# Laryngeal Gestures and States of the Glottis

# Vocal Fold Vibration and Laryngeal Gestures

- Requires two sets of conditions to be met:
  - aerodynamic conditions
    pressure below the glottis must be greater than pressure above the glottis.
  - laryngeal conditions
    Vocal folds must be narrowed,
    Vocal folds cannot be too stiff.
- Laryngeal gestures will not always have expected consequences if their aerodynamic conditions are not met.

| Gesture | Expected Consequences |
|---|---|
| Vocal Fold Adduction | Voicing |
| Vocal Fold Abduction | Voicelessness |

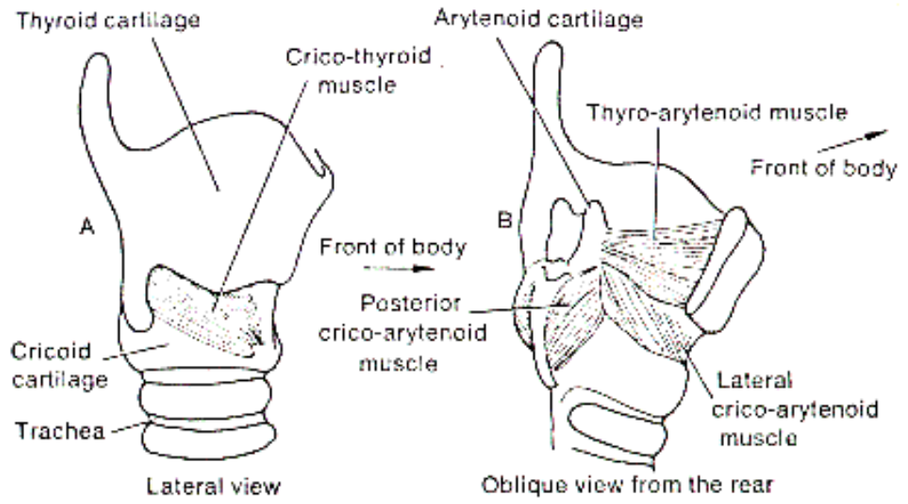
# Abduction/Adduction Gestures

- Separation of vocal folds by rocking of arytenoid cartilages with respect to cricoid cartilage.

- Rocking caused by action of posterior crico-arytenoid (PCA) muscles.

- In speech, vocal folds re-adduct immediately after maximum glottal opening is reached.

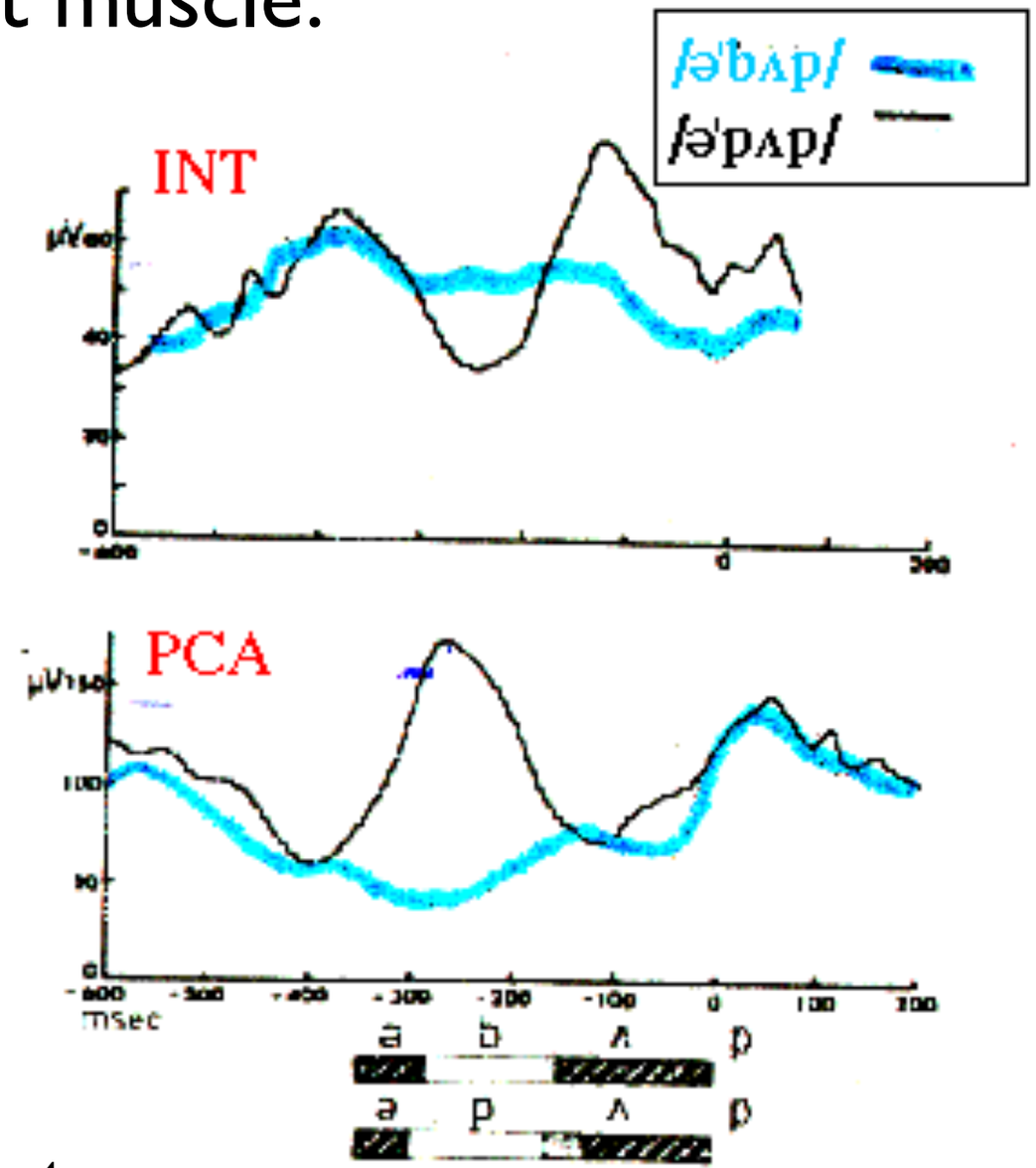
- Re-adduction is accomplished by action of inter-arytenoid (INT) and lateral crico-thyroid (LCA) muscles.





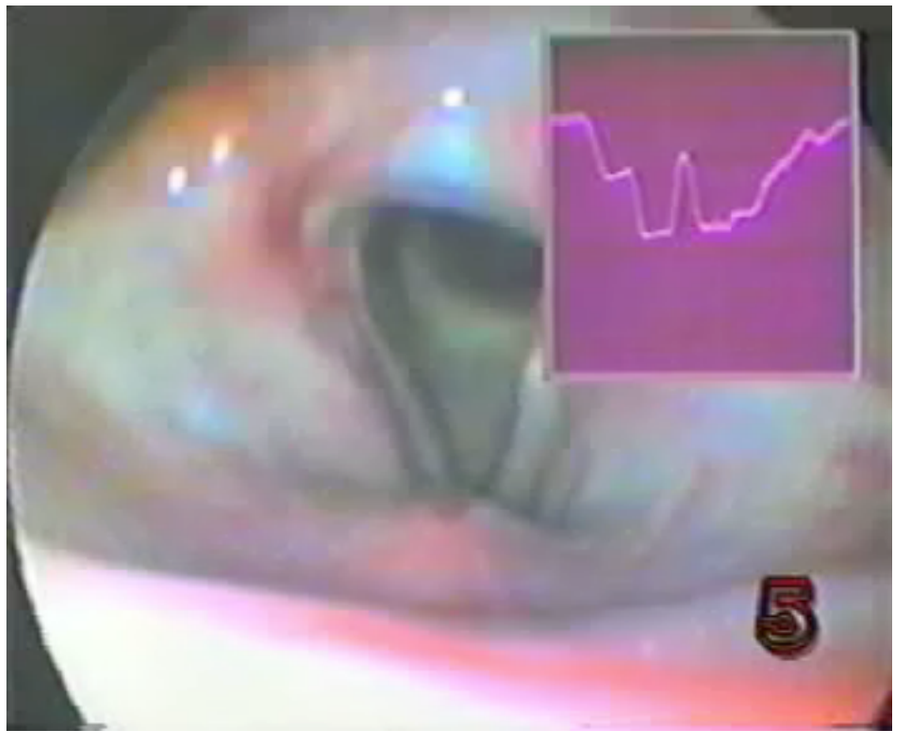
# Investigation of abduction *in situ*

- electromyography (EMG)
- measures muscle activation by means of electrical potentials in the relevant muscle.



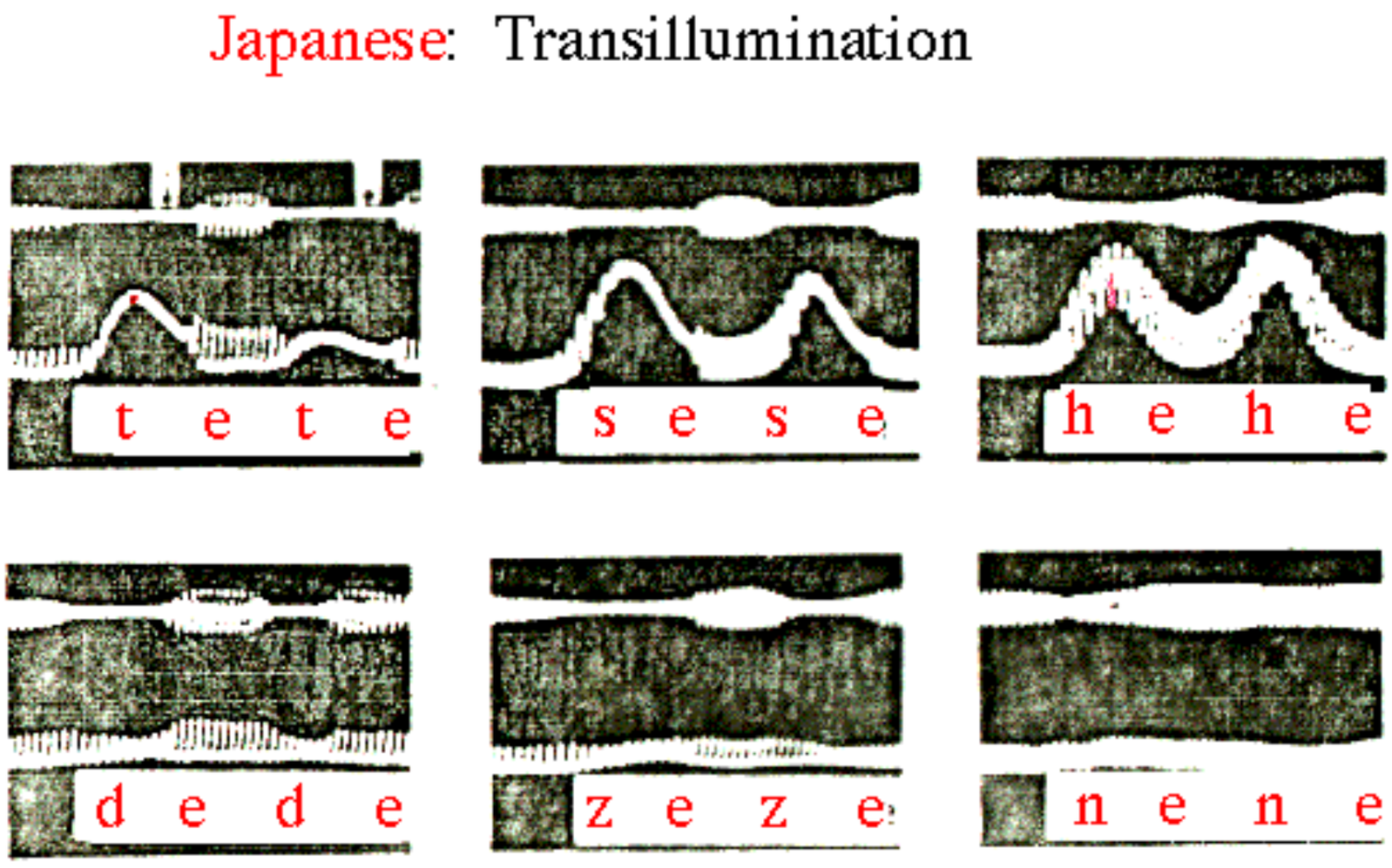
# Fibroscopy

# Transillumination



# Transillumination

- Abducted vocal folds can still vibrate (murmur).



# Consequences of Basic Abduction Gesture

| Consequence | Context |
| --- | --- |
| Voicelessness | oral airflow is reduced by stop or fricative gesture |
| Murmur | when oral airflow is unimpeded and rapid |

# Consequences of Adduction Gesture

| Consequence | Context |
| --- | --- |
| Voicing | with sufficient airflow and tension |
| Voicelessness | when oral airflow is reduced, e.g. b̥ z̥ |

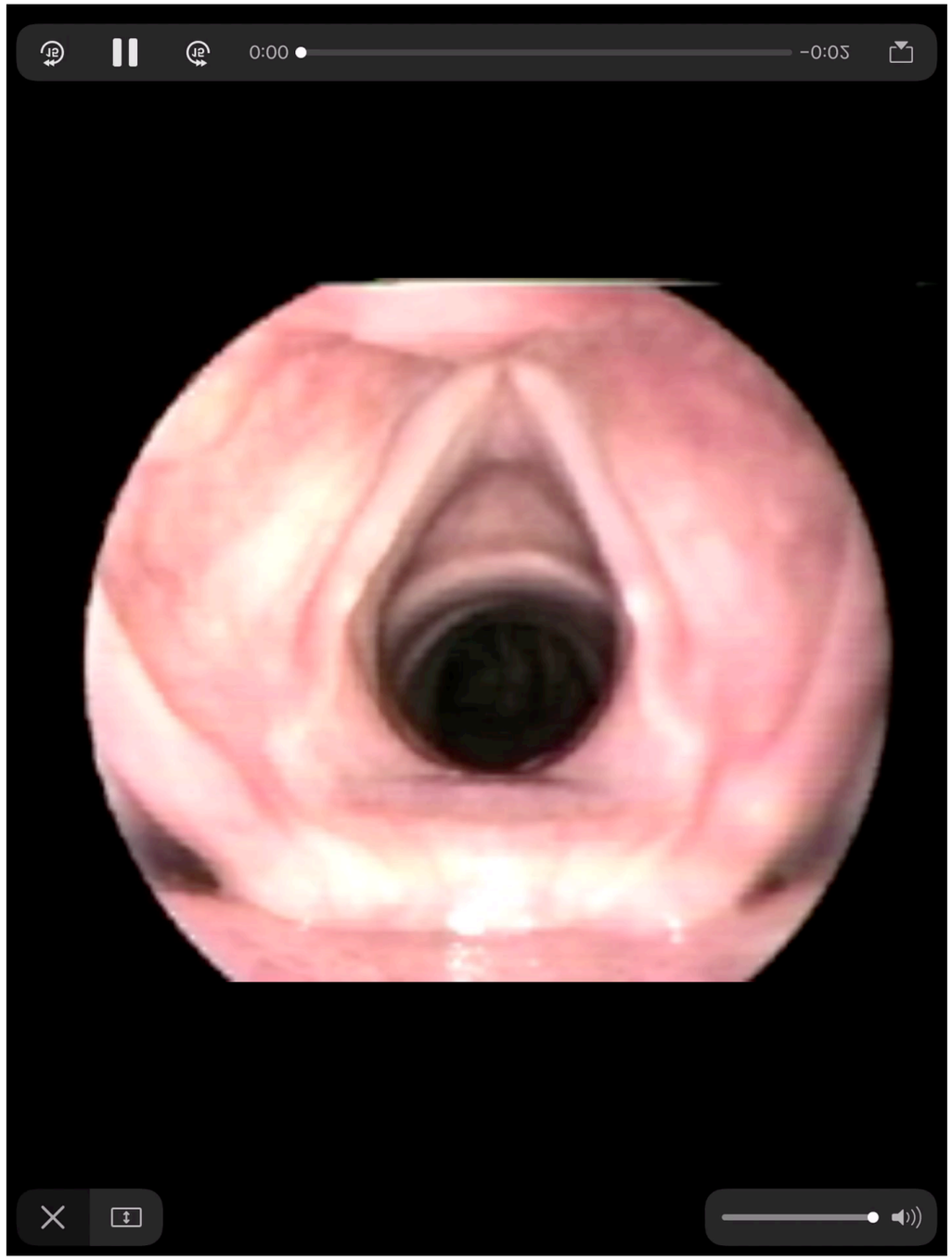
# States of the Glottis

| State | Symbol | Description | Gestures |
|---|---|---|---|
| Voiceless | ḁ | open<br>turbulent source | abduction |
| Murmur | a̤ | breathy voice | abduction<br>medial compression |
| Voice | a | modal voice | adduction<br>medial compression |
| Laryngealized | a̰ | creaky voice | adduction<br>aryepiglottal constriction |
| Closed | ʔ | no source | ventricular<br>constriction |

# Breathy Voice (murmur)

- Medial compression without Adduction of the arytenoids

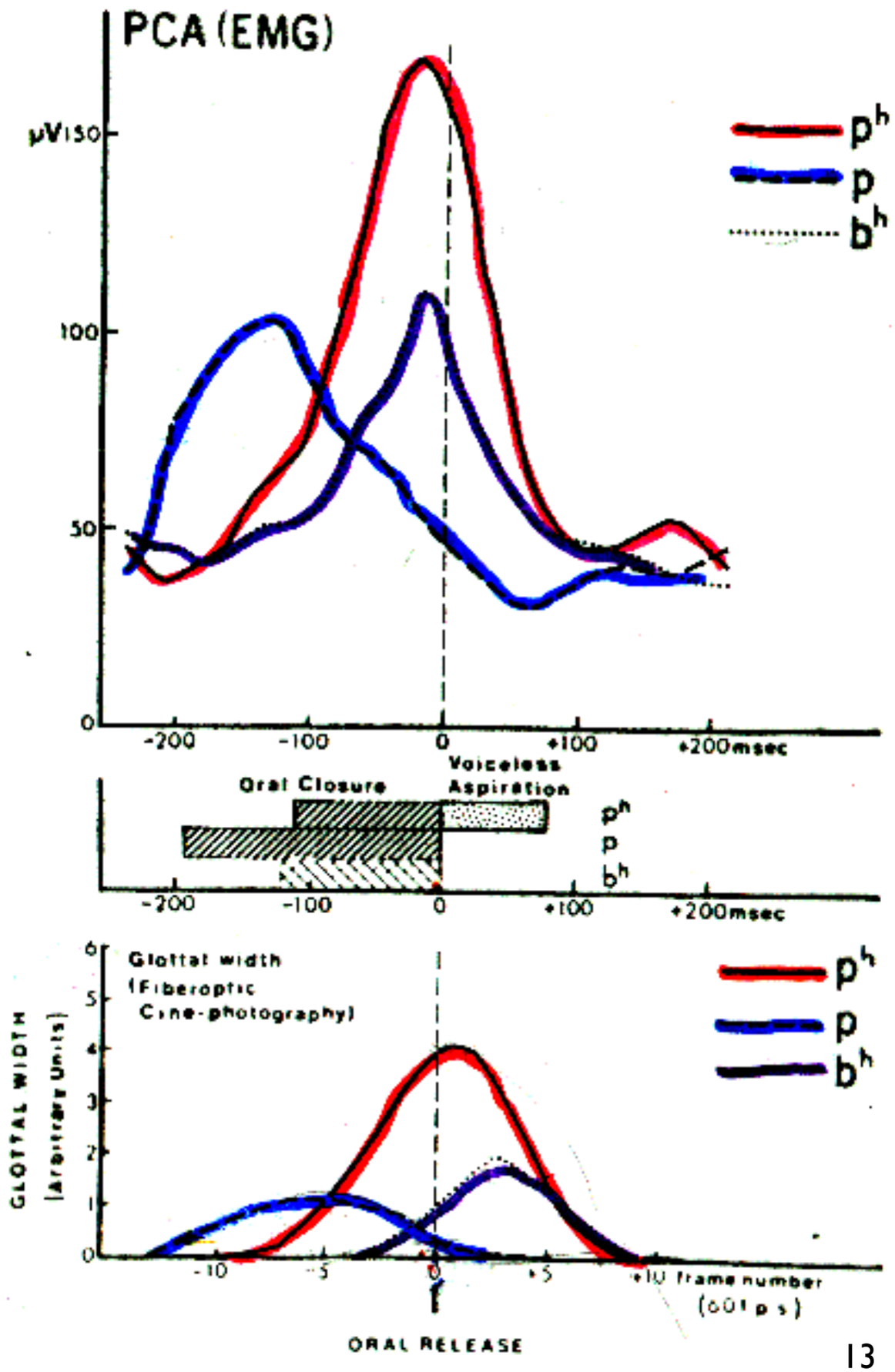

Medial Compression




From: John Esling, IPA Phonetics app

# Timing and Scaling of Basic Abduction Gesture

- Abduction gesture may exhibit:
  - different patterns of coordination with respect to oral closure gestures
  - different magnitudes of opening
- These variations can lead to four stops in some languages that contrast in phonation type (e.g., Hindi, Gujarati)




## 1)voiceless unaspirated stop [p]

- Adduction complete at stop release
  - voicelessness during closure
  - voicing begins at release
  - Voice Onset Time is short.

## (2)voiceless aspirated stop [$p^h$]

- Adduction begins at stop release
  - voicelessness during closure
  - voicing is delayed after release
  - Voice Onset Time is long.

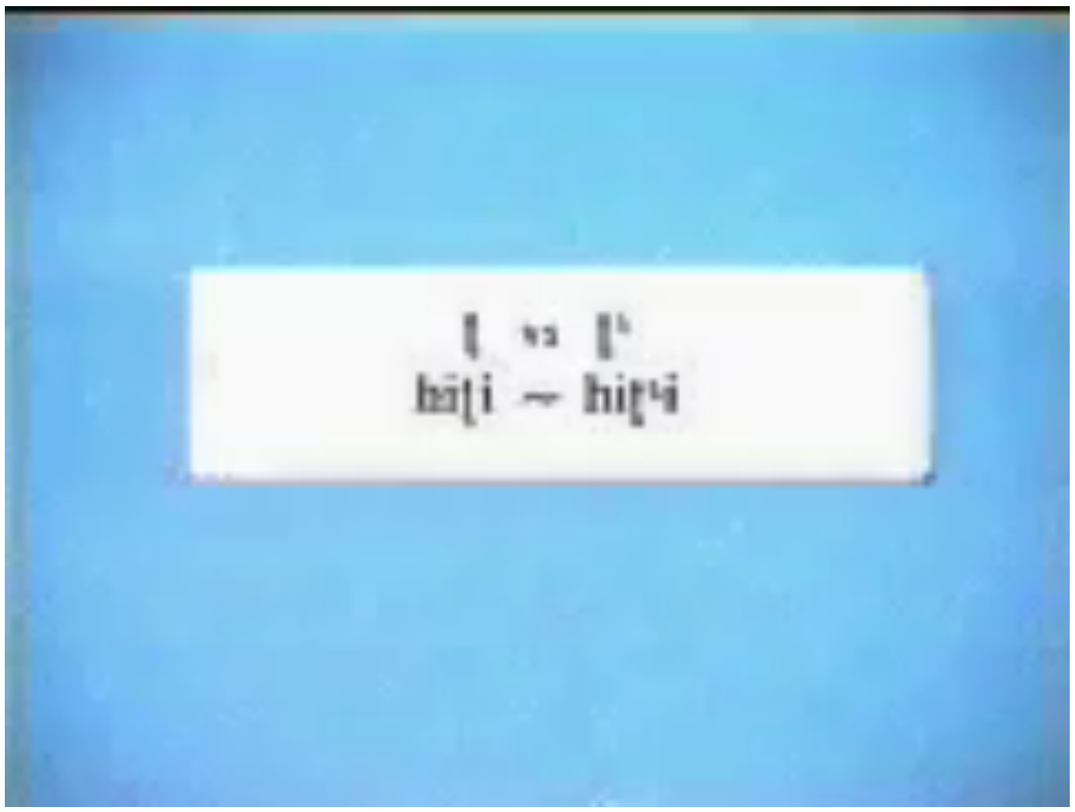
## (3)voiced aspirated stop [$b^h$]

- Abduction begins at stop release
  - voicing during closure
  - breathy voice after release

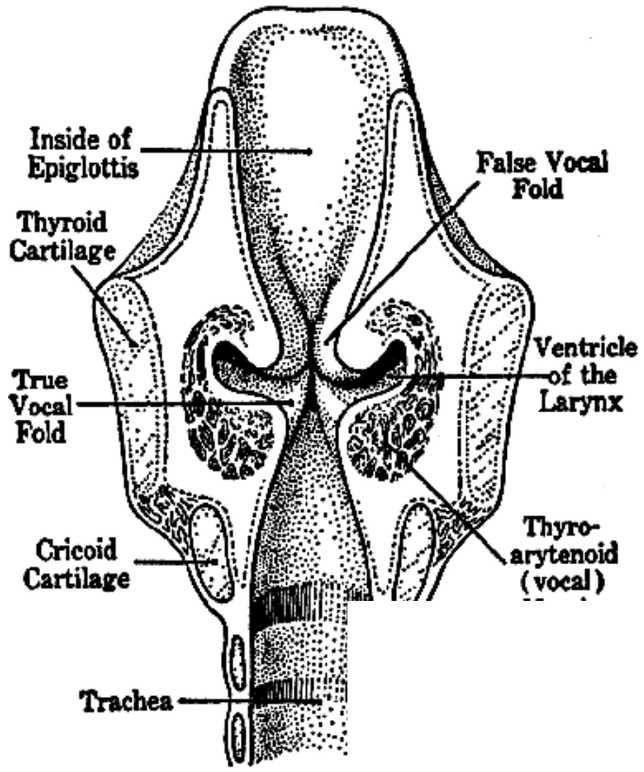
# Gujarati

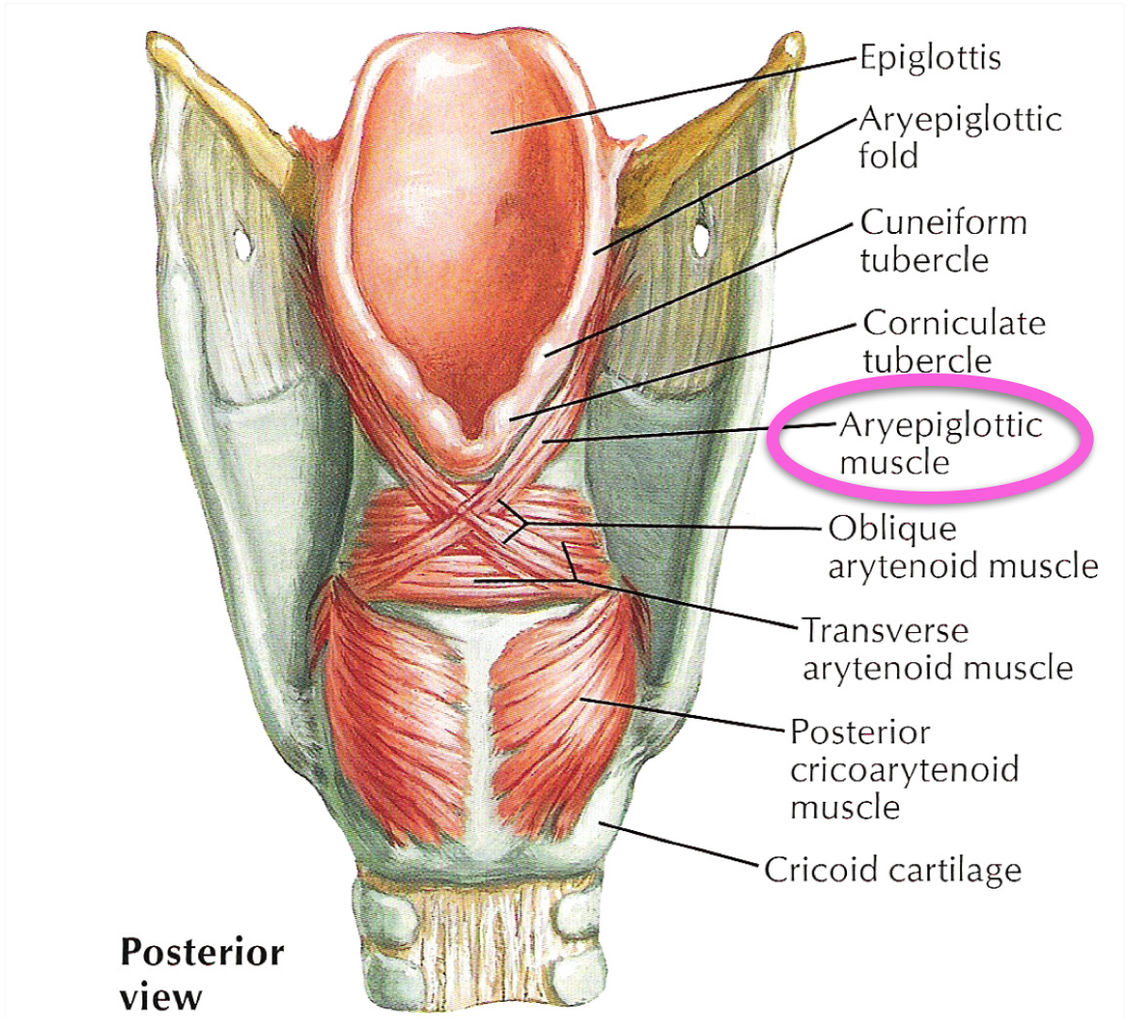
[ɖ] vs. [ɖʰ]

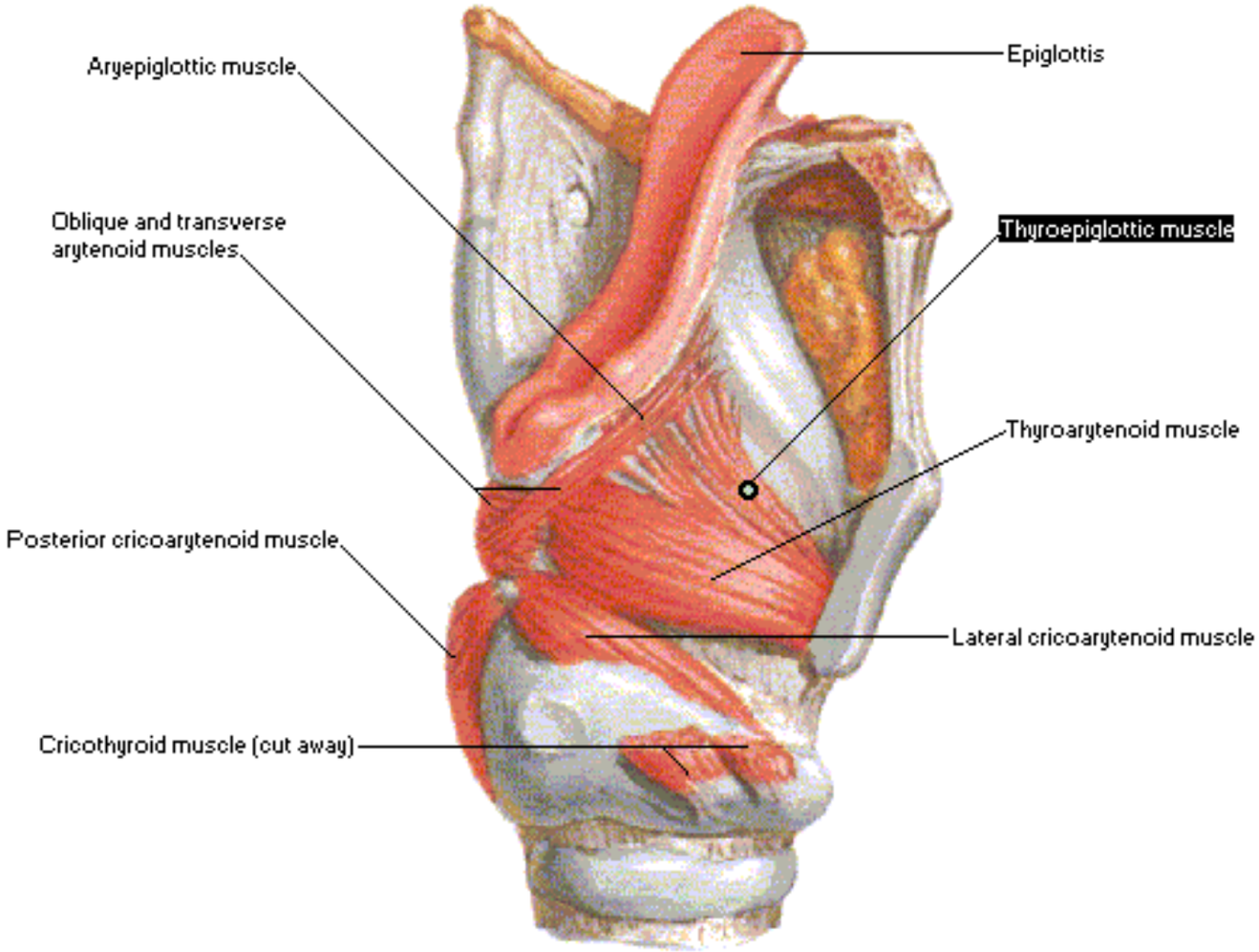

[ʈ] vs. [ʈʰ]



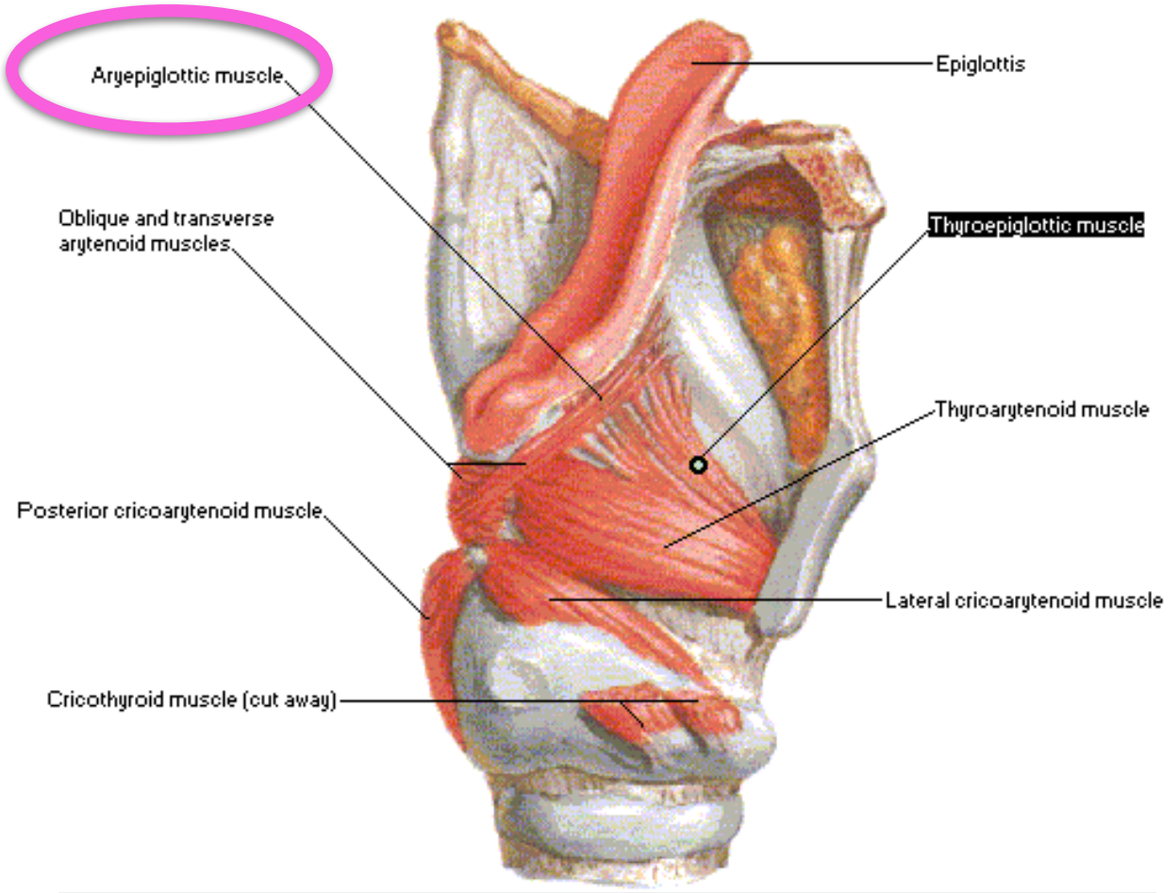
- Creaky voice
- Constriction of the aryepiglottal folds (false vocal folds)
- Action of aryepiglottal muscles



# Creaky Voice

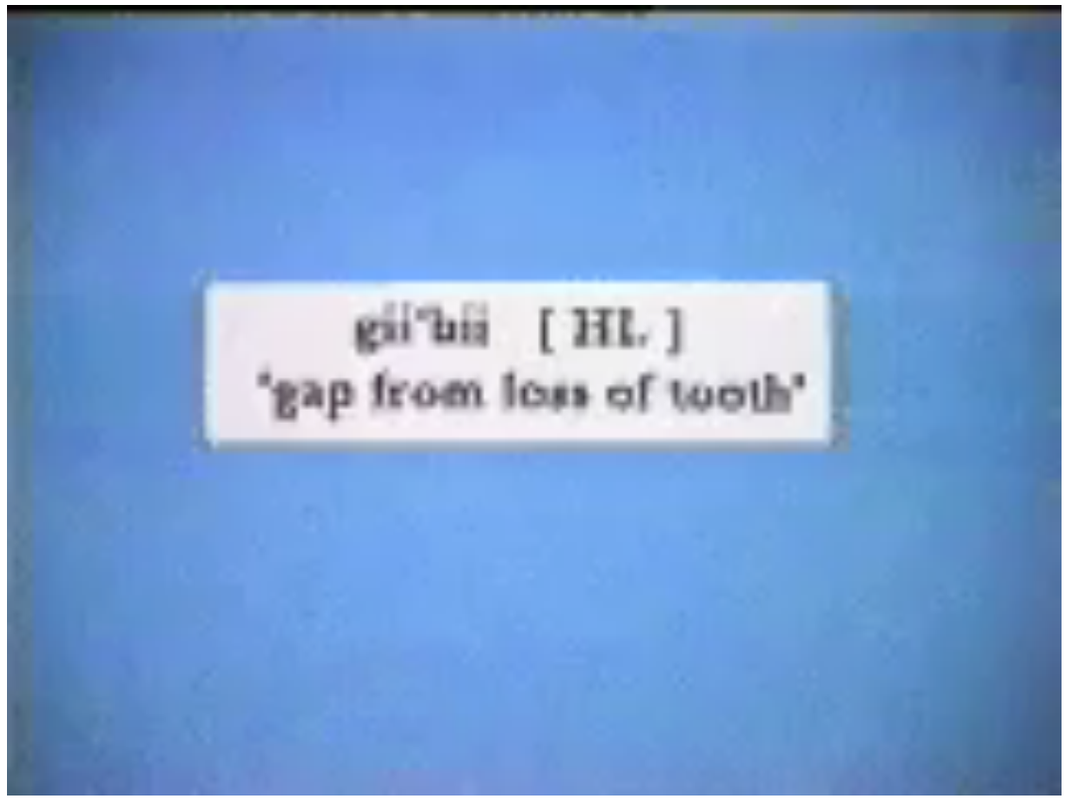





From: John Esling,  IPA Phonetics app

# Hausa


[dʒiːbi]



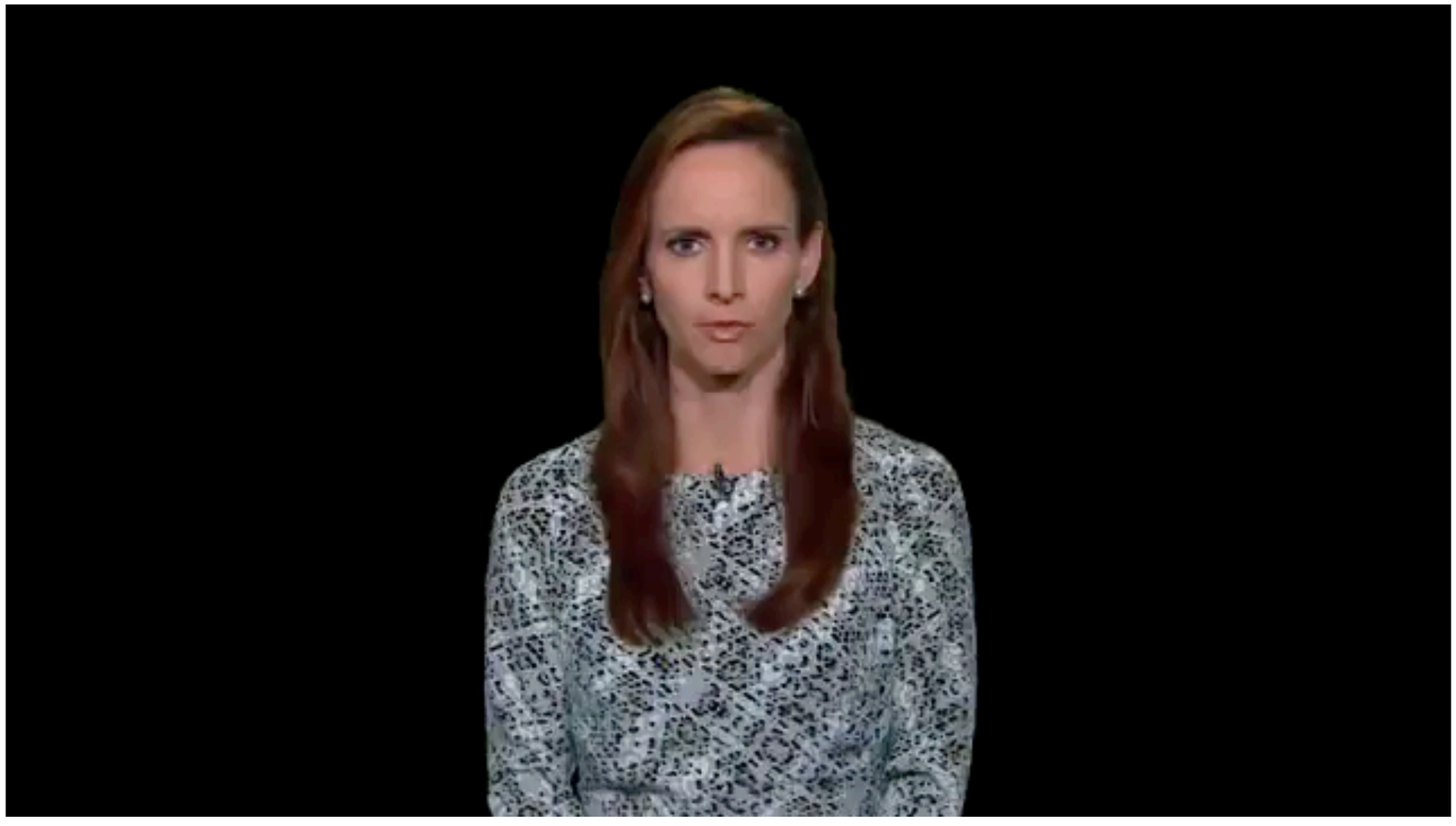

[giːɓiː]

# Creaky Voice

- Mazatec (Oaxaca)
- Mpi (Thailand)

# Vocal Fry

- Social meaning

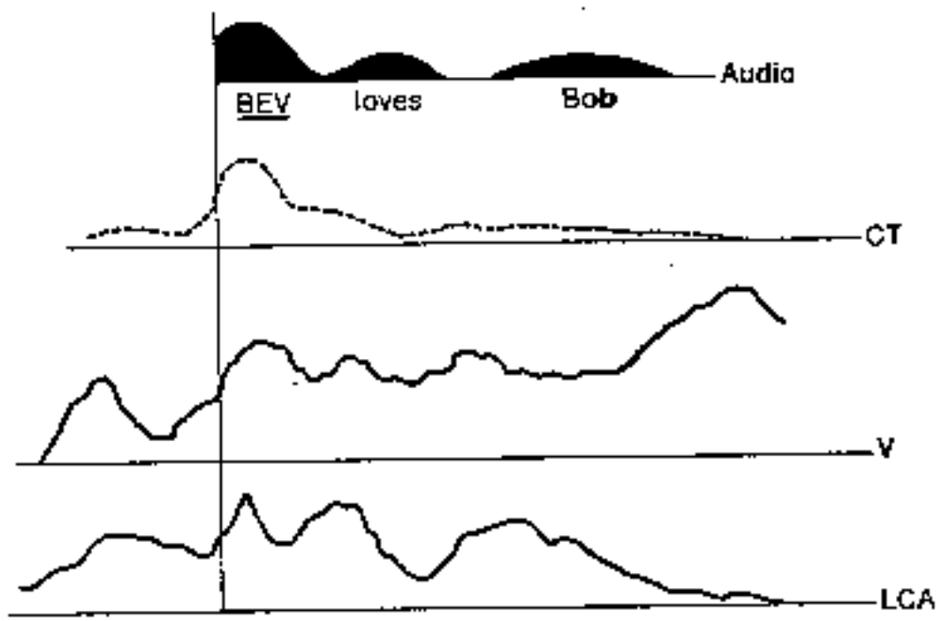


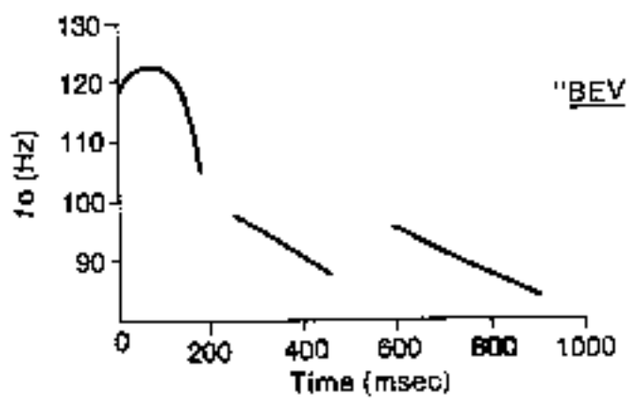
Faith Salie

# Muscles that control f0 (tone)

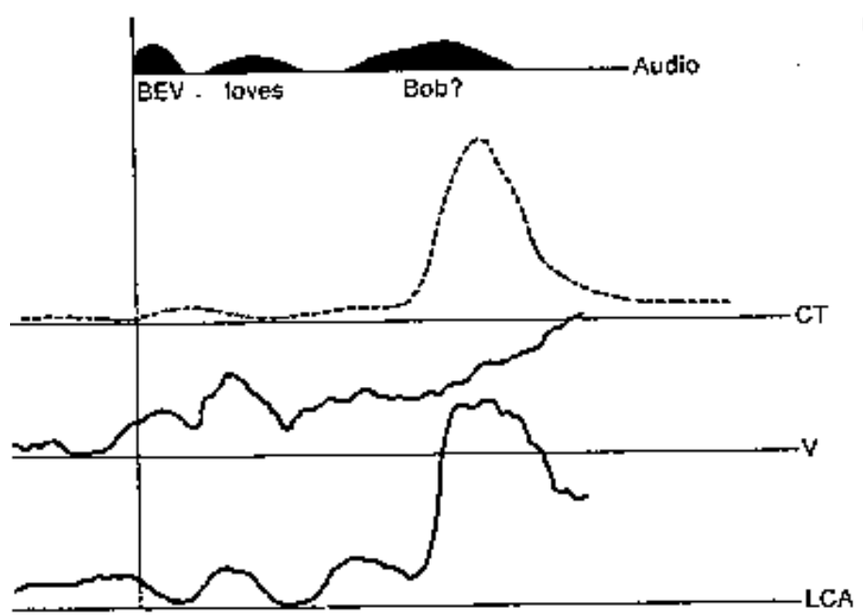
- Increasing <u>longitudinal tension</u>
- Crico-thyroid muscle increases angle between thyroid and arytenoid cartilages.

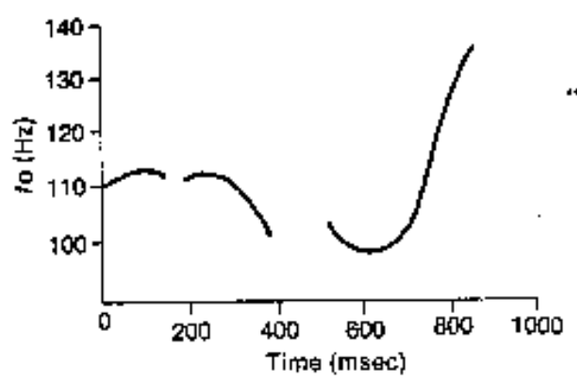
Statement: BEV loves Bob.



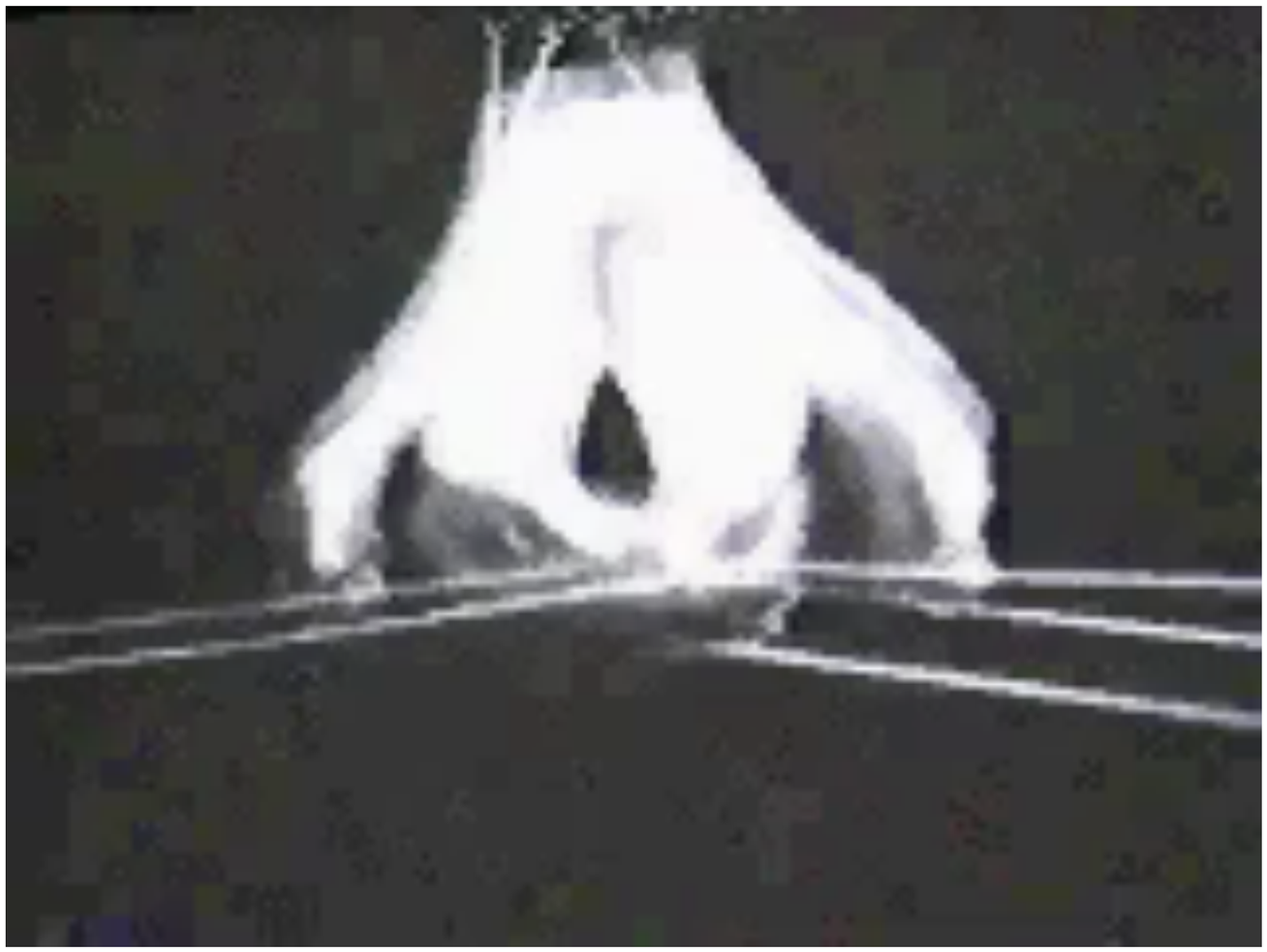




Question: Bev loves Bob?



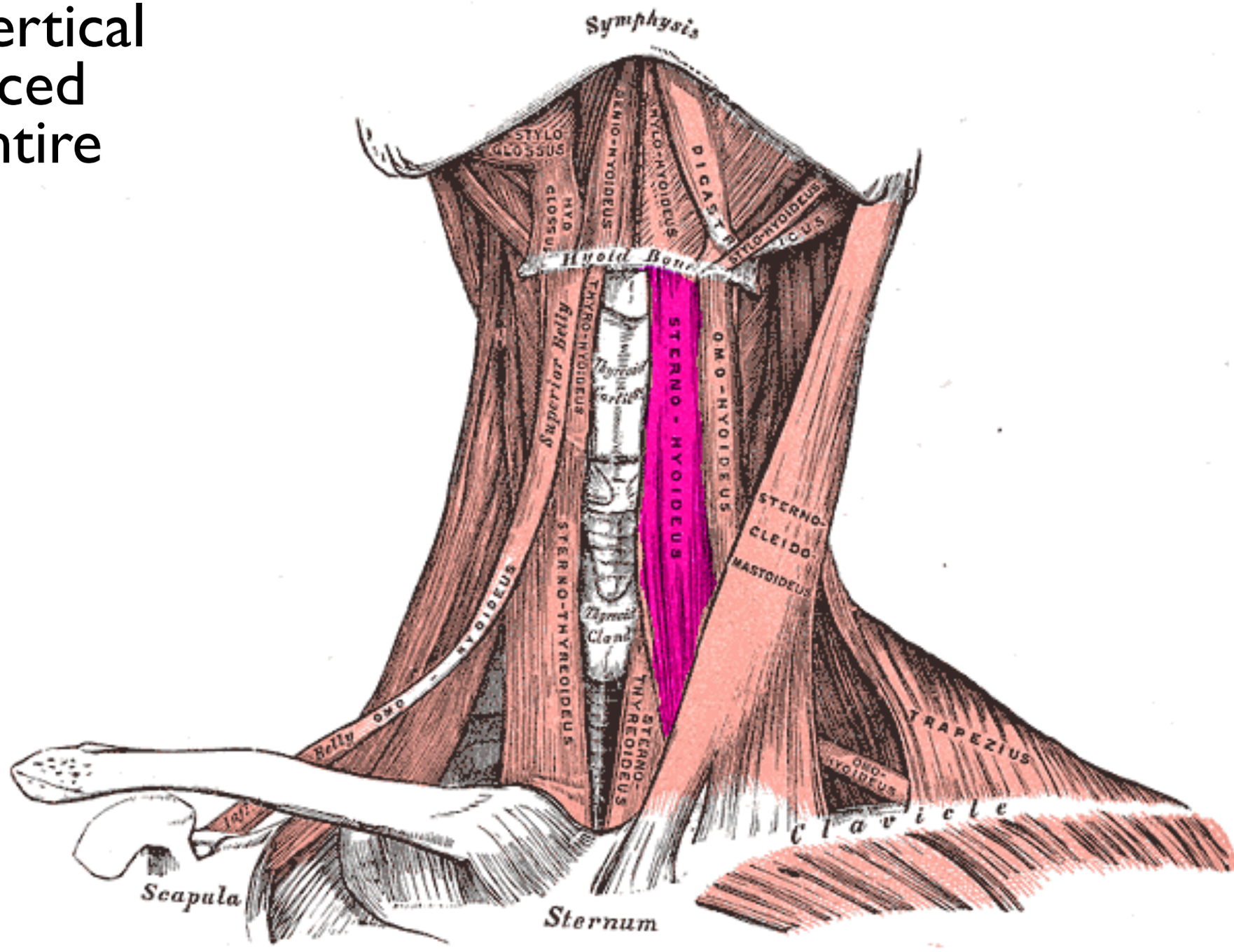



# Longitudinal Tension



# Pitch Lowering

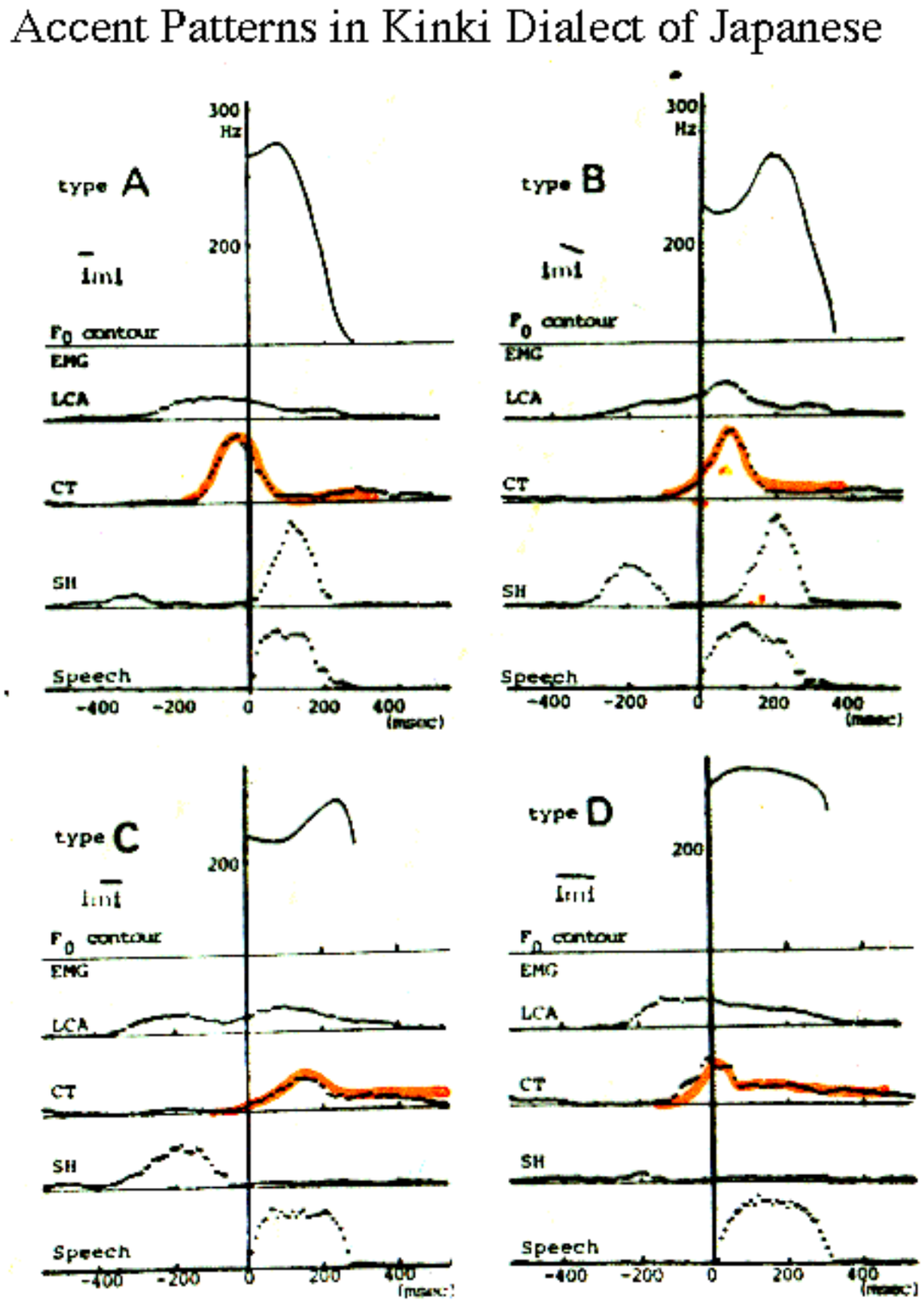
- Decrease in vertical tension produced by lowering entire larynx.
- Action of the sterno-hyoid muscles



Example:

H and L in Japanese

Sugito & Hirose (1978)

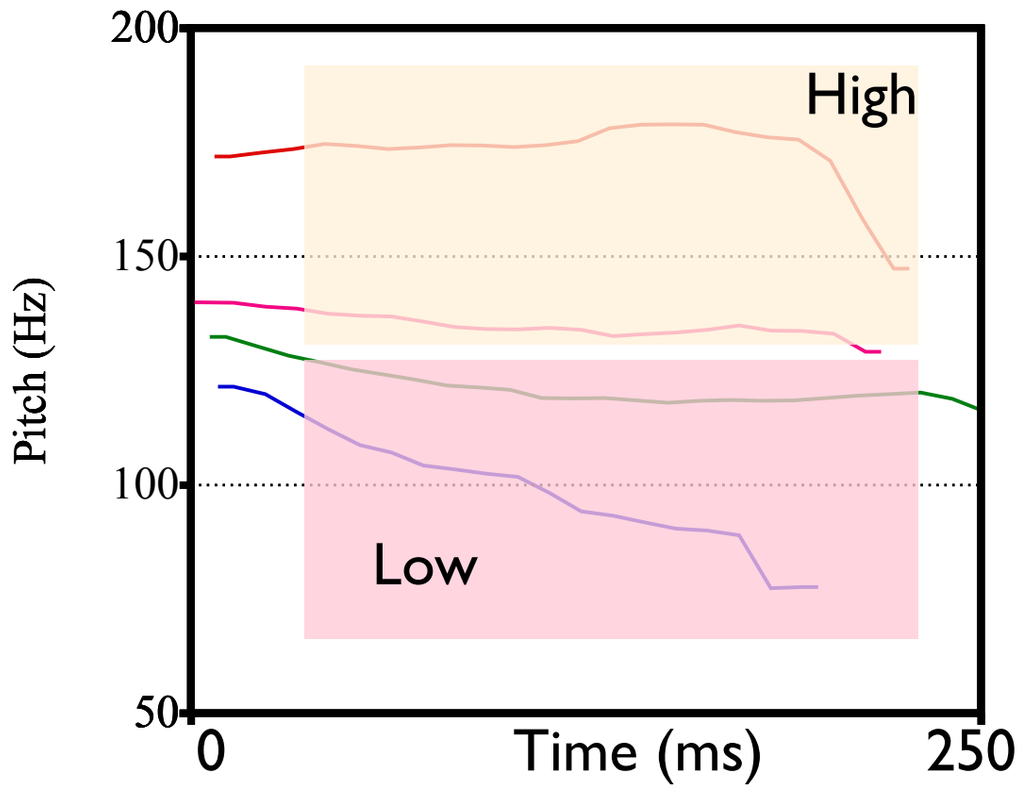


# Pitch Gestures and Phonological Tones

- Most basic elements of phonological tone representation are H, L
- Contrastive tones are controlled by discretely different mechanisms
  - CT vs SH
  - H, L are not points on a continuum
- What about languages with more than two contrastive tones?

# Cantonese Tones

- Four pitch levels
- Nissenbaum (2010) hypothesized they are produced with a 2x2 combination of
  - Larynx Height (“register”)
  - Stretching (CT)




Nissenbaum, J., ”Articulatory vs. acoustic representation of tone”. Poster presented at the 12th conference on Laboratory Phonology, University of New Mexico, Albuquerque, July 8–10, 2010.

# Cine-MRI evidence: extreme tones

Male speaker age 20

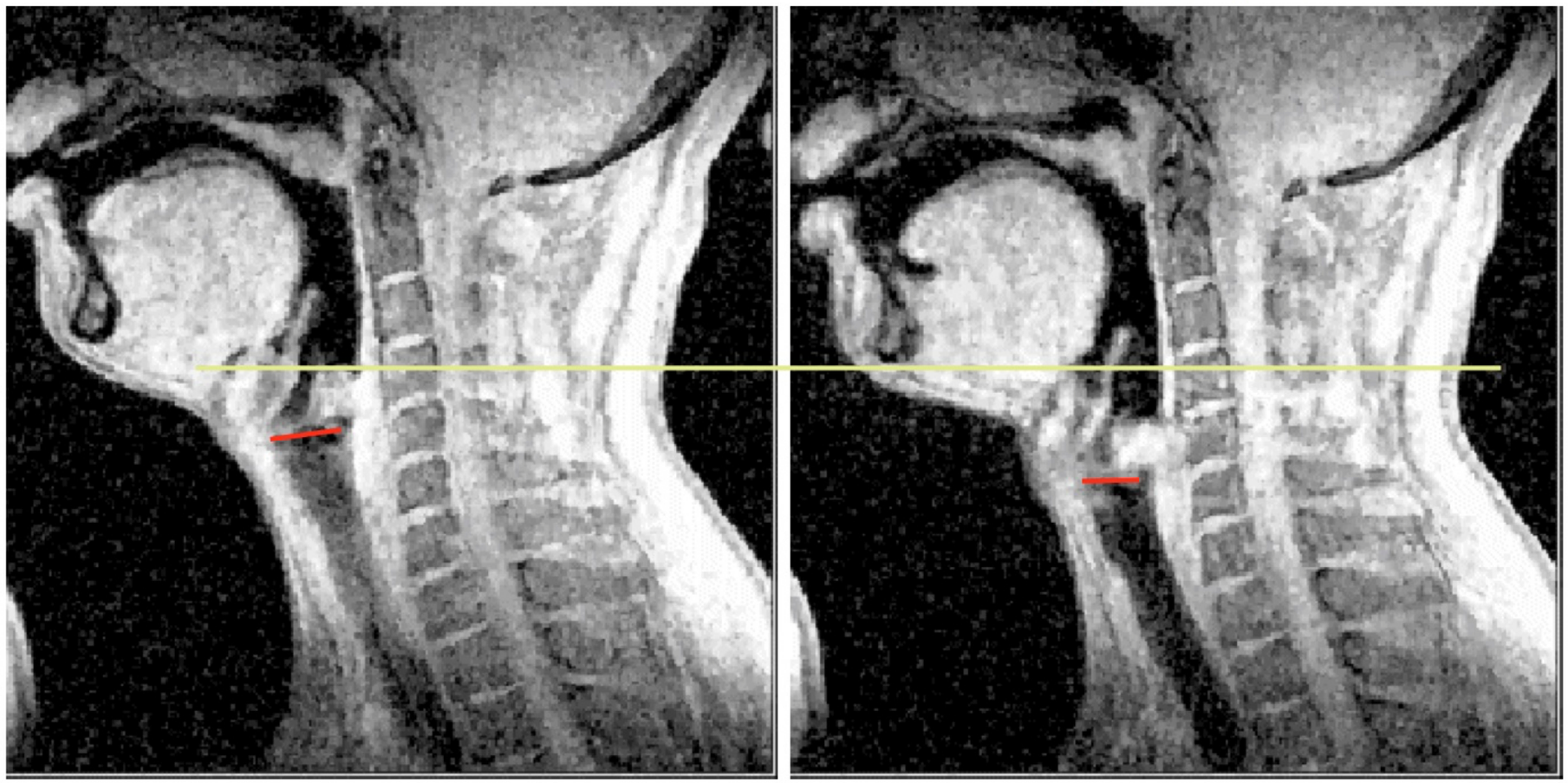
**Upper and Lower extreme tones**

High Larynx
Stretched folds

Low Larynx
Short folds

**UPPER register, H**

**LOWER register, LOW tone**



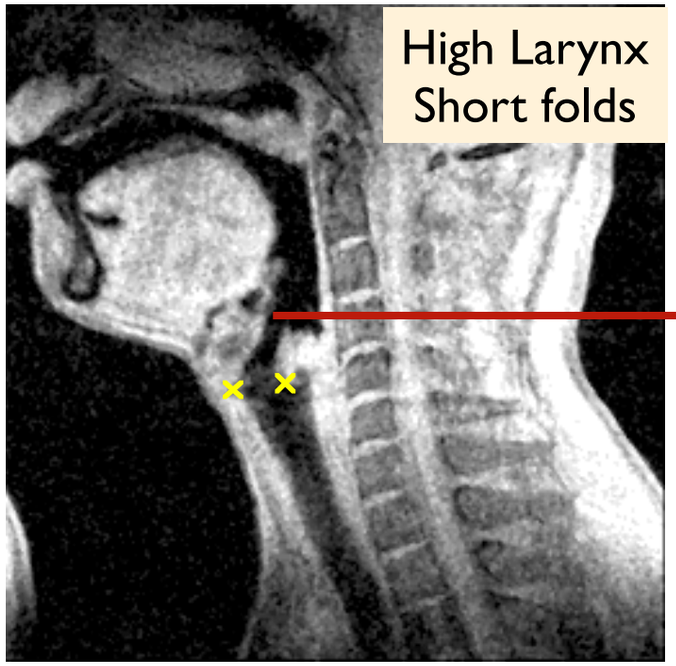
# Mid tones

- In running speech, the f0 of the two middle tones are not distinct, but they are produced with distinct gesture combinations.

**Mid tones**

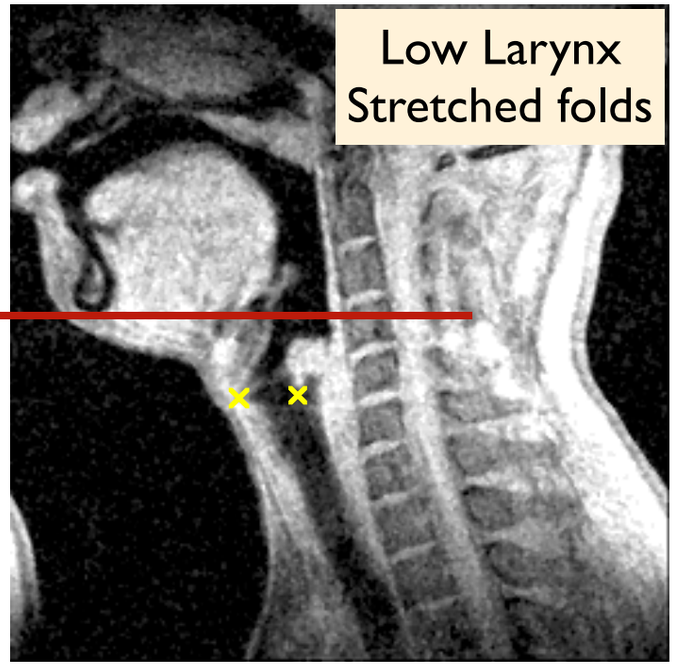
**/u³/ UPPER mid-tone**

vocal fold length = 17.7 mm
posterior vertical dist. from top = 127.7 mm




**/u⁶/ LOWER mid-tone**

vocal fold length = 19.7 mm
posterior vertical dist. from top = 132 mm




- Difference in vocal fold length between tones 3 and 6 for this subject is 2 mm (i.e. vocal folds are 11% longer at onset of tone 6 than at onset of tone 3)
- Difference in vertical position is 4.3 mm (i.e. larynx lowers by nearly 1/2 cm for tone 6)

# Cine-MRI

- not real-time
- utterance has to be repeated multiple times; each time is used to image the next temporal snippet.