The sounds of language

PHONETICS AND PHONOLOGY

Study of speech sounds

- Which part of linguistics studies speech sounds (phones)?
- Phonetics

Phonetics

- How are speech sounds made?
- How does sound travel through the air?
- How is it registered by the ears?
- How can we measure speech?

Phonetics

- Articulatory phonetics: Place and manner of articulation
- Acoustic phonetics
- IPA transcription
- Suprasegmentals

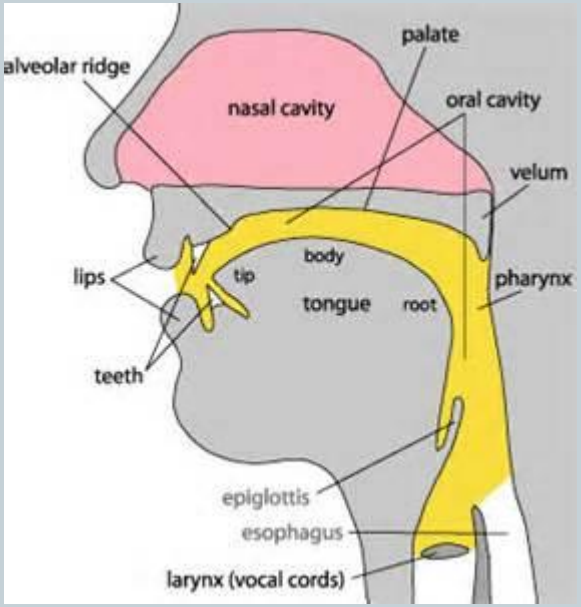
Introduction

- What is a sound?
- How are sounds produced?

The vocal tract

- The sound: vibrating air
- Speaking means using your vocal tract (lungs, trachea, larynx, mouth and nose) to get air moving and vibrating
- Most speech sounds made with air exiting the lungs: speech begins with breath: egressive pulmonic sounds (most languages)
- (Ingressive pulmonic sounds: clicks, implosives)

Vocal tract


palate
alveolar ridge
nasal cavity
oral cavity
velum
body
lips
tip
pharynx
tongue
root
teeth
epiglottis
esophagus
larynx (vocal cords)

The vocal tract

- At the top of the trachea is larynx (Adam's apple)
- Inside the larynx there are two folds of soft tissue – vocal chords
- If the vocal chords are held in the correct position with the correct tension, the air flowing out of the trachea causes them to flap open and closed very quickly (200 times per second)

The vocal tract

- Find your larynx and hum a tune: muscles attached to the cartilages of the larynx allow you to adjust the tension of vocal chords, adjusting the rate of vibration and raising or lowering the pitch
- The faster the vibration, the higher the pitch of the voice
- Other muscles allow you to draw the folds apart so that no vibration occurs

The vocal tract

- Just above the larynx, at the base of the tongue, is the epiglottis – a muscular structure that folds down over the larynx when you swallow to prevent food from going down into the lungs
- The payoff for the risk of a larynx located low in the throat is an open area at the back of the mouth, the pharynx
- The pharynx allows the tongue front and back movement

The vocal tract

- Other mammals, including nonhuman primates, have the larynx high up at the back of the mouth, connected to the nasal passages
- Because they have no pharynx, chimps could never learn to talk
- Inside the mouth: active articulators and passive articulators

The vocal tract

- Active articulators: lips and the tongue
- Passive articulators : alveolar ridge, the postalveolar region, the hard palate, the soft palate (velum)

Articulation

- Sounds produced with vocal fold vibration – **voiced**, those produced without vibration – **voiceless**
- **(**Place your finger on your larynx and produce prolonged [z], then produce [s])

Articulation

- For some sounds, the vocal folds are held apart far enough and long enough to produce an extra "puff of air" to exit the mouth (*pop, pill)* – **aspiration –** **(**hold your fingertips in front of your lips)
- If the velum is open, so that air flows into the nose, the sound is **nasal**: [m, n, ng]; if the velum is closed, the sound is **oral**

Consonants

- Obstruction of the air flow: consonants
- There are different ways of stopping the air flow, depending on which part(s) of your vocal tract you use to stop it: the **place of articulation**, and on the manner in which you stop it: **manner of articulation**
- Focusing on places and manners of articulation gives us the phonetic features of sounds we make in producing spoken language

Place of articulation (English consonants) :

- Bilabial: [p], [b], [m]
- Labiodental: [f], [v]
- Dental [ð], [θ]
- Alveolar: [t], [d], [n], [l], [s], [z]
- Palatoalveolar: [ʃ] , [ʒ] [tʃ] , [dʒ]
- Palatal: /j/
- Velar: /k/, /g/, [ŋ]
- Labiovelar: /w/
- Laryngeal: /h/

Manner of articulation

- Place of articulation combines with other features involving how the sounds are produced

Stops/ Plosives

- Air flow is completely stopped:
- [p], [t], [k] : *voiceless* (also: *plosives*); [b], [d], [g] : *voiced ;* [m] – nasal stop

Approximants

- Air is partially obstructed as it flows through the vocal tract: w, j, r, l

Fricatives

- The air flow is never completely obstructed:
- [s], [z], [f], [v]
-

Affricates

- A sound begins as a plosive and ends as a fricative:
- [tʃ] , [dʒ]

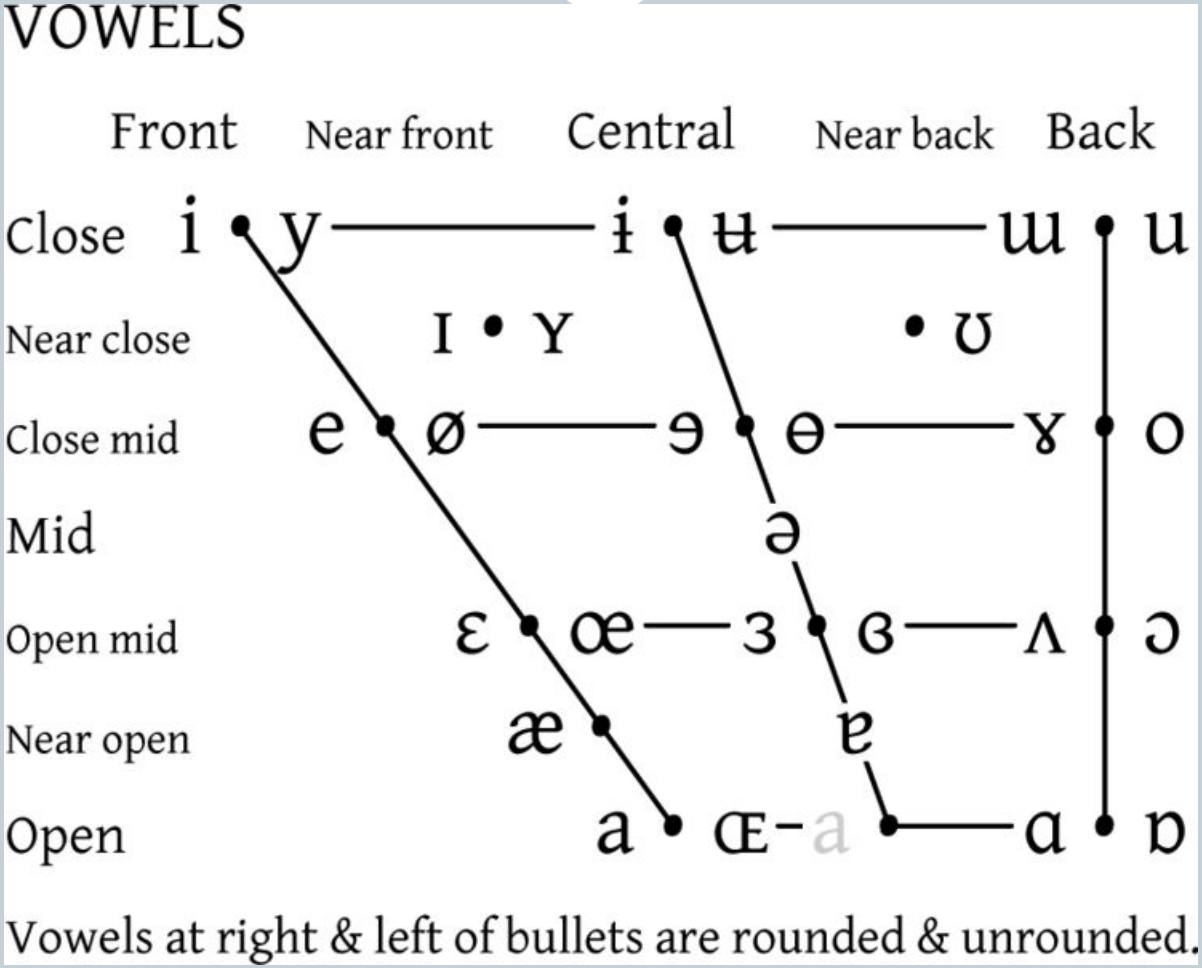
Manner of articulation

- Stops (also: *plosives*) : [p], [t], [k] : *voiceless*; [b], [d], [g] : *voiced ;* [m] – nasal stop
- Fricatives: [s], [z], [f], [v]
- Affricate (stop+fricative): [tʃ] , [dʒ]
- Approximant : [j], [w], [l], [r]

Place of articulation: Vowels

- Vowels – an open vocal tract, so the tongue does not touch the upper surface of the vocal tract at any particular place
- Vowels – described in terms of the ways in which the tongue body and lips move
- Classified by the height of the tongue body, whether it is bunched toward the front or back of the mouth, and whether the lips are rounded

English vowels



Transcription

- In 1888 the International Phonetic Association tackled the problem of how to precisely describe any sound the members might encounter in their efforts to describe all languages of the world
- They published symbols for the new alphabet – International Phonetic Alphabet (IPA) based on two principles:
- The alphabet would be universal
- The alphabet would be unambiguous (1 sound 1 symbol)

THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993, updated 1996)

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q G		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	N		
Trill	B			r					R		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks		Voiced implosives		Ejectives	
ʘ	Bilabial	ɓ	Bilabial	’	Examples:
ǀ	Dental	ɗ	Dental/alveolar	pʼ	Bilabial
ǃ	(Post)alveolar	ʄ	Palatal	tʼ	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	kʼ	Velar
ǁ	Alveolar lateral	ʛ	Uvular	sʼ	Alveolar fricative

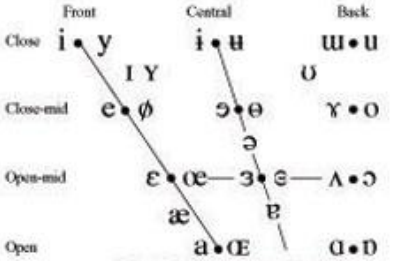
OTHER SYMBOLS

- ʍ Voiceless labial-velar fricative
- w Voiced labial-velar approximant
- ɥ Voiced labial-palatal approximant
- ʜ Voiceless epiglottal fricative
- ʢ Voiced epiglottal fricative
- ʡ Epiglottal plosive
- ʗ ʖ Alveolo-palatal fricatives
- ɺ Voiced alveolar lateral flap
- ʧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary.

k͡p t͡s

VOWELS



Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

- ˈ Primary stress
- ˌ Secondary stress ˌfoʊnɔˈtɪʃən
- ː Long eː
- ˑ Half-long eˑ
- ˘ Extra-short ĕ
- | Minor (foot) group
- ‖ Major (intonation) group
- . Syllable break ɹi.ækt
- ‿ Linking (absence of a break)

TONES AND WORD ACCENTS

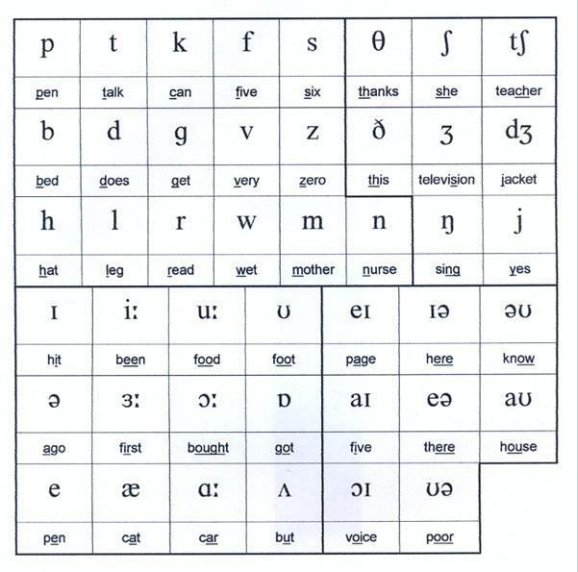
LEVEL		CONTOUR	
˩̋ or ˥	Extra high	˨˩ or ↗	Rising
˦ or ˧	High	˥˩ or ↘	Falling
˧	Mid	˩˥	High rising
˨ or ˩	Low	˧˩	Low rising
˩̏ or ˩	Extra low	˥˩˧	Rising-falling
↓	Downstep	↗	Global rise
↑	Upstep	↘	Global fall

DIACRITICS

Diacritics may be placed above a symbol with a descender, e.g. n̥

◌̥	Voiceless	n̥ d̥	◌̤	Breathy voiced	b̤ a̤	◌̪	Dental	t̪ d̪
◌̬	Voiced	s̬ t̬	◌̰	Creaky voiced	b̰ a̰	◌̺	Apical	t̺ d̺
◌ʰ	Aspirated	tʰ dʰ	◌̼	Linguolabial	t̼ d̼	◌̻	Laminal	t̻ d̻
◌̹	More rounded	ɔ̹	◌ʷ	Labialized	tʷ dʷ	◌̃	Nasalized	ẽ
◌̜	Less rounded	ɔ̜	◌ʲ	Palatalized	tʲ dʲ	◌ⁿ	Nasal release	dⁿ
◌̟	Advanced	u̟	◌ˠ	Velarized	tˠ dˠ	◌ˡ	Lateral release	dˡ
◌̠	Retracted	e̠	◌ˤ	Pharyngealized	tˤ dˤ	◌̚	No audible release	d̚
◌̈	Centralized	ë	◌̴	Velarized or pharyngealized	ɫ			
◌̽	Mid-centralized	e̽	◌̝	Raised	e̝	(ɹ̝ = voiced alveolar fricative)		
◌̩	Syllabic	n̩	◌̞	Lowered	e̞	(β̞ = voiced bilabial approximant)		
◌̯	Non-syllabic	e̯	◌̘	Advanced Tongue Root	e̘			
◌˞	Rhoticity	ɚ a˞	◌̙	Retracted Tongue Root	e̙			

IPA Chart (English)



p	t	k	f	s	θ	ʃ	tʃ
pen	talk	can	five	six	thanks	she	teacher
b	d	g	v	z	ð	ʒ	dʒ
bed	does	get	very	zero	this	television	jacket
h	l	r	w	m	n	ŋ	j
hat	leg	read	wet	mother	nurse	sing	yes

ɪ	iː	uː	ʊ	eɪ	ɪə	əʊ
hit	been	food	foot	page	here	know
ə	ɜː	ɔː	ɒ	aɪ	eə	aʊ
ago	first	bought	got	five	there	house
e	æ	ɑː	ʌ	ɔɪ	ʊə	
pen	cat	car	but	voice	poor	

Suprasegmentals

- Speaking involves stringing sounds together into larger units
- Aspects of speech that influence stretches of sound larger than a single segment - suprasegmentals

Suprasegmentals

- Length,
- tone,
- intonation,
- syllable structure
- stress

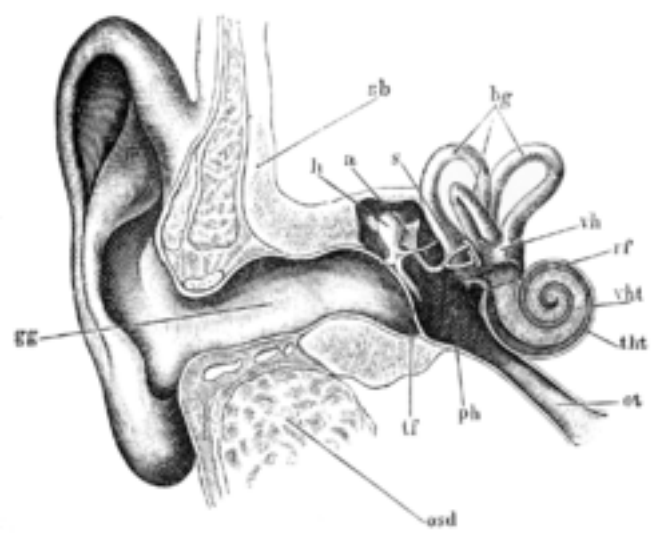
Acoustic phonetics

- In order to understand how people use sound to communicate, we must understand how articulators turn air movements into sound, what happens to sound after it passes through the lips, how it travels through the air, and how it impacts on the ears and the brain of those who listen

Sound waves

- Articulation is about getting air to move
- Moving patterns of vibration – **sound waves**
- When the sound waves reach our ears they set the eardrum vibrating according to the same pattern
- Inside the ear, the vibrations set off nerve impulses, which are interpreted by our brain as sound

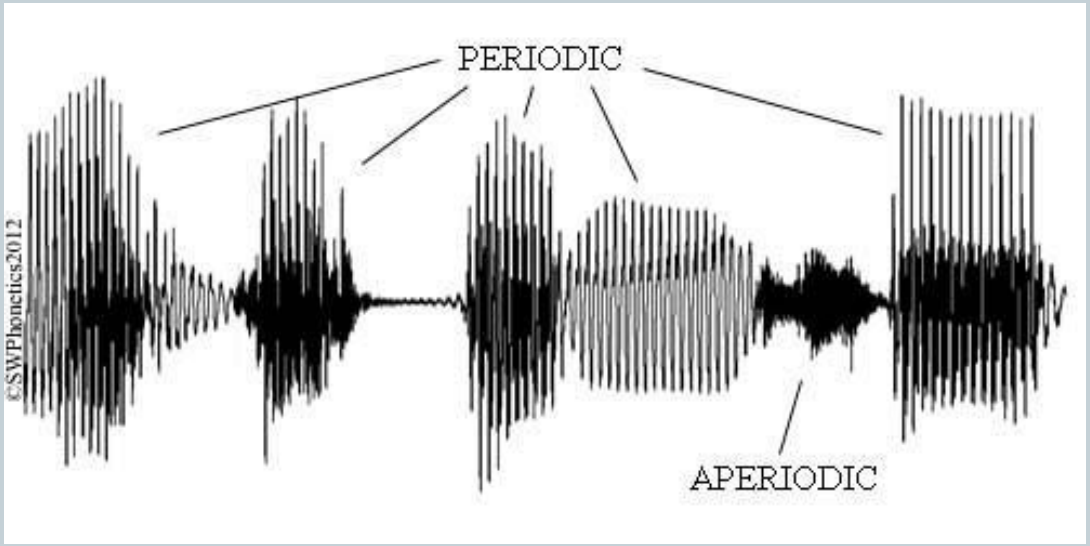
Hearing



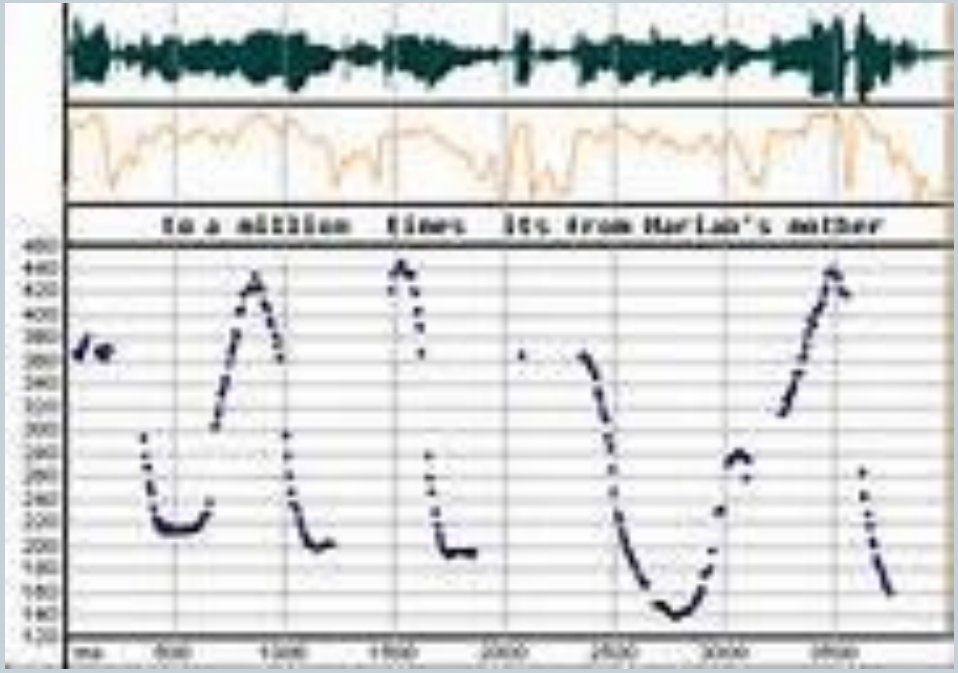
Measuring speech

- Speech analysis done by computer
- Microphones convert the vibration of the membrane into variations in electrical current
- Once represented and stored in a digital format, sound files can be matematically analyzed to separate out the diferent frequencies

Waveform for the utterance “not got room for”



Pitch track



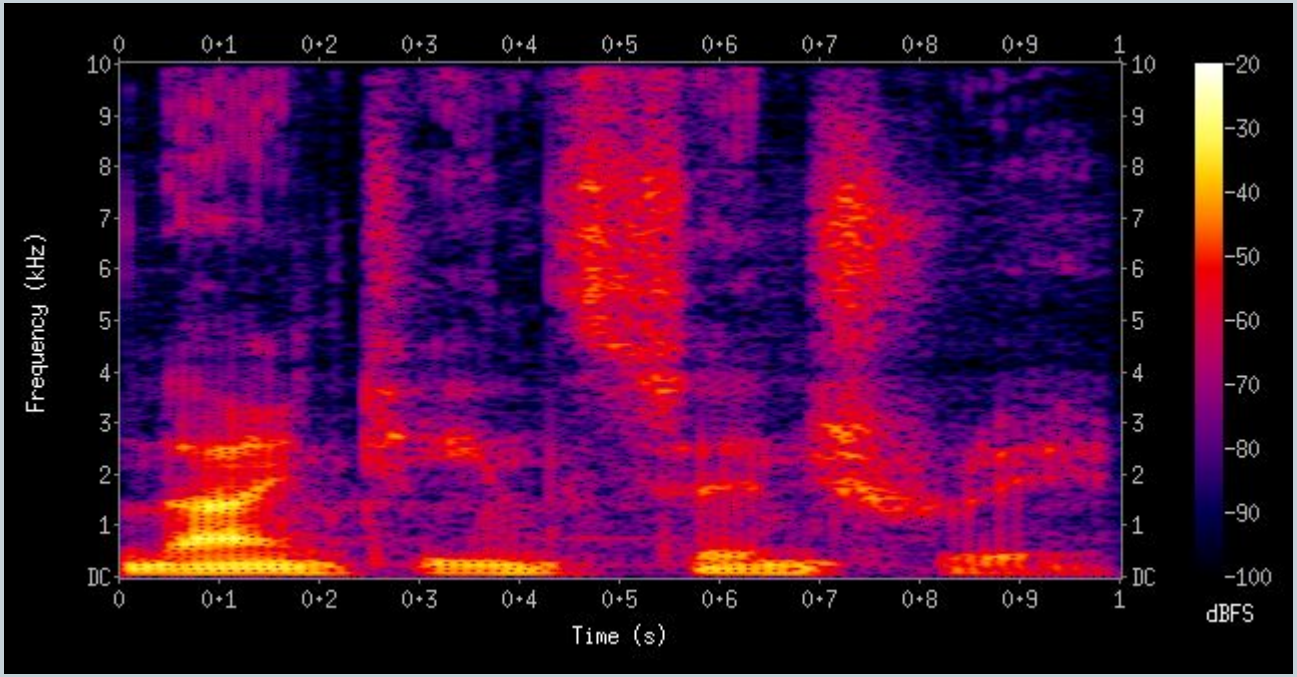
Spectrogram

- The computer can further analyze the sound wave to separate its component frequencies
- Instead of a single line graph, we see a complicated pattern of the many frequencies present in each sound

Spectrogram

- Each vowel has a pattern of two or three most prominent frequencies, which are called formants, above the fundamental frequency of the speaker's vocal folds
- Because every person's vocal tract size and shape is unique, every person's formant structure is unique too. We recognize familiar voices, regardless of what they are saying and in the hands of an expert, a spectrographic voice print is almost as unique as a fingerprint

Spectrogram



Sounds

- Every sound – composed of smaller components that can be combined in different ways to make other sounds, and each component offers a typically binary opposition:
- voiced or voiceless,
- nasal or oral,
- open or closed,
- front or back etc.

Phonemes

- Related to each other: some sets of sounds differ only by changing one parametar, others in several parameters
- These parameters – **distinctive features** – important in describing sound patterns within a linguistic system

Phonology

- When we turn from analyzing physical aspects of speech sounds to studying their cognitive organization, we move from phonetics to phonology

Distinctive features

- Phonemes of all languages may be described in terms of differing subsets of distinctive features

Phonemes and allophones

- Pairs of words that differ in only a single sound in the same position – **minimal pairs**
- The existence of minimal pairs means that the difference between the two sounds is **contrastive**: change one sound into another and you've created a contrast in meaning (i.e. it's a different word)
- **Examples:** *pat – bat*
- *Pit-bit*
- *Cup-cub*

Phonemes and allophones

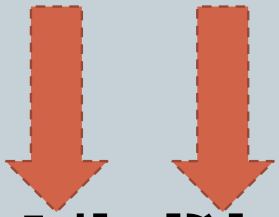
- Phonemes - underlying abstract mental representations that we hold in our linguistic repertoire of meaningful sounds
- allophones - the actual soundings of those representations

Phonemes and allophones

- When two sounds form minimal pairs (i.e., their distribution is unpredictable and contrastive), those sounds represent different **phonemes**
- When two sounds are in complementary distribution (i.e. their distribution is predictable and non-contrastive), the two sounds are **allophones** of the same phoneme; in English [d] and [ð] – different phonemes; in Spanish [d] and [ð] – allophones of the same phoneme

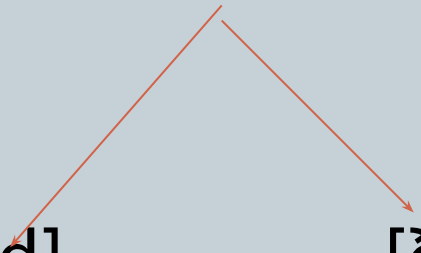
Phonemes and allophones

- English:
- /d/ /ð/



- [d] [ð]

- Spanish:
- /d/



- [d] [ð]
- Word-initial between vowels
- Phonemes – indicated by slashes, allophones by brackets
- At the allophonic level, English and Spanish have the same sounds; at the phonemic level, English has a contrast where Spanish has none

Phonemes and allophones

- Differences in phonemic and allophonic distribution pose significant problems for language learners: a native speaker of Spanish learning English will have trouble with the distinction between *den* and *then*

Phonological theory

- Phonologists don't want to know just "What is the inventory of sounds in Polish" but "What is the inventory of sounds in any language?"
- They want to know not just "How are Russian and Ukrainian different?" but "How different can languages be?"
- Distinctive feature theory aims to encode all the phonetic dimensions that languages have available to encode contrasts and natural classes