

# Sound Source Initiation

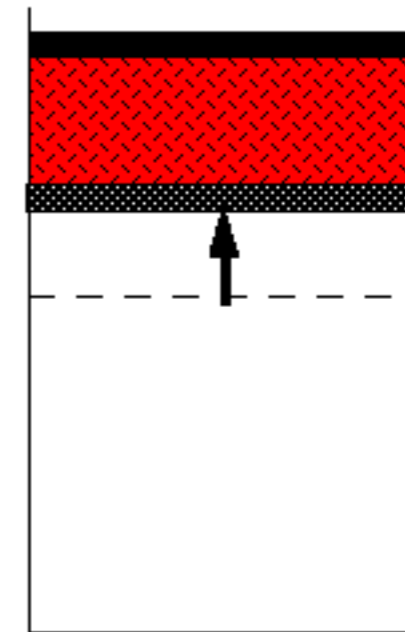
# Sound Generation

- Speech as audible gesture
- How is sound generated within the vocal tract?  
vibration of vocal folds
  - Vibration of vocal folds
  - turbulence noise (rush of air through slit)
  - release of cavity under high pressure
- **Airflow**  
All these sound generation mechanisms in the vocal tract require getting air to flow.
- **Initiation** is the mechanism by which air is caused to flow within the vocal tract (cg. Ladefoged's airstream mechanisms)

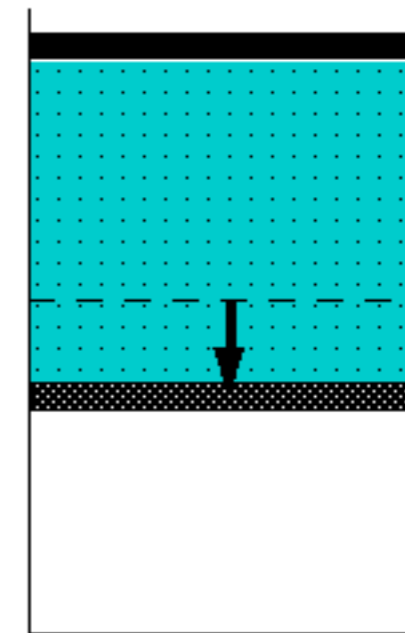
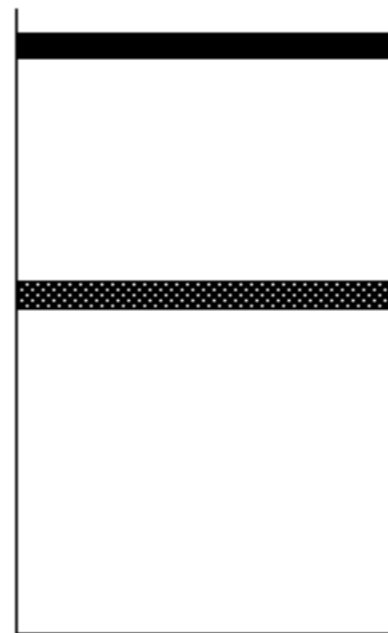
# Aerodynamics

- aerodynamics = movement, or flow, or air
- changing volume of a container can cause:
  - change in pressure
  - flow when container is opened

Note the effect of changing the volume of a closed chamber by moving a piston



Decrease in volume creates **high** pressure

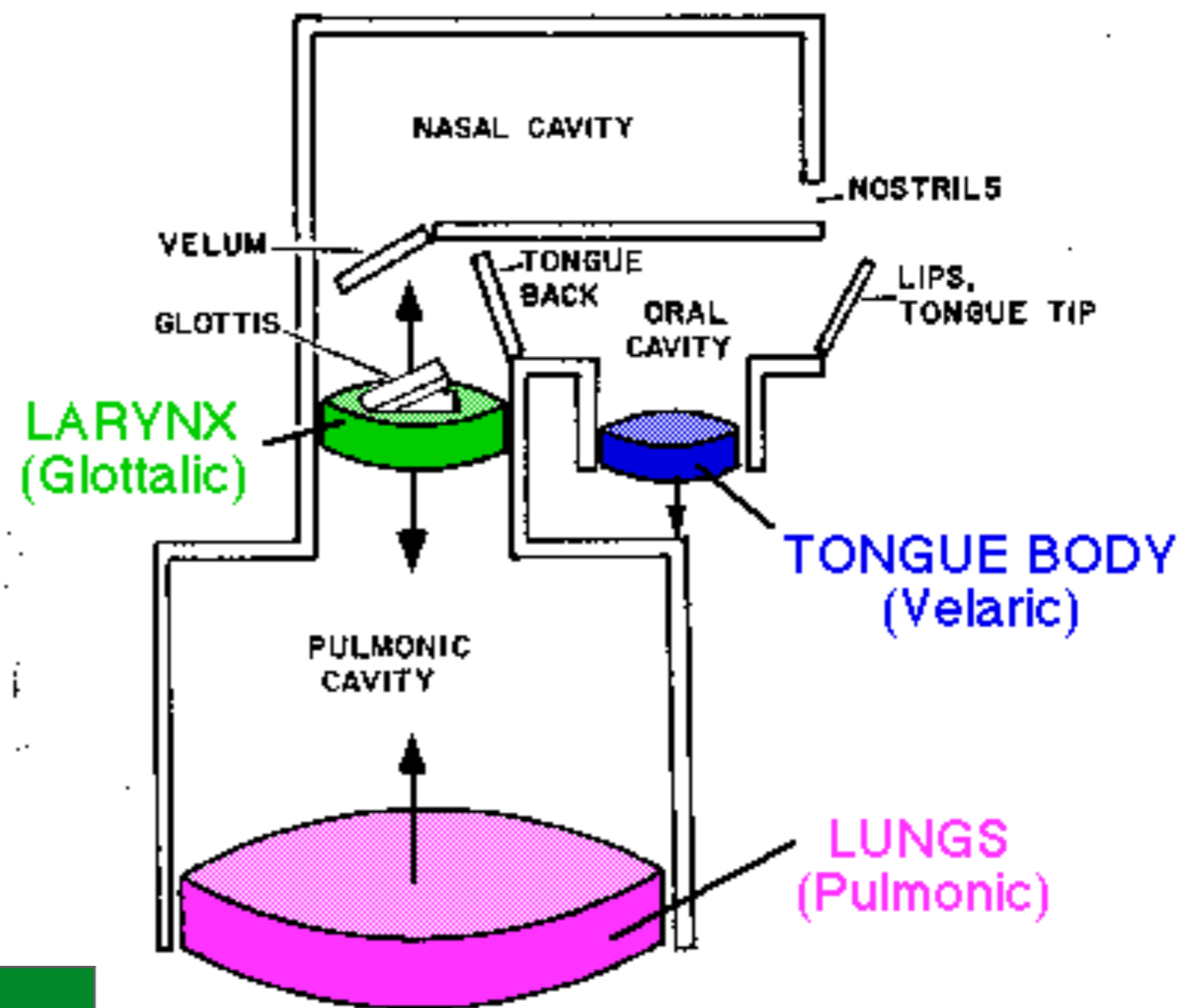


Increase in volume creates **low** pressure

Venting **high** or **low** pressure chambers to atmosphere will cause flow:  
from high pressure chamber out to atmosphere  
or  
from atmosphere in to low pressure chamber

# Initiators in the Vocal Tract

- Pulmonic (Lungs)
- Larynx (Glottalic)
- Tongue (Velaric)
- Direction:
  - pressure decrease volume of enclosed space
  - suction increase volume of enclosed space

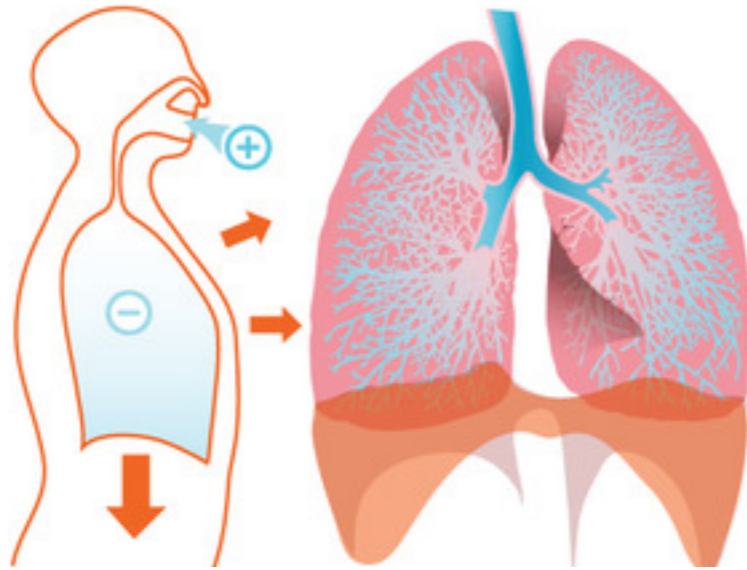


(after Ohala, 1983)

	Pressure	Suction
Pulmonic	plosives	
Glottalic	ejectives	implosives
Velaric		clicks

# Mechanisms of Lung Action

## Inhalation



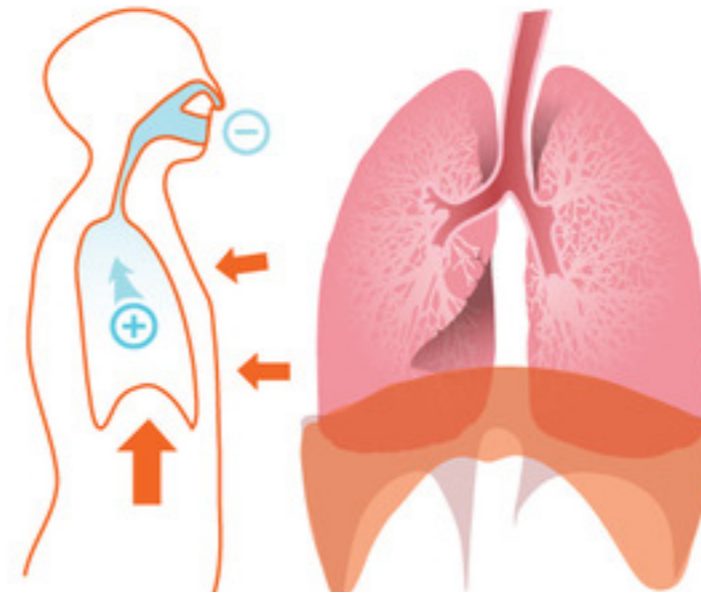
Lung volume expands as a result of the contraction of diaphragm and action of the *external* intercostal muscles.

Due to this increase in volume, the pressure is decreased

This decrease of pressure in the thoracic cavity makes the cavity pressure less than the atmospheric pressure.

Pressure gradient allows air to rush into the lung

## Expiration



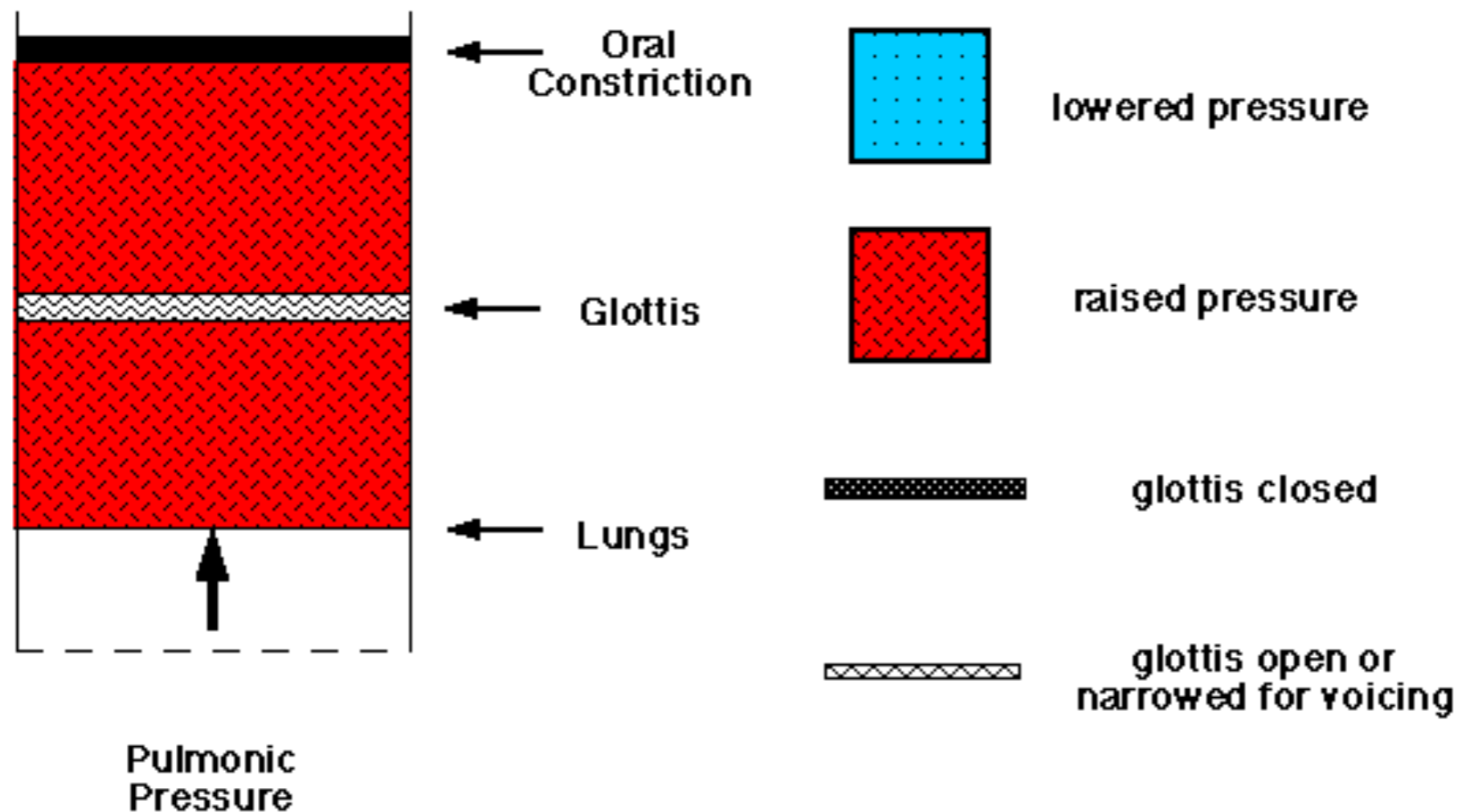
The lungs are elastic.

On exhalation, the elastic recoil forces the air out of the lungs, by decreasing volume and therefore increasing pressure.

**During breathing:** the *external* intercostal muscles relax, returning the chest wall to its original position

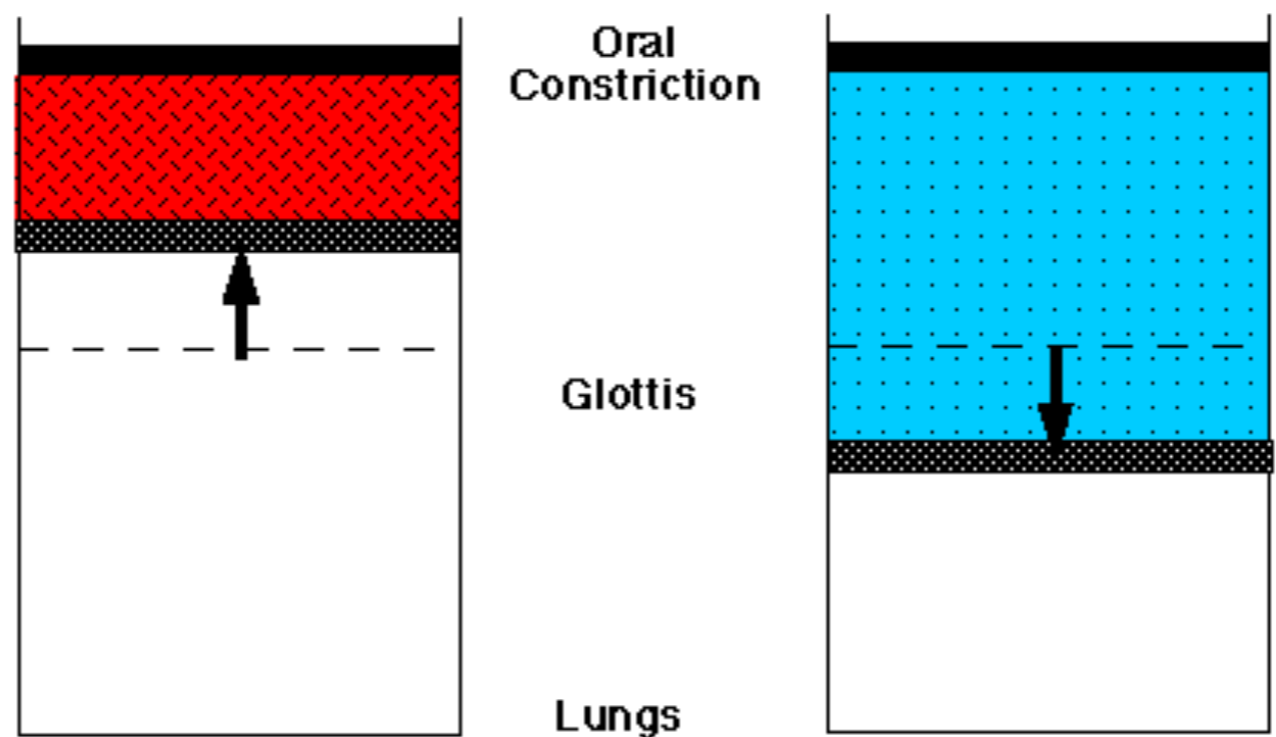
**During speaking:** the *external* intercostal muscles can continue to fire to slow down the cavity contraction due to elastic recoil.

# Pulmonic Pressure Stops (Plosives)



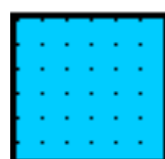
- Most common initiator type
- Occurs in every language
- Why is pulmonic suction not employed?

# Glottalic Pressure Stops (ejectives)



Glottalic Pressure  
(voiceless)

Glottalic Suction  
(voiceless)



lowered pressure



glottis closed



raised pressure



glottis open or  
narrowed for voicing

# Ejectives (p' t' k' q')

PLOSIVE



EJECTIVE

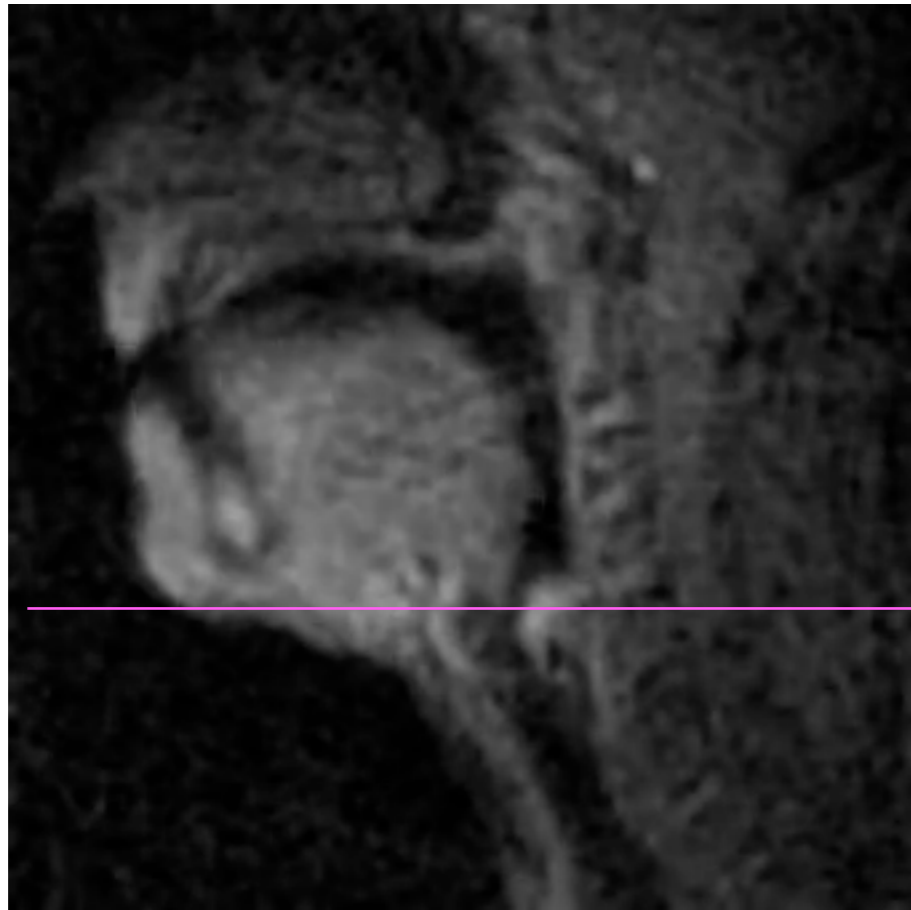


Ejectives contrast with plosives in many languages

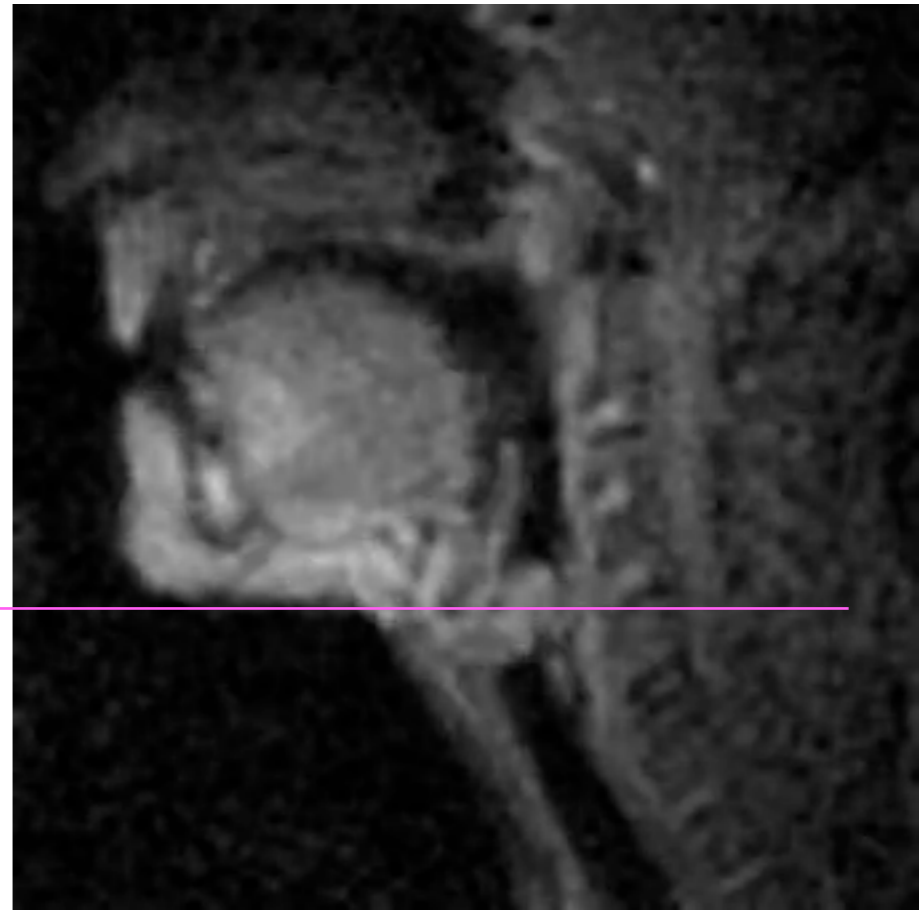
SPAN: Matt Gordon



PLOSIVE



EJECTIVE



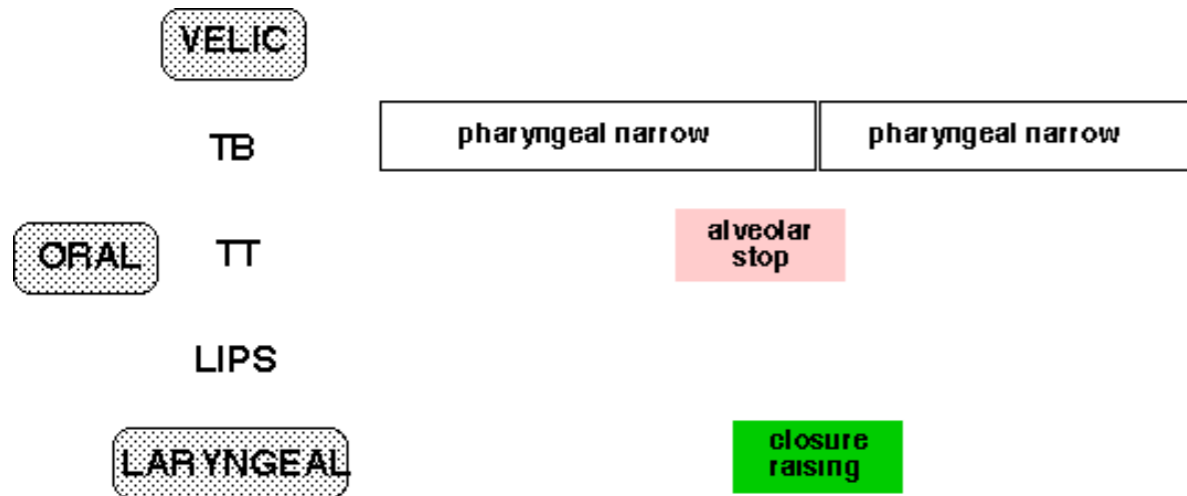
SPAN: John Esling

# Gestural composition of ejectives

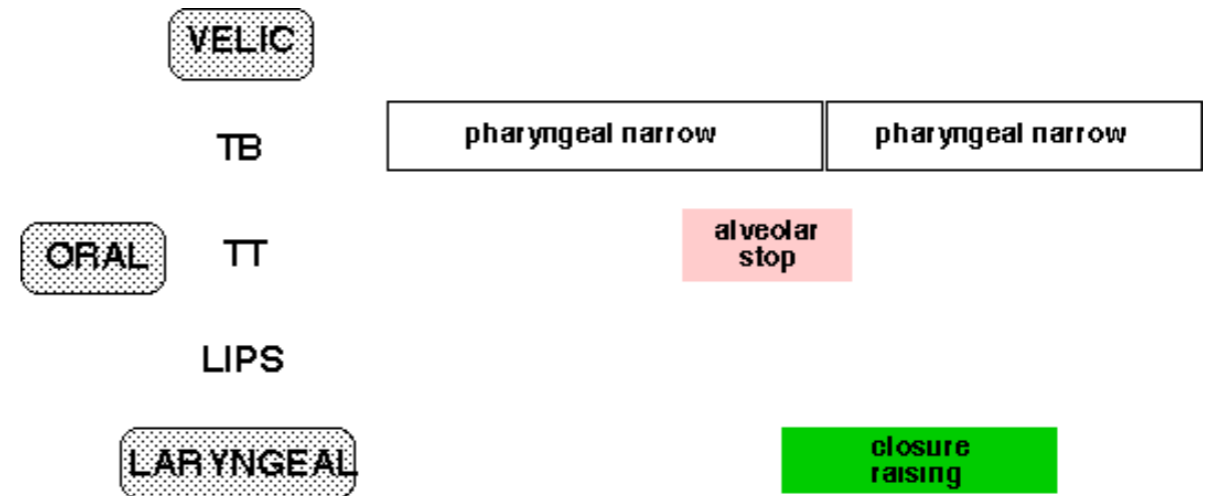
- glottal closure
- closure of one of the oral constrictors
- larynx raising
- Constraints on gestural timing
  - which gesture is released first?
  - which gesture is formed first?

# Language Differences in Ejective Timing

at'a



at'a



Hausa (Afro-Asiatic spoken in Nigeria)

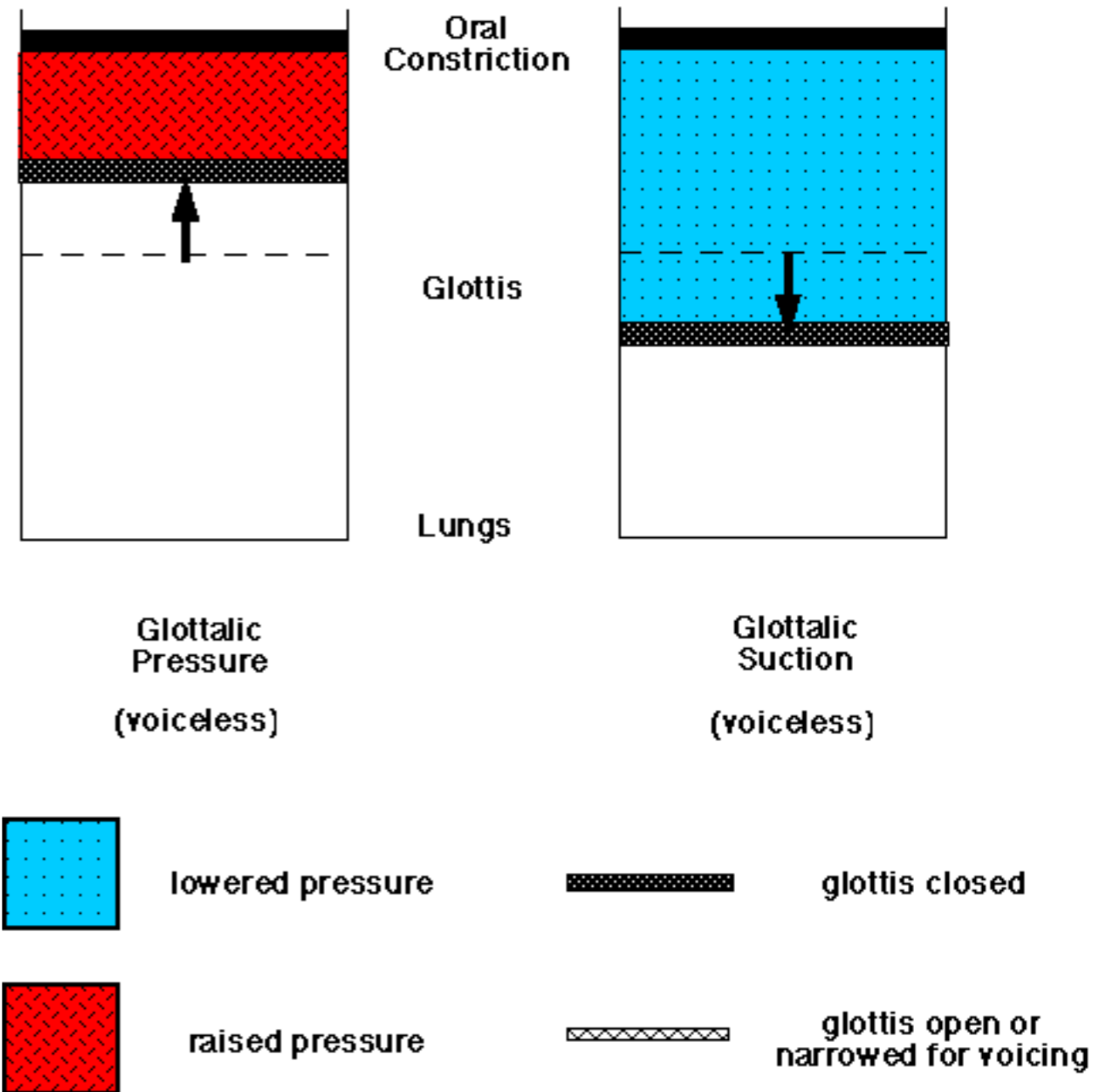
Lakota (Siouxan spoken in North America)

K'ekchi (Mayan language spoken in Guatemala).

# Glottalic Suction stops (implosives)

## Voiceless implosives

- $\beta$   $\text{t}$   $\text{k}$   $\text{q}$
- not as common as ejectives
- Mayan (Tojolabal),  
Bantu (Basa, Igbo),  
Cushitic (Lendu)
- apparently do not contrast with ejective
- cf. voiced implosives



# Velaric Suction (Clicks)

## Varieties

## Release Types

- dental [k|]
- lateral [k||]
- post-alveolar [k!]

## Gesture Combinations

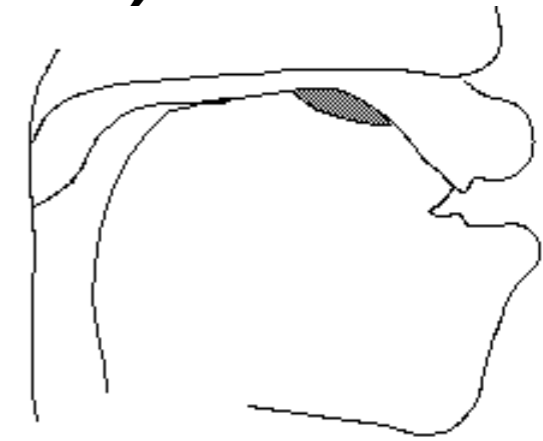
- voiced [g|]
- voiceless [k|]
- aspirated [k<sup>h</sup>]
- nasal [ŋ|]

## Xhosa examples

### enclosure

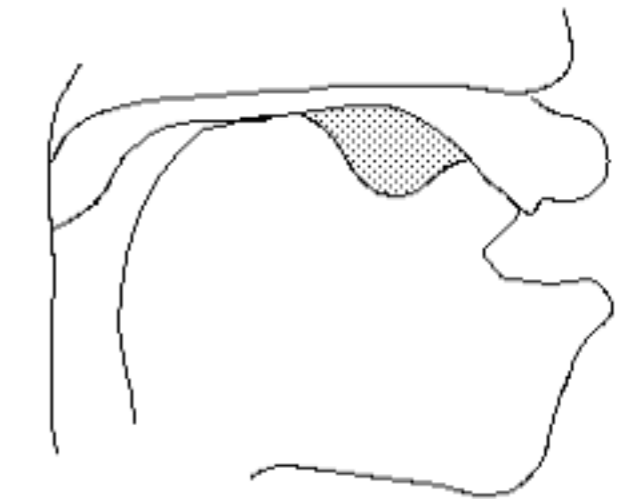
Simultaneous Stops:

- dorsal (Tongue Body)
- coronal (Tongue Tip)



### rarefaction

Lowering  
the **tongue body**



### release

of **coronal constriction**

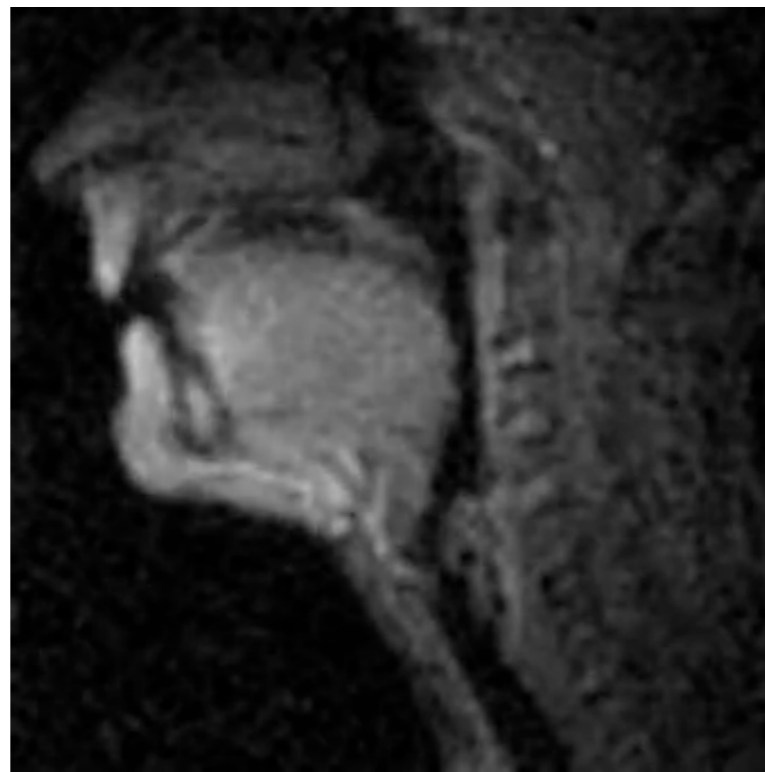


# Click Examples (JE)



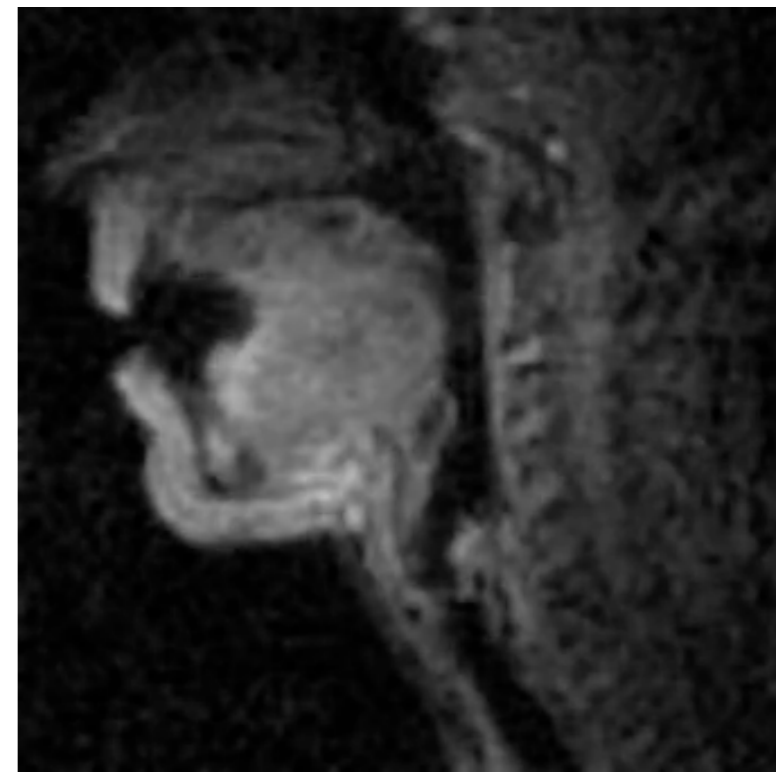
dental

kl



alveolar lateral

kll



post-alveolar

k!

# Click Examples (MG)



dental

kl



alveolar lateral

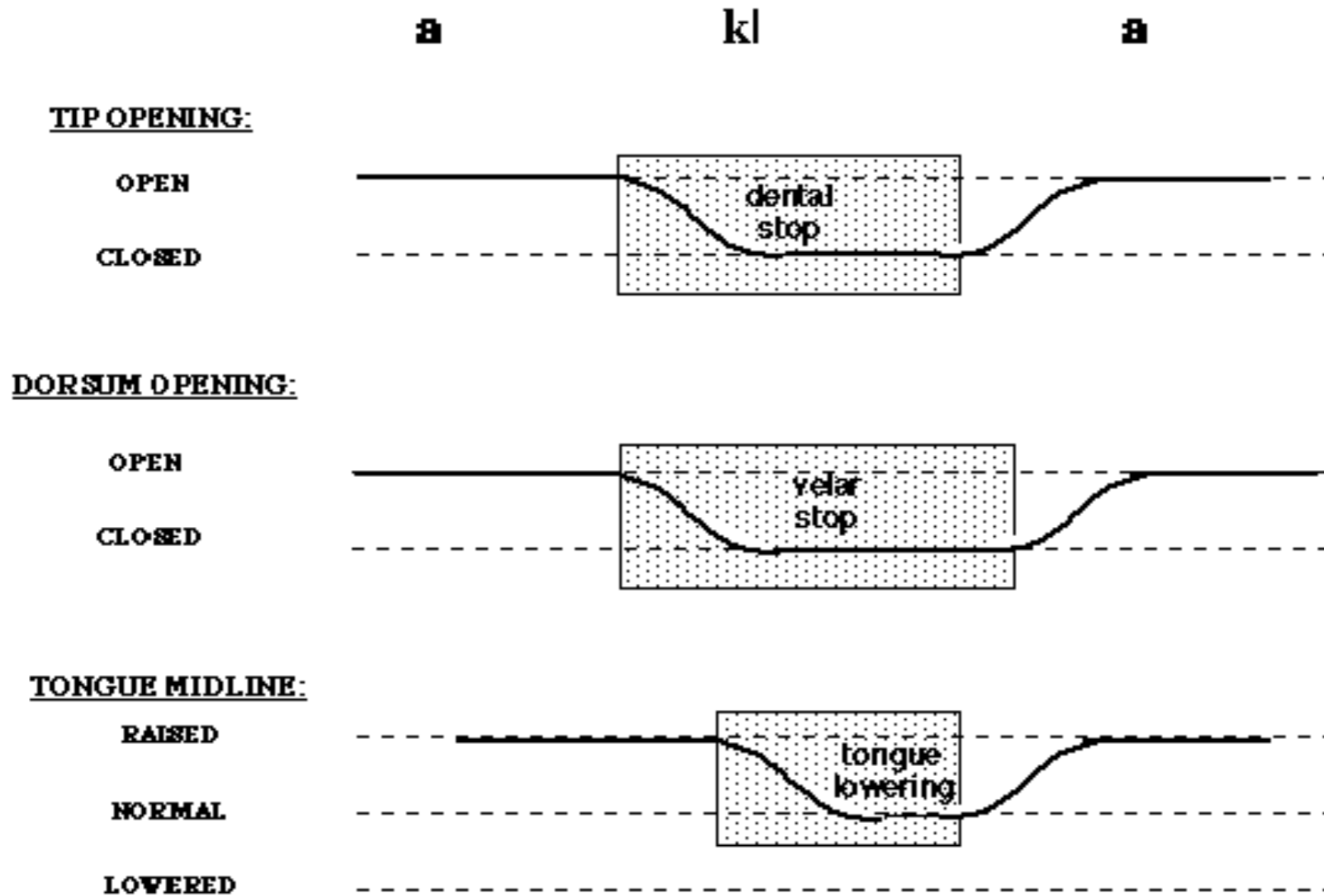
kll



post-alveolar

k!

# Gestural Score of click



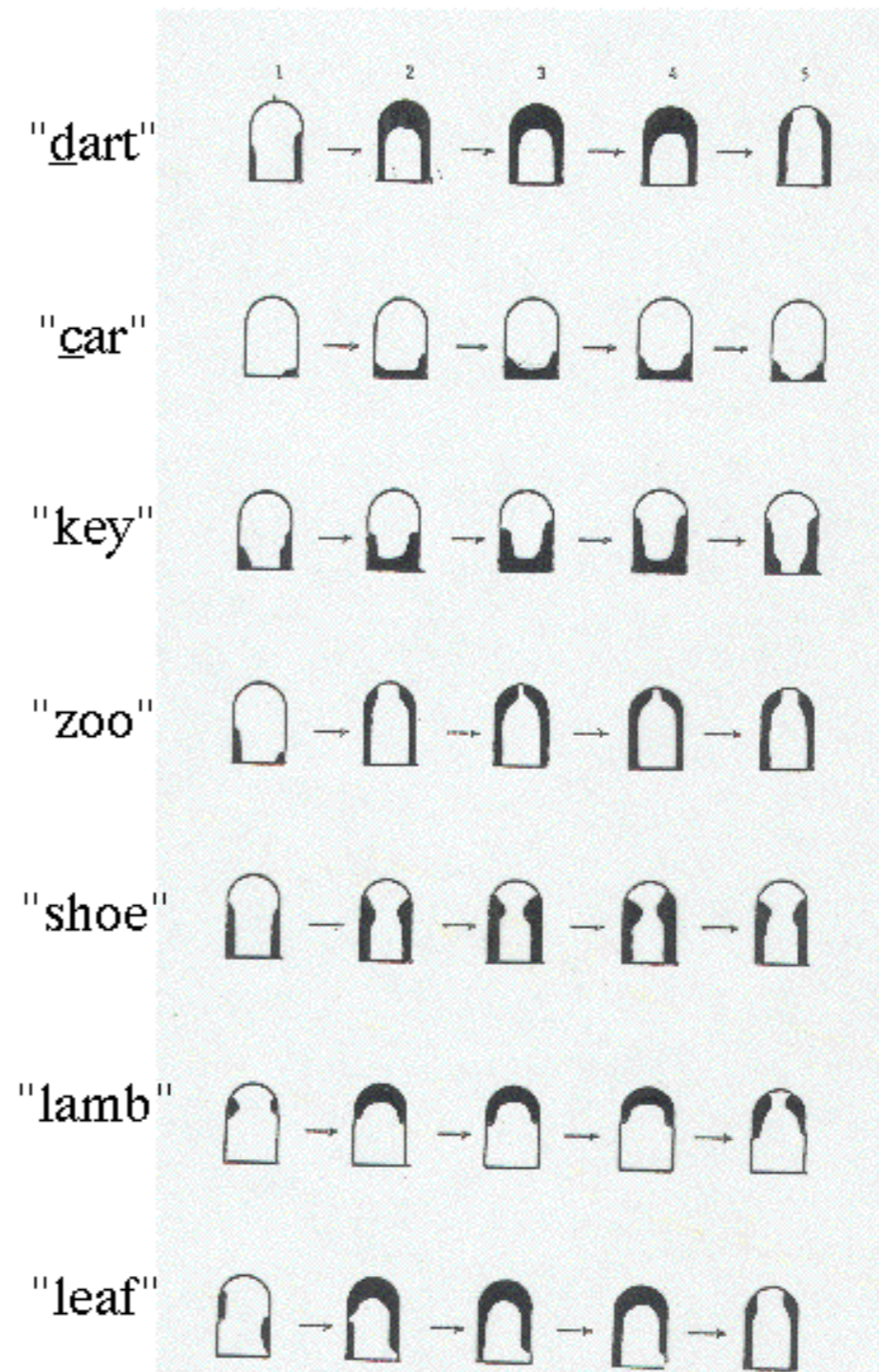


# View from palate: electropalatography

By placing an acrylic sheet with embedded electrode over a speaker's palate, we can observe the contact pattern of the tongue against the palate, and how it changes over time.

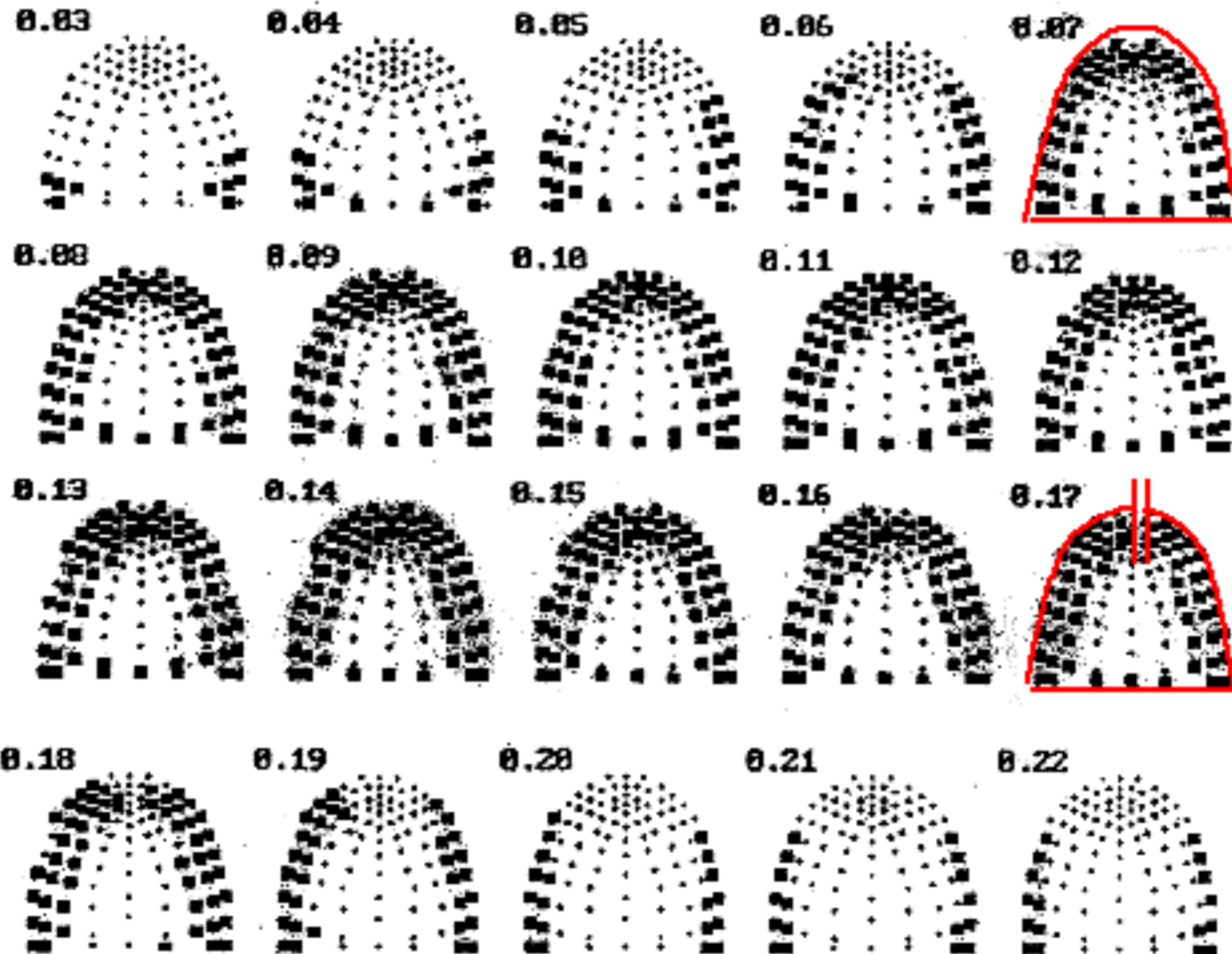
During a click, we can see a complete seal of the palate by the tongue--tip, sides and rear.

When the tongue body lowers, this sealed cavity is rarified



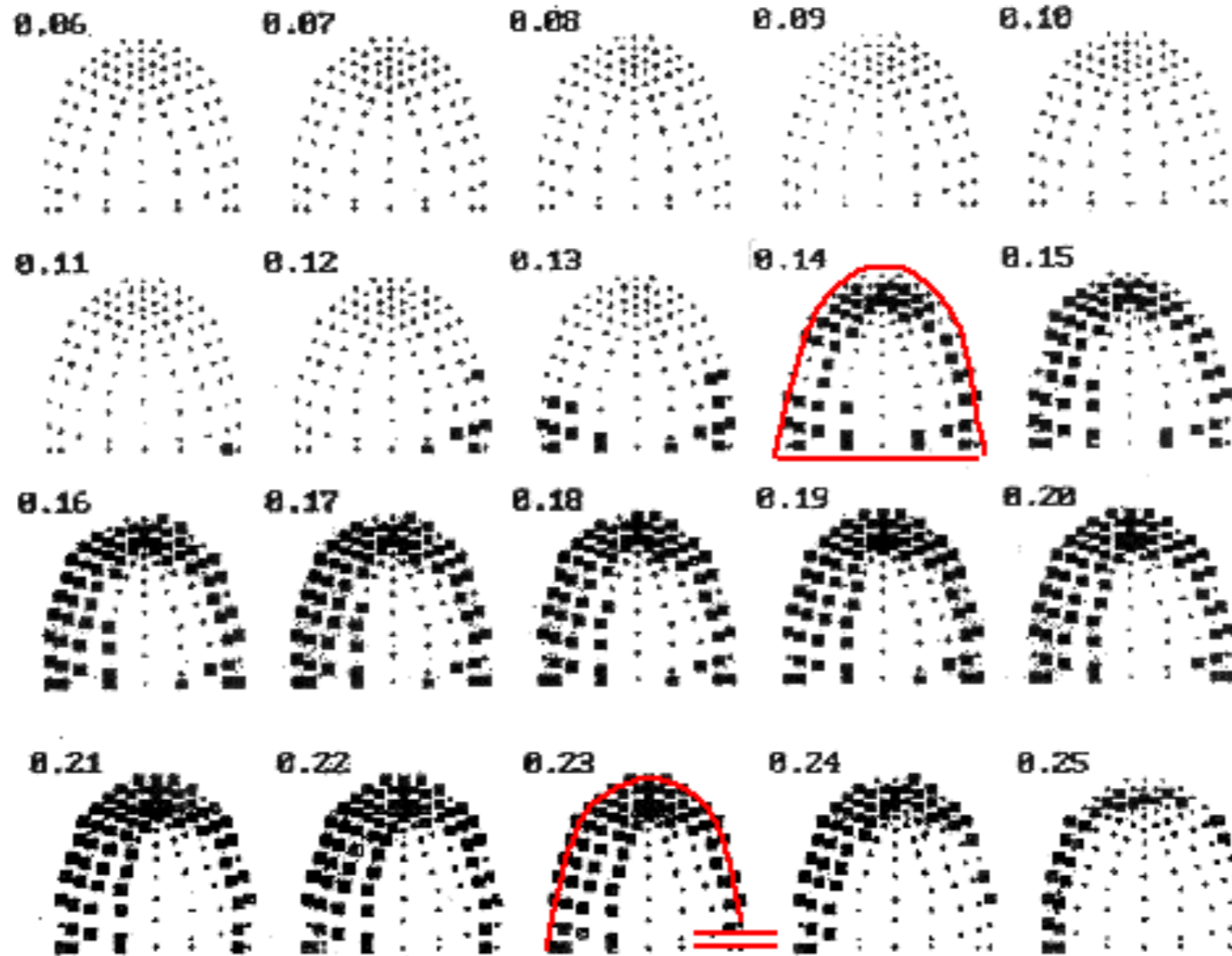
Time →

# Dental Click kl



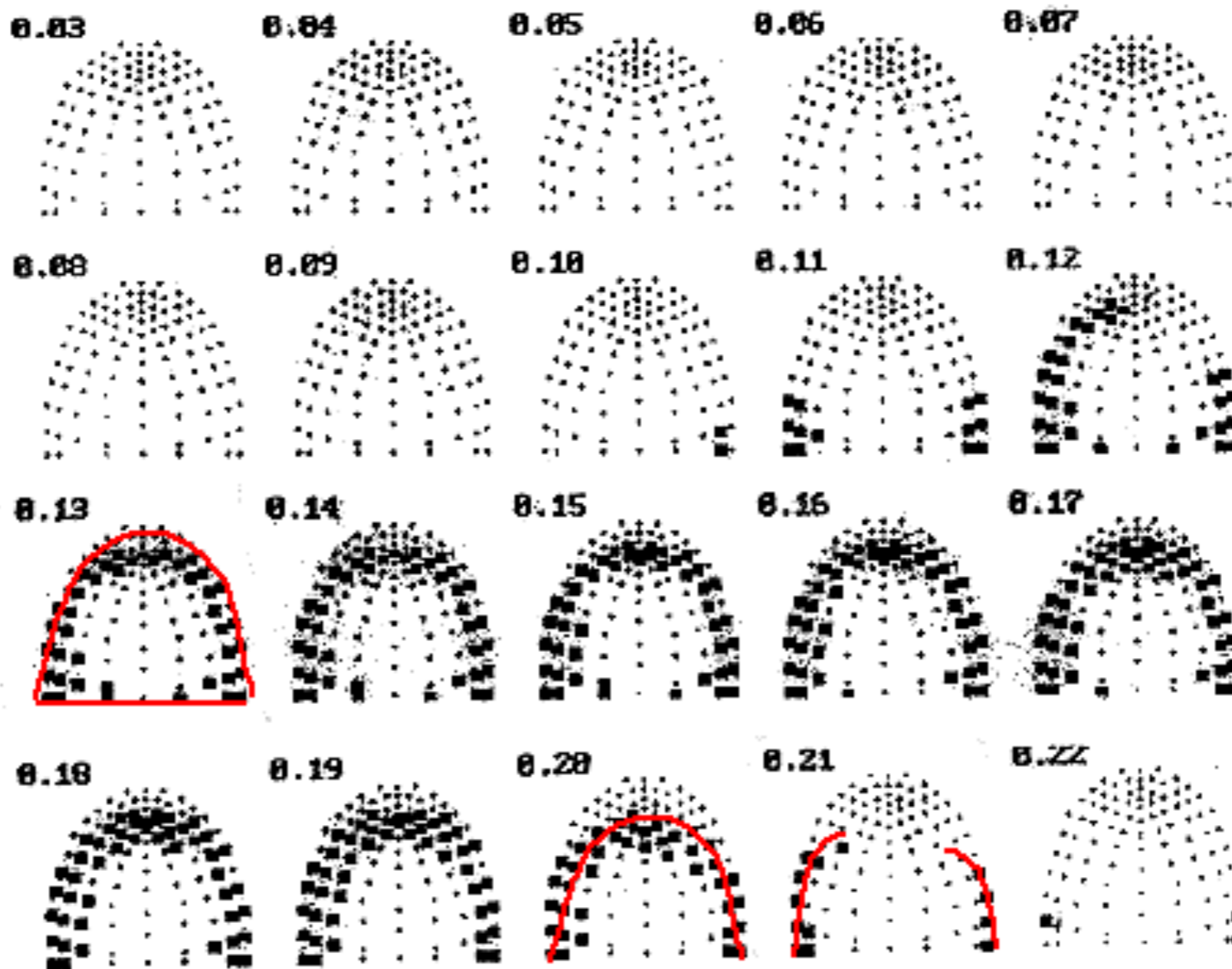
after Thomas, 1997

# Lateral Click kII



after Thomas, 1997

# Post-Alveolar Click k!



after Thomas, 1997