

English Consonants & Vowels

- Phonetics: a study on speech

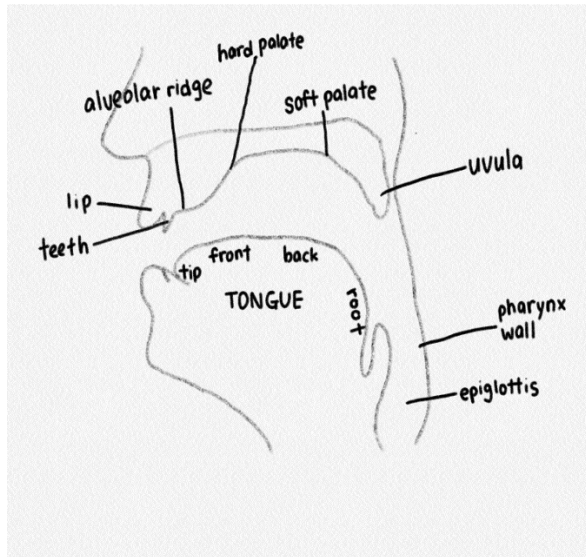
articulatory phonetics (from mouth) → how to produce speech

acoustic phonetics (through air) → how to transmit speech

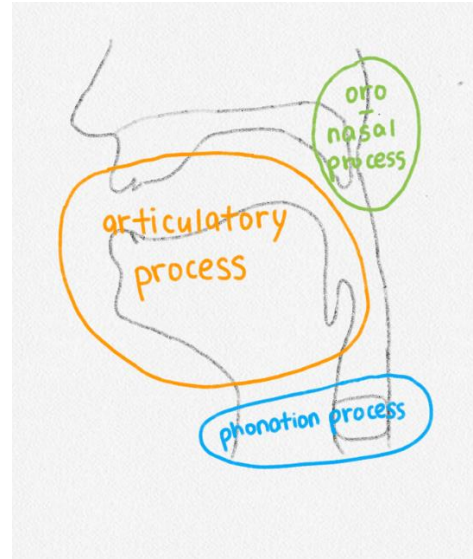
auditory phonetics (to ear) → how to hear speech

Articulation

- Vocal tract:



- 5 speech organs = constrictors = articulators



Phonation Process in Larynx

- larynx = voicebox: voiced → can feel vibration

ex. v, z, l, m, a, i

voiceless → can't feel vibration

ex. f, s, k, p, h

Oro-nasal Process in Velum

- nasal: when velum lowered

ex. m, n, ng

Articulatory Process

- lips / tongue tip / tongue body

Control of Constrictors(Articulators)

- Each constrictor needs to be more specific in geometry

constriction location(CL) / constriction degree(CD)

- Constriction location: Lips → bilabial / labiodental

Tongue body → palatal / velar

Tongue tip → dental / alveolar / retroflex / palate-alveolar

- Constriction degree: stops > fricatives > approximants (/r, l, w, j/) > vowels

How to Produce English Consonants and Vowels

- constrictors(lips, tongue tip, tongue body) / CD / CL / velum / larynx
 - ex) /p/: lips / bilabial / stop / velum raised / larynx open
 - /b/: lips / bilabial / stop / velum raised / larynx closed
 - /d/: tongue tip / alveolar / stop / velum raised / larynx closed
 - /z/: tongue tip / alveolar / fricative / velum raised / larynx closed
 - /n/: tongue tip / alveolar / stop / velum lowered / larynx closed
- * 모든 모음은 constrictor로서 tongue body 만 사용(constrictor location 정의 X)
- Phonemes: individual sounds that form words
 - a combination of speech organs' actions

Acoustics

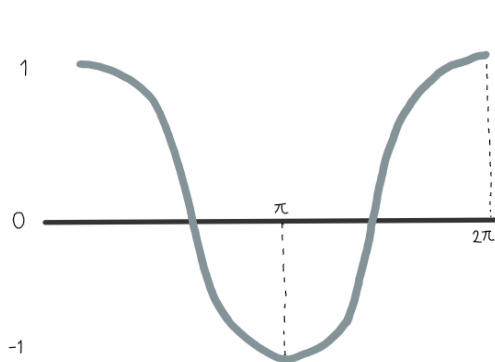
- Praat: duration > select(click and drag on waveform or spectrogram) →
 - read a value (sec.) on the top → zoom in (if not visible)
 - intensity > show intensity → click on green → read a value (dB) on the right
 - pitch > show pitch → pitch setting > pitch range > 65-200Hz male / 145-276Hz female
 - click on blue → read a value (Hz) on the right
 - formant(모음 구별 수치) > show formants → place the cursor on one of the trajectories
 - read a value (Hz) on the left
- the number of occurrences of a repeating event per second (frequency, Hz)
 - repeating event = vibration of vocal folds / repeating > sine wave = pure tone
 - * sine wave: frequency + magnitude(amplitude) (x 축 시간 / y 축 value, voltage)
- 모든 신호는 단순한 sine wave 들의 합으로 표현된다. (synthesis)
 - complex tone 이 반복하는 주기는 Fundamental Frequency 와 동일
 - spectrum: x 축 frequency / y 축 magnitude(amplitude)
 - spectrogram: spectrum 을 시간으로 visualize 한 것 (x 축 시간 / y 축 frequency)
 - sine wave(time-value graph)→spectrum: spectral analysis
- pure tone→spectral analysis: frequency 가 같은 sine wave 한 개
 - complex tone→spectral analysis: 일정한 간격의 sine wave 여러 개 (간격=pitch)
 - (Praat: Spectrum > View Spectrum Slice)
- source: 성대에서 나는 소리 (measured by EGG)
 - human voice source consists of harmonics
 - a complex tone = sum of pure tones at integer multiples of the lowest pure tone
 - the lowest pure tone = fundamental frequency(F0) = rate of vibration of the larynx
 - = the number of opening-closing cycles of the larynx per second
 - amplitude of pure tones gradually decreases
- filter: vocal tract 에 의해서 달라지는 소리
 - filter 의 spectrum → jiggjagging with peaks and valleys (amplitude 의 패턴이 사라짐)
 - peaks/mountains: frequencies VT likes (formants)
 - valleys: frequencies VT does not like

행렬과 벡터

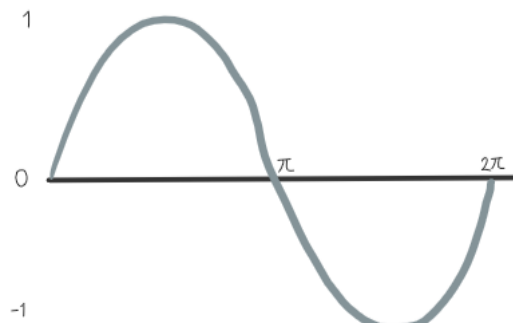
- 이미지, 소리, 텍스트 > 벡터
모든 데이터는 벡터로 나타낼 수 있음
- 흑백 이미지 > 2 차원 / 컬러 이미지 > 3 차원 / 영상 > 4 차원

Sound

- Sinusoidal: cos 이나 sin 과 같은 곡선
Phasor: sinusoidal 의 function 을 만드는 것
- π (무리수)
 $0 \sim \pi \sim 2\pi$ (radians - sin/cos 의 입력값 / θ)
 $0^\circ \sim 180^\circ \sim 360^\circ$ (degree)
- Phasor:

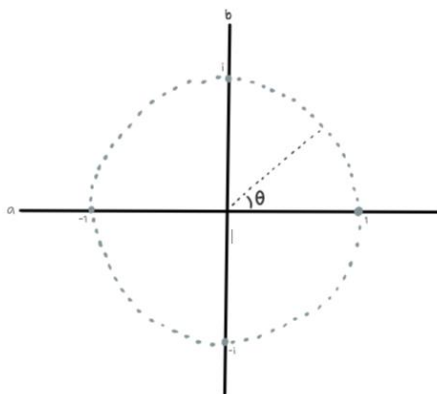


cos 함수



sin 함수

- 오일러 공식: $f(\theta) = e^{i\theta} = \cos(\theta) + \sin(\theta)i$
 $e = 2.71...$ (무리수)
 $i = \text{imaginary (허수, } \sqrt{-1})$
복소수 = $a + bi$ (모든 수 표현 가능) > $f(\theta)$
 $\theta = 0 > f(0) = e^0 = 1$
 $\theta = \frac{\pi}{2} > f(\frac{\pi}{2}) = \cos(\frac{\pi}{2}) + \sin(\frac{\pi}{2})i = i$
 $\theta = \pi > f(\pi) = \cos(\pi) + \sin(\pi)i = -1$
 $\theta = \frac{3\pi}{2} > f(\frac{3\pi}{2}) = \cos(\frac{3\pi}{2}) + \sin(\frac{3\pi}{2})i = -i$



복소평면 (complex plane): a 실수 / b 허수

Projection: x 축(a)에서 볼 때 > 허수(sin 그래프)

y 축(b)에서 볼 때 > 실수(cos 그래프)

- sin 과 cos 음의 같음 (sin 그래프와 cos 그래프는 $\frac{\pi}{2}$ 의 차이)

인간의 귀는 phasor shift 는 구별하지 못함 / frequency 의 차이만 구별