

# Dark and light /l/s in Georgian

Diana Archangeli & Jeff Berry  
University of Arizona  
Ultrafest V, Haskins Lab

# Thanks! to

- ▶ Leila Lomashvili for consulting on Georgian
- ▶ Colin Gorrie, Lio Mathieu, Jessamyn Schertz, and Jae-Hyun Sung for tongue tracing and discussion about analysis
- ▶ James S. McDonnell Foundation grant #220020045 BBMB to Diana Archangeli

# Introduction

## Timing of gestures in [l]

1. Timing of articulatory gestures corresponds to syllable position (Byrd et al. 2009)
2. Anteriority peripheral in the syllable (Gick 2003)
3. But not universal: Gick et al. (2006) compares [l] in six languages

## [l]s studied in Gick et al. (2006)

	onset	intervocalic	coda
W. Canadian Engl.	light	light	dark
Quebec French	light	light	light
Serbo-Croatian	dark	dark	dark
Squamish Salish	dark	dark	dark
Beijing Mandarin	r-like	r-like	r-like
Korean	r-like	r-like	l-like

## Georgian vs. English light and dark [l]

	onset/intervocalic		coda
	---{i,e}	---{a,o}	
Georgian	light	dark	dark
W. Canadian Engl.	light	light	dark

## Specific questions about Georgian [l] (based on Gick et al. (2006, p. 69))

1. do Georgian *postvocalic [l]s* always have a measurable dorsal constriction?
2. are Georgian *patterns of gestural timing*. . . almost always different. . . in *pre- vs. postvocalic positions*?
3. are Georgian *multiple gestures simultaneous* in *intervocalic*. . . position?
4. does Georgian *intergestural timing* tend to follow a *sonority-like hierarchy* corresponding largely to *anteriority*? (i.e. anterior gestures towards syllable periphery)

# Goals of study

1. Describe articulation of Georgian dark and light [l] in different syllabic positions
2. Answer questions from Gick et al. (2006)



# Methods

# Experimental design

1. Ultrasound Georgian items; head adjustment with Palatron (Mielke et al. 2005)
2. Georgian items selected from Kenstowicz & Kisseberth (not optimal selection)
3. 1 female Georgian speaker, resident in US for several years, speaks Georgian regularly on the phone with her brother

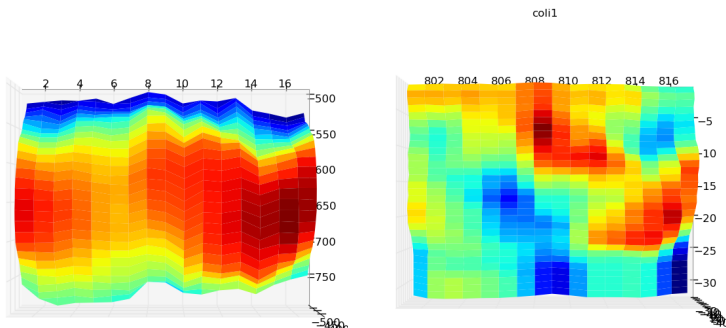
## Data analysis to follow Gick et al (2006)

1. Find relevant dimension in front and back of tongue for measurement
2. Find time of highest point of tongue tip & of tongue back during each [l]
3. Lag: back precedes tip (positive) or tip precedes back (negative)
4. Simultaneity: 0 lag

## Relevant dimension: Neutral subtraction

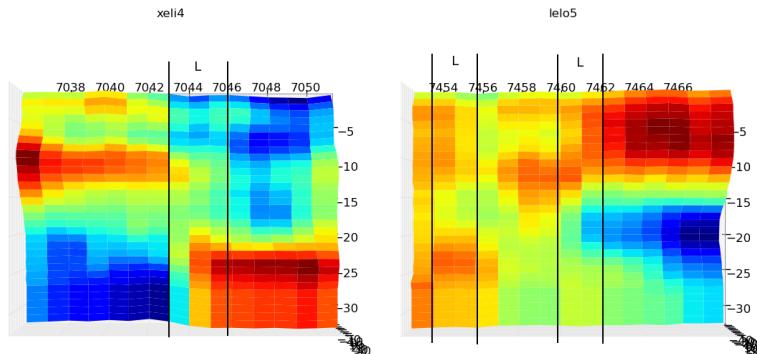
1. Neutral subtraction to separate tongue gesture from tongue bulk
2. Subtract a neutral tongue position from the trace
3. Positive numbers mean tongue has raised that amount above neutral (red)
4. Negative numbers mean tongue has dropped that amount below neutral (blue)

# Relevant dimension: Neutral subtraction linguagram comparison



**Figure:** Comparison of raw contours (left) to neutral-subtracted contours (right) of the same token

## Result from neutral subtraction: [e] vs. [i]



**Figure:** A light /l/ preceding [i] (left), and light /l/ preceding [e] (right). The /l/ preceding [e] shows a distinct tongue tip gesture independent from the vowel

## Identify tip and back peak of [l]

1. Use results of neutral subtraction
2. Identify [l] frames (spectrogram)
3. Identify highest point in front of mouth and in back of mouth
4. Use correspondents of this point over time to calculate Lag

# Identifying tip and back peaks for Lag

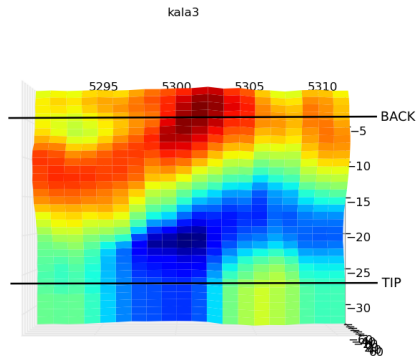
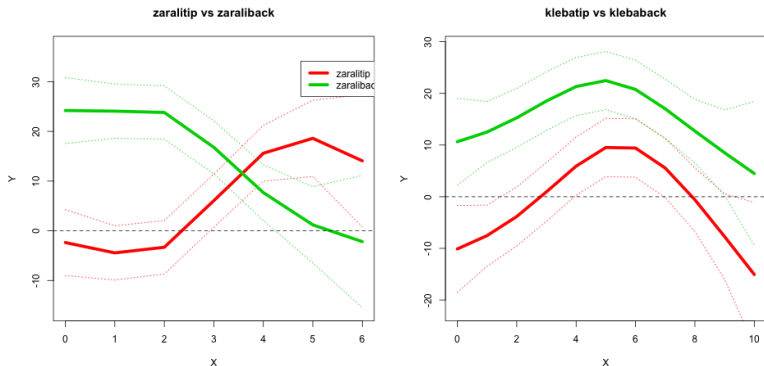


Figure: Rows are selected by hand for back and tip peaks



# Lag in light onsets



**Figure:** Tip (red) and back (green) height vs. time for /l/ before [i] (left), and /l/ before [e] (right). Dashed line shows neutral position.

# Lag in dark onsets

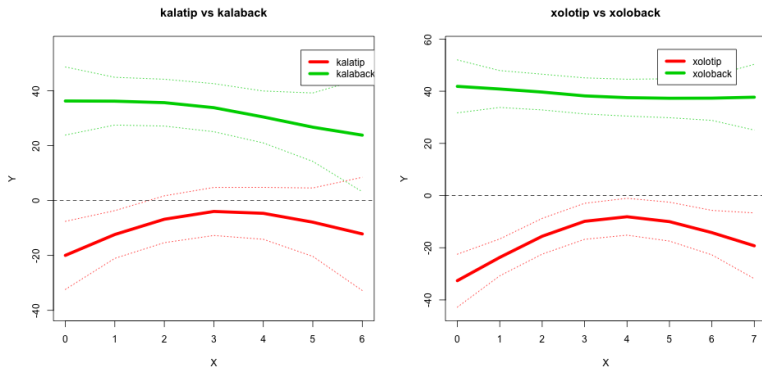


Figure: Tip (red) and back (green) height vs. time for /l/ before [a] (left) and /l/ before [o] (right)

# Lag in dark codas

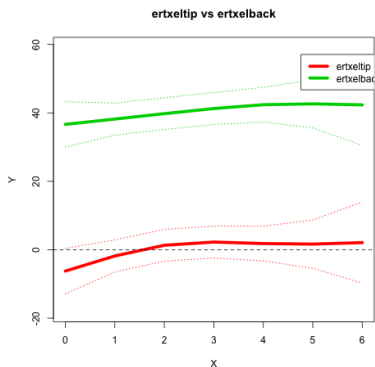


Figure: Tip (red) and back (green) height vs. time for /l/ in coda position

# Results

# Statistical analysis

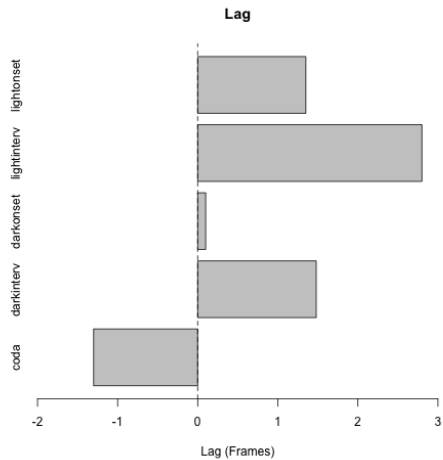
1. Compared dark vs. light /l/ in onset, intervocalic, and coda positions
2. Used linear mixed effects models in R (lmer)
3. Lag was dependent variable, position/type were fixed factors, word was random factor
4. t values greater than 2 are significant

## Results

	$\beta$	S.E.	t value
(Intercept)	0.5882	0.3610	1.629
light vs. dark	-0.8020	0.3309	-2.424*
onset vs. interV	-1.0863	0.6195	-1.754
onset vs. coda	1.1549	0.4284	2.696*

**Table:** Results of LMER analysis of traced contours. Comparing lag for light vs. dark shows significant difference, as does comparing onset vs. coda.

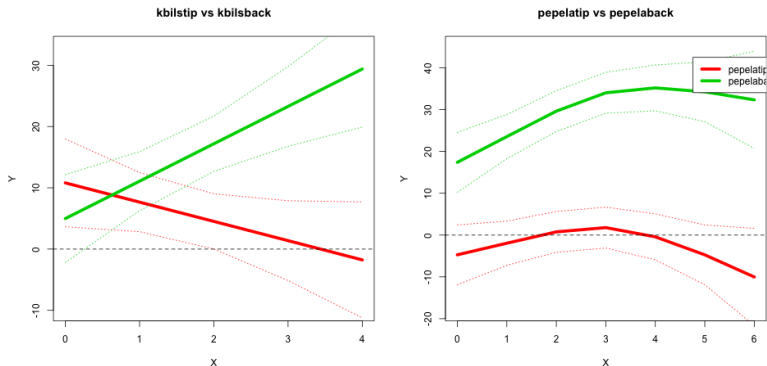
# Results



# Discussion

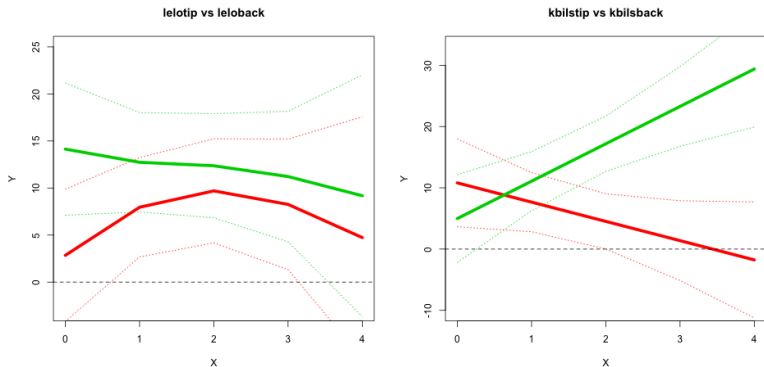


# Postvocalic [l]s have a measurable dorsal constriction



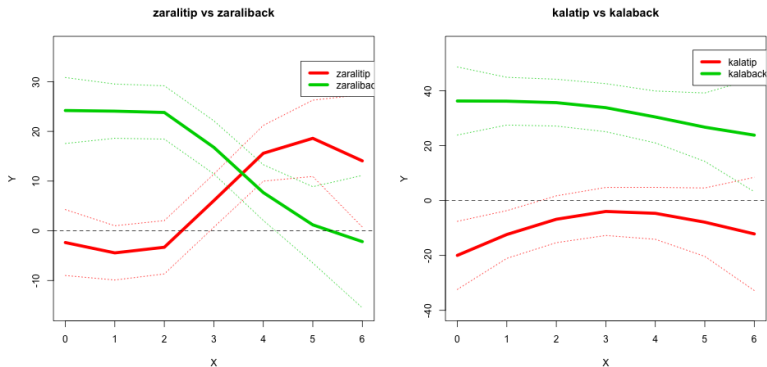
**Figure:** Tip (red) and back (green) height vs. time for /l/ after [i] (left) and /l/ after [e] (right). This is true for all tokens.

# Pre- vs. postvocalic positions timing patterns are different



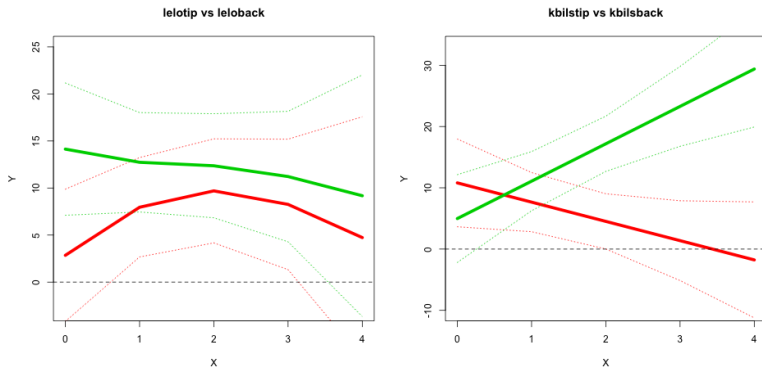
**Figure:** Tip (red) and back (green) height vs. time for /l/ before [e] (left) and /l/ after [i] (right). Onset-coda distinction t-value = 2.696.

# Multiple gestures are NOT simultaneous when intervocalic!



**Figure:** Tip (red) and back (green) height vs. time for /l/ between [i] and [a] (left) and /l/ between [a] and [a] (right). Average intervocalic lag for light /l/ is 2.80 frames, and 1.48 for dark /l/.

# The anterior gesture is NOT closer to syllable edges!



**Figure:** Tip (red) and back (green) height vs. time for /l/ before [e] (left) and /l/ after [i] (right). Anterior gesture (red) is closer to syllable center. Average lag for onset is 0.68, and -1.30 for coda.

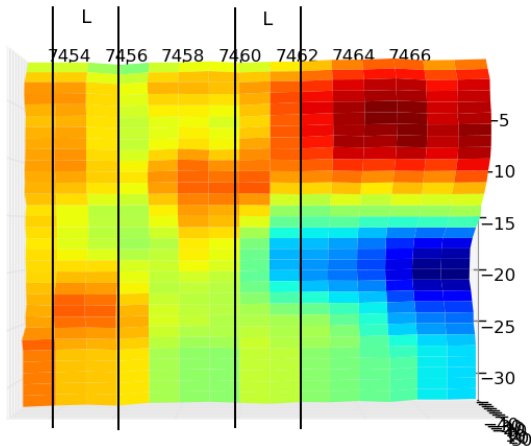
# Significance

	<i>Perceptual recoverability</i> Chitoran et al. 2002	<i>Jaw cycle</i> MacNeilage 1998 Redford 1999	Gick et al. 2006 <i>assessment</i> tendency to...
preV	simultaneity	front-to-back	simultaneity
postV	back-to-front	back-to-front	back-to-front

# Conclusion

1. 2 findings are consistent with Gick et al. 2006
  - ▶ Measurable post V dorsal constriction
  - ▶ Pre vs. post V timing differences
2. 2 findings are not consistent with Gick et al. 2006, nor Jaw Cycle
  - ▶ Positive intervocalic lag
  - ▶ Syllable peripheral posteriority (contra Jaw Cycle)
3. Results significant despite only 1 subject and poor design
4. Suspect due to conditioning environment for Georgian light /l/: following vowel (not syllable position)
5. NOT simple coarticulation (lelo)

lelo5



Thanks for your attention!