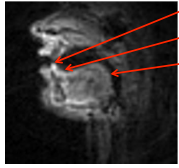


PRODUCTION OF LATERAL LIQUIDS



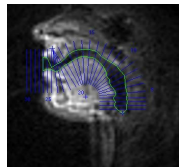
- Tongue tip makes contact with alveolar ridge
- Tongue blade lowered/curled
- Tongue body retracted

What are the main tasks associated with lateral liquid production?

- Hypothesis 1: Creation of side channels (tongue tip contact + tongue blade curling/lowering) is a main production task for /l/
- Hypothesis 2: Tongue blade curling is a main production task for /l/
- Sequencing of tongue tip contact and tongue body retraction varies by syllable position (Sproat & Fujimura 1993)
- Full tongue tip closure often not achieved during production of /l/ in syllable coda position: /l/ vocalization (Hardcastle & Barry 1989)
- Variability vs. stability of achievement of tongue tip contact and its timing across syllable positions may point toward true production goals of /l/

IMAGE ACQUISITION & ANALYSIS

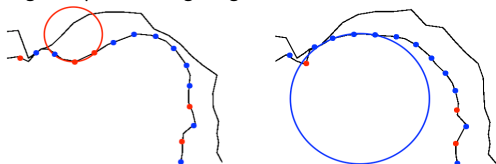
- MRI-TIMIT database at USC: balanced corpus of 460 sentences
- Two female speakers of American English
- Temporal resolution: 23.18 frames per second
- Field of view: 68 x 68 pixels (200 x 200 mm)
- Lay grid of ≈30 lines orthogonal to vocal tract
- Air/tissue boundaries for upper and lower surfaces of vocal tract found for each gridline



One frame of midsagittal MRI with grid overlaid and upper and lower surfaces of vocal tract outlined

MEASUREMENTS

- Tongue blade curling:
 - Down-sample tongue contour to fifteen evenly spaced points
 - Calculate radius of circle passing through each set of three contiguous points along tongue

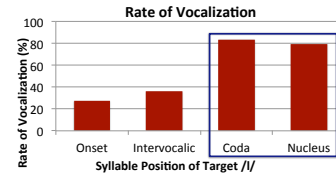


Evenly spaced points along tongue contour during production of /l/ in 'excluded' (left) and /d/ in 'adult' (right)

- Curvature score = $100/\text{radius}$
- **Negative curvature score** if circle lies outside tongue contour
- **Positive curvature score** if circle lies within tongue contour
- Rate of vocalization: percentage of tokens produced without contact between tongue tip and alveolar ridge/teeth
- Temporal measurements:
 - Frame of achievement of tongue tip contact with alveolar ridge/teeth
 - Frame of greatest degree of negative curvature along tongue blade
 - Frame of greatest tongue body retraction

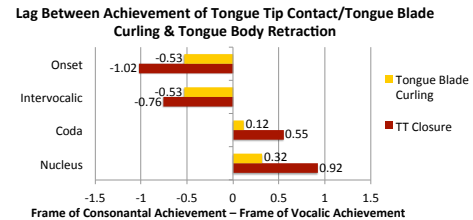
RESULTS: RATE OF GESTURAL ACHIEVEMENT

- Tongue blade curling (negative curvature) observed in all /l/ tokens
- Greater rate of vocalization (no tongue tip contact) in nucleus and coda positions than in onset and intervocalic positions:



RESULTS: GESTURAL SEQUENCING

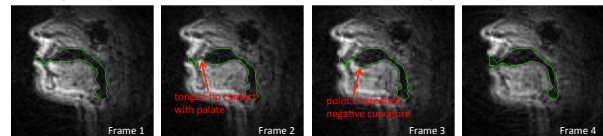
- Lag between tongue tip contact/tongue blade curling and tongue body retraction of /l/ varies by syllable position:



- Onset and intervocalic positions: tongue tip closure/tongue blade curling precede tongue body retraction
- Nucleus and coda positions: tongue body retraction precedes tongue tip closure/tongue blade curling
- All positions: magnitude of lag is substantially less between tongue blade curling and tongue body retraction than between tongue tip contact and tongue body retraction

TONGUE TIP CLOSURE AS BRACING

Tongue Tip Closure → Maximal Curvature → Tongue Body Retraction

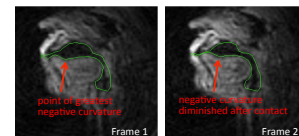


Time course of production of /l/ in the word 'black'

- Tongue tip contact is followed by greater degree of tongue blade curling

Onset/intervocalic tongue tip contact is a form of bracing to facilitate tongue blade curling

Tongue Body Retraction → Maximal Curvature → Tongue Tip Closure



Time course of production of /l/ in the word 'help'

- Tongue tip contact is followed by diminished degree of tongue blade curling
- Nucleus/coda tongue tip contact may be inhibitory to tongue blade curling (a possible motivation for vocalization in these contexts)
- Position of tongue body (anterior/posterior) when tongue blade curling occurs determines whether bracing is necessary/helpful

Tongue blade curling is a main production task for /l/