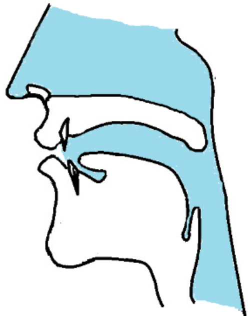
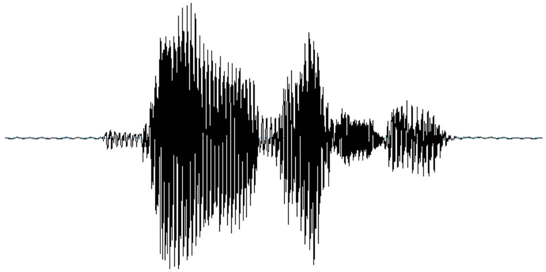
Phonetic diversity in the world's languages

Lecture 3

The entire unit is based on

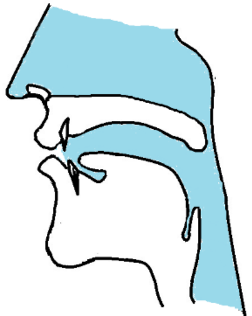
Ladefoged, Peter and Maddiesen Ian (1996) The Sounds of the World's Languages. Blackwell

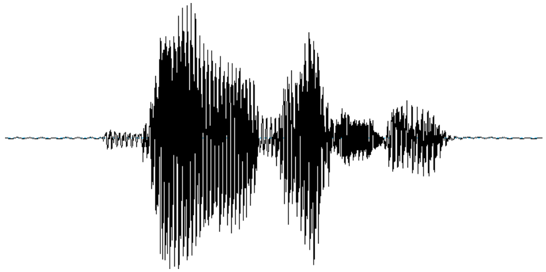




Summary so far

- Language endangerment and the threat to linguistic diversity
- Great amount of phonetic diversity

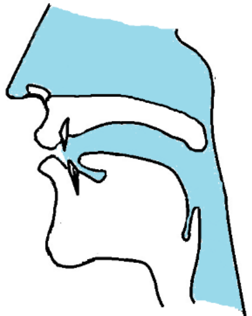




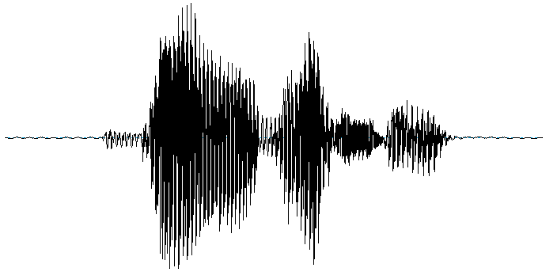
Sounds of the world’s languages: Consonants around the world

Table 1. the relationship between the major place features and individual places of articulation

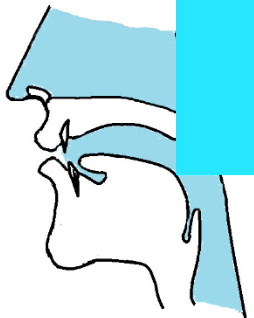
Labial		1. Bilabial 2. Labiodental
Coronal	1. Laminal	3. lingo-labial 4. Interdental 5. Laminal dental 6. Laminal alveolar 7. Laminal post-alveolar (palato-alveolar)
	2. Apical	8. Apical dental 9. Apical alveolar 10. Apical post-alveolar
	3. Sub-apical	11. sub-apical palatal (retroflex)
Dorsal		12. Palatal 13. Velar 14. Uvular
Radical		15. Pharyngeal 16. Epiglottal
Laryngeal		17. Glottal



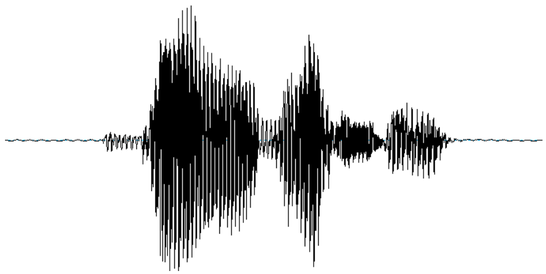
Glottis State



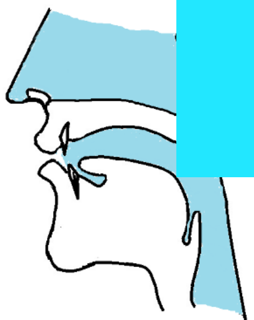
1. Voiced
2. Voiceless
3. Murmured
4. Laryngealized
5. Closed

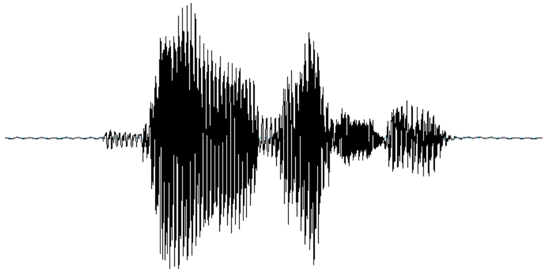


Phonation



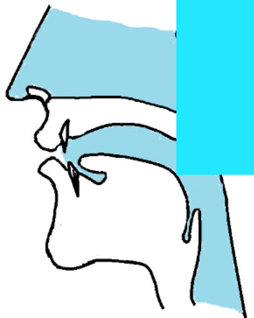
- Normal voicing – modal voicing
- Air passing through the glottis with a moderate constriction
- Regularly spaced glottal pulses
- Creaky – Air passing through the glottis with a smaller constriction.
- Irregularly paced
- Breathy – Airflow is greater. Noisy component

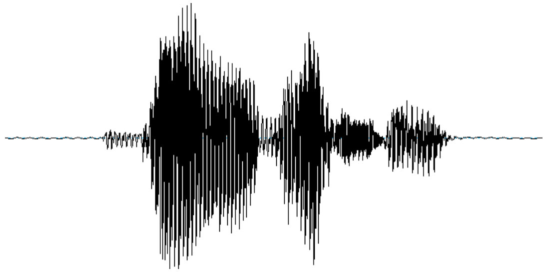




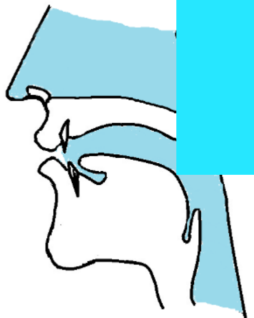
Phonation

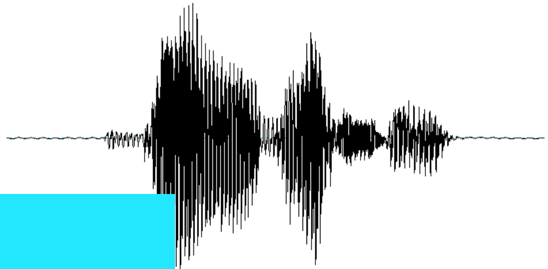
- Some people have a different phonation while speaking
- But when sounds are distinguished linguistically then it’s called phonation





1. Airstream Mechanism/direction
2. Glottal state
3. Part of Tongue
4. Primary Place of Articulation
5. Manner of Articulation
6. Centrality
7. Nasality





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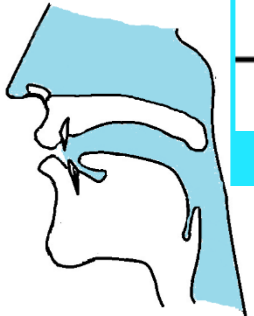
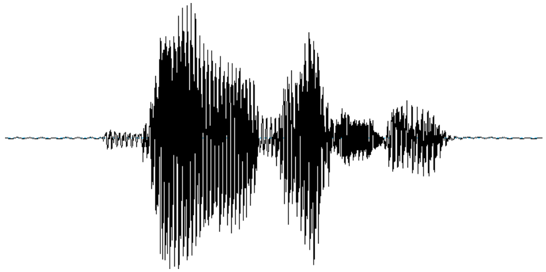
Airstream	Direction	Glottis	Tongue	Place	Centrality	Nasality	Manner
Pulmonic	egressive	voiced	apical	bilabial	central	oral	stop
Glottalic	ingressive	voiceless	laminal	labiodental	lateral	nasal	fricative
Velaric		murmured	(neither)	dental			approximant
		laryngealized		alveolar			trill
		closed		retroflex			flap
				palato-alveolar			tap
				palatal			
				velar			
				uvular			
				pharyngeal			
				labial velar			

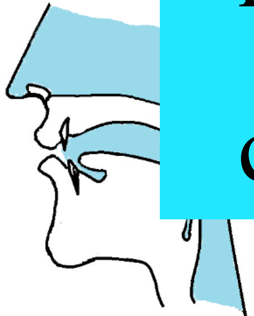




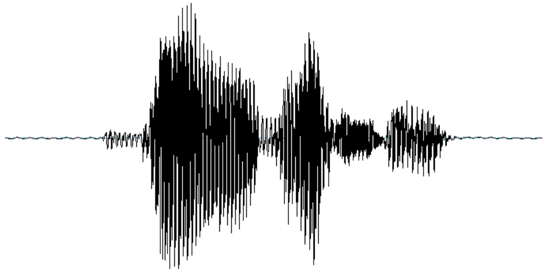
Phonation

Matthew Gordon & Peter Ladefoged

- People can control the glottis to produce harsh, soft, creaky, breathy phonation types.
- controllable variations in the actions of the glottis.
- uncontrollable pathological voice quality for one person might be a necessary part of the set of phonological contrasts for someone else.



Cross-linguistic distribution of phonation contrasts

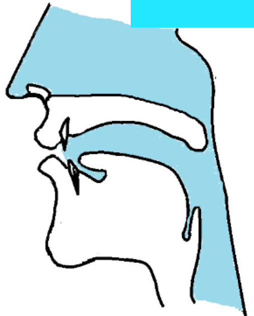


- **Ladefoged (1971)**: there might be a continuum of phonation types.

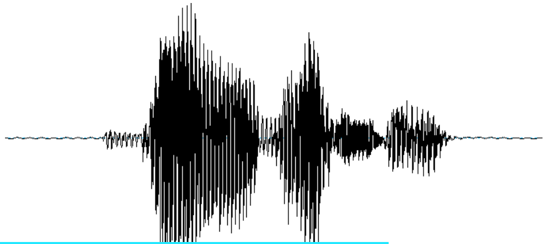
	Most open	⟵	⟶		**Mostclosed**
Phonation type	Voiceless	Breathy	Modal	Creaky	Glottal closure

Fig. 1. Continuum of phonation types (Ladefoged 1971)

- defined in terms of the aperture between the arytenoid cartilages

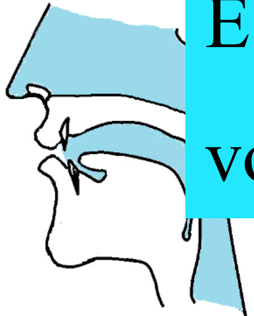


Voiced vs. voiceless contrasts



- Two points employed by the majority of languages: ***voiced*** and ***voiceless*** sounds.
- This contrast is common among ***stop consonants***. E.g. English, Japanese, Arabic and Russian.
- In a smaller set of languages, the voiced vs. voiceless contrast is found in ***sonorants***.

E.g. Burmese, Hmong, Klamath, and Angami have a voiced vs. voiceless contrast among the ***nasals***.



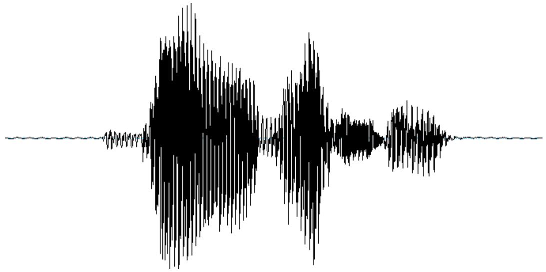
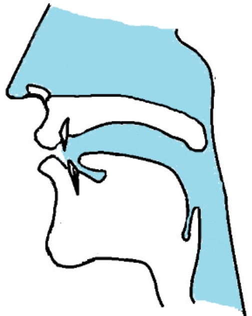
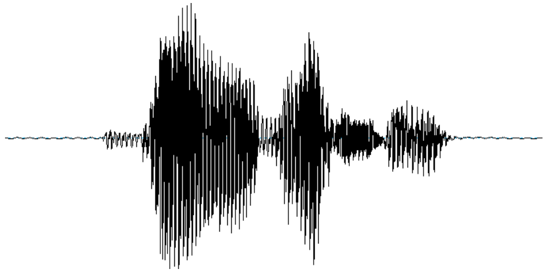


Table 1. Voiced and voiceless nasals in Burmese (from Ladefoged and Maddieson1996:111)

	Voiced		Voiceless	
Bilabial	mă	‘hard’	m̥ǎ	‘notice’
Alveolar	nǎ	‘pain’	n̥ǎ	‘nose’
Palatal	≠ă	‘right’	≠̥ă	‘considerate’
velar	ŋǎ	‘fish’	ŋ̊ǎ	‘borrow’
Labialized alveolar	nʷǎ	‘cow’	n̥ʷǎ	‘peel’



Breathy voice

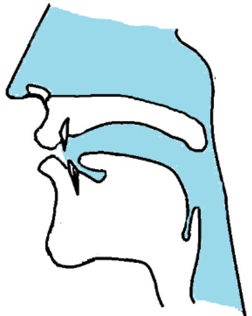


- **Breathy phonation** is characterized by vocal cords that are fairly abducted (relative to modal and creaky voice) and have little longitudinal tension.
- Some languages contrast ***breathy*** voiced and regular ***modal*** voiced sounds.

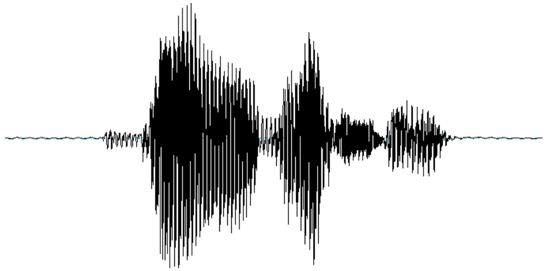
E.g. Hindi, Newar, Tsonga, make this contrast among their ***nasals***.

Modal voiced		**Breathy voiced**	
maː	‘garland’	ma̤ː	‘be unwilling’
naː	‘it melts’	na̤ː	‘knead’

Table 2. Modal voiced and breathy voiced nasals in Newar



Breathy voice



- **Waveforms:**
  - The waveform for the ***breathy voiced nasal*** is characterized by a fair amount of noisy energy.
  - The ***modal voiced nasal*** is not marked by this turbulence and has relatively well-defined pitch pulses.

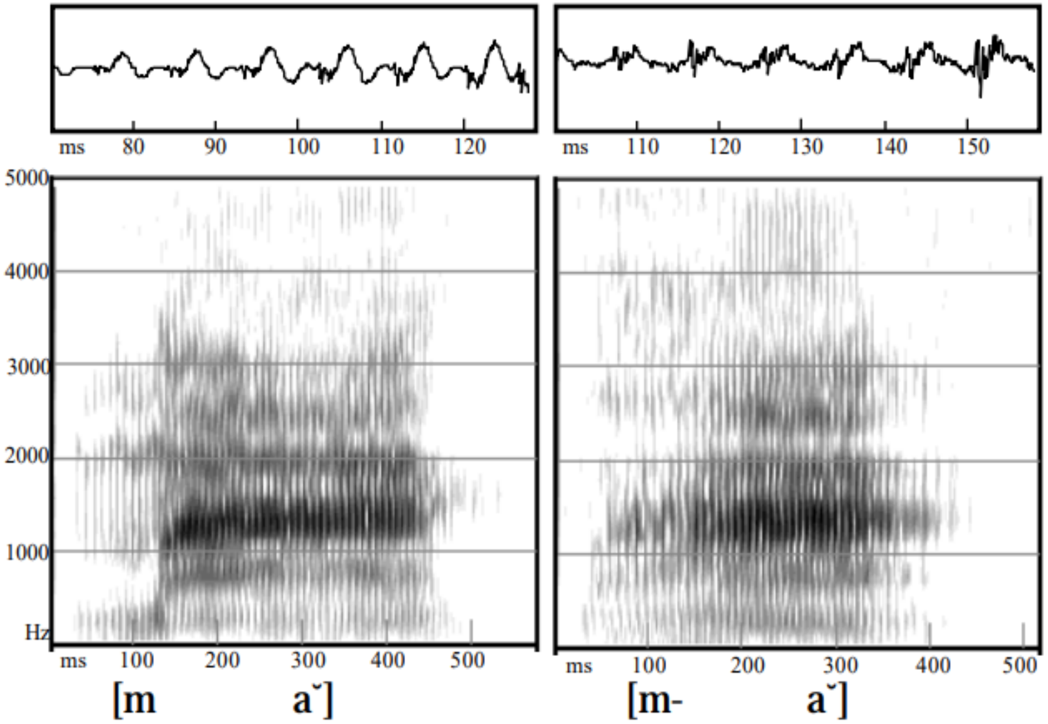
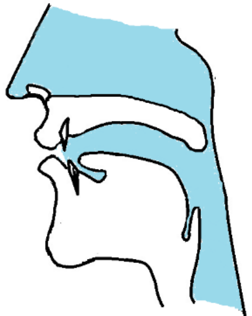
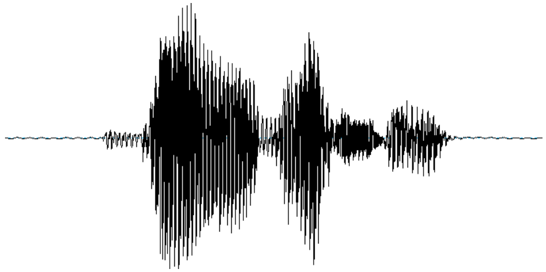


Fig. 2. Spectrograms of modal and breathy voiced nasals in the Newar words /maː/ ‘garland’ and /ma̤ː/ ‘be unwilling’ (male speaker)



Breathy voice



- Newar also makes a breathy vs. modal voiced contrast in their ***stops***.
- Languages with contrastively breathy voiced obstruents are relatively rare cross-linguistically.

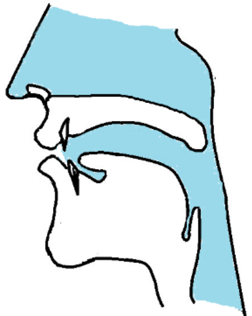
E.g. Hindi, Maithili, Telugu and Newar.

- Some languages contrast breathy and modal voicing in their ***vowels*** rather than consonants.

E.g. Gujarati

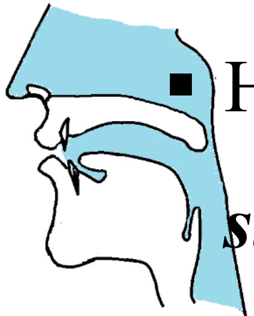
Modal voiced		Breathy voiced	
Bar	‘twelve’	bar̤	‘outside’
pɔr	‘last year’	pɔr̤	‘dawn’
kan	‘ear’	kan̤	‘krishna’
mɛl	‘dirt’	mɛl̤	‘palace’

Table 3. Modal and breathy voiced vowels in Gujarati

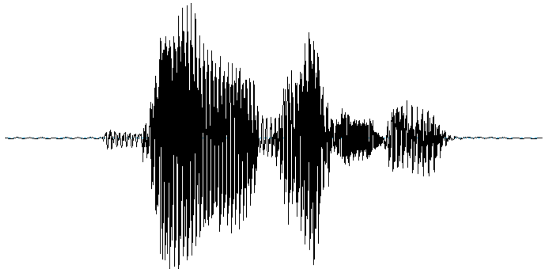


Creaky voice

- **Creaky phonation (vocal fry):** is associated with vocal folds that are tightly adducted but open enough to allow for voicing (Ladefoged 1971, Laver 1980).
- The acoustic result is a series of irregularly spaced vocal pulses that give the auditory impression of a "rapid series of taps, like a stick being run along a railing" (Catford 1964:32).
- Contrasts between ***creaky*** and ***modal*** voice are rare in obstruents.
- Hausa and certain other Chadic languages make such a contrast for ***stops***.



Creaky voice

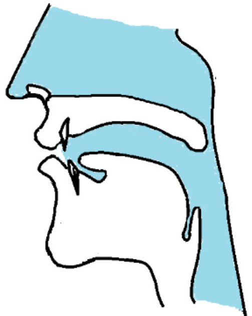


- Some languages contrast ***creaky*** and ***modal voicing*** among their ***sonorants***.

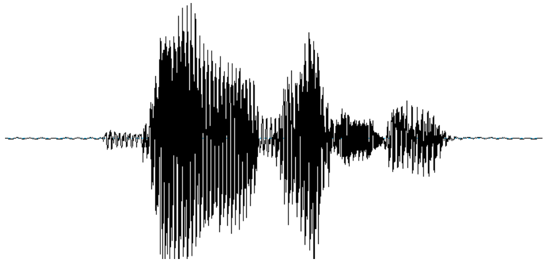
E.g. Kwakw'ala, Montana Salish, Hupa, and Kashaya Pomo.

Modal voiced		**Breathy voiced**	
nəm	'one'	n̰an̰bəm̰a	'nine'
naka	'drinking'	n̰ala	'day'

Table 4. Modal and creaky ***nasals*** in Kwakw'ala (Boas 1947)



Creaky voice



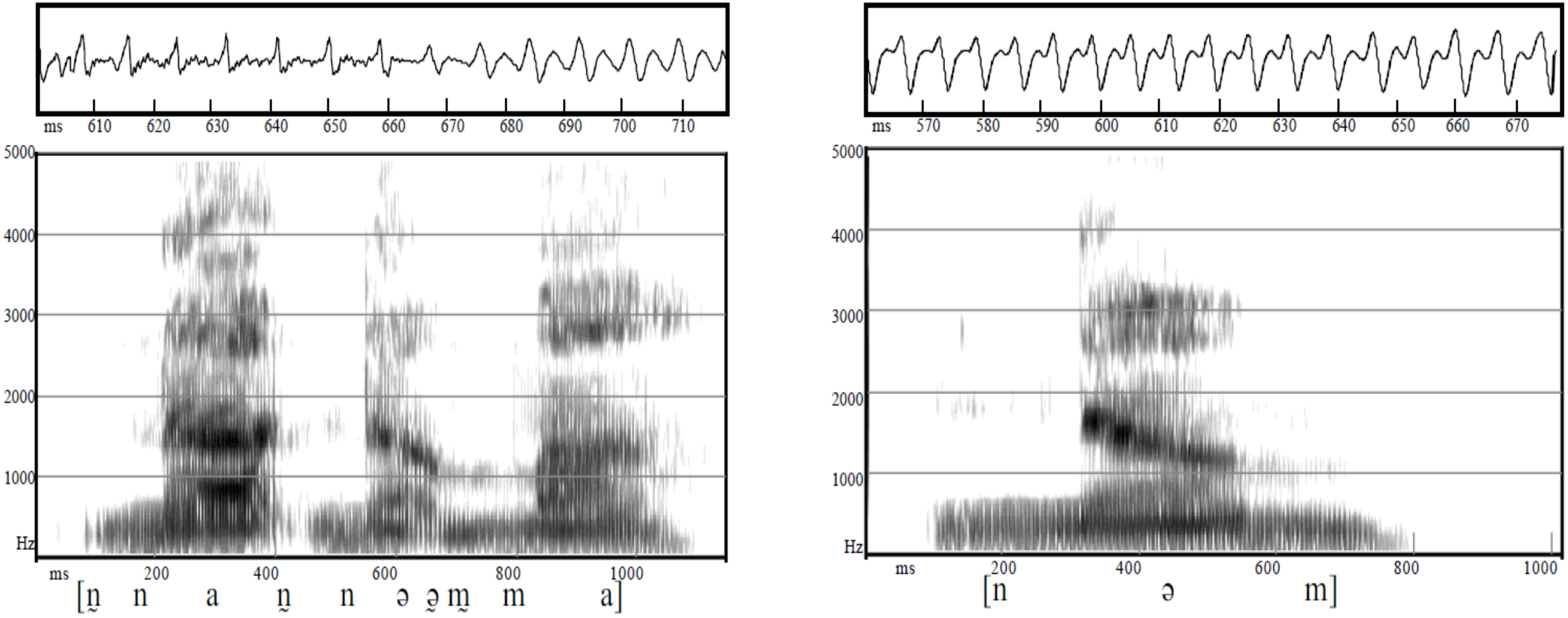
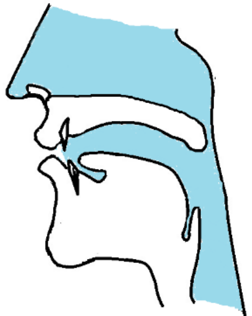
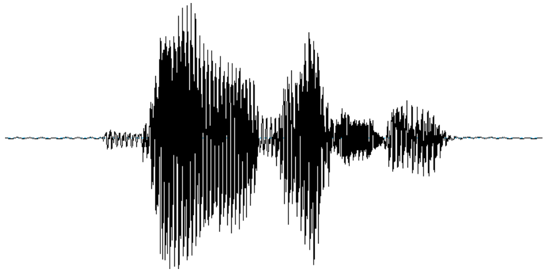


Fig. 3. Spectrograms of ***creaky*** and ***modal voiced nasals*** in the Kwakw'ala words /n̰an̰bəma̰/ 'nine' and /nəm/ 'one' (female speaker).



Creaky voice



- **Waveforms:**

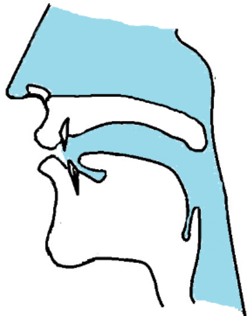
1) The ***creaky*** phonation is characterized by irregularly spaced pitch periods and decreased acoustic intensity relative to modal phonation.

2) There are fewer pitch periods per second in the ***creaky*** token than in the modal one.

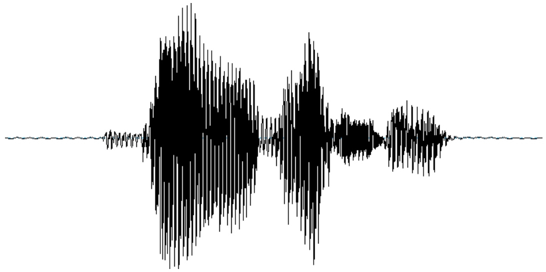
- This indicates a lowered fundamental frequency for the ***creaky nasal***.

- **Spectrograms:**

- The spectrogram on the left indicates that creak is realized primarily at the ***beginning*** of the creaky voiced nasals.
- The localization of creak to the beginning of sonorants is a common timing pattern in languages with ***creaky voiced sonorants***.



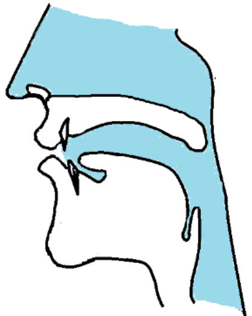
Creaky voice



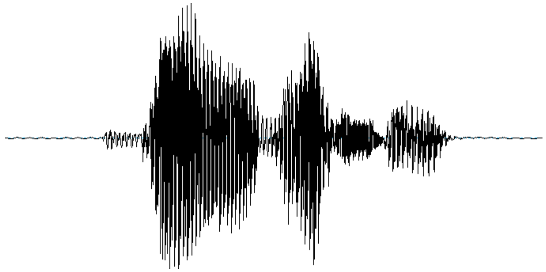
- Creaky voicing is also found among **vowels** in certain languages,
- This includes some languages which also use breathy voice to create a ***three-way phonation*** contrast. E.g. Jalapa Mazatec (Table 5).

Modal voiced		Breathy voiced		Creaky voiced	
já	‘tree’	já̤	‘he wears’	já̰	‘he carries’
ntʰǽ	‘seed’	ndǽ̤	‘horse’	ndǽ̰	‘buttocks’

Table 5. Modal, breathy, and creaky voiced vowels in Jalapa Mazatec
(Ladefoged and Maddieson 1996: 317)



Creaky voice



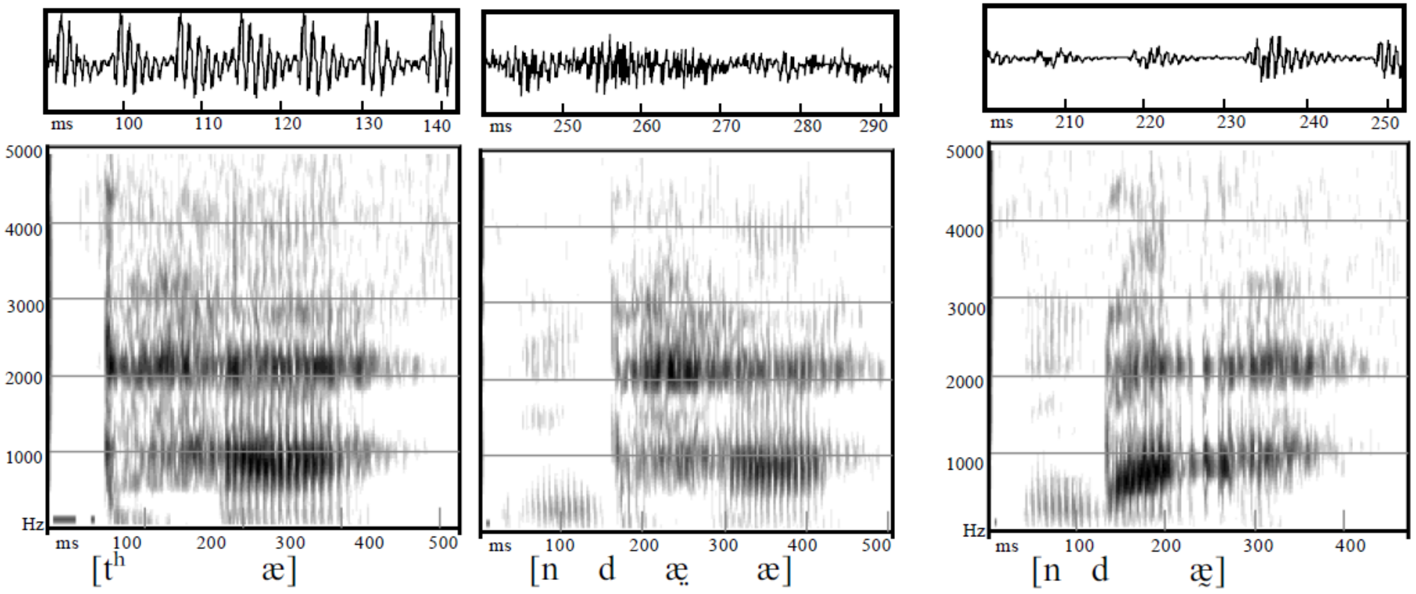


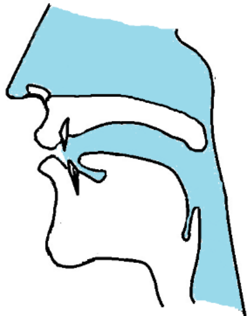
Fig. 4. Spectrograms of modal, breathy, and creaky voiced vowels in the Jalapa Mazatec words /ntʰæ/ ‘seed’, /ndǽ̤/ ‘horse’, and /ndǽ̰/ ‘buttocks’(female speaker)

- **Waveforms:**

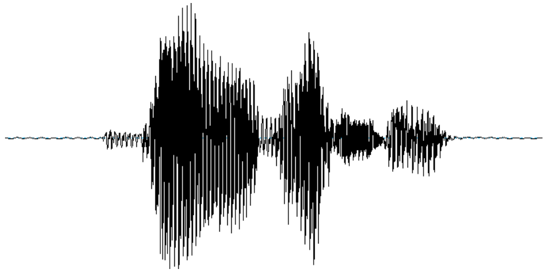
1) Both the breathy voiced and the creaky voiced vowels are characterized by decreased ***intensity*** lowered ***fundamental frequency***.
2) The breathy voiced vowel is marked by substantial ***turbulent energy.***

- **Spectrograms:**

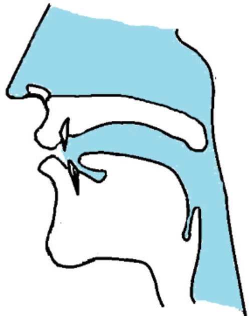
1) The breathy phase of the breathy vowel is largely localized to the ***first*** portion of the vowel.
2) In the creaky voiced vowel, creakiness is most pronounced during the middle of the vowel, as reflected in the widely spaced vertical striations reflecting ***lowered*** fundamental frequency.
3) Both the breathy and creaky vowels have greater overall duration than their modal voiced counterparts.



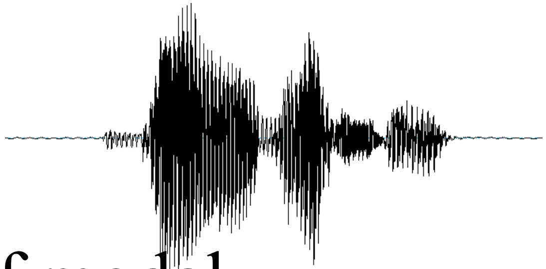
Glottal stop



- **Complete glottal closure**, entails an absence of vocal fold vibration, as occurs in the middle of the English interjection *uh-oh*.
- **Glottal stops** like the one occurring in this English example are quite common in languages of the world often contrasting with ***oral stops***, unlike in English where glottal stop is non-contrastive.
- Often phonemic glottal stops are realized as creaky phonation on neighboring sounds rather than with complete glottal closure (Ladefoged and Maddieson 1996: 75).



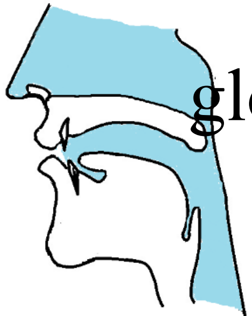
Allophonic non-modal phonation

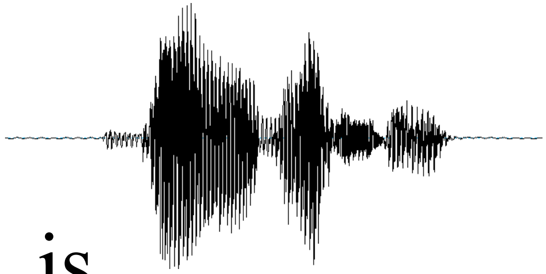


- **Non-modal phonation** types arise as allophonic variants of modal phonation in certain contexts.
- Segmentally conditioned allophonic non-modal phonation on ***vowels*** is extremely common

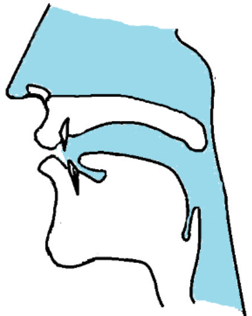
E.g. a) Allophonic breathiness is characteristically found on vowels adjacent to /h/

b) Allophonic creak is often associated with vowels adjacent to glottal stop.

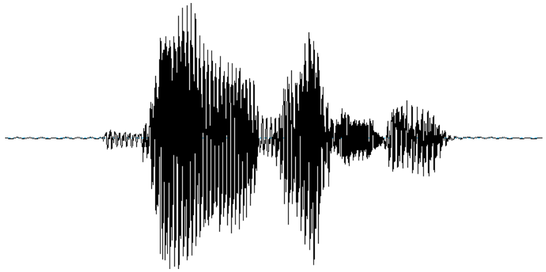




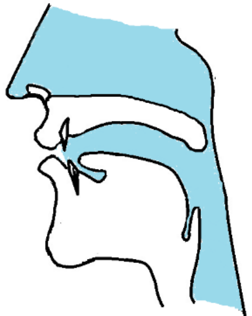
- Non-modal phonation, especially creaky voice, is commonly used cross-linguistically as a marker of prosodic boundaries, either initially and/or finally. E.g. Swedish, English, Finnish, Czech and Serbo-Croatian.
- Vowel-initial words frequently have a ***creaky onset*** in many languages



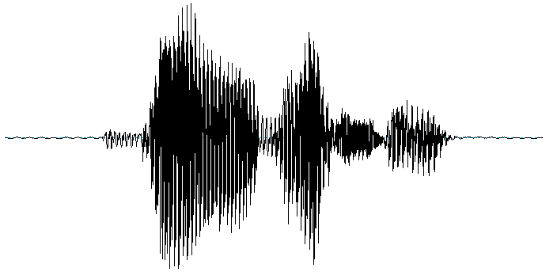
Timing of non-modal phonation in vowels



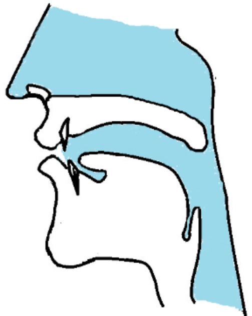
- In **Jalapa Mazatec** creakiness and breathiness are localized to a ***portion of the vowel***.
- Silverman (1995, 1997) links between the confinement of non-modal phonation to a portion of vowels and the use of contrastive tone in Jalapa Mazatec.



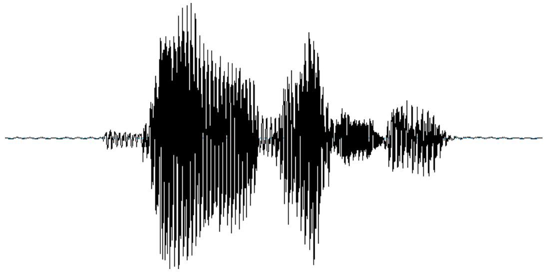
Timing of non-modal phonation in consonants

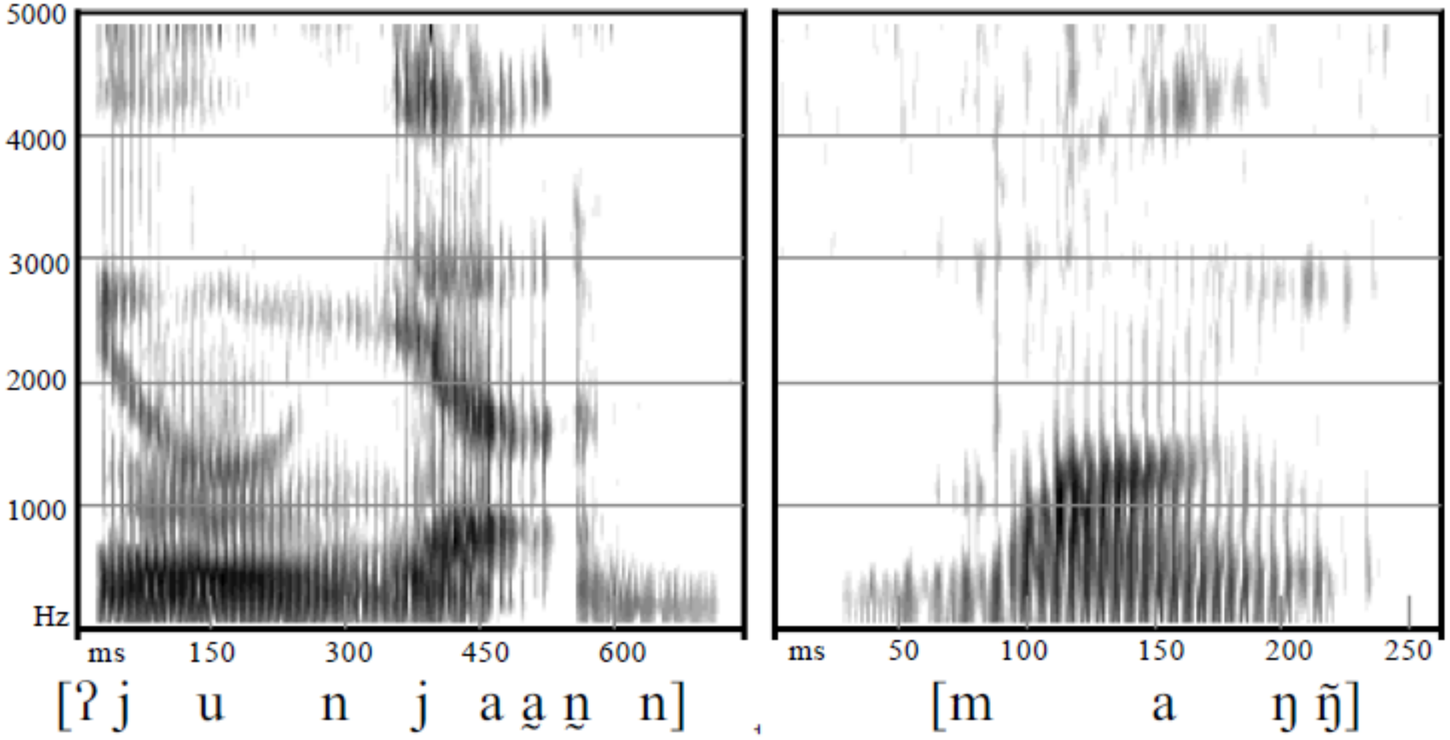


- Hupa (Golla 1970, 1977, Gordon 1996) has morphologically contrastive timing difference between ***preglottalized nasals*** in prevocalic position and ***postglottalized nasals*** in preconsonantal and final position.
- This is due to apocope process affecting final short vowels.
- Preglottalized sonorants appear in ***root-final*** position of stems which ended in a short vowel.
- while postglottalized nasals occur in ***consonant-final stems.***



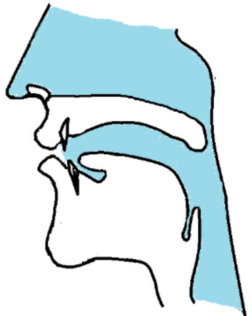
Timing of non-modal phonation in consonants



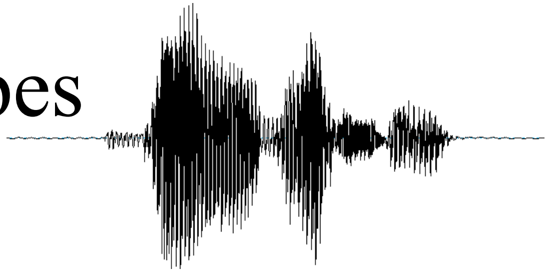


- In the **preglottalized nasal** on the left, creak is realized primarily on the end of the ***preceding vowel*** (450 to 550 msec).
- In the **postglottalized nasal** at the end of the word on the right, creak is realized at the end of the ***velar nasal*** (210 to 230 msec).

Fig. 5. Spectrograms of a pre- and post-glottalized sonorants in the Hupa words /kʲʼunjaːn̰/ (in this token, phonetically [ʔjunjaːn̰]) ‘acorn’ and /maŋ̰/ ‘fly’ (female speaker)

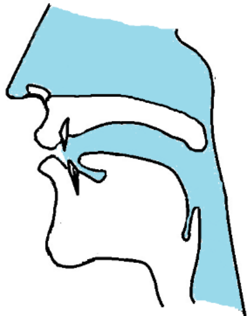


Phonetic properties associated with phonation types

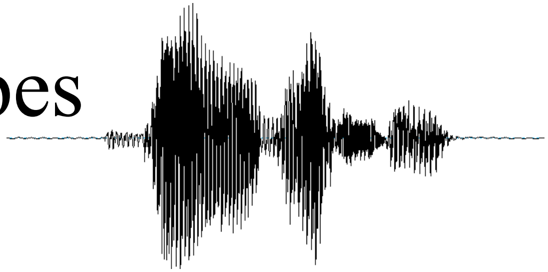


❑ Periodicity

- **Creaky phonation** is associated with ***aperiodic glottal pulses***.
- The degree of aperiodicity in the glottal source can be quantified by measuring the "jitter", the variation in the duration of successive fundamental frequency cycles.
- Jitter values are higher during ***creaky phonation*** than other phonation types, e.g. Burmese and Jalapa Mazatec.
- **Breathiness** is characterized by increased spectral noise, e.g. Newar, Jalapa Mazatec.

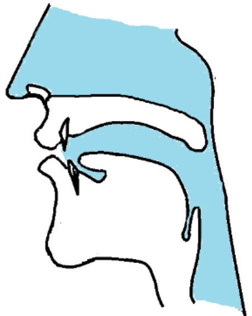


Phonetic properties associated with phonation types



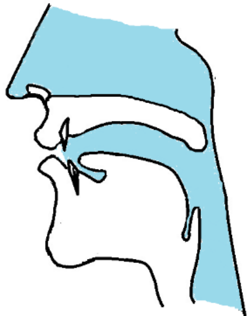
❑ Acoustic intensity

- Breathy phonation is associated with a ***decrease*** in overall acoustic intensity in many languages, e.g. Gujarati, Kui, Chong, Tsonga and Hupa.
- Creakiness also triggers a ***reduction in intensity*** in certain languages, e.g. Chong and Hupa.



Spectral tilt

- It is the degree to which intensity drops off as frequency increases.
- Spectral tilt - the amplitude to that of higher frequency harmonics. (e.g. the harmonic closest to F1, or the harmonic closest to F2).
- Spectral tilt is most steeply ***positive*** for creaky vowels and most steeply ***negative*** for breathy vowels.
- Spectral tilt differentiates phonation types in a number of languages:



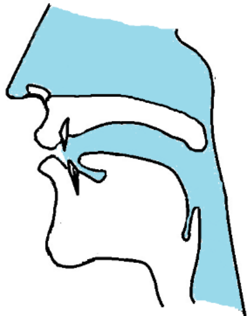
Phonetic properties associated with phonation types

3) Gujarati contrasts breathy and modal vowels (Fischer-Jørgensen 1967).

4) Kedang contrasts modal and breathy vowels (Samely 1991).

5) Hmong distinguishes breathy and modal vowels (Huffman 1987).

6) Tsonga contrasts breathy and modal nasals (Traill and Jackson 1988).



Phonetic properties associated with phonation types

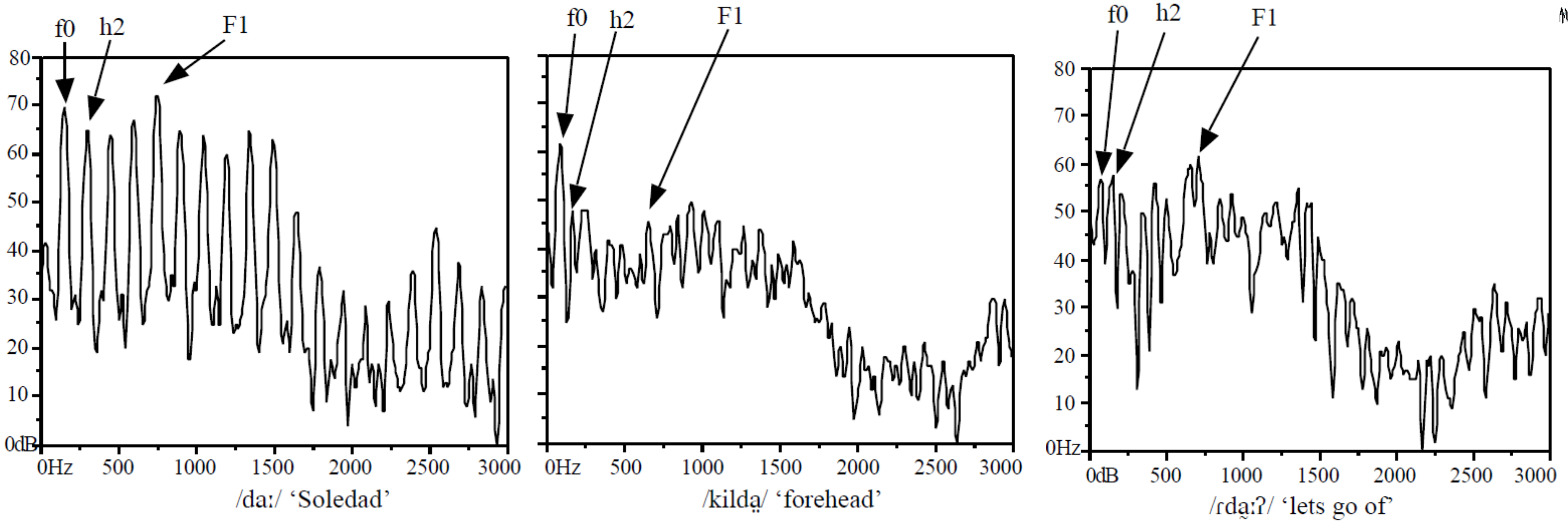
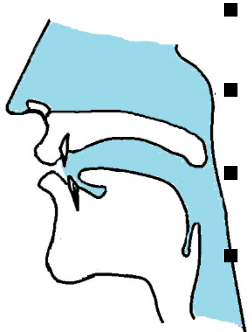
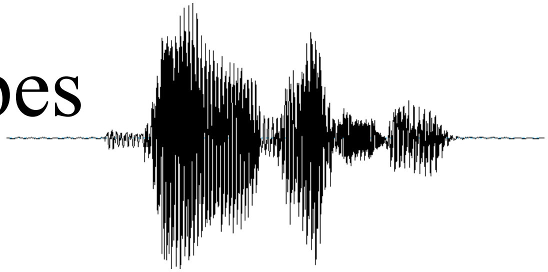


Fig. 6. FFT spectra of modal, breathy, and creaky /a/ in the San Lucas Quiaviní Zapotec words /daː/ 'Soledad', /kildḁ/ 'forehead', and /ɾdḁ̰ːʔ/ 'lets go of' (male speaker)

- In the **creaky** vowel, the amplitude of the second harmonic is slightly ***greater*** than that of the fundamental.
- In the **breathy** vowel, the amplitude of the second harmonic is considerably ***less*** than that of the fundamental.
- The **modal** vowel occupies ***middle*** ground between the creaky and breathy vowels.
- In the **breathy** vowel, the harmonic closest to F1 has much ***lower*** amplitude than the fundamental.
- In the **creaky** vowel, the harmonic closest to F1 has much ***greater*** amplitude than the fundamental.
- The **modal** vowel is ***intermediate***, characterized by very similar amplitude values for the fundamental and F1



Phonetic properties associated with phonation types

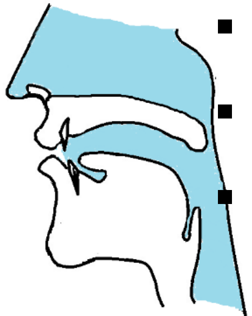


❑ Fundamental frequency

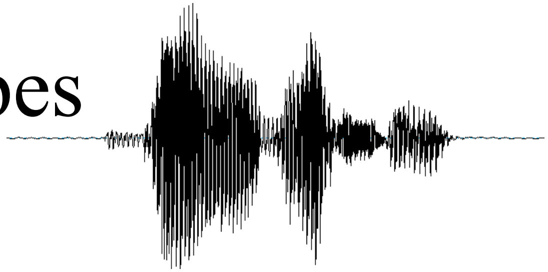
- Non-modal phonation types are associated with ***lowering*** of fundamental frequency.
- Creaky voice is associated with lowered fundamental frequency values in many languages, e.g. Mam (England 1983), Mohawk, Cayuga, and Oneida (Chafe 1977, Michelson 1983, Doherty 1993).
- This lowering effect is not universal, as certain languages have developed high tone as a reflex of glottal constriction.
- **Breathy phonation** is more consistently associated with ***lowered tone*** in the majority of languages.

❑ Formant frequencies

- Kirk et al. (1993): frequency values for F1 are ***higher*** during creaky phonation than either breathy or modal phonation in Jalapa Mazatec.
- Maddieson and Ladefoged (1985): ***raised*** F1 values for tense vowels in Haoni.
- Conversely, Thongkum (1988): breathiness is associated with a ***lowering*** of F1 in Chong.
- Samely (1991): breathy vowels have ***lower*** F1 and F2 values than modal vowels in Kedang.



Phonetic properties associated with phonation types

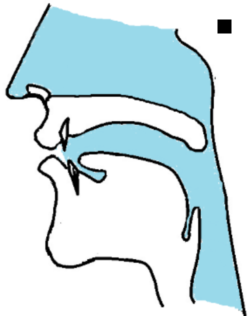


❑ Duration

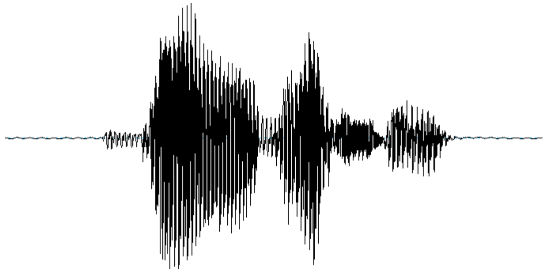
- Non-modal phonation types in some languages are associated with ***increased duration***.
- Breathy vowels are ***longer*** than modal vowels, e.g. Kedang (Samely 1991) and Jalapa Mazatec (Kirk et al. 1993, Silverman et al. 1995).
- Creaky vowels are ***longer*** than modal vowels, e.g. Jalapa Mazatec (Kirk et al. 1993, Silverman et al. 1995).
- Non-modal phonation may occur on ***phonemic long vowels*** but not on phonemic short vowels, e.g. Hupa (Golla 1970, 1977, Gordon 1998).

❑ Aerodynamic properties

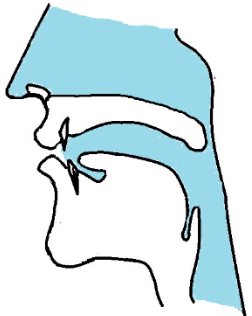
- Ladefoged and Maddieson's (1985) (Jingpho, Wa, Yi, Haoni): tense vowels in the four languages are generally associated with less airflow for a given subglottal pressure than the lax vowels.
- Tense vowels are associated with a more constricted glottis that allows less air flow.

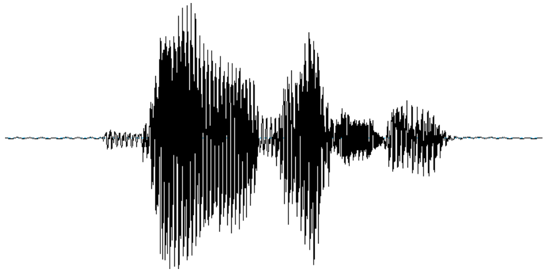


Conclusion



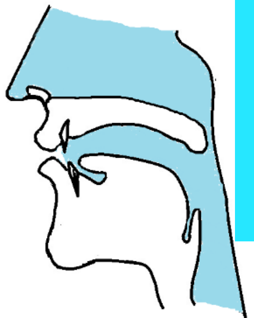
- Many languages employ distinctions which rely on differences in ***voice quality***.
- These distinctions may involve two or more different phonation types and may affect consonants, vowels, or both ***consonants*** and ***vowels***.
- Other languages use ***non-modal phonation*** types as variants of modal voice in certain prosodic contexts.
- Languages differ in their ***timing*** of non-modal phonation relative to other articulatory events.
- Differences in phonation type can be signaled by a large number of quantifiable ***phonetic properties*** in the acoustic, aerodynamic, and articulatory domains.



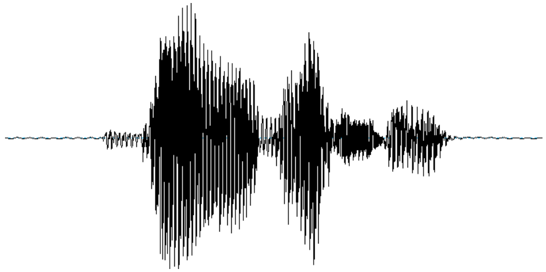


Vowel inventories

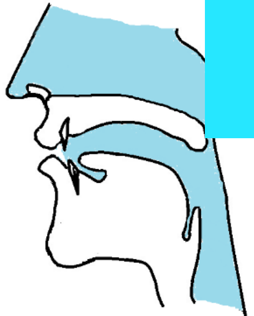
- Basic set of five vowels which contrast in backness, roundedness, height
- Triangular (most common)
- … vs. vertical systems --- Northwest Caucasian, Arandic, Chadic
  - height contrast is important

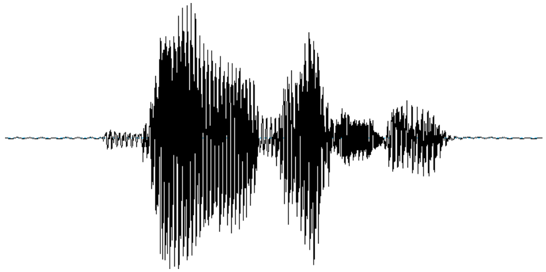


Vowel inventories



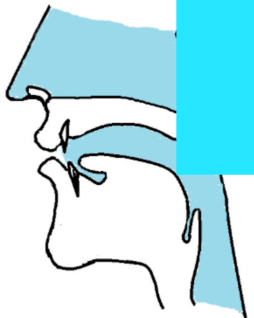
- roundedness is not preferred for contrast
- A small minority of languages have front rounded or back unrounded vowels
- Nasalization
- pharyngealization
- length

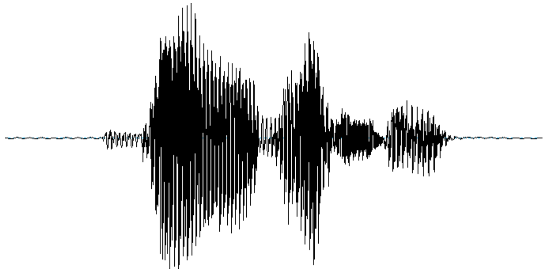




Pragmatic requirements

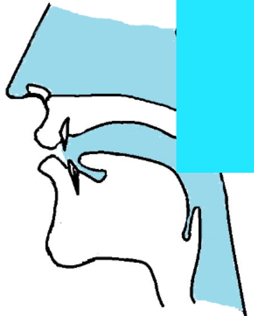
- Maddieson: “Pervasive pragmatic requirements for efficient communication”; “better balance between … relative ease of articulation and relative perceptual salience”

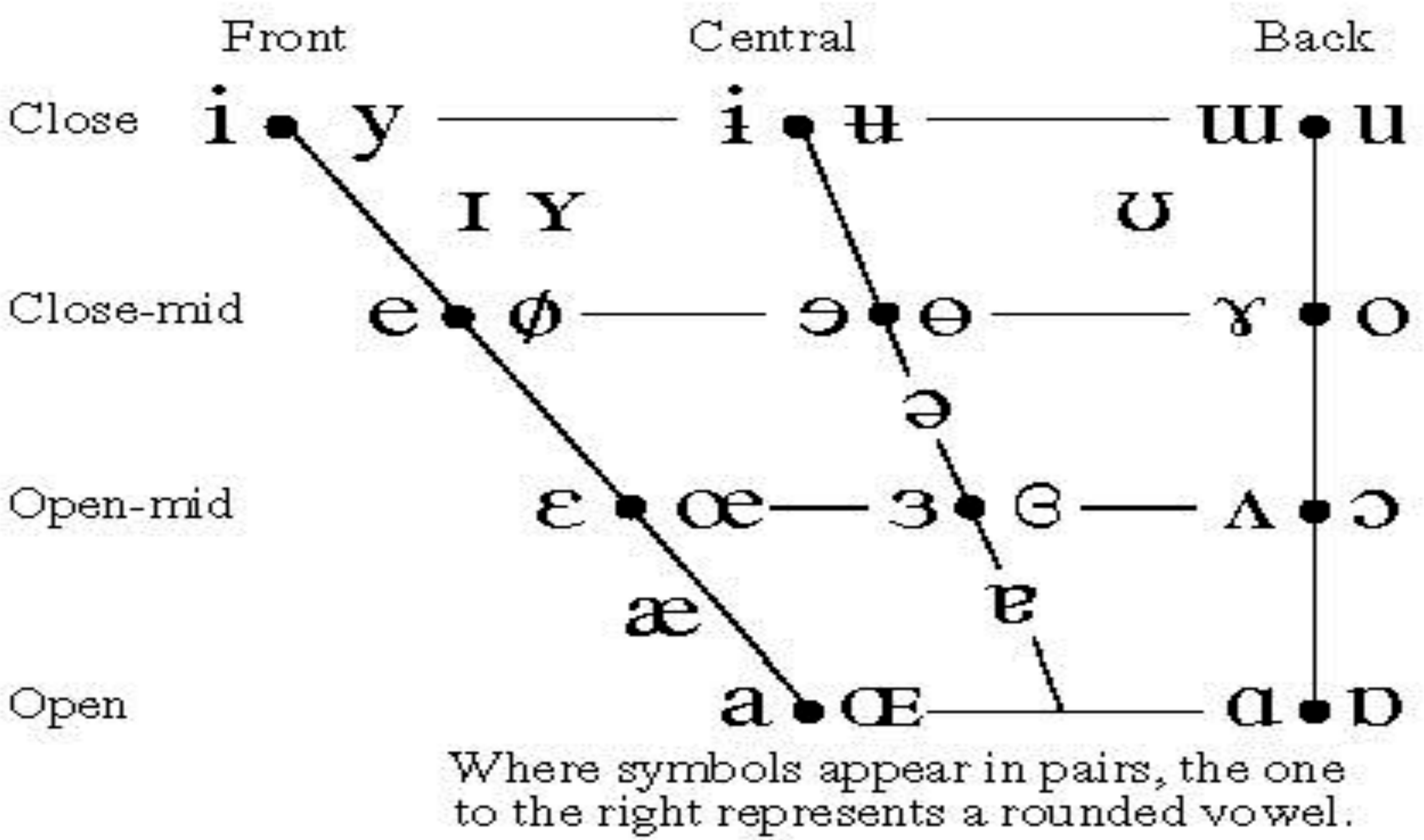




vowels

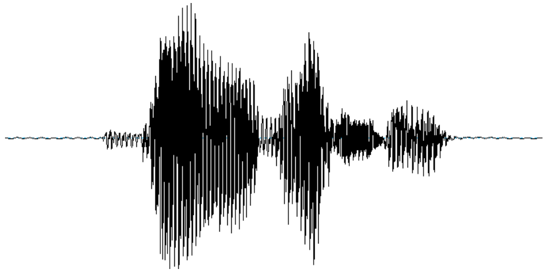
- Front vowel rounding
- Nasal vowels
- Central vowels





note: close = high, open = low, etc...

- There are also combinations of gestures for vowels that English doesn’t use

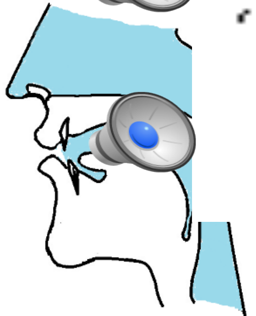


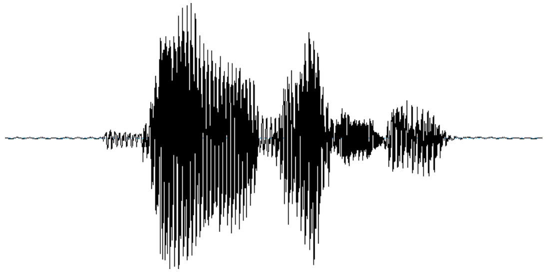
• Dutch has vowels that are both front and rounded

Dutch

(West Coast dialect)

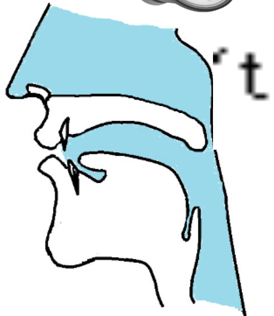
Front: unrounded	Front: rounded	Back
bit 'beet'	byt (game word)	but 'repent' [imper.]
bɪt 'bit'		
bet 'bit' [pt.]	pøt 'turpentine'	bot 'boat'
bɛt 'bed'	pœt 'ditch'	bɔt 'bone'

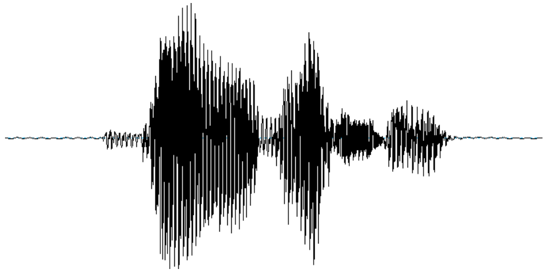




- Vietnamese has vowels that are back and unrounded.

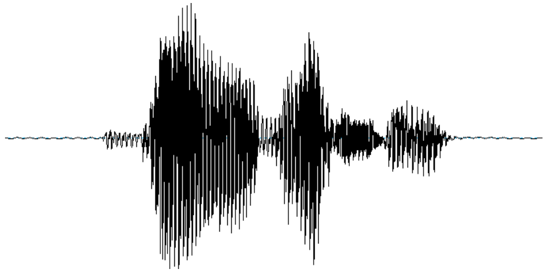
ti ‘bureau’	tɯ ‘fourth’	tu ‘to drink’
te ‘numb’	tɤ ‘silk’	to ‘soup bowl’
tɛ́ ‘to fall down’	ʌŋ ‘favor’	tɔ ‘large’





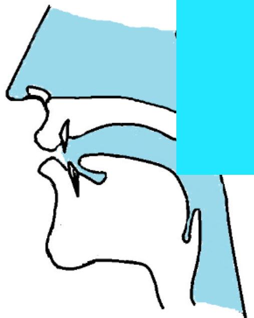
- Air can flow through the nose during a vowel, too.
- Examples from French:

le	lø	lo		lõ
‘the [pl.]’	‘the [m.sg.]’	‘prize’		‘long’
lɛ	lœʁ	lɔʁ	lɛ̃	lœ̃di
‘ugly’	‘their’	(name)	‘flax’	‘Monday’
la		lɑ	lɑ̃	
‘there’		‘tired’	‘slow’	

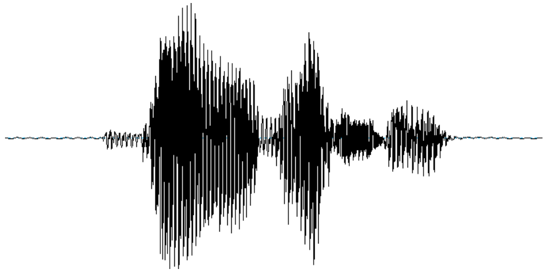


Length distinction

- In vowels only
- In consonants only (gemination)
- Both vowels and consonants



Tone



- When pitch enters into lexical distinction
- Creating difference in meaning because of pitch is called tone
- There are more tone languages in the world than non-tonal languages
- Mandarin has five tones