Speech Production

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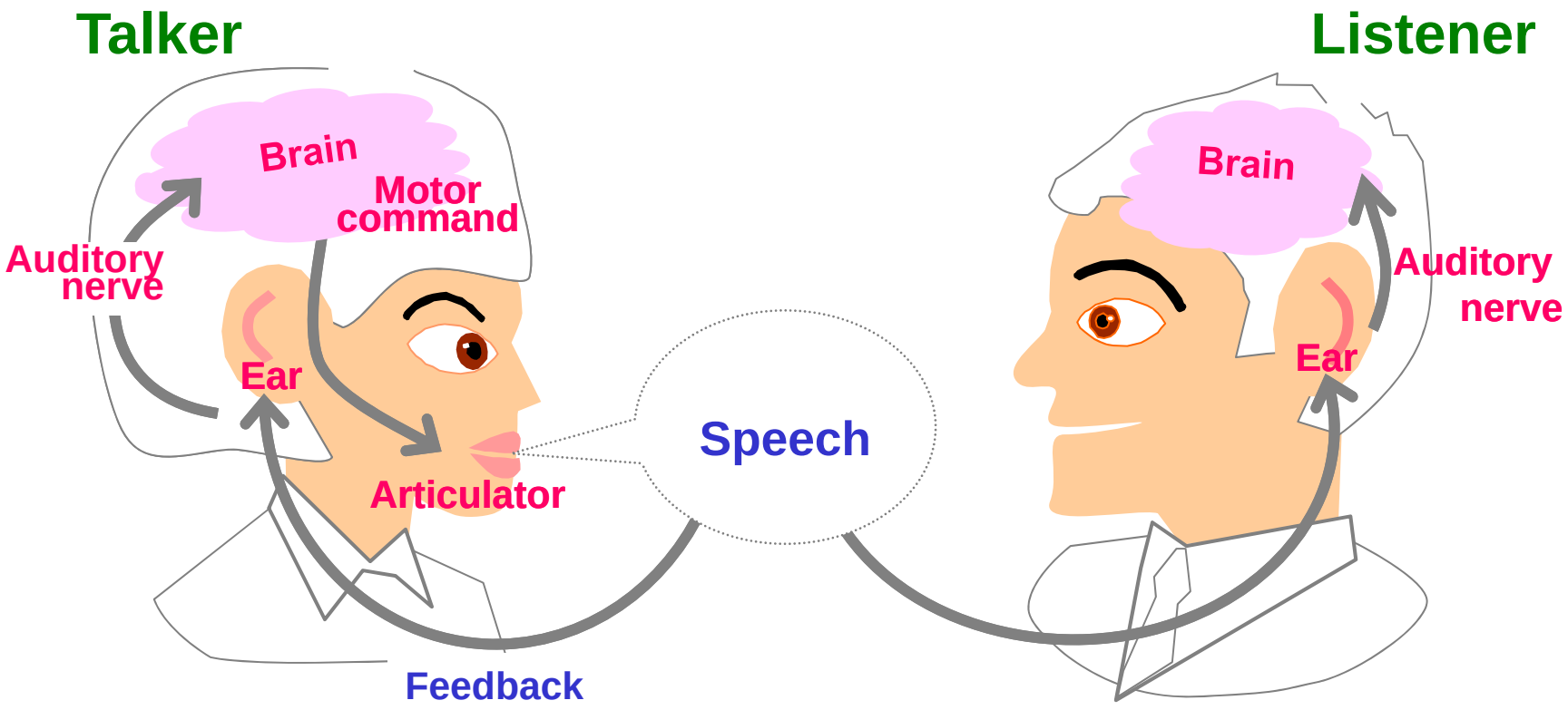
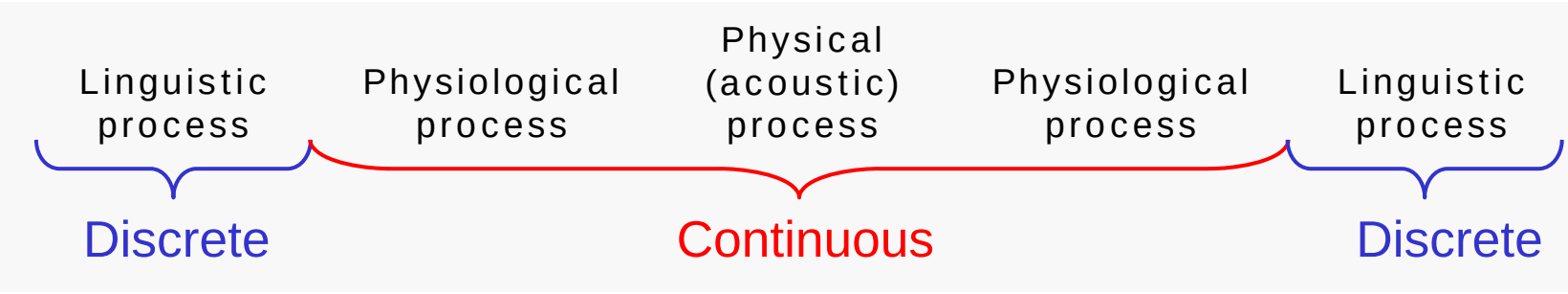
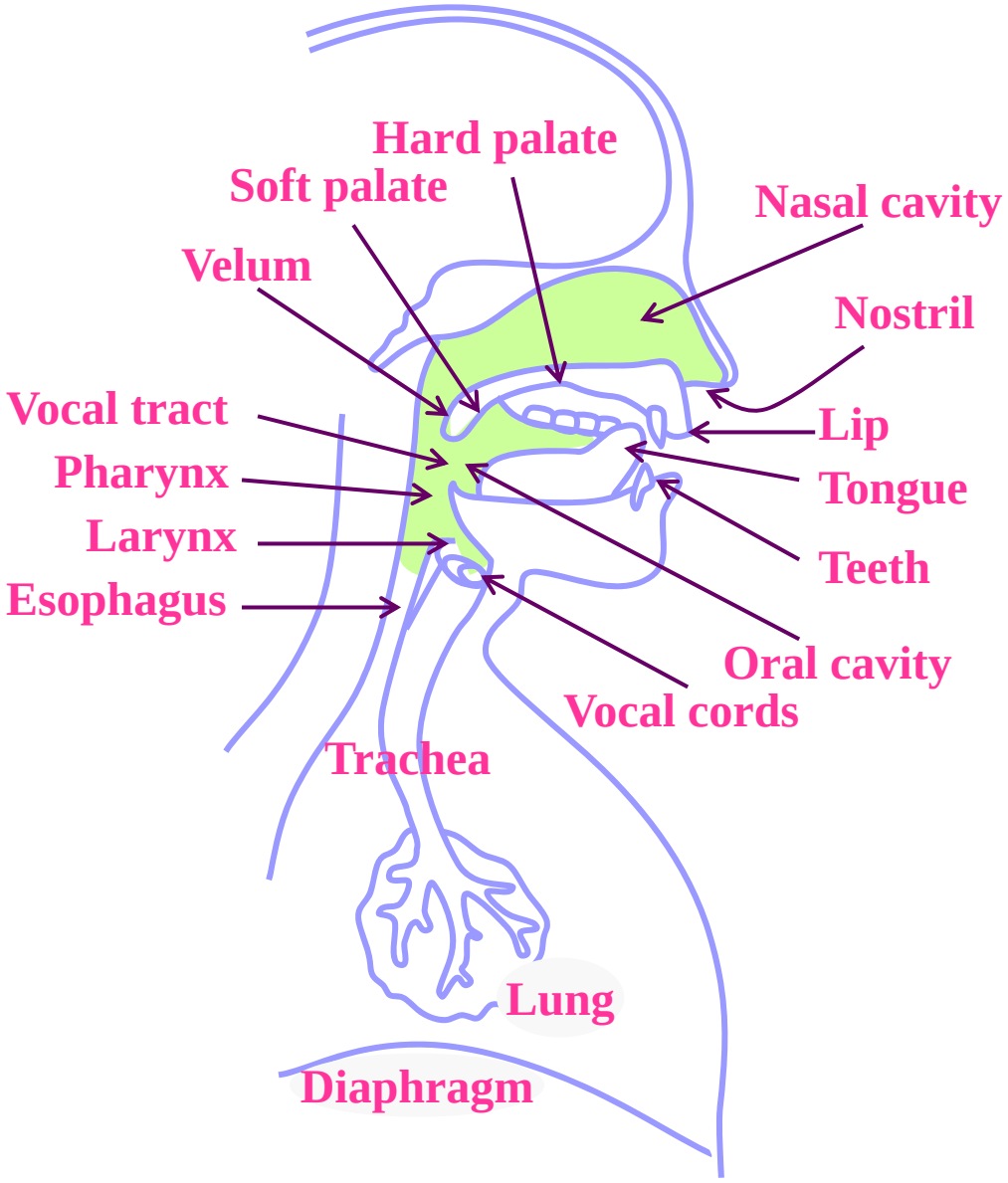
Speech chain

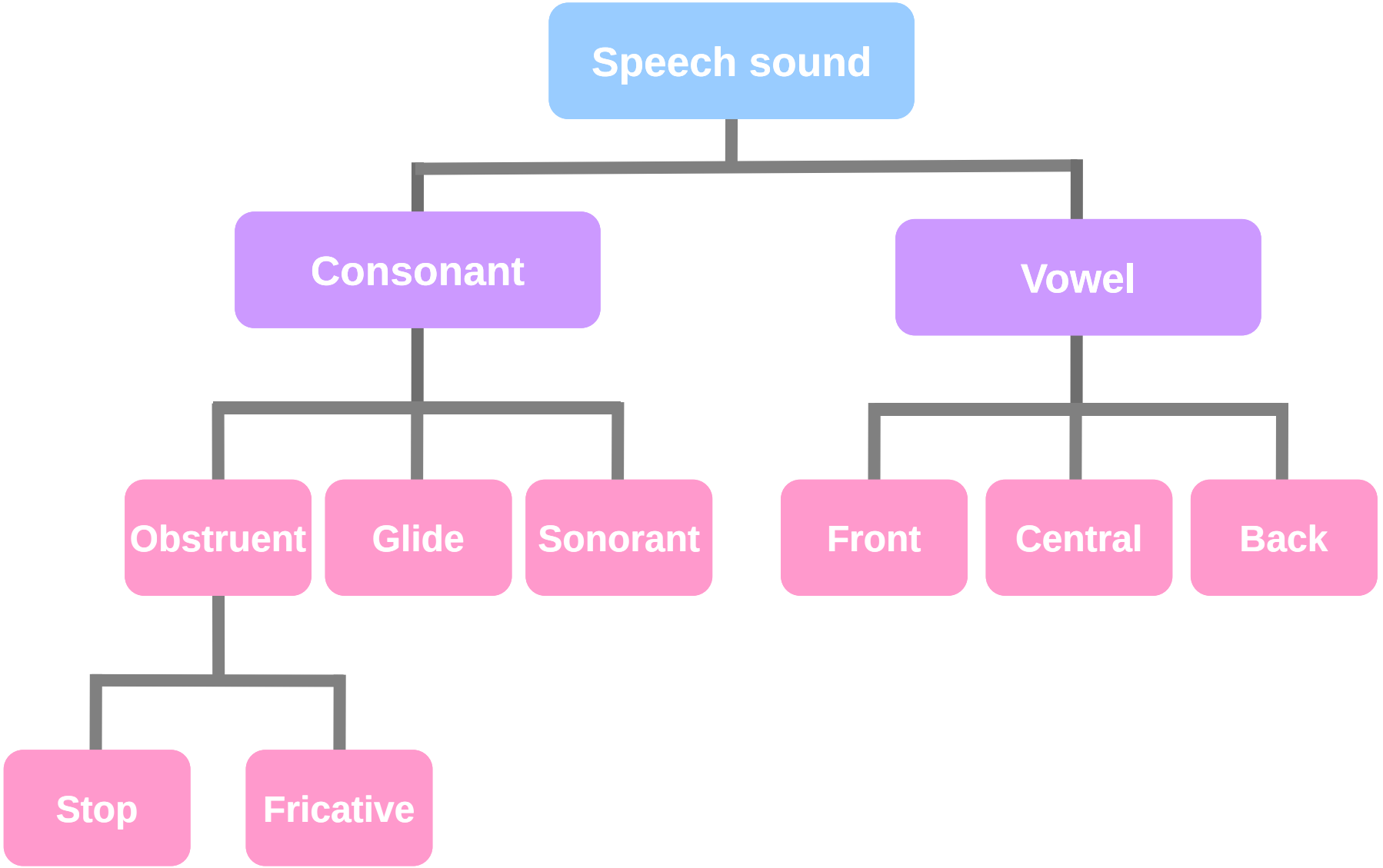




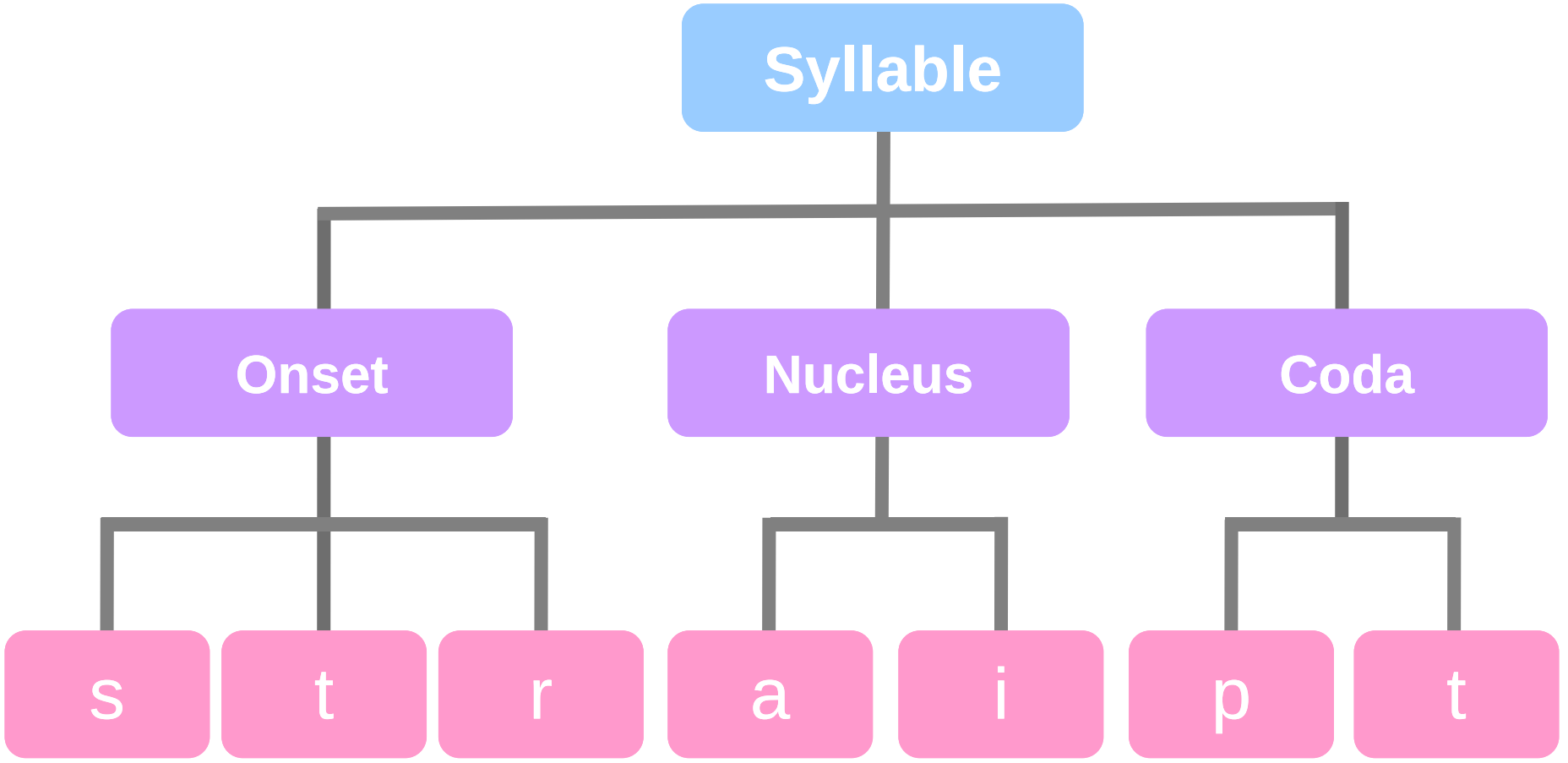
Schematic diagram of the human vocal mechanism



Example of a logical concept hierarchy of phonemes

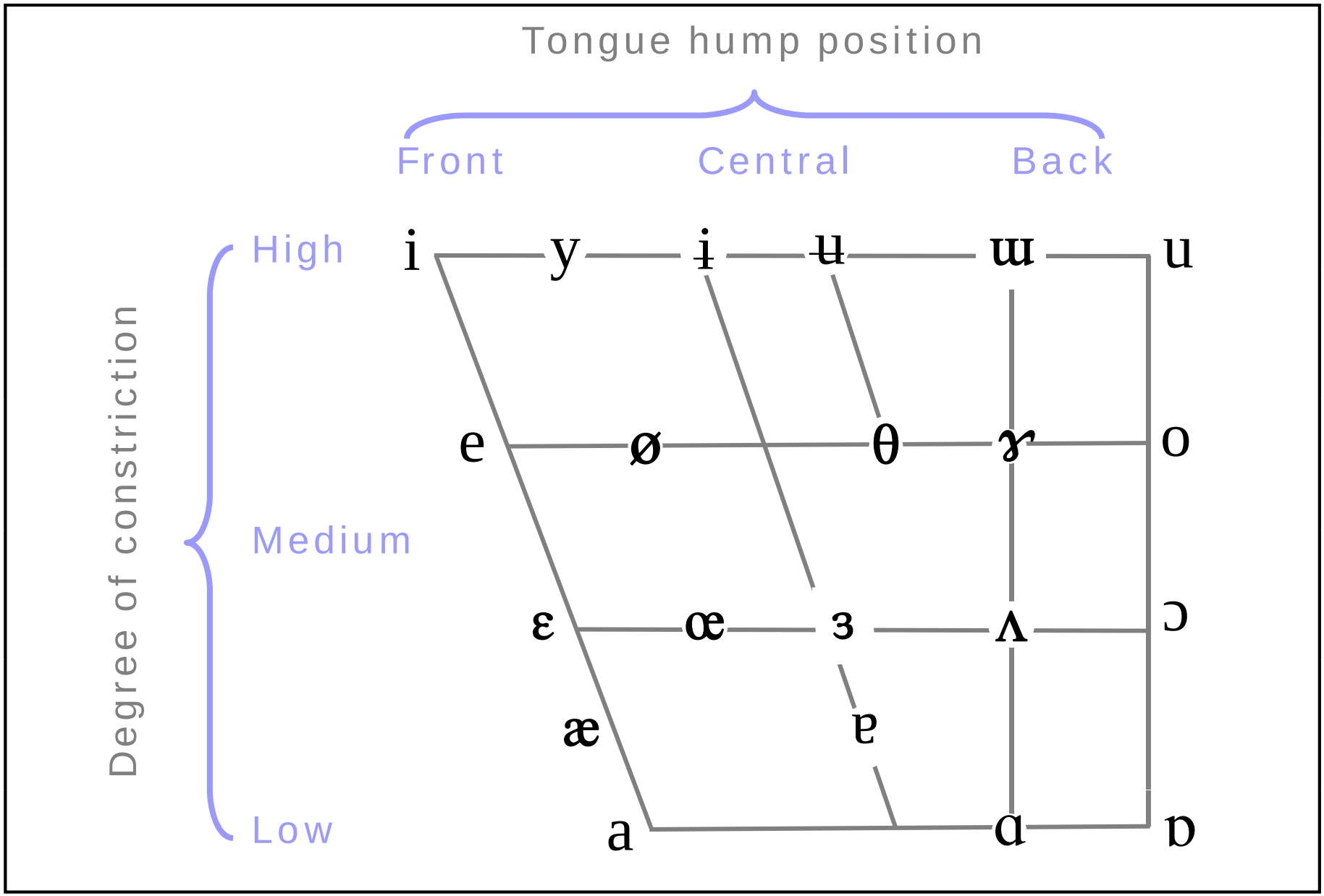


Example of an ontological hierarchy



“striped”

Vowel classification from approximate vocal organ representation



Consonants

Articulation place		Labial		Dental		Alveolar		Palatal		Glottal	
Source		V	UV	V	UV	V	UV	V	UV	V	UV
Articulation manner	Fricatives	v	f	ð	θ	z	s	ʒ	ʃ		h
	Affricates					dz	ts	dʒ	tʃ		
	Plosives	b	p			d	t	g	k		
	Semivowels	w				l		j, r			
	Nasals	m				n		ŋ			

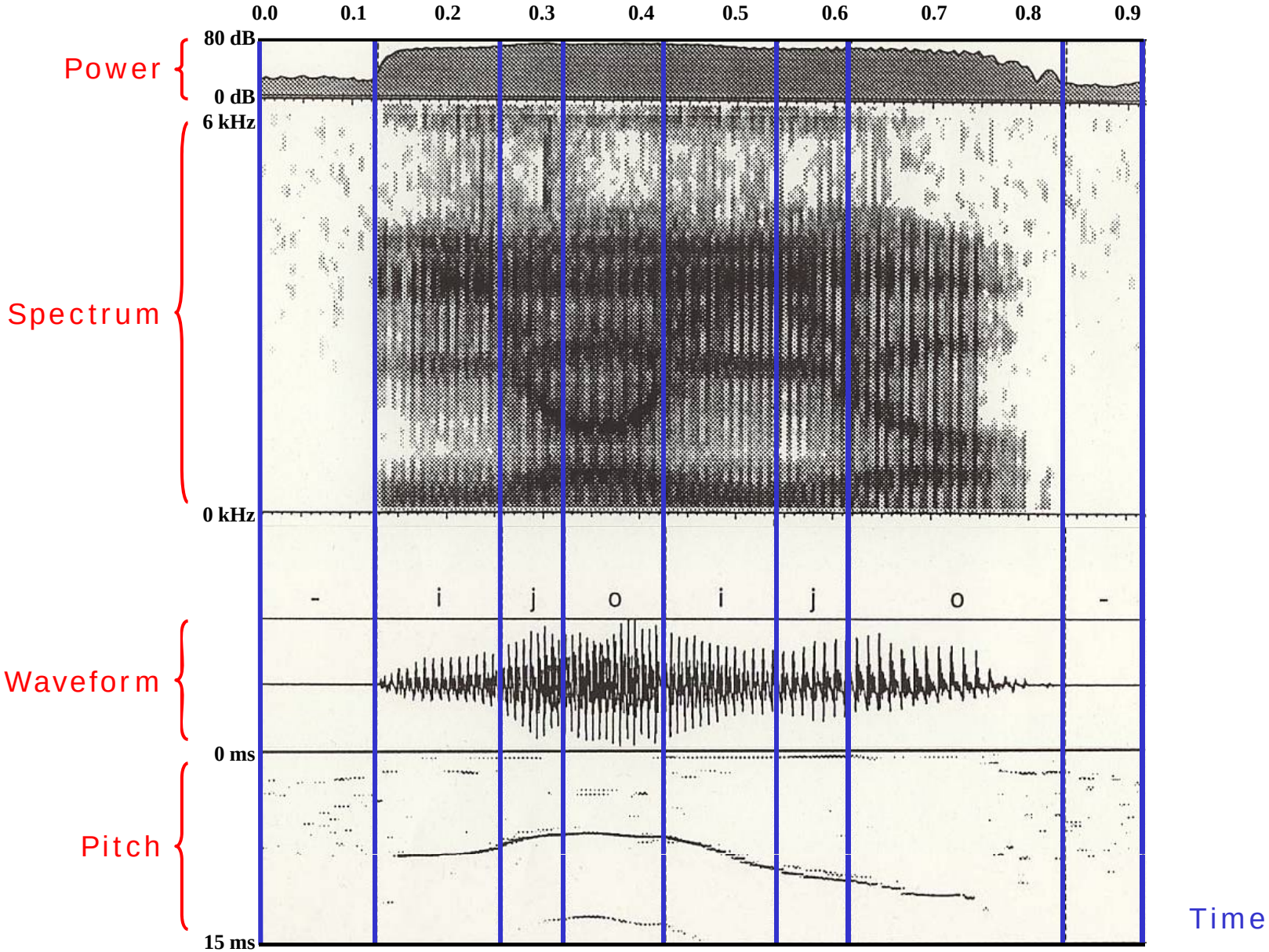
V= voiced; UV= unvoiced

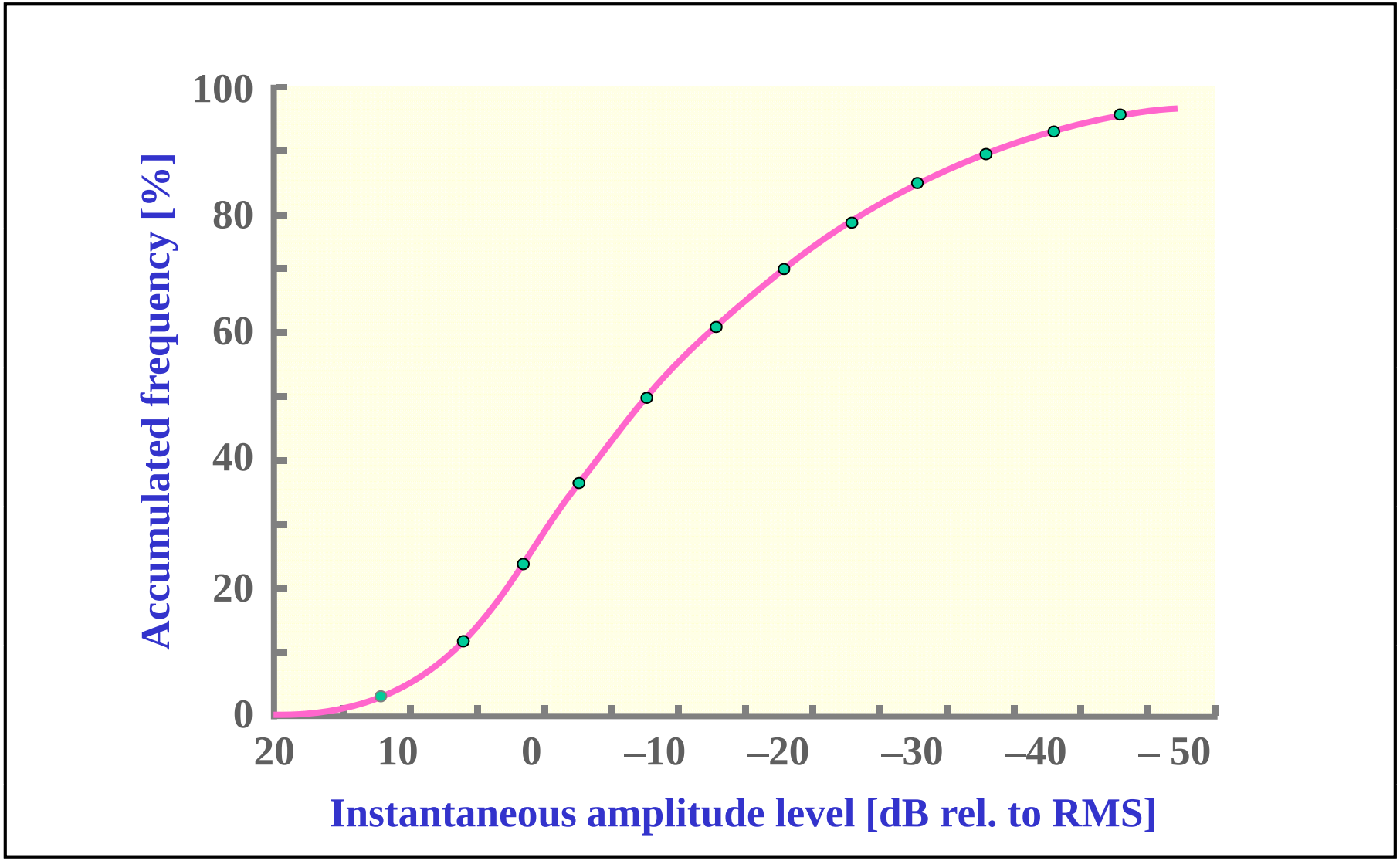
Speech production process models

Type	Speech production model	System function
Vowel type	Voiced source → Vocal tract → Radiation	**Resonance only (all-pole model)**
Consonant type	Vocal tract (back) ← Unvoiced source → Vocal tract (front) → Radiation	**Resonance and anti-resonance (pole-zero)**
Nasal type (nasal & nasalized vowel)	Voiced source → Vocal tract (back) → Nasal tract / Vocal tract (front) → Radiation	**Resonance and anti-resonance (pole-zero)**

(p.28, table3.1)

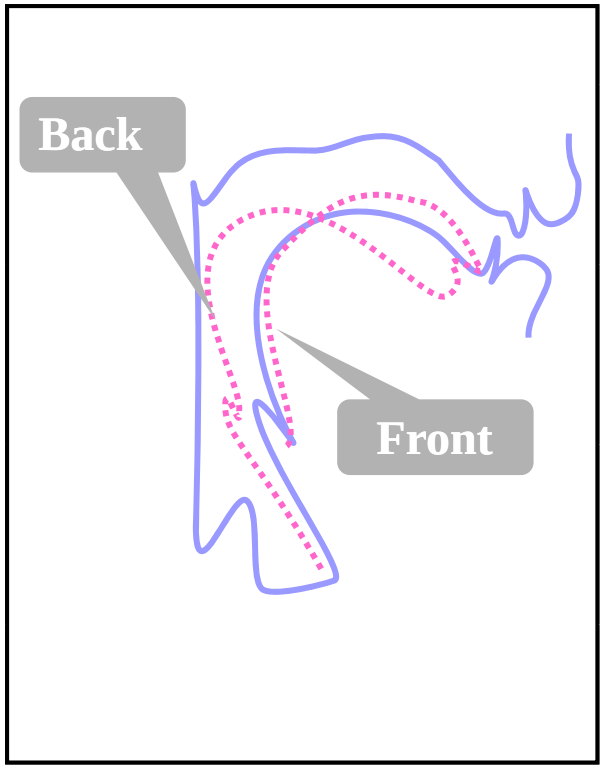
Speech energy, sound spectrogram, waveform and pitch





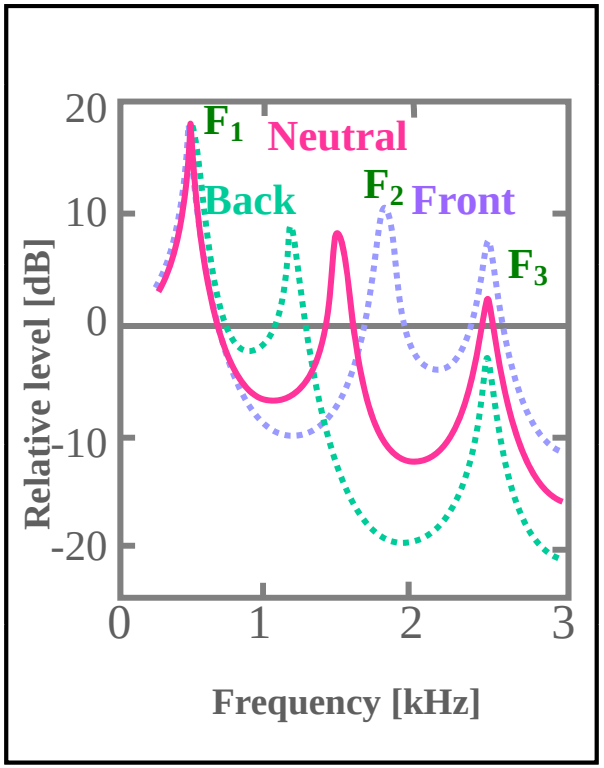
Accumulated distribution of speech amplitude level calculated for utterances made by 80 speakers having a duration of roughly 37 min.

Examples of the relationship between vocal tract shapes and vowel spectral envelopes



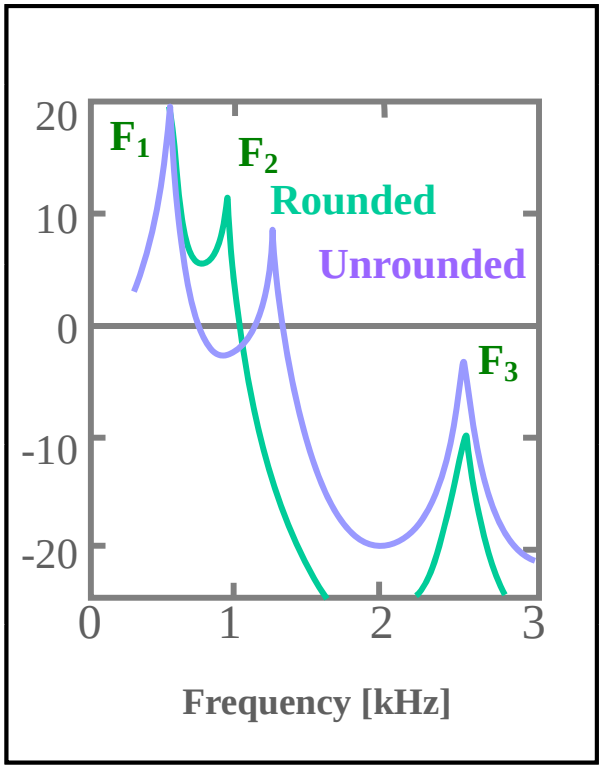
(a)

Schematization of mid-sagittal section of vocal tract for a neutral vowel (solid contour), and for back and front tongue-body positions.



(b)

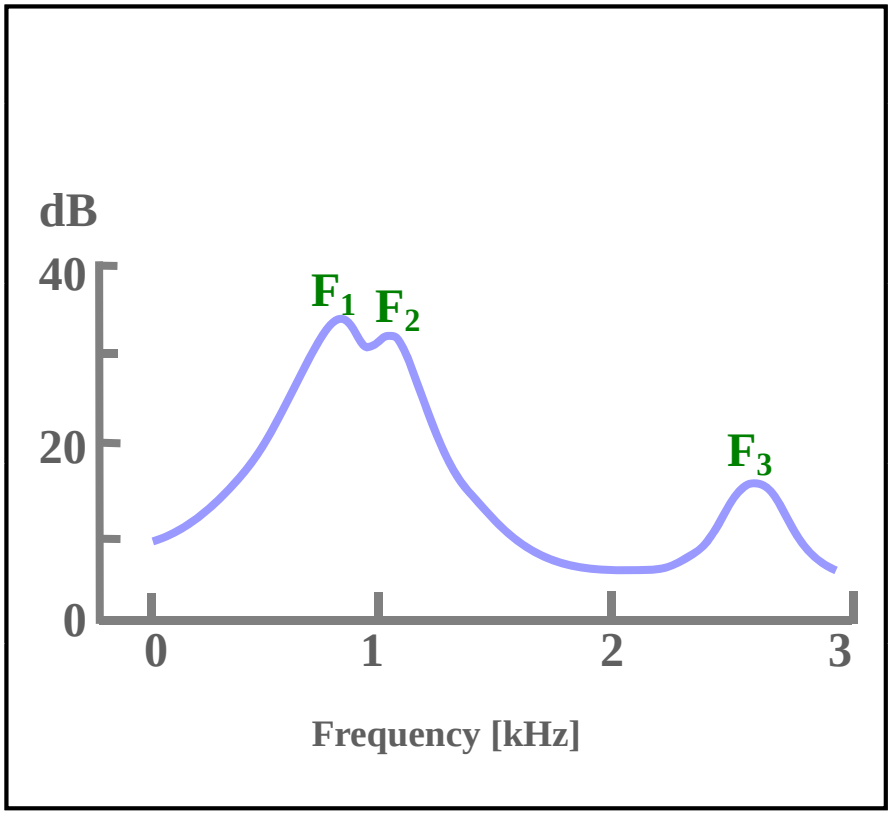
Idealized spectral envelopes corresponding to the three tongue-body configurations in (a).



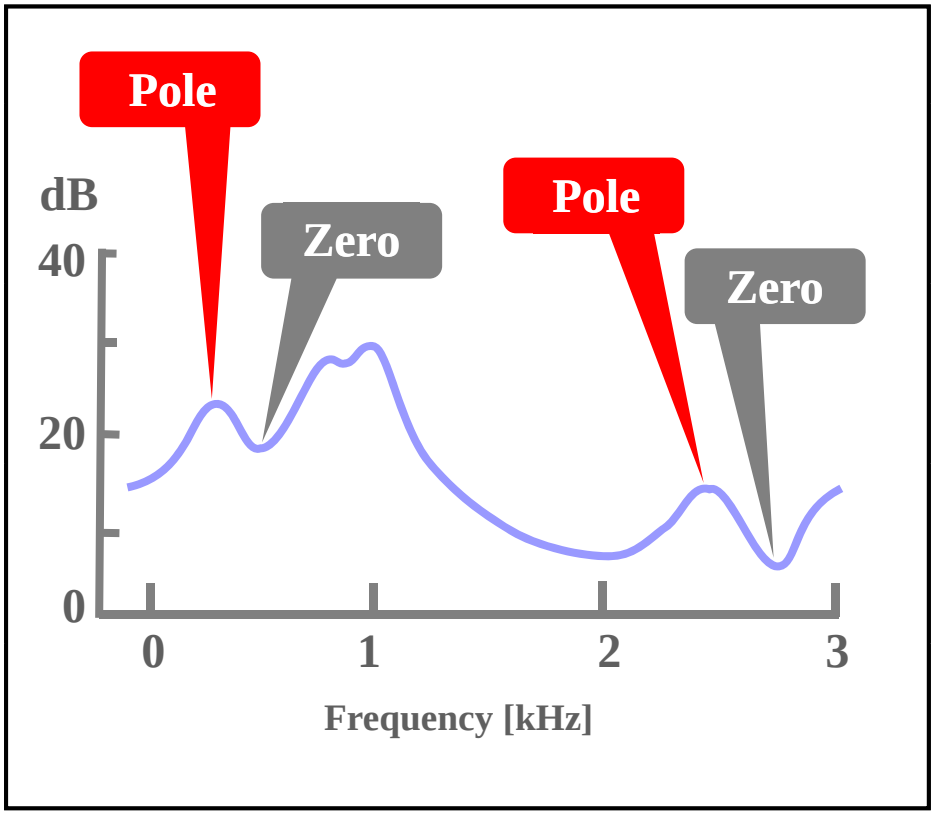
(c)

Approximate effect of lip rounding on the spectral envelope for a back vowel.

Vowel /a/

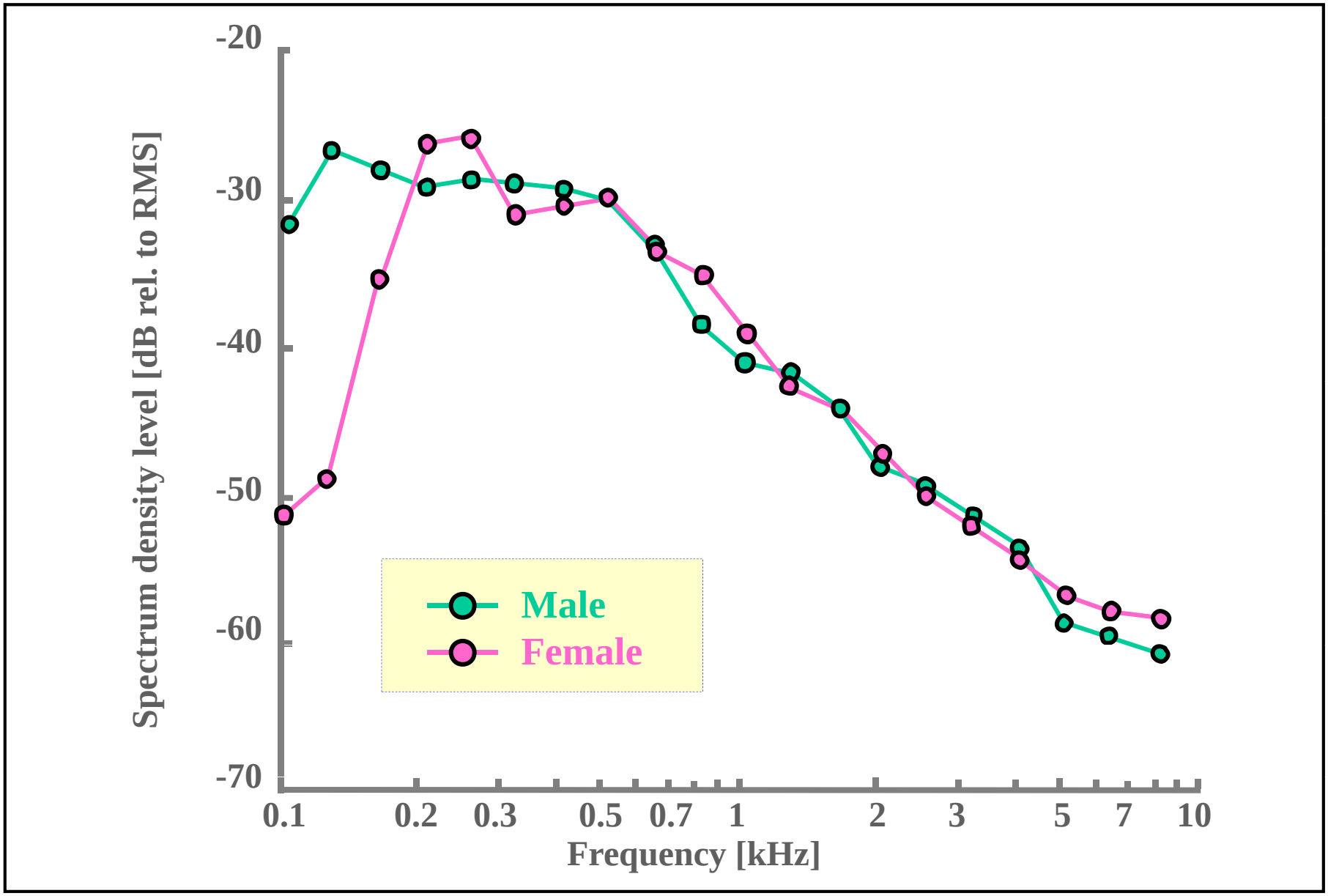


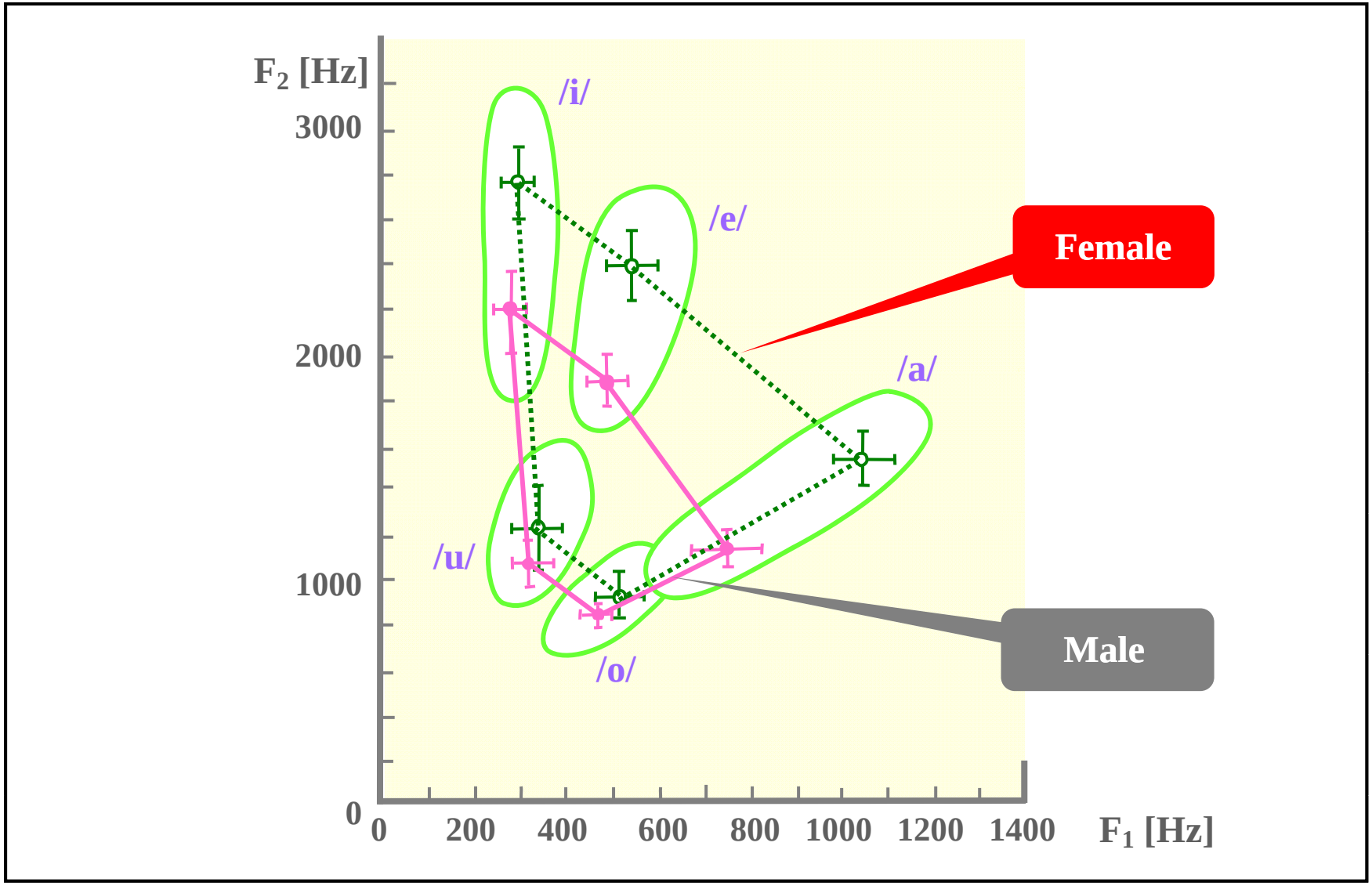
Nasalization



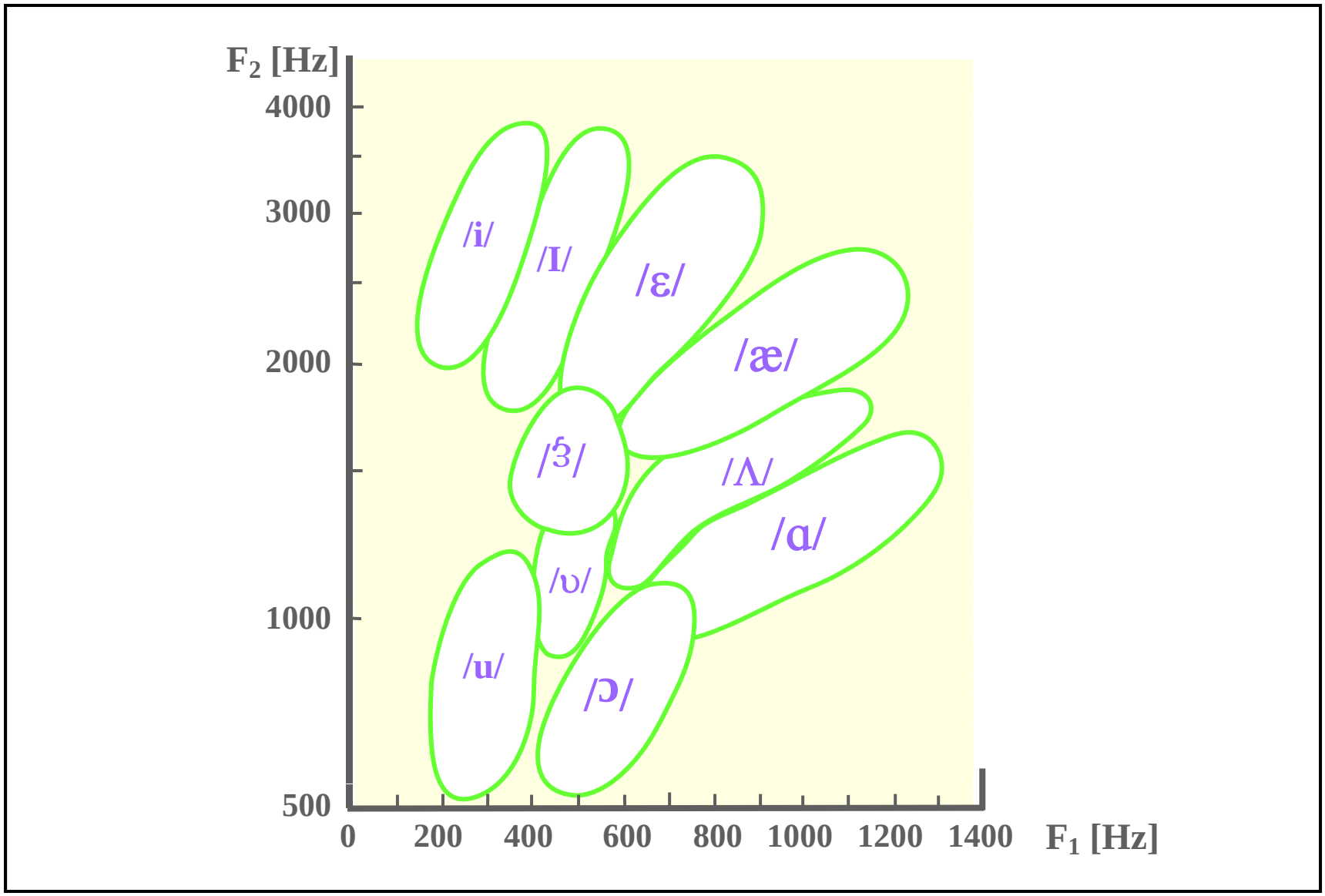
An example of spectral change caused by the nasalization for vowel /a/. It is characterized by pole-zero pairs at 300~400 Hz and at around 2500 Hz. F_1, F_2 , F_3 are formants.

Long-time averaged speech spectrum calculated for utterances made by 80 speakers

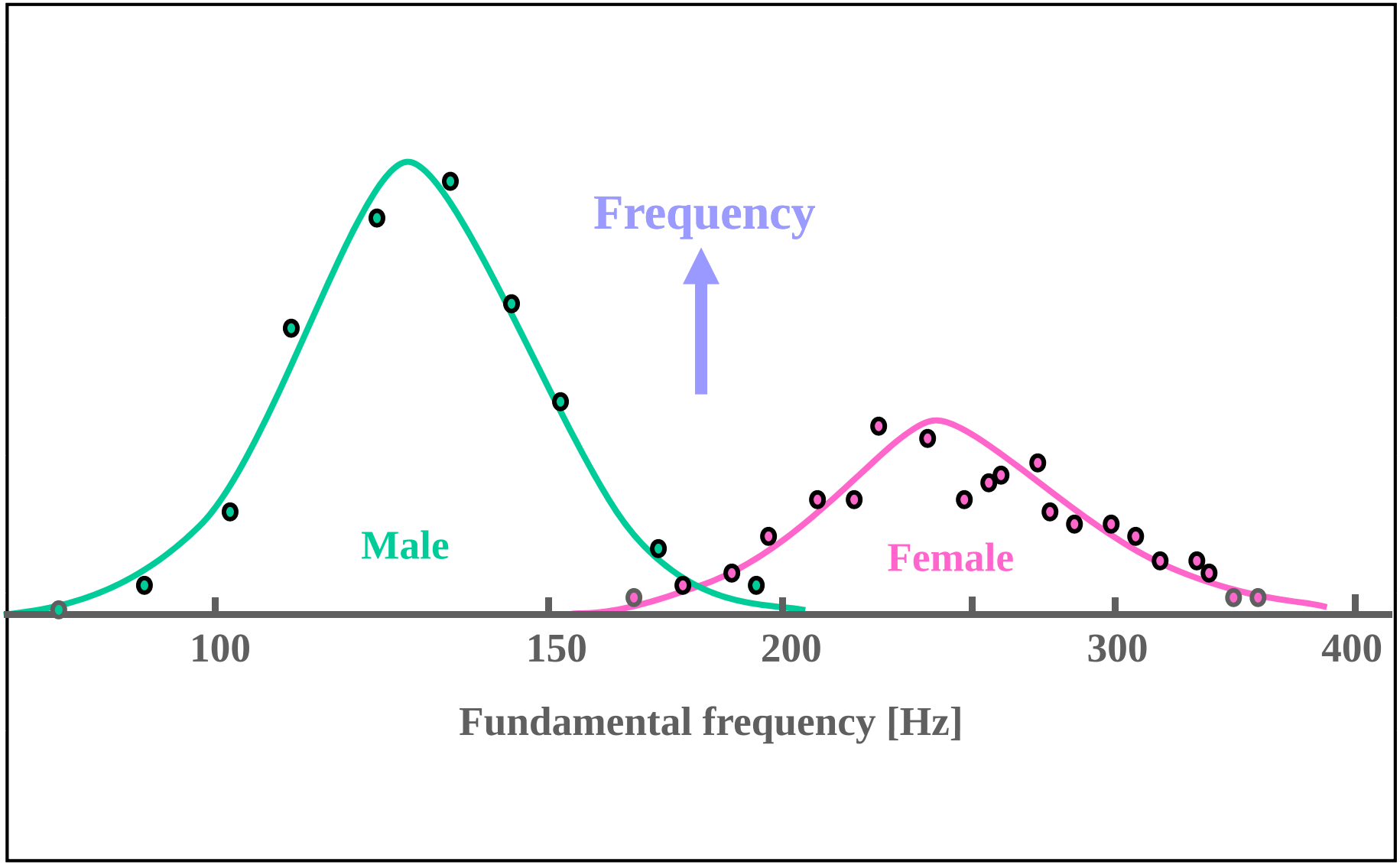




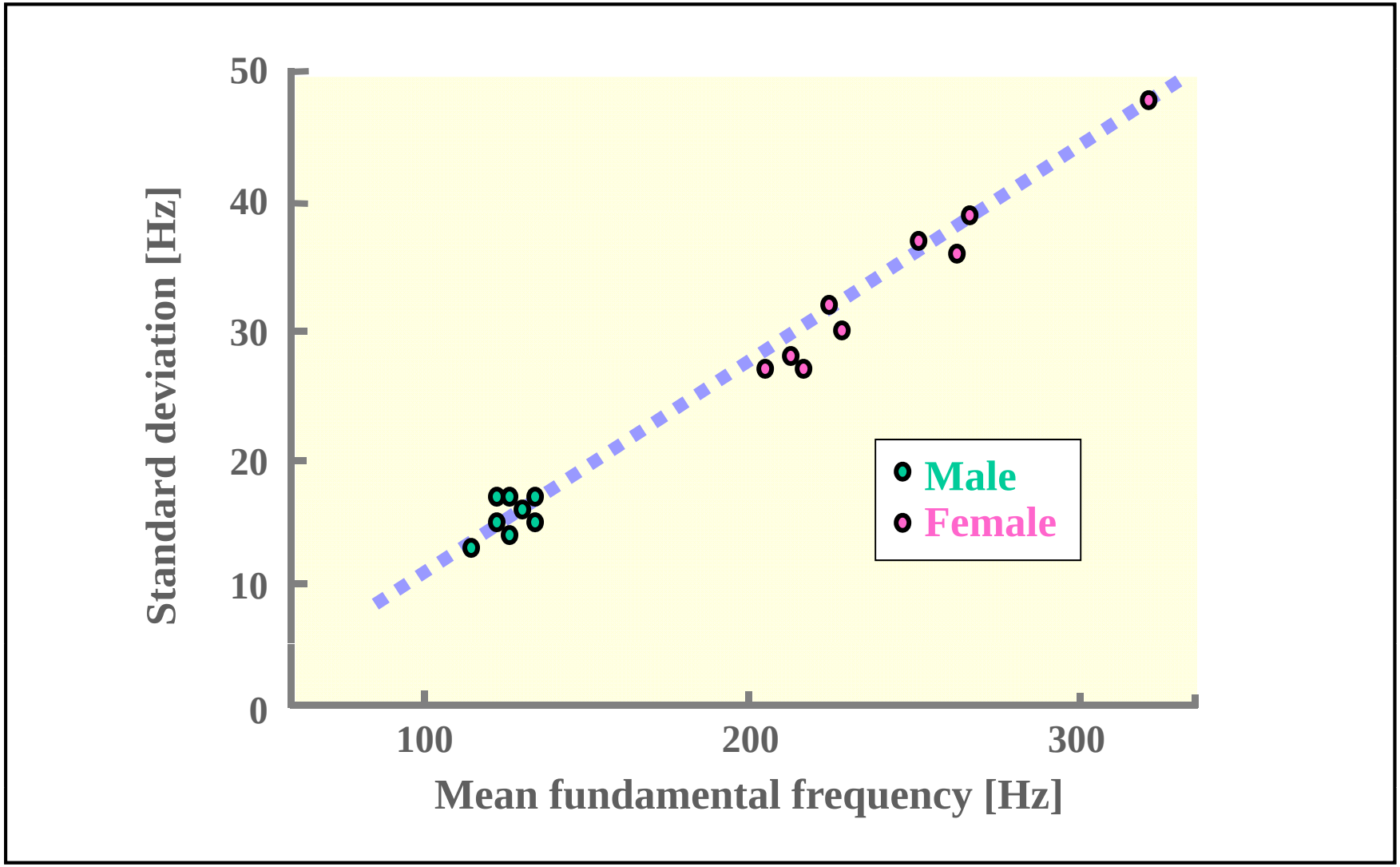
Scatter diagram of formant frequencies of five Japanese vowels uttered by 60 speakers (30 males and 30 females) in the F_1-F_2 plane



Scatter diagram of formant frequencies of 10 English vowels uttered by 76 speakers (33 adult males, 28 adult females, and 15 children) in the F_1~F_2 plane.

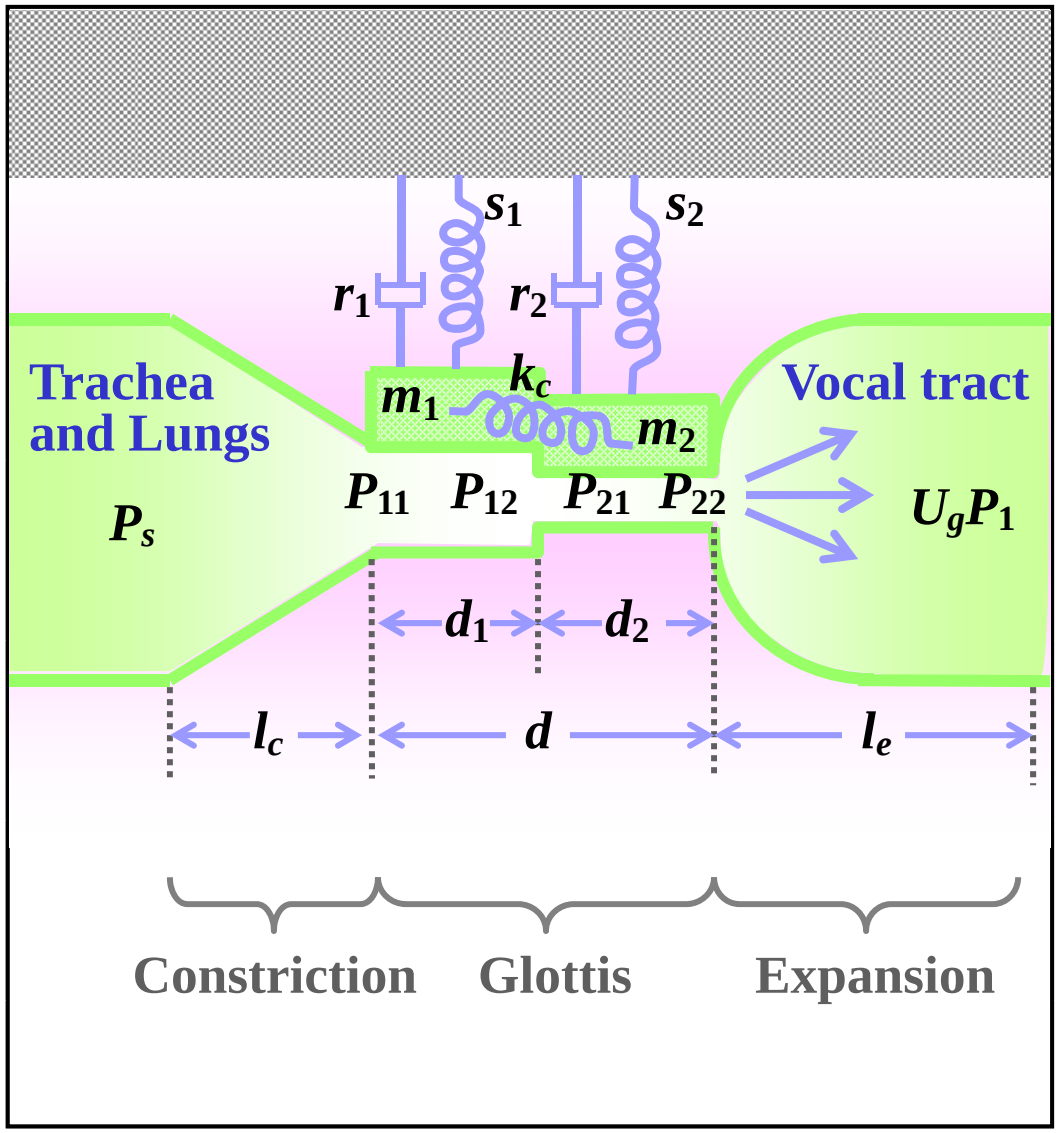


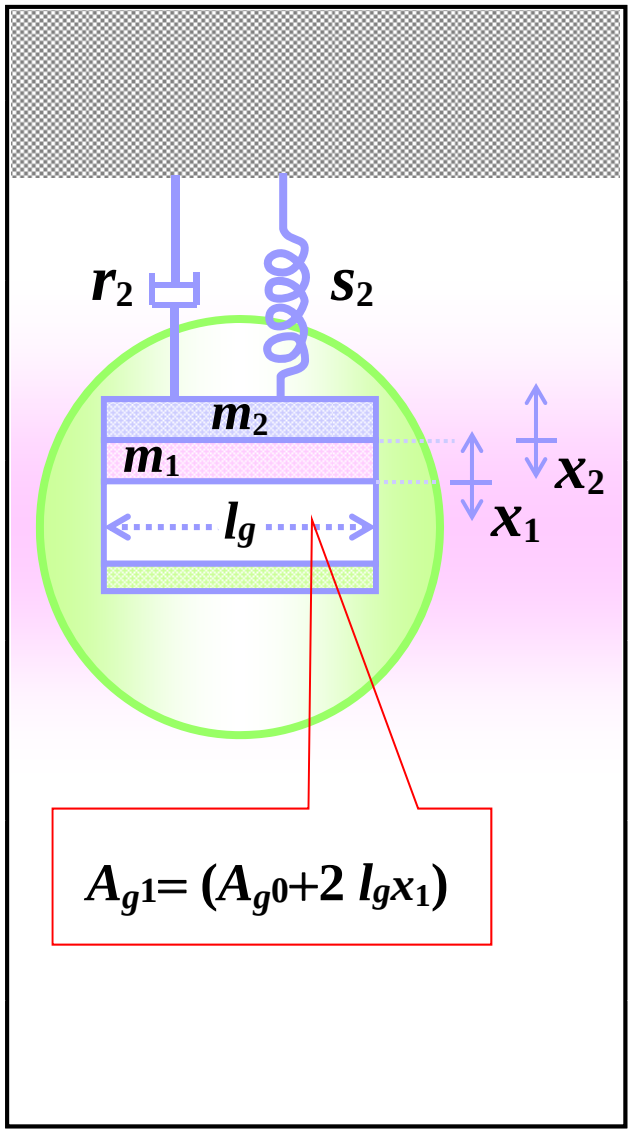
Fundamental frequency distribution over speakers

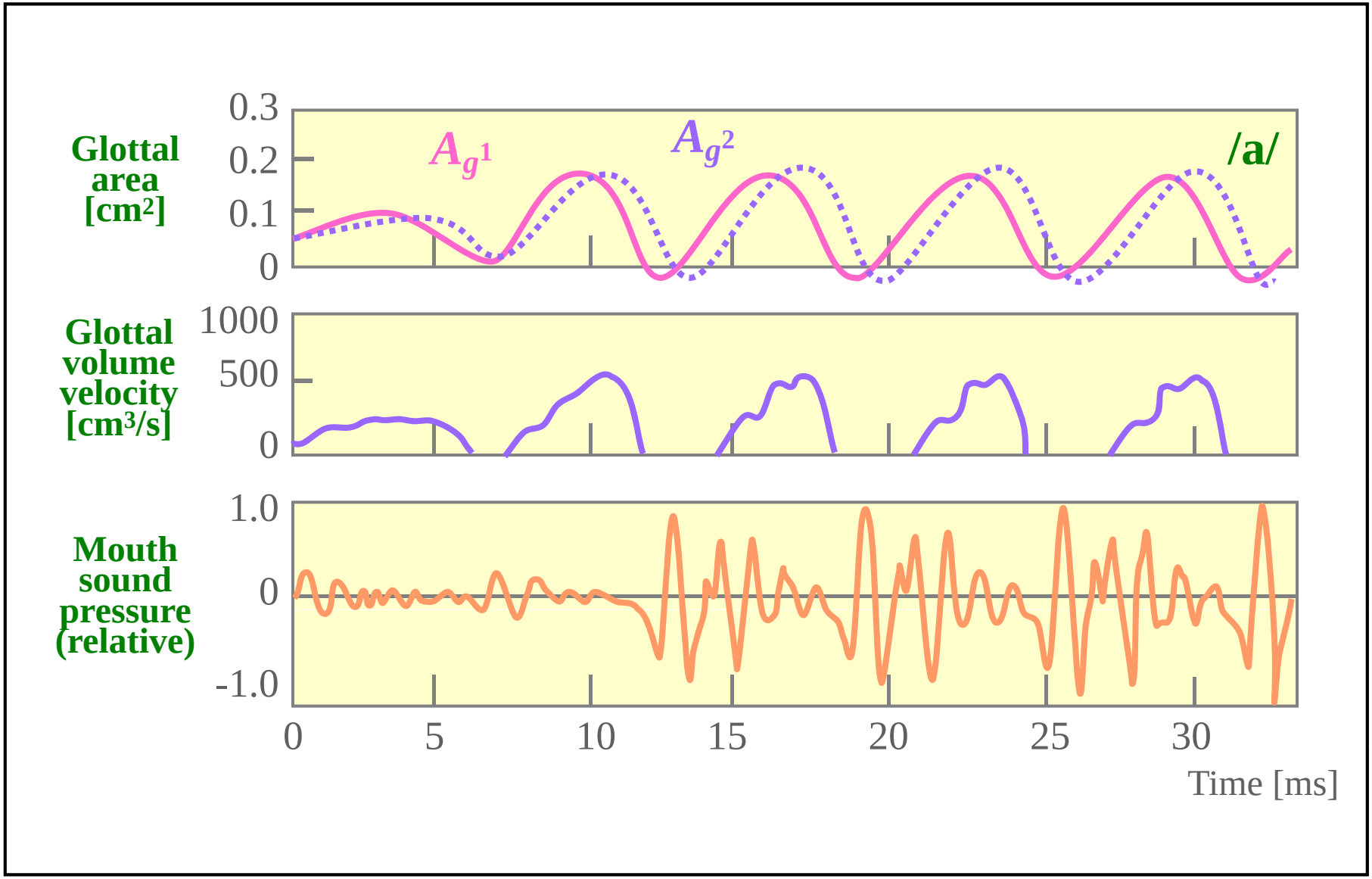


Mean and standard deviation of temporal variation in fundamental frequency during conversational speech for various speakers

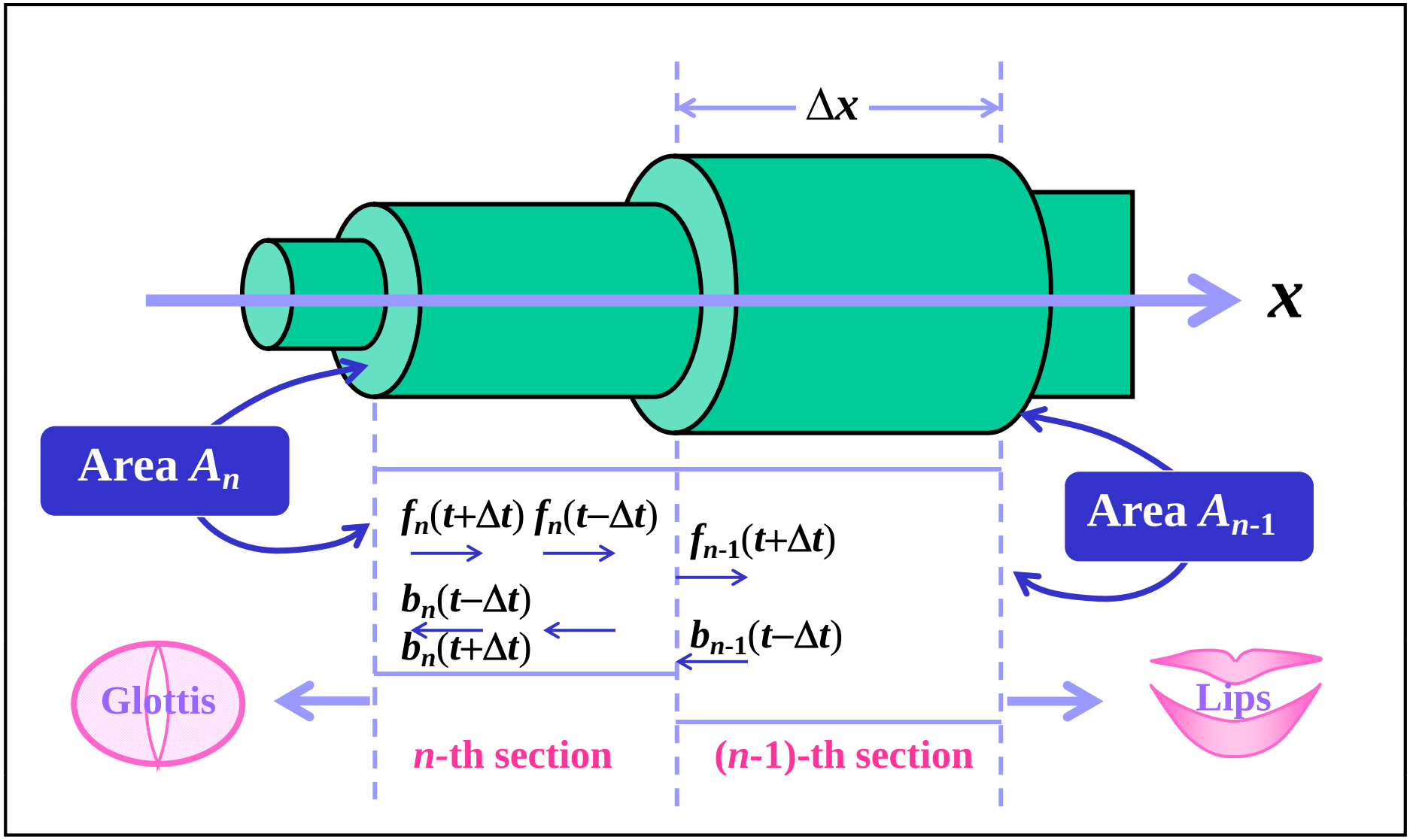
Configuration of two-mass model; cross section of glottis (A_{g1}=area at d_1 section; A_{g0}=area in the neutral state at d_1 section)







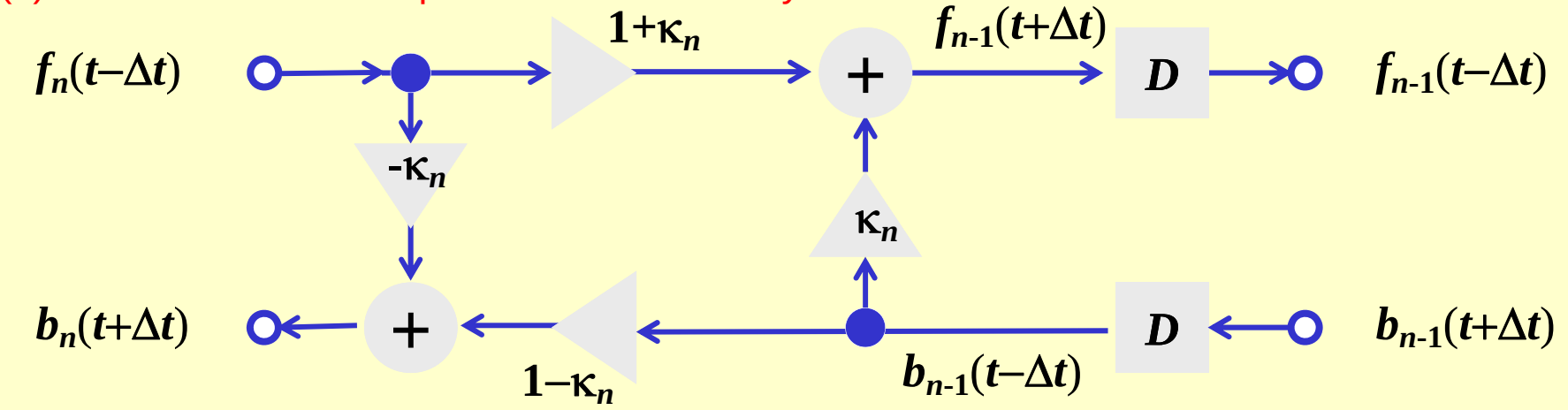
Simulation of speech production for vowel /a/ using the two-mass model



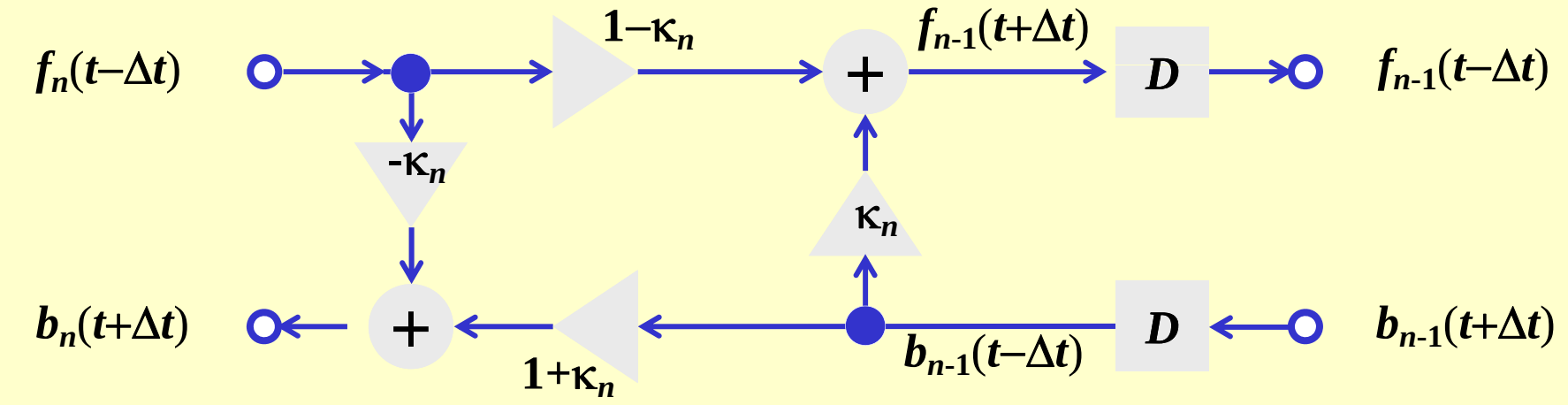
Definition of forward and backward waves with respect to volume velocity at the *n*th cross section, and continuity condition for the volume velocity at the boundary between the (*n*-1)th and *n*th sections

Transmission model of acoustic waves in the vocal tract

(a) Transmission with respect to volume velocity

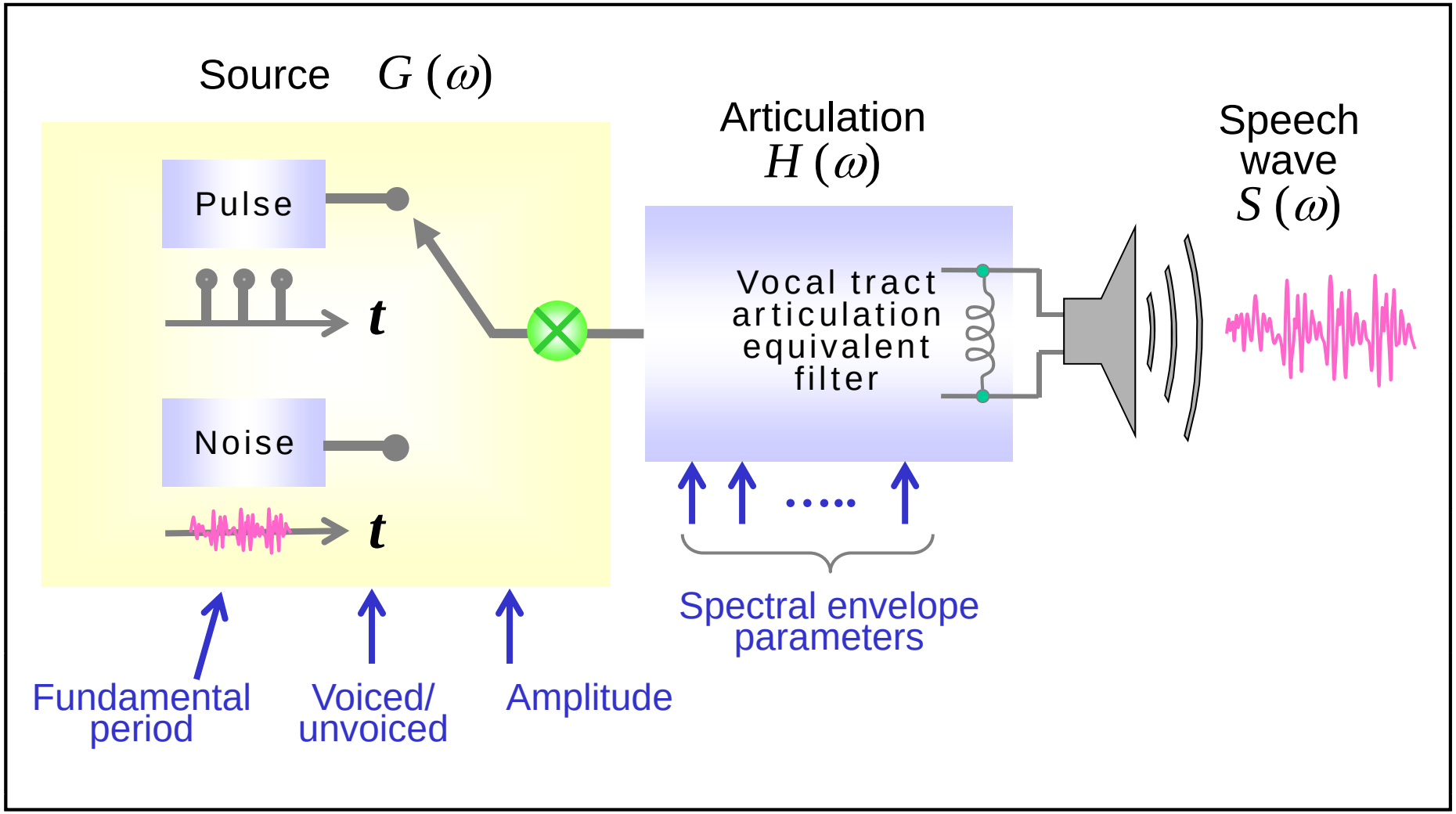


(b) Transmission with respect to sound pressure



(D = time delay of $2\Delta t$)

Linear separable equivalent circuit model of the speech production mechanism



$$S(\omega) = G(\omega) \cdot H(\omega)$$