



## Main Points

- This study presents tongue articulation data using real-time 3D ultrasound images and digitized 3D palate impressions, with time-aligned audio recordings.
- Production study focuses on production of laterals and rhotics.
- It presents preliminary observations of two American English speakers
  - One speaker from New England with doubly-articulated laterals, including a coronal and a dorsal constriction.
  - One speaker from Indiana with no coronal contact, even in pre-vocalic positions
  - Both speakers exhibit mirrored temporal phasing of (coronal) and dorsal occlusions in // in onset vs. coda position.
- Rhotic production is complex but consistent across speaker, syllable position, and vowel context.

## Background

### Laterals and 3-dimensional imaging:

- Linguistic analyses of speech sound articulation usually rely on configurations in the mid-sagittal plane.
- Lateral sounds, sounds such as American English (AmE) //, are known exceptions.

**This study presents preliminary observations of AmE liquids from 3D ultrasound imaging.**

### Laterals (previous observations):

- Laterals in AmE include two constrictions: coronal and dorsal.
- The coronal occlusion occurs on the midline with lateral airflow around the occlusion.
- Dialects in lower mid-west often exhibit loss of coronal occlusion in coda position

### Rhotics (previous observations):

- Rhotics in AmE include both oral and pharyngeal constrictions, analogous to the dual constrictions in laterals.

## Methods

### Talkers

- Two female speakers of American English, one from southwestern New Hampshire and one from southern Indiana. Both speakers have a varied residential history in the U.S.

### Palate Impressions

- Palate impressions were made for each speaker and digitized with a NextEngine 3D laser scanner.

### Ultrasound Recordings

- Ultrasound images were recorded with a Philips EpiQ 7G system using an xMatrix x6-1 digital 3D transducer secured under the chin using an Articulate Instruments ultrasound stabilization headset.
- Participants produced the following words in isolation, separated by the phrase “tea cod”: *keel, kill, call, leek, lick, lock, reek, rick, rock, roll, lore, coke*
- Recording frame rates were approximately 10 volumes per second.

### Joint Palate-Ultrasound Analysis

- Fully uncompressed DICOM ultrasound files were transferred to a Windows 7 computer and exported to binary FLD file format using Philips QLab software.
- Ultrasound FLD and palate STL files were loaded into MATLAB and analyzed using a custom graphical user interface.
- Palates were manually rotated and translated to subjectively align with the tongue data.
- Sagittal ultrasound slices with superimposed palate outline were converted to JPG images, uploaded to a web-accessed SQL database, and traced in the browser window by clicking-and-dragging with a mouse.
- Multiple sagittal slices were traced for each frame of each word, working with images as far off the mid-line as to allow visual tracking of the tongue surface.