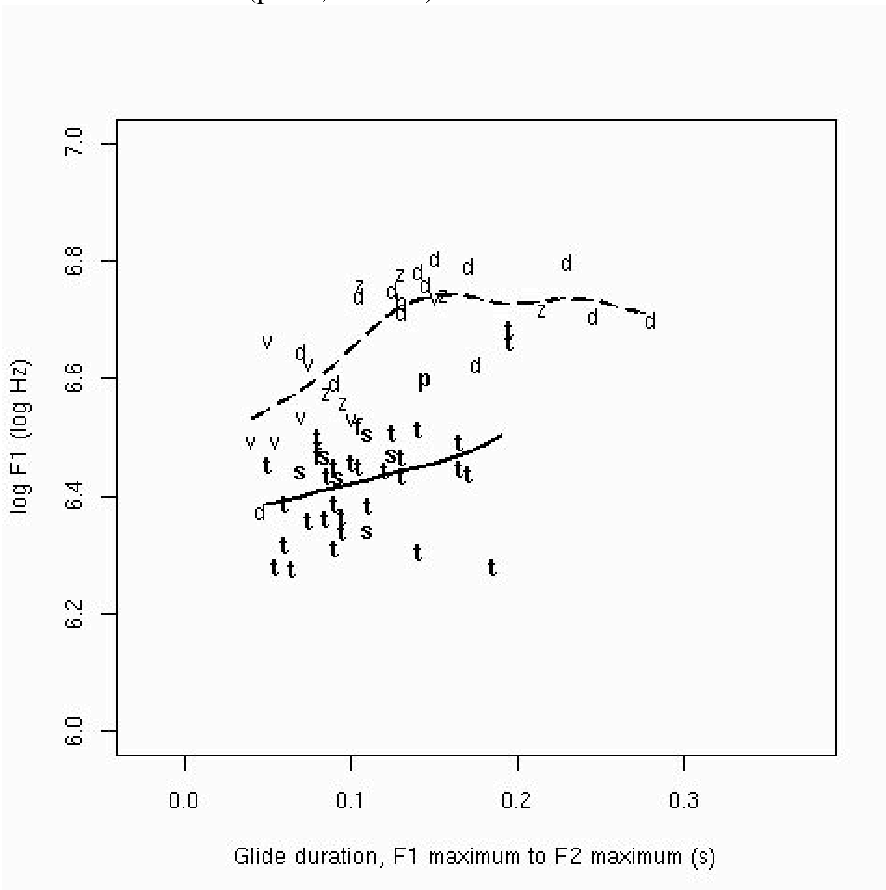
(46) Duration normalization

a. Want to know effect of voicing when /ai/ duration is controlled

b. <u>Solution</u>: plot formants vs. glide duration, draw moving-average curves (Gaussian window, s.d. = 25 ms), calculate average difference between curves over region where both exist.

(47) Ex.: Speaker 1977 (male)

a. Nuclear F1 vs. glide duration. Curves show moving averages for the voiceless (boldface, solid) and voiced (plain, dashed) codas.



b. Mean distance between corresponding points on curves is –0.234, i.e.,

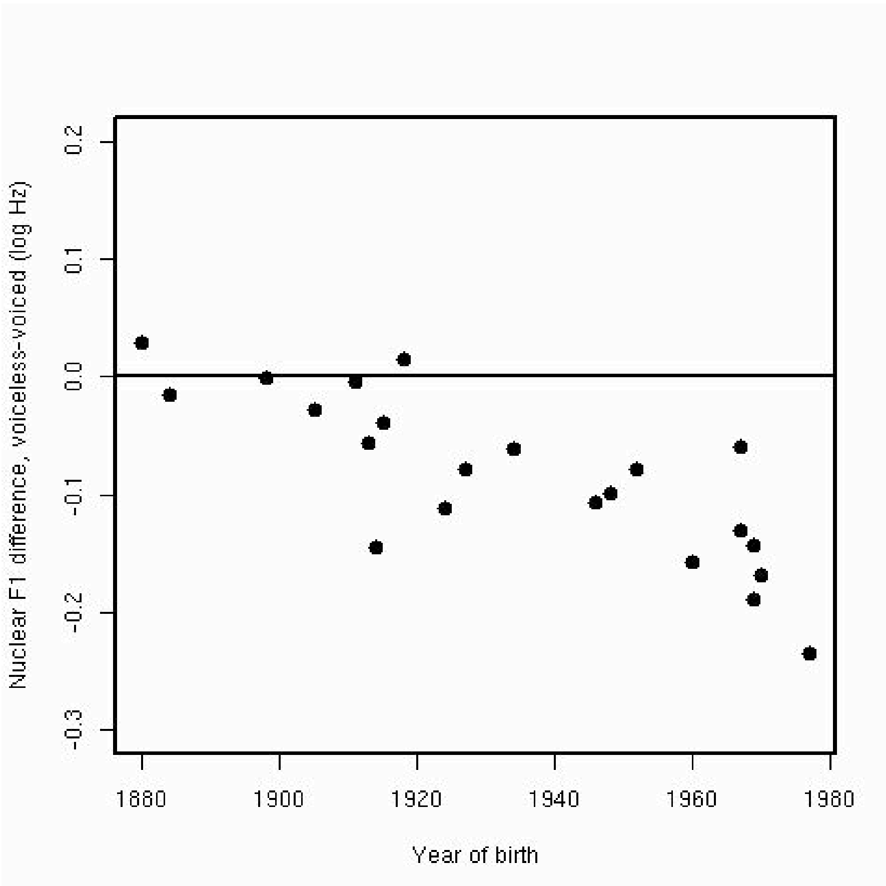
c. Pre-voiceless /ai/ of a given duration had a nuclear F1 that was about $e^{-0.234}$, or 0.79, times that of a pre-voiced /ai/ of the same duration.

d. => pre-voiceless nuclear raising.

6.4. Results and discussion (F1 only)

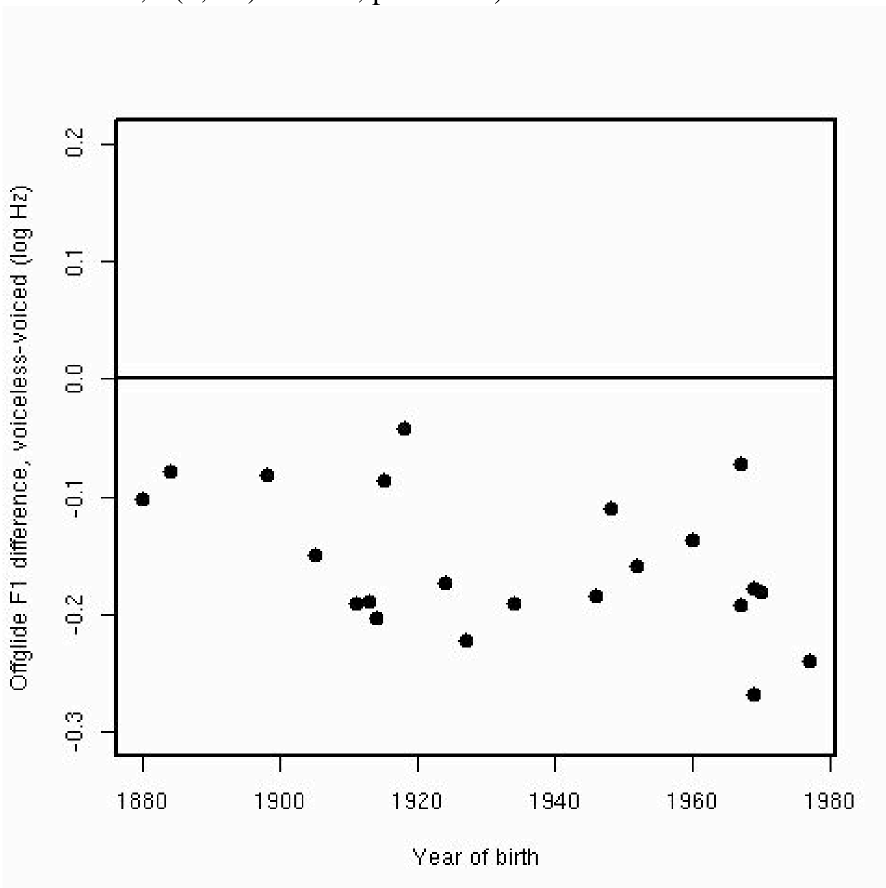
(48) Do the earliest speakers show an effect of coda voicing in the nucleus (A-A: no; GVS: yes).

(49) Coda-voicing effect on nuclear F1 starts at 0 and increases with birth year (ordinary least-squares fit: –0.190 log-Hz per century, $R^2 = 0.652$, $F(1, 20) = 37.41$, $p < 0.001$)



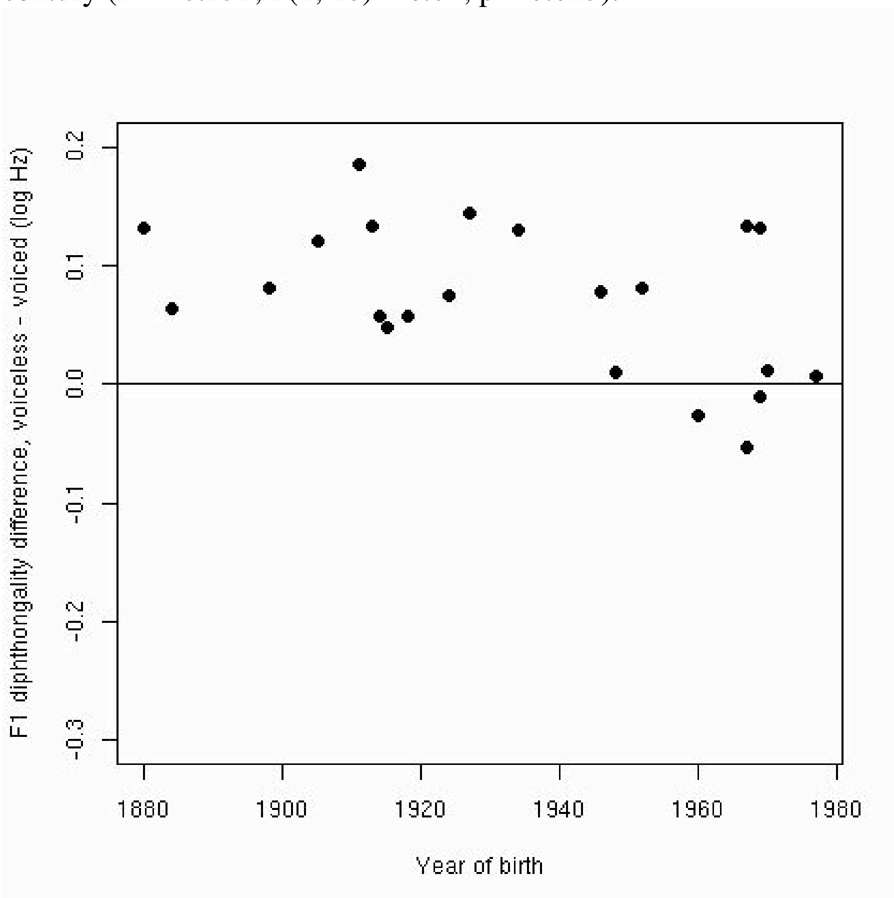
(50) Does offglide alternation predate nuclear one? (A-A: yes; GVS: no.)

(51) Coda-voicing effect on offglide F1 starts nonzero and grows (OLS fit: –0.088 log-Hz per century, $R^2 = 0.195$, $F(1, 20) = 4.852$, $p = 0.040$).



(52) Which allophone is more diphthongal, pre-voiceless (A-A) or pre-voiced (GVS)?

(53) Pre-voiceless is more diphthongal except in the most recent speakers (OLS fit: 0.10 log-Hz per century ($R^2 = 0.232$, $F(1, 20) = 6.04$, $p = 0.023$).



(54) Results favor the asymmetric-assimilation hypothesis over the GVS-based alternatives.

	Asymmetric assimilation	Great Vowel Shift
Allophony first appears in	**Offglide**	Nucleus
Voicing effect is bigger in	**Offglide (initially)**	Nucleus (always)
More-diphthongal allophone	**Pre-voiceless (initially)**	Pre-voiced (always)

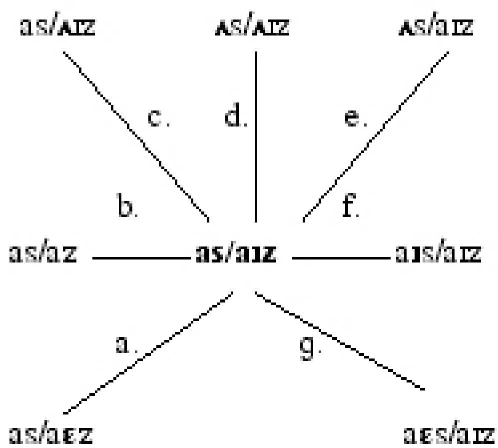
7. Diachronic inaccessibility of the missing alternations

(55) Cleveland results corroborate asymmetric-assimilation hypothesis.

(56) Explanation for the "missing" alternations: they are *diachronically inaccessible*: <u>No minimally different pattern tends to change in the right direction.</u>

(57) Assumptions:
   a. Gradual sound change: For vocoids, approximate as one insertion, deletion, or feature change. (Excludes analogy, borrowing, etc.)
   b. "Minimally different pattern" = *potential immediate ancestor* via gradual sound change
   c. Asymmetric assimilation
   d. Change does not affect rest of contrast system (i.e., allophonic alternation arises through subphonemic splits)

(58) <u>Ex.</u>: Neighborhood of potential immediate ancestors for *[as aɪz]



(59) <u>Ex</u>.: Diachronic inaccessibility of *[as aɪz]

Potential ancestor	Ruled out because
a. [as a**ɛ**z] > *[as a**ɪ**z]	Offglide *dis*similated from nucleus before voiced.
b. [as az] > *[as a**ɪ**z]	Offglide *added* before voiced
c. [as **ʌ**ɪz] > *[as **a**ɪz]	Nucleus *dis*similated from offglide before voiced.
d. [**ʌ**s **ʌ**ɪz] > *[**a**s **a**ɪz]	Affects rest of contrast system (neutralizes voicing contrast after [ʌ])
e. [**ʌ**s aɪz] > *[**a**s aɪz]	Affects rest of contrast system (neutralizes voicing contrast after [ʌ])
f. [a**ɪ**s aɪz] > *[as aɪz]	Offglide, rather than nucleus, lost before voiceless.
g. [a**ɛ**s aɪz] > *[as aɪz]	Offglide, rather than nucleus, lost before voiceless.

8. General discussion

(60) Summary of main points:
  a. Multiple independent re-innovation of CR-like alternations
    i. Much variation as to the allophones
    ii Uniform pattern: higher allophone before voiceless
  b. Proposed diachronic basis: asymmetric assimilation of nucleus and offglide in pre-voiced vs. pre-voiceless environments.
  c. Check: re-innovation of CR in and around Cleveland, 1880–1977. Agrees with asymmetric-assimilation hypothesis, disagrees with standard historical account of CR.
  d. "Missing" CR versions (lower allophone before voiceless) are
    i. representable by the synchronic grammar.
    ii. synchronically "natural"
    iii. diachronically inaccessible
  e. ⇒ Systematic typological gaps can result from diachronic bias (S. Myers 2003, Blevins & Garrett to appear)

(61) Does synchronically natural = diachronically natural? No—diachronic naturalness can conflict with, and in this case overcome, synchronic naturalness.

(62) How can we tell whether a systematic gap in the typology is due to synchronic or diachronic bias?
  a. Absence of plausible alternative
    i. Diachronic, not synchronic: Epenthetic repair to *NC (S. Myers 2003); see also typology of metathesis in Blevins & Garrett (to appear).
    ii. Synchronic, not diachronic: Stop-place perceptibility is much diminished intervocalically (esp. between front vowels), but this is not phonologized (Cole & Iskarous 2001).
  b. <u>Direct</u> evidence of synchronic "analytic bias" (Wilson 2003) in the absence of experience:
    i. Artificial-language learning (e.g., Pater & Tessier 2003, Wilson 2003)
    ii. Speech production (e.g., Dell et al. 2000, Goldrick 2003, Davidson 2003)
    iii. Speech perception (e.g., Pertz & Bever 1975, Moreton 2002)
    iv. Acquisition (e.g., Davidson et al. in press)

Appendix

(A1) Factorial typology from existing account of CR (Bermúdez-Otero 2003) predicts unattested *[as aɪz]

a. CLIP-DIPH: "[aɪ aʊ] are forbidden in a short environment" (adapted from Bermúdez-Otero 2003; see also Chambers 1973, J. Myers 1997).

b. CLEAR-DIPH: "[ʌɪ ʌʊ] are forbidden" (adapted from Bermúdez-Otero 2003; see also Minkova & Stockwell 2003).

c. Canadian Raising (adapted from Bermúdez-Otero 2003)

/aɪs/	CLIP-DIPH	CLEAR-DIPH
☛a. ʌɪs		*
b. aɪs	*!	

/aɪz/	CLIP-DIPH	CLEAR-DIPH
a. ʌɪz		*!
☛b. aɪz		

d. Tacitly relies on another constraint to ban /a/ from Canadian English altogether. If ranked to permit /a/, the result is *[as aɪz]:

/aɪs/	CLIP-DIPH	CLEAR-DIPH	"*[a]"
a. ʌɪs		*!	
b. aɪs	*!		
☛c. as			*

/aɪz/	CLIP-DIPH	CLEAR-DIPH	"*[a]"
a. ʌɪz		*!	
✖ b. aɪz			
c. az			*!

e. I.e., if voiceless contexts disfavor diphthongality, /a/ is less diphthongal than any of the other choices.

(A2) Even if the CLIP-DIPH/CLEAR-DIPH analysis is rejected, there is independent evidence for a different synchronic constraint *[–LOW][–VOICE] favoring lower vocoids before voiceless codas (see (15) above)

(A3) *[–LOW][–VOICE] in Central and South Shetlandic Scots:

a. /ɛ/=[ɛ(ː)] or [æ(ː)] before voiceless sounds, [ɛ̝ɪ] or [eɪ] before voiced ones e.g., *bet* [bæt], *bed* [bɛ̝ɪd] (Johnston 1997:471, p.c. 2003).

bet	*[–LOW][–VOICE]	*[+LOW –BACK]
a. bɛɪt	*!	
☛b. bæt		*

bed	*[–LOW][–VOICE]	*[+LOW –BACK]
☛a. bɛɪd		
b. bæd		*!

b. Parallel to missing alternations:

Shetlandic		Unattested	
bæt	*bet*	bat	*bite*
bɛ̝ɪd	*bed*	bʌɪd	*bide*

c. Only synchronic difference is nuclear backness. If the grammar can represent one, why not the other?

ice	*[–LOW][–VOICE]	"*[a]"
a. ʌɪs	*!	
☛b. as		*

eyes	*[–LOW][–VOICE]	"*[a]"
☛a. ʌɪz		
b. az		*!

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