Acoustic cues to the [j]-[i] distinction in American English

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Zack Jaggers

NYU

Study Aims

1) To test whether American English has a glide-vowel distinction ([i] vs. [j]) occurring in uniform C_V environments.
2) To identify what acoustic aspects most consistently convey any such distinction, for the purposes of
    a) acoustic phonetic documentation,
    b) comparing phonological representations.

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Background

glide-vowel distinctions

Existence

- fully phonologically predictable (Steriade 1984)
  - [j] and [i] are surface allophones of the same phoneme
- a distinction available to the grammar (Levi 2004, 2008)
  - not fully predictable

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Phonological representation

- constriction/height: /j/ = [–vocalic] (Padgett 2008)
- place/articulator: /j/ = Coronal; /i/ = Dorsal (Levi 2008)
- syllabic pre-linking (Levi 2008, Levin 1985)

Methods

- 9 native speakers of American English
- Sentence reading task
  - real words + nonce names (separate blocks, 4 reps each)
  - self-paced slide presentation
  - ½ target stimuli, ½ filler stimuli
  - semi-randomized
    - attention paid to spacing respective glide/vowel-expectant pairs
- Setting
  - sound-attenuated booth, NYU campus
  - Shure SM35-XLR head-mounted microphone
  - Marantz PMD 660 audio recorder

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Stimuli

real word pairs

By expected pronunciation:

[iV]:	Estonia,	hernia,	millennia,	Armenia
[jV]:	pneumonia,	California,	Kenya,	gardenia

Example sentences:

The citizens of Estonia protested the decision.

Her pneumonia pushed her into a heavy fever.

Stimuli

nonce names

C_		initial <i>	initial <y>	non-initial <i>	non-initial <y>
Labial	/p_/	Piácho	Pyásha	Nópia	Dápya
	/b_/	Biási	Byásu	Shábia	Chóbya
	/f_/	Fiáki	Fyága	Gófia	Zúfya
	/m_/	Miáshu	Myáchi	Súmia	Fímya
Coronal	/t_/	Tiágu	Tyáko	Bítia	Pótya
	/d_/	Diáfa	Dyápu	Módia	Vádya
	/s_/	Siáko	Syági	Kúsia	Gísya
	/n_/	Niáfa	Nyápa	Vónia	Búnya
Dorsal	/k_/	Kiása	Kyáso	Dókia	Púkya
	/g_/	Giáfu	Gyápi	Nágia	Tígya

Last names assigned random honorifics:
Coach, Dr., Governor, Miss, Mr., Mrs., Officer, Reverend, Sister

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Stimuli

nonce names

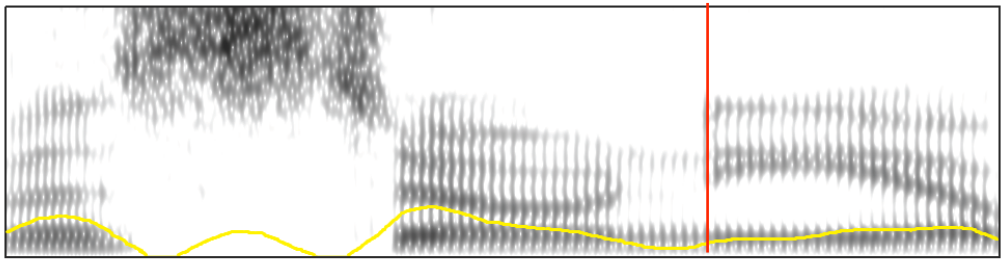
- Training
  - Directions (spoken, face-to-face)
    - Will say sentences with unfamiliar last names.
    - All use the vowels [ɑ], [i], [u], [o].
    - Be consistent: e.g., <g> is always [g].
    - The stressed vowel is marked with an accent.
  - Practice
    - Listen and repeat (honorific + nonce name).
    - Say + any feedback (honorific + nonce name).
    - Use in full sentence, making sure not to pause.
- Example Sentences

  Miss Vónia paused the movie.

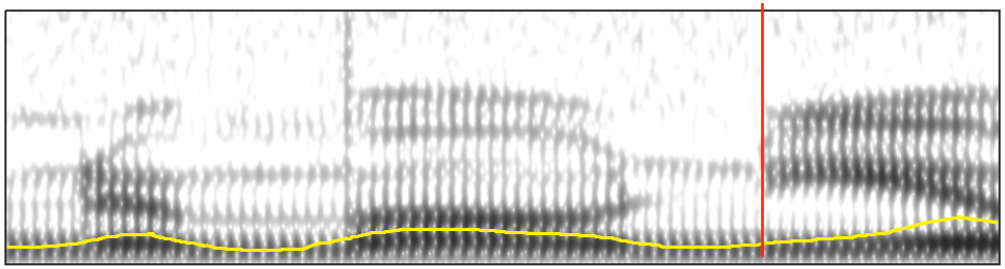
  Judge Búnya paints beautifully.

Example Utterances

and initial observations



Estonia (speaker CH43, utterance 4)



pneumonia (speaker CH43, utterance 3)

[jV]: overall shorter duration
less of an apparent targeted climb of F2
earlier fall of F2 transitioning to following vowel
greater intensity range (yellow line)

Measurements and Predictions

re: vocalic material from C_ to _C

Place/Articulator (Levi 2008, Halle et al. 2000)

- F2max: [j] > [i] ([j] more front)

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Constriction/Height (Padgett 2008)

- F1min: [i] > [j] ([j] higher)
- Intensity range: [jV] > [iV] ([j] more constricted)

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Measurements and Predictions

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- F2max: [j] > [i] ([j] more front)

Constriction/Height (Padgett 2008)

- F1min: [i] > [j] ([j] higher)
- Intensity range: [jV] > [iV] ([j] more constricted)

Earliness/Speed (pre-linking account: Levi 2008, Levin 1985)

- Duration: [iV] > [jV] ([jV] only 1syll)
- F2max time: [i] > [j] ([j] = earlier transition) (Chitoran 2002)
- F2 slope: [j] > [i] ([j] faster) (Liberman et al. 1956, Gay 1968)

(While the other accounts should also predict temporal differences, the pre-linking account should, if anything, predict more centralization of formants for [j].)

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Acoustic Cue Analysis

Generalized linear mixed-effects (Glmer) analysis predicting expected outcome

- acoustic measurements scaled and tested against each other as predictors*
- random slopes per speaker (individual differences):

  e.g., speech rate → duration
- terms of interaction with stimulus aspects:

  e.g., syllable count × duration

  C_ place × F2max time

* See Li et al. (2009) for a similar model reversing dependent and independent variables.

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Acoustic Cue Results

real word stimuli (predicting expected pronunciation)

	Fixed Effect	Estimate	*p*-value	
[j] > [i]	Int. range	1.2456	$1.82e^{-6}$ ***	
[i] > [j]	F1min	-.5559	.0106 *	*LogLik*
[i] > [j]	F2max time	-.6047	.0203 *	-130.5
	duration	-.9936	.1546	
	F2slope	-.3641	.393	# of obs
	F2max	.1089	.8674	274

(+ estimate: higher value more likely to come from [j]-expectant stimulus)

[j]: lower intensity (relative to following vowel)
higher articulation
earlier transition to following vowel
not significantly more frontward

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Acoustic Cue Results

nonce name stimuli (predicting orthography)

	Fixed Effect	Estimate	*p*-value	
[i] > [j]	F2max time	-.3564	.00058 ***	
[i] > [j]	Int. range	-.1985	.00336 **	*LogLik*
[j] > [i]	F2slope	.1651	.08524 •	-942.9
[i] > [j]	F1min	-.0988	.09558 •	
	F2max	.1597	.15614	# of obs
	duration	.1062	.37071	1398

(+ estimate: higher value more likely to come from <y> stimulus)

[j]: earlier transition to following vowel
faster transition
higher articulation

(intensity reversal suspected task effect: att'n to stress placement)

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Conclusions

- Distinction? Seems to be one.
- Acoustic cues:
  - F2max earliness most consistent cue: [j] earlier transition than [i]
  - Both real word (sig.) and nonce name (trend) stimuli suggest that [j] also has higher articulation (F1min).
- Phonological interpretation:
  - Results support Padgett's (2008) constriction/height-based characterization for this distinction.
  - Results suggest that [j] and [i] do not differ in articulator/frontness.
  - F2max earliness cue dependence could explain apparent constraint against dorsal Cj sequences. (Ohala 1978)

e.g., adaptation of *Tokyo* [toː.kʲoː] → [toʊ.ki.oʊ] (cf. [toʊ.kjoʊ])

Further Directions

- Perception
  - Do listeners perceive this distinction?
  - Do the cue weightings line up with those observed here?
- Extension
  - Languages previously reported on to support competing representations
  - Use of this kind of cue modeling in the acoustic classification of other distinctions

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Thank [j]ou!

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