Electroglottography tutorial

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What is electroglottography

- Two electrodes are placed on both sides of the neck.
  - Vocal folds closed → low impedance of the current → high current amount
  - Vocal folds open → high impedance of the current → low current amount
- EGG is frequently used to **indirectly** represent the degree of contact of vocal folds.

Source: https://phon.wordpress.ncsu.edu/lab-manual/electroglottograph/

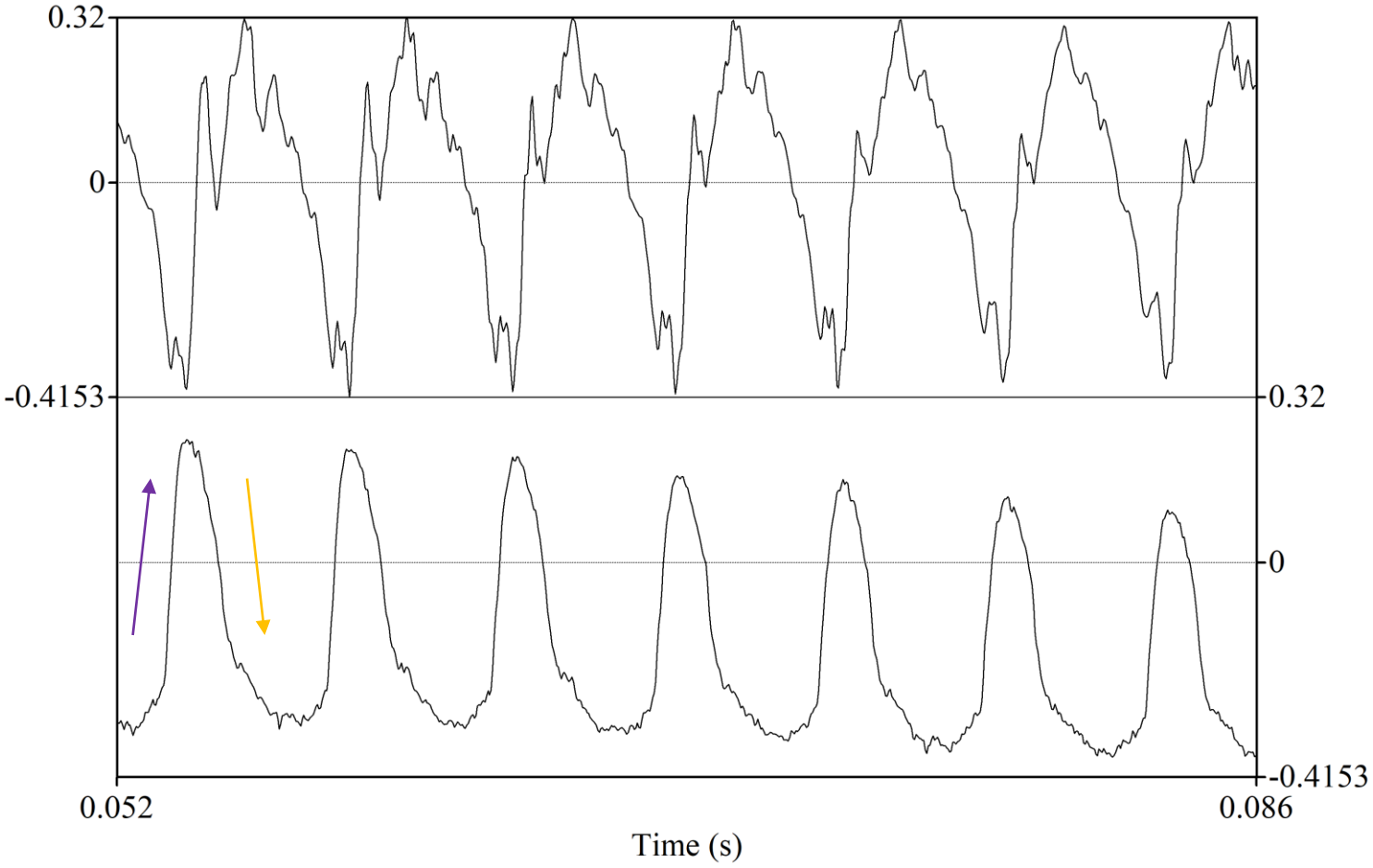
The applications of EGG

- Confirm presence of voicing
- Determine the fundamental frequency (f0)
- Measure voice quality (phonation type)
  - During consonants (Garellek et al. 2016)
  - Avoid interactions with other articulations, such as nasality (Carignan 2017).

Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

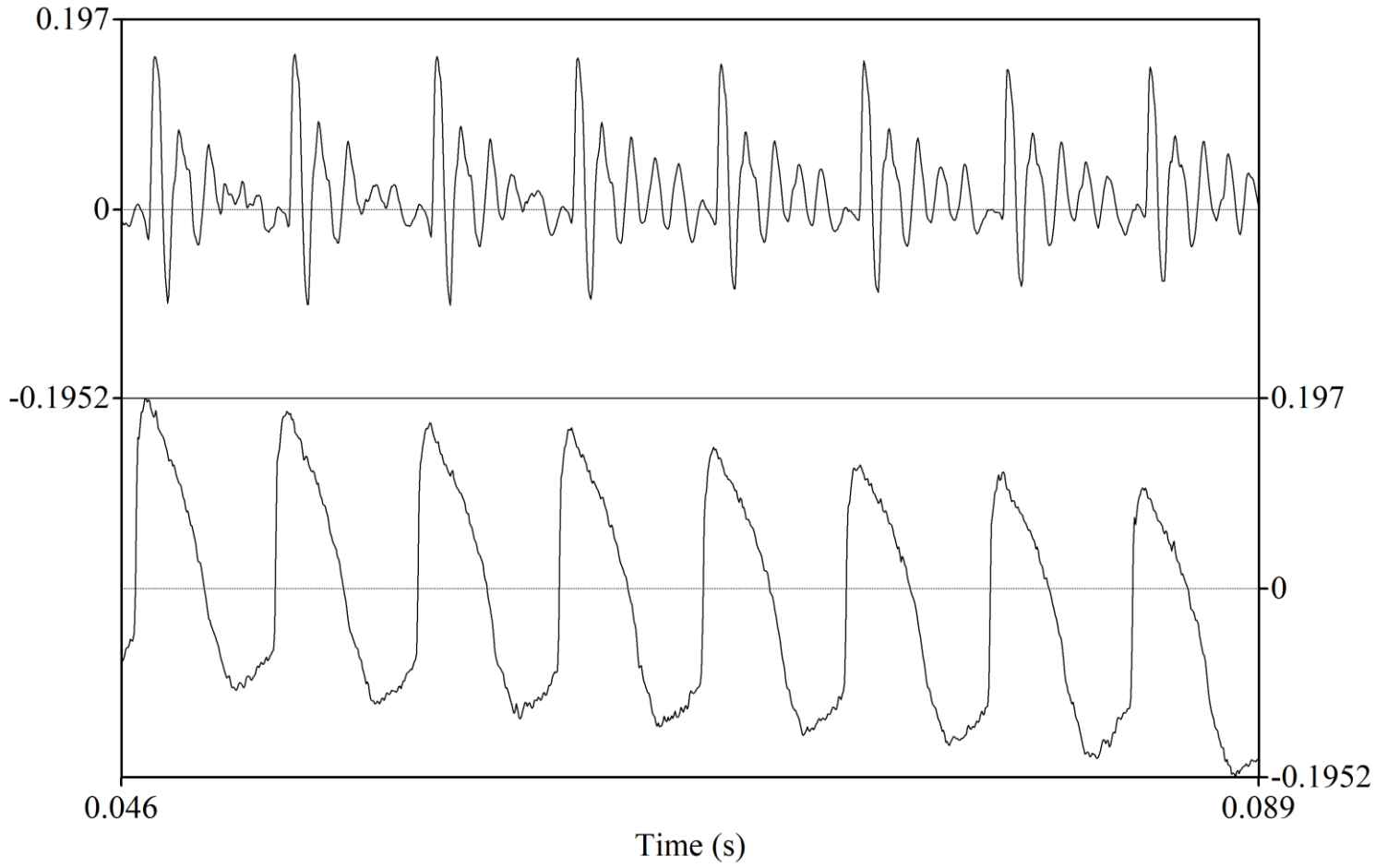
Breathy voice – Gujarati

[pa̤ḍ] “mountain” http://www.phonetics.ucla.edu/voiceproject/voice.html



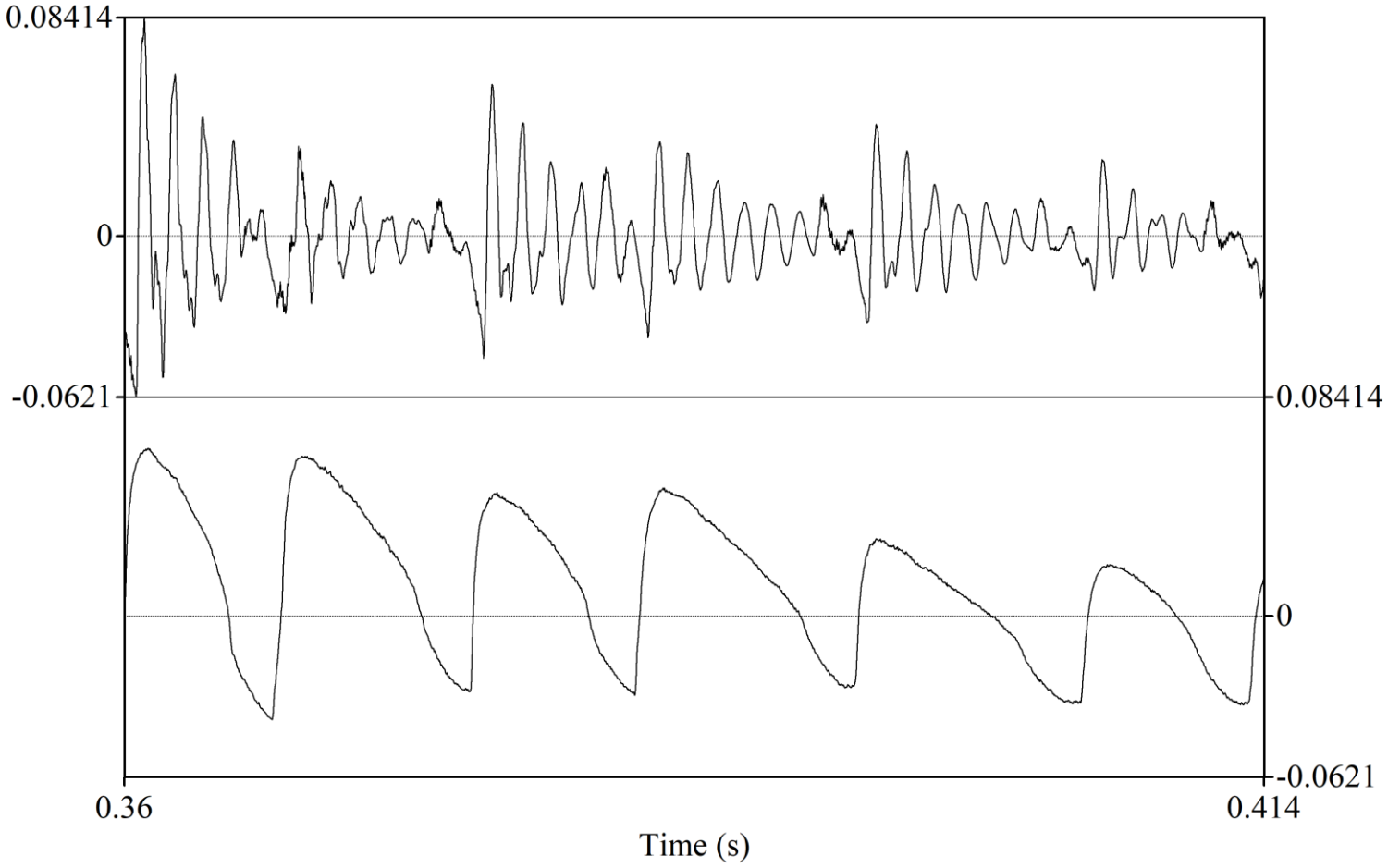
Modal voice – Gujarati

[baɾ] “twelve” http://www.phonetics.ucla.edu/voiceproject/voice.html



Creaky voice – Yateé Zapotec

[zą̂] “corn”

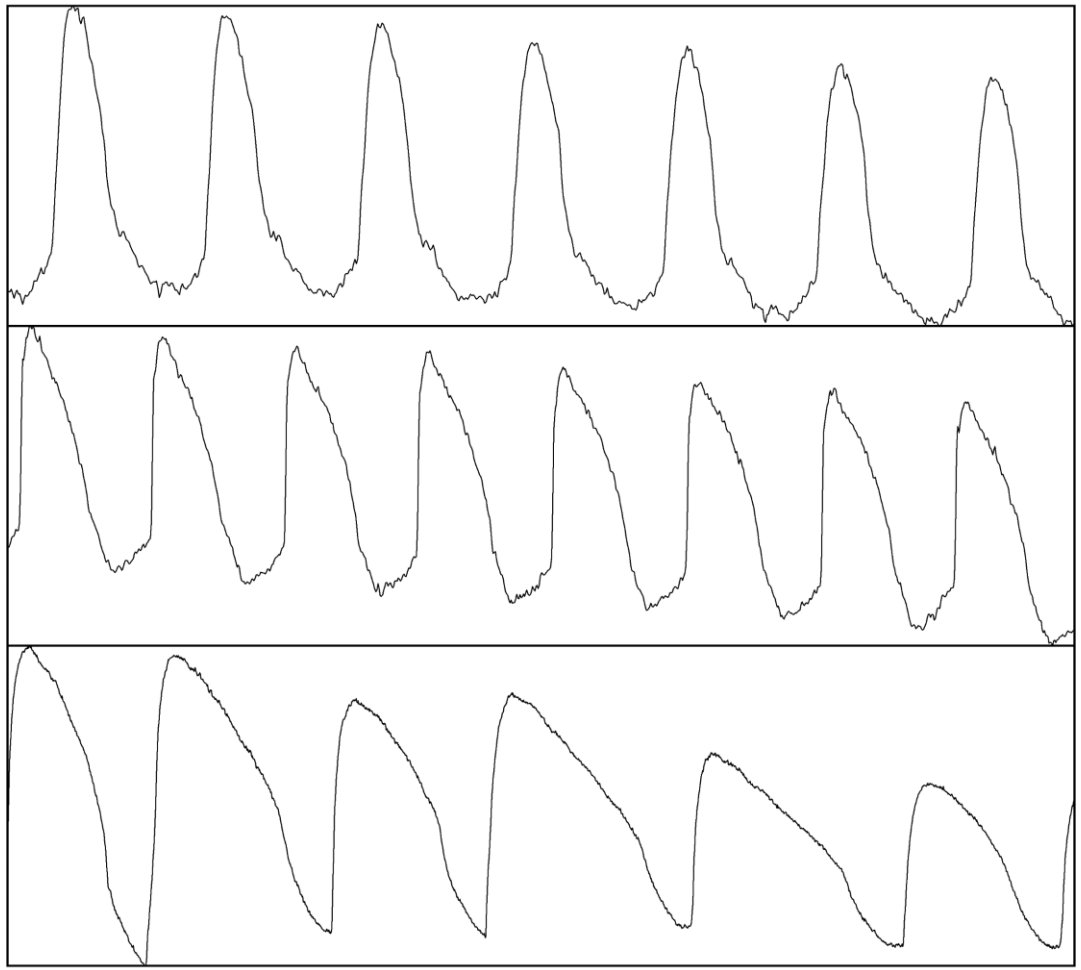


Breathy vs. Modal vs. Creaky

Breathy

Modal

Creaky



EGG measures

- Contact quotient (CQ)
- Pulse symmetry (ratio)
- Speed of closing
- Overall shape of pulse

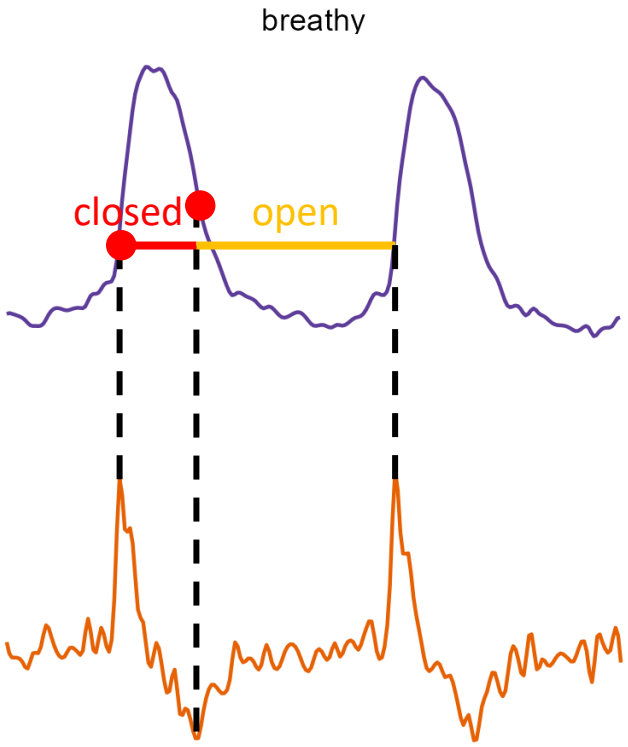
Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

Contact quotient

- Contact quotient (CQ) – Within one cycle, the portion when vocal folds are closed;
- The larger the CQ is, the more constriction there is.

Contact quotient – Derivative measure

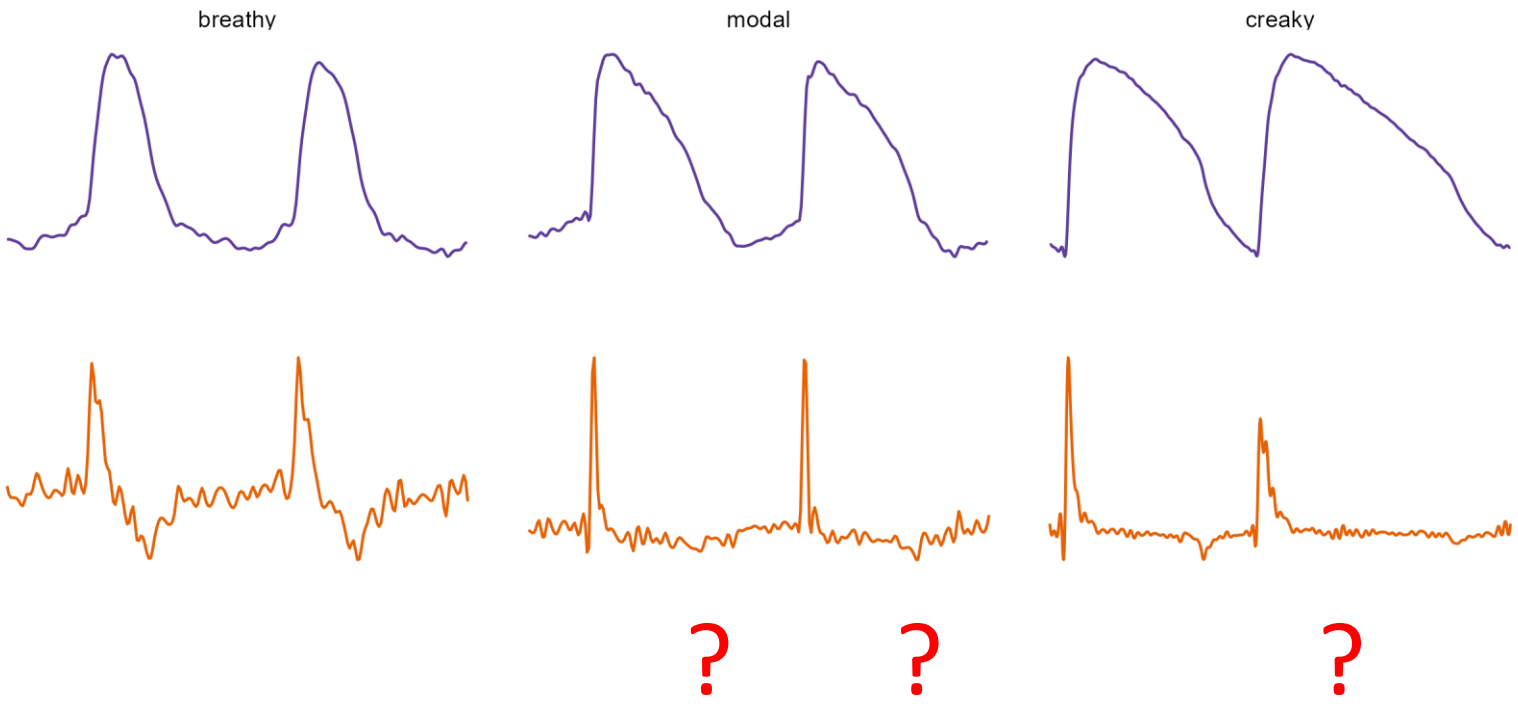
- The maximum derivative peak marks the start of the closing phase.
- The minimum derivative peak marks the end of the closing phase



Contact quotient – Derivative measure

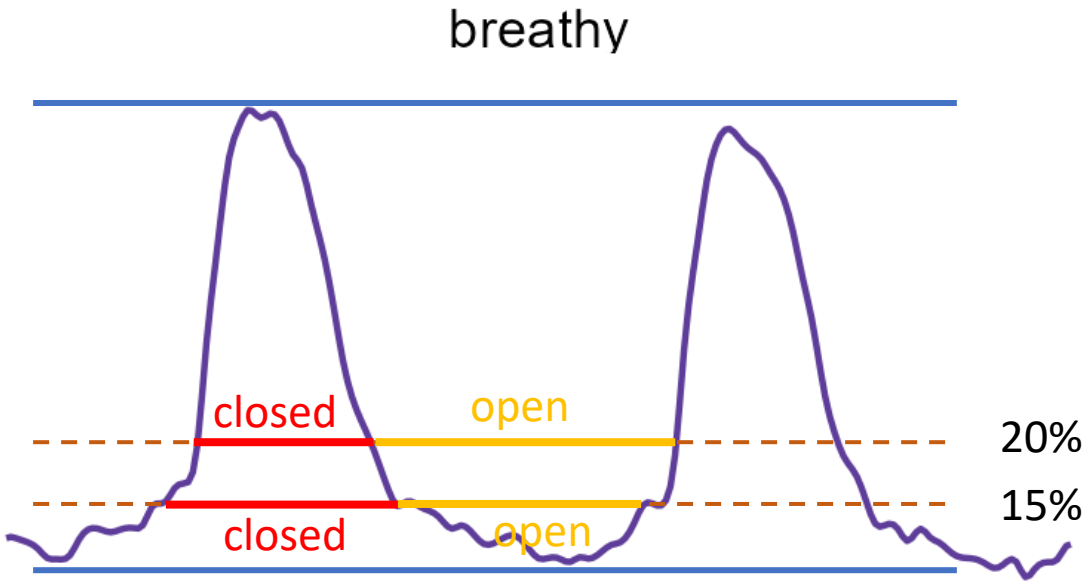
- Problem of the derivative measure:

The minimum derivative peak is not always well-defined.



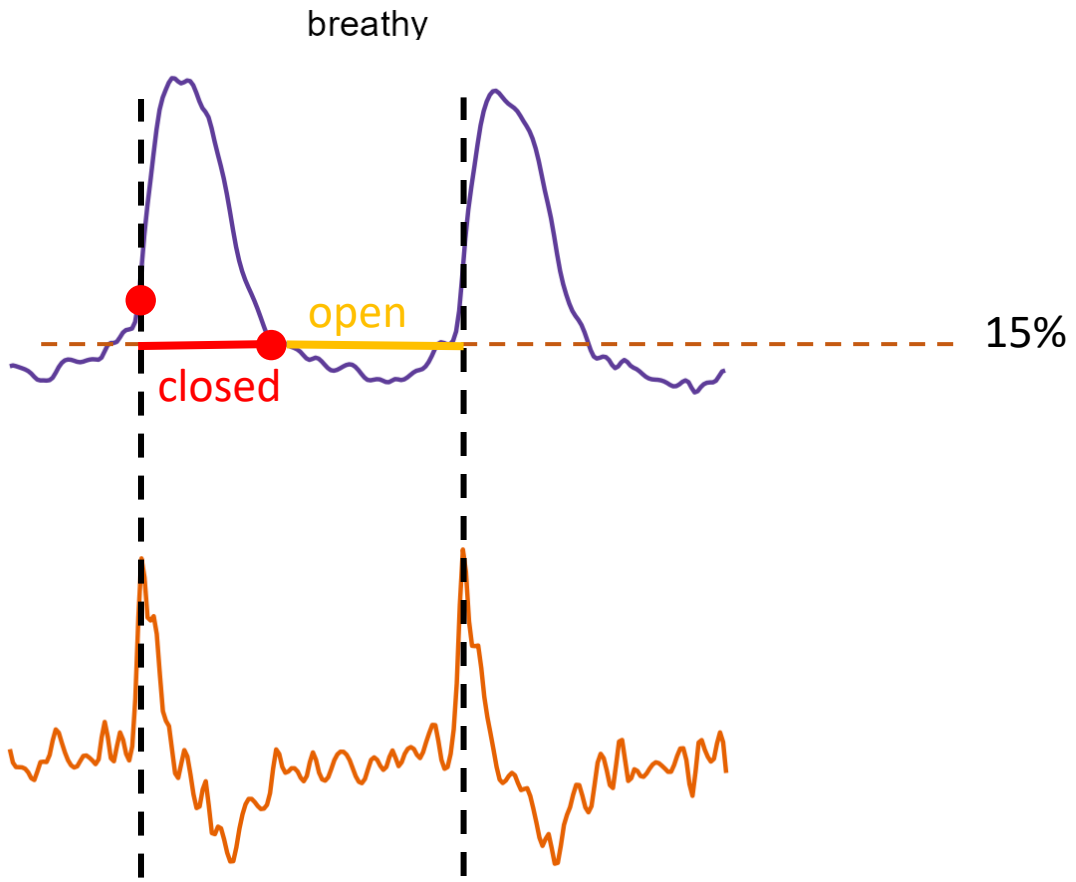
Contact quotient – Threshold measure

- Set a % out of the overall current displacement threshold
- Above the threshold → closed
- Below the threshold → open
- The threshold value is arbitrary.
- Kania et al. (2004) compared between different thresholds.

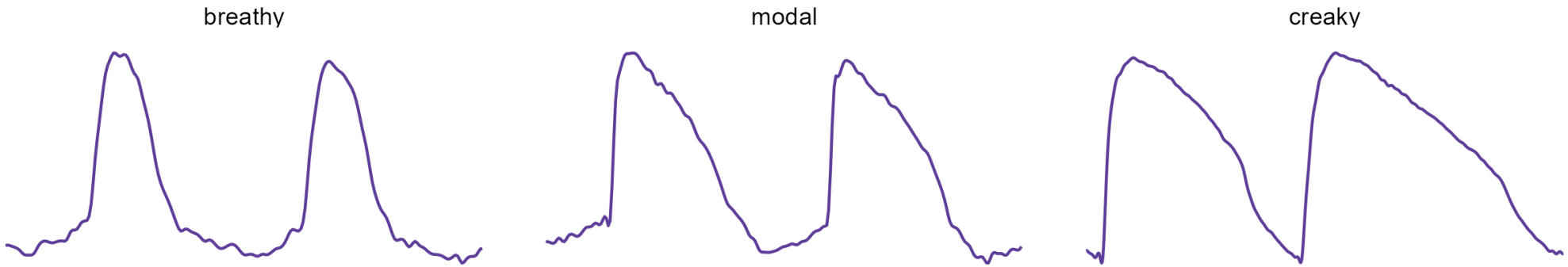


Contact quotient – Hybrid measure

- Use the maximum derivative peak to determine the closed point;
- Use the threshold to determine the open point



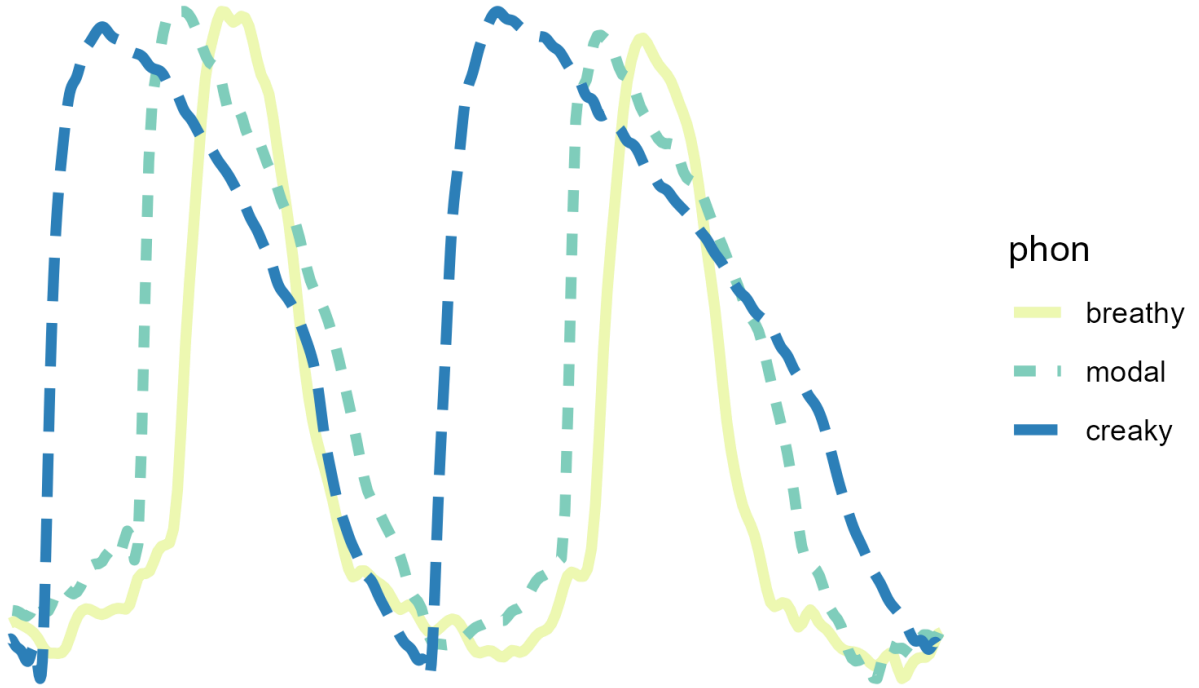
Contact quotient



	CQ_threshold	CQ_derivative	CQ_hybrid
Breathy	0.37	0.24	0.33
Modal	0.54	0.46	0.5
Creaky	0.75	0.7	0.71

Pulse symmetry

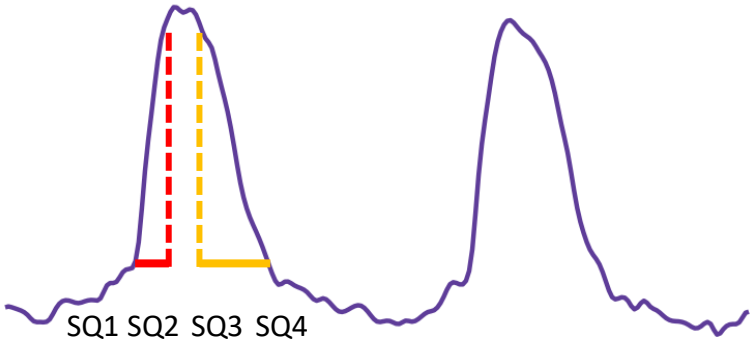
- More glottal constriction tends to lead to a more right-skewed pulse shape (Childers & Lee, 1991; Kuang & Keating, 2014).



Pulse symmetry

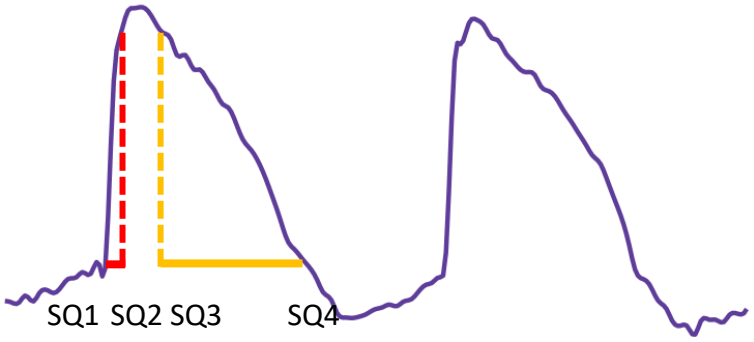
- Skew quotient can be used to measure the pulse symmetry (Mayr, 2017; Holmberg et al., 1995; Dromey et al., 1992)
  - Skew quotient = Contacting phase / Decontacting phase
  - Contact phase = (SQ2 – SQ1)/(SQ4 – SQ3)
    - SQ1: the time of 10% above the minimum value of each cycle (closing slope)
    - SQ2: the time of 90% above the minimum value of each cycle
    - SQ3:the time of 90% above the minimum value of each cycle (opening slope)
    - SQ4: the time of 10% above the minimum value of each cycle (opening slope)

breathy



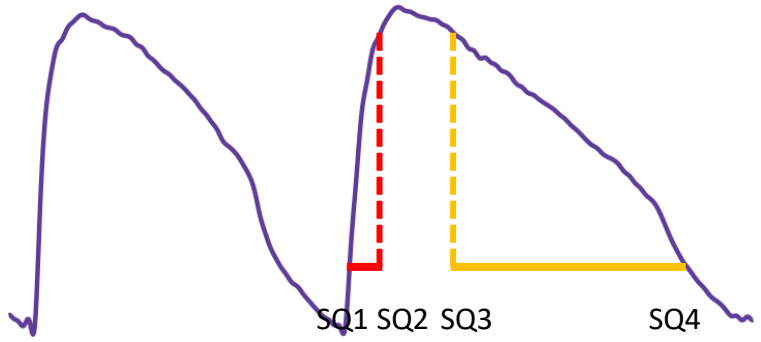
0.82/0.41 = 0.58

modal



0.55/2.27 = 0.24

creaky



0.74/6.28 = 0.12

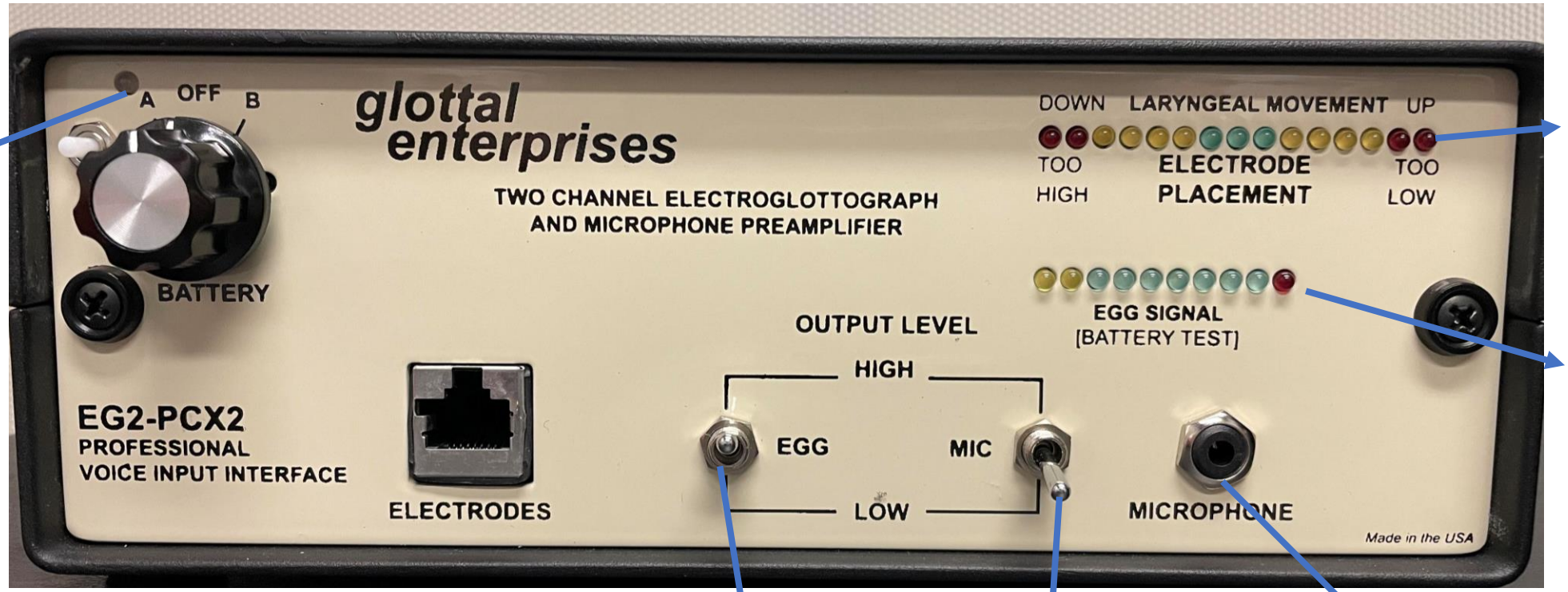
Software for EGG analysis

- EGGWorks
  - A free software developed by Henry Tehrani. Currently, the standalone only works on Windows PC.
  - Required software: PCquirerX (https://sciconrd.com/downloads.aspx) (free “lite” version is sufficient for running EGGWorks.)
- The output from EGGWorks can be integrated with VoiceSauce output and be exported with other acoustic measures outputted by VoiceSauce.
- Download at https://github.com/yuanchaiyc/EGGWorks

Software for EGG analysis

- Praat (download the newest version of Praat)
  - Open an EGG waveform
  - Convert → Extract Electroglottogram;
  - To TextGrid → Threshold method to determine the CQ;
  - To AmplitudeTier → Given a threshold, calculate the amplitude of the EGG waveform at the point of glottal closure;
  - Derivative → Output the derivative of the EGG waveform; Can be saved as a text file and then be used to calculate CQ using the derivative measure.

EGG



Battery – should be green

Electrode placement – should be green

EGG signal gain – should be green

EGG gain high/low

Mic gain high/low

Microphon 3.55 mm port

EGG

Plug in here if you plug EGG into an audio interface

Plug in here if you connect EGG to computer directly

Microphone XLR port

Control whether the mic is from the front or the back

EGG setup – Charging

- EGG has two batteries (A and B). Do not charge the batteries for more than 24 hours. And do not leave the batteries uncharged for more than two months. Before usage, charge the device between two to four hours.
- Avoid recording EGG while it is being charged.
- Switch battery of OFF when charging.
- Green battery light means the batteries are well-charged. Orange light means the battery is low. No light means the batteries need to be replaced.

Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

EGG setup – Recording

- EG2-PCX allows us to record both EGG and audio signals.
  - Device needed: EGG, microphone
  - Cable needed: USB cord
- Connect microphone to EGG
  - Front of EGG – microphone jack
  - Back of EGG – XLR
  - Use the switch at the back of the EGG to control whether you are recording from the front or the back port.
- Connect EGG to the computer as an audio interface
  - Use the USB cord; the port is at the back of EGG

EGG setup – Recording

- Record EGG and audio separately
  - Device needed: EGG; microphone; audio interface
  - Cables needed: 3.55 mm TS mono male to 6.55 mm TS mono male; or 3.55 mm TS mono male to XLR male (depending on the audio interface)
- Connect EGG to audio interface
  - The end connected to EGG should be a 3.55mm TS mono male cable. The other end connected to the audio interface depends on the port of your audio interface.
- Connect microphone to audio interface
- Connect audio interface to computer

EGG setup – Electrode placement

- The electrodes should be placed on both sides of the neck at the level of thyroid cartilage (the most prominent part on neck).
- The electrodes should be glued to the collar.
- The gold-plated areas on the electrodes should be horizontal.
- The wires should point downwards.

Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

EGG setup – Electrode placement calibration

- Turn on the battery to A or B and put the electrode on the participant's neck.
- Let participant produce and sustain a vowel.
- Observe the top right panel of EGG with a label "ELECTRODE PLACEMENT". The light should be green when the participant speak.
- If the light is red, you can
  - Adjust the electrodes up and down;
  - Move the electrodes closer or further apart;
  - Coat the electrodes with a thin layer of gel or use a saline solution.

Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

EGG setup – Recording

- When recording, make the recording as 2 channel, 16 bit, 44.1K Hz.
- Monitor the signal to avoid clipping.
  - The gain can be adjusted between high and low in the front of the EGG.

Adopted from Marc Garellek's EGG tutorial at Annual Meeting of Phonology 2019.

EGG setup – Some final notes

- If the EGG light is still orange after charging,
  - It is possible that the battery is failing
  - It is also possible that the charging cable is failing.
- If the EGG outputs noisy signal even though the battery test gives green light,
  - It could also be due to battery failing. Changing batteries could fix this problem.

References

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