

Phonetics: Study of Sounds

October 4, 2017

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1 Phonetics

Phonetics is the study of sound. There are two main types of phonetics.

- **Acoustic Phonetics** deals with the physical properties of sounds. It analyses any kind of sound from guitar notes to birds chirping.
- **Articulatory Phonetics** is interested in human speech production. It focuses on how air from the lungs is turned into sound. OR, it focuses on handshape, orientation, movement, location, etc. in sign languages.

We will be focusing on **articulatory phonetics** rather than acoustic phonetics.

2 Sound & Segments

Sound is some sort of a physical wave. It has physical reality.

Our auditory mechanisms (ears etc.) are designed for converting sound waves into electrical signals. The mind (wherever it is) interprets these physical signals and determines whether a piece of sound wave contains speech sounds or not.

Sound segments

- The smallest pieces of sound used in language are called segments.

(1) [p, s, t, z, a, i, etc.]

Human language capacity makes it possible for us to decompose sound waves into meaningful units.

Question

- How do we know whether a piece of sound wave is a segment or not?

Answer

- Errors in speech are helpful.

- (2) a. welcome mat vs. melcome wat
b. ask vs. aks

- **Minimal pairs** are definitely helpful.

- (3) a. pin vs. bin
b. cat vs. mat

3 Perception of Sound

How do we perceive speech sounds?

(Un)fortunately, human beings are quite biased in speech perception. Our minds have a grammar (remember it includes phonetics). The sound waves are interpreted based on our inventory of speech segments in the grammar that we have. We try to match our inventory of speech sounds with the waveforms. However, this is not always successful. We might be biased towards what we already know.

For example:

I can find you some people who would swear that these words sound the same.

- (4) a. wander vs. wonder
b. law vs. raw

Bias does not always stem from knowledge of the grammar though. Physical inputs other than sound can cause bias as in McGurk effect.

4 Airstream Mechanisms

- Pulmonic airstream mechanism uses lungs as the air compressor.
- Glottalic airstream mechanism uses the glottis as the air compressor.
- Egressive mechanisms push air out.
- Ingressive mechanisms pull air in.

English uses **pulmonic egressive** airstream mechanism.

There are languages that can use a combination of these mechanisms. Georgian, for example, uses glottalic egressive mechanism to produce some ejective sounds like [kʰ].

5 Orthography

Orthography is the way we write down words. In many languages orthography reflects the phonetics but in many others it does not.

For example

- (5) thing

“thing” is a word in English. (5) is the orthographic representation of the word. There are **five** letters in the orthographic form. Orthography is the only place where we will use **letters**.

Phonetics (and language in general) does not care about orthography at all. The phonetic form of the word above is [θɪŋ]. It has **three** sound segments (phones).

We aren't studying orthography. Just beware that phonetics cares about what you say or hear but not what you write down. We could be using pictures or other symbols to describe words. In other words, when doing phonetics, **forget about letters focus on sounds**.

6 Production of Speech Sounds

Remember, we said "The smallest sound piece used in language is a segment."

(6) [p, s, z, l, u, a, θ, ð, ŋ, ...]

However, sound segments are not atomic. We can further analyze sound segments and see what **features** they are composed of. Vowels and Consonants are composed of different features.

Consonants

(7) [p, b, t, d, s, z, f, v, l, r, k, g, j, n, m, h, w, ʃ, ʒ, ð, θ, ŋ, ʔ, ɾ, tʃ, dʒ] Consonants in English

A consonant consists of at least three features.

- (8) **Features/ Feature Types**
- a. Place of articulation
 - b. Manner of articulation
 - c. State of glottis

Place of articulation

- **Bilabial:** Produced with the closure of both lips
- **Labio-dental:** Produced with the upper lip and the lower teeth
- **Interdental:** Produced with the tongue touching the upper teeth
- **Alveolar:** Produced with the tongue touching the alveolar ridge
- **Alveo-palatal:** Produced with the tongue touching the area between the alveolar ridge and palate
- **Palatal:** Produced with the tongue touching the palate
- **Velar:** Produced with the tongue touching the velum
- **Glottal:** Produced with a constriction in the glottis

Manner of articulation

- **Stop:** Sounds produced with a complete constriction of air flow in the mouth
- **Fricative:** Sounds produced with a friction of air in the mouth
- **Affricate:** Sounds produced with a delayed release of the air in the mouth
- **Nasal:** Sounds produced with airflow through the nose
- **Liquid:** Laterals and rhotics. [l] and [r]
- **Glide:** Sounds that are produced with almost no friction.

State of glottis

Depends on the vibration of the vocal folds.

- **Voiced:** Vocal folds are relaxed and cause vibration
- **Voiceless:** Vocal folds are tightened and cause no vibration

Practice Identify the features of the sounds below.

[k] : voiceless velar stop	[t] :
[s] :	[ʃ] :
[j] :	[ŋ] :
[m] :	

Vowels

(9) [i, ɪ, e, ɛ, æ, ə, ʌ, ɑ, ɔ, ʊ, u, ʊ]

Vowels in English

Each vowel is created by a mixture of the position of tongue, status of lips, and the status of the tongue root.

Features are

- Height: Vertical position of the tongue
- Backness-Frontness: Horizontal position of the tongue
- Lip Rounding
- Tongue Root

Height

High	[i, ɪ, u, ʊ]
Mid	[e, ɛ, ə, ʌ, ɔ, ɔ]
Low	[æ, ɑ]

Backness-Frontness

Front	[i, ɪ, e, ɛ, æ]
Central	[ə, ʌ]
Back	[u, ʊ, o, ɔ, ɑ]

Lip Rounding

Rounded	[u, ʊ, o, ɔ]
Unrounded	[i, ɪ, e, ɛ, æ, ə, ʌ, ɑ]

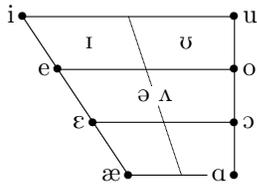
Tongue Root

Tense	a.k.a +ATR (advanced tongue root)	[i, e, u, o]
Lax	a.k.a. -ATR	[ɪ, ɛ, ʊ, ɔ]

Diphthongs

Diphthongs are vowels produced by combination of a vowel and a glide. There are (about) 5 diphthongs in English. For the sake of ease, we will use only 3 of them. Just beware that these are not the only diphthongs in English. You can look them up in your book if you are interested. We'll assume that all diphthongs are Tense (+ATR).

[ɔj]	as in "boy"
[aʊ]	as in "now"
[ɔj]	as in "I"

IPA Chart for English Vowels**Practice**

Determine the vowel in the words below.

Word	IPA Symbol	Features
pick	ɪ	High, Front, Unrounded, Lax Vowel
peek		High, Front, Unrounded, Tense Vowel
pick		
shoe		
book		
say		
said		
sad		
go		
law		
boy		
spy		
spa		
crowd		
cut		
atom		
atomic		

More Practice

Transcribe the following English words using the IPA

Word	Transcription	Word	Transcription
skip	[skɪp]	dogs	
tough	[tʌf]	singer	
knee		measure	
jam		yam	
noisy		this	
supply		think	
boat		sheep	

7 Natural Classes

Each sound segment consists of a bunch of features. Features also group together sound segments.

For example:

Bilabials [p, b, m, w]
 Velars [k, g, ŋ]
 Fricatives [f, v, s, z, θ, ð, ʃ, ʒ, h]
 Front Vowels [i, ɪ, e, ε, æ]

Note that a natural class is exhaustive. This means, [p, b, m] cannot be the natural class *bilabials* in English because it excludes [w] which is a bilabial, too.

Natural classes are intersective. Consider natural classes like sets. Intersection of sets gives you another set. Similarly, intersection of natural classes gives you another natural class.

For example:

The natural class *bilabial stops* consists of the intersection of bilabial segments and stop segments.

Bilabial stops [p, b, m]

Practice

Complete the following chart. Some sets of sounds may not constitute a natural class.

Natural Class	IPA Symbols
lateral liquids	
high tense vowels	
	[w, j]
	[m, n, ŋ]
	[m, l, p, k]
	[h]
alveolar nasals	
voiced fricatives	

Major Natural Classes

The natural classes that can be generated by the features discussed before are relatively small. There is phonological evidence that languages can group sounds in larger natural classes. We will see this in phonology. However, note that the idea of natural classes is not an arbitrary one. There is empirical evidence indicating for such groupings. The following are some larger natural classes.

Sonorants

Sounds produced with more resonance are called sonorants. Sonorants encapsulate the following natural classes:

Vowels, Glides, Liquids, Nasals

Obstruents

The opposite end of Sonorants is Obstruents. The production of obstruents includes a lot of obstruction compared to Sonorants. Obstruents are:

Fricatives, Affricates, Stops

Practice

Determine the vowel in the words below.

Word	IPA Symbol	Features
pick	i	High, Front, Unrounded, Lax Vowel
seat		High, Front, Unrounded, Tense Vowel
sit		
zoo		
took		
say		
said		
sad		
low		
law		
boy		
try		
spa		
crowd		
cut		
atom		
atomic		

More Practice

Transcribe the following English words using the IPA

Word	Transcription	Word	Transcription
skip	[skip]	apples	
tough	[tʌf]	sprinkle	
pneumonia		measure	
feathers		record (v)	
phonetics		record (n)	
physics		think	
psychology		sheep	

Even More Practice

Identify the English words represented by the transcriptions below.

Transcription	Word	Transcription	Word
[nefən]		[krika]	
[dʒɪʃ]		[heɪr]	
[əlaʊ]		[sim]	

8 Aspiration

When we produce some sound segments, there is a strong burst of breath that accompanies these sound segments. This happens especially with sounds like [p, t, k] (voiceless stops) in English.

For example

When we produce the words *pick*, *top*, *cart*, we can feel a strong burst of breath with the first sound segments. This is called, aspiration. We indicate aspirated sound segments with the superscript ^h.

[p^h], [t^h], [k^h]

[p^hɪk], [t^hɑp], [k^hɑrt]

Note that [p, t, k] in English are not always aspirated. Check the following words: *spot*, *stop*, *scarf*. The [p, t, k] sounds following [s] in these examples are not aspirated.

When transcribing these words, we should make sure we show if [p, t, k] are aspirated or not.

[spat], [stɑp], [skɑrf]

9 Sonority Hierarchy

Universally, sounds obey a hierarchy called the Sonority Hierarchy. Sonority hierarchy is a scale from the most sonorous to the least sonorous. It is about the amplitude of sound segments. Sonority hierarchy:

Sonority Hierarchy

Vowels	most sonorous
Glides	
Liquids	↑
Nasals	
Fricatives	↓
Affricates	
Stops	least Sonorous

Although not always so robust, sonority hierarchy operates on phonotactic constraints. Phonotactic constraints are constraints that determine the co-occurrence of certain sounds in certain positions.

For example

[plɑr]	[lpar]
[trɑl]	[rtɑl]
[snɪl]	[nsɪl]
[kɛlp]	[kepl]
[sɑrp]	[sɑpr]
[pɑns]	[pɑsn]

The patterns above indicate the sonority hierarchy. Crosslinguistically, sonority tends to raise towards the vowel of the syllable and decline after that.

Let's read with the IPA

ðə sʌn ænd ðə nɔrθ wɪnd wɪ dæspjʊərəŋ wɪtʃ wəz ðə strɔŋr wɛn ə trævəlɪ kem əlɔŋ ɪn ə wɔrm klɔk. ðe
 ægrɪd ðæt ðə wʌn hu frst səkʰsɪdəd ɪn mekənŋ ðe trævəlɪ tek hɪz klɔk ɔf ʃʊd bi kənsɪrɪd strɔŋr ðæn ðe ʌðr. ðen
 ðə nɔrθ wɪnd blu æz hɑrd æz hi kʊd, bʌt ðe mɔr hi blu ðe mɔr klɔsli dɪd ðe trævəlɪ fɔld hɪz klɔk əraʊnd hɪm;
 ænd æt læst, ðe pʊr nɔrθ wɪnd gev ʌp ðe ətɛmpt. ðen ðe sʌn ʃaɪnd aʊt wɔrmli, ænd əmɪrɪətli ðe trævəlɪ tʊk
 ɔf hɪz klɔk. ænd so ðe nɔrθ wɪnd wəz əblɑɪdʒd tə kənʃes ðæt ðe sʌn wəz ðe strɔŋr ɔf ðe tu.