Acoustic phonetic representation of speech sounds

Silence, Unvoiced and Voiced Portions of Speech

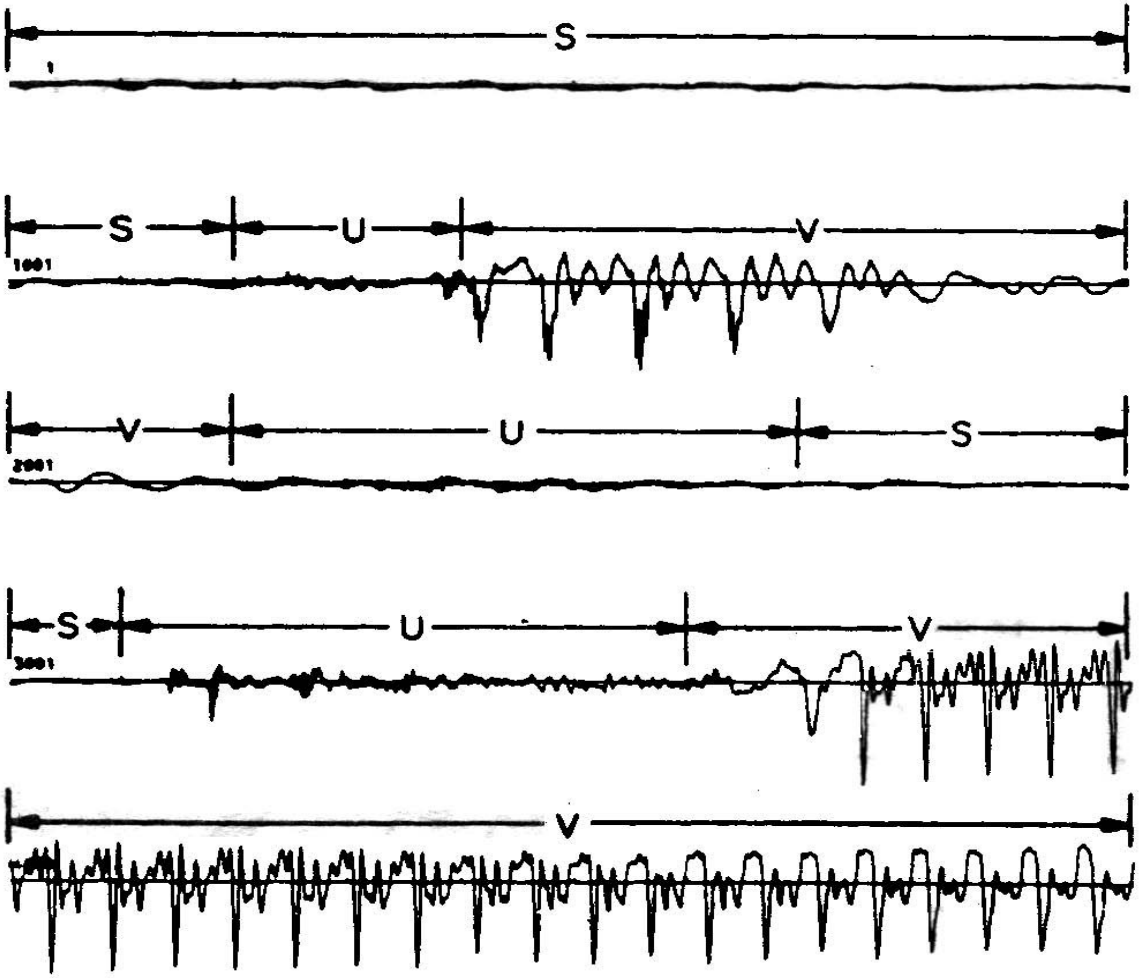


Figure 2.7 Waveform plot of the beginning of the utterance "It's time."

Narrowband & Wideband Spectrograms

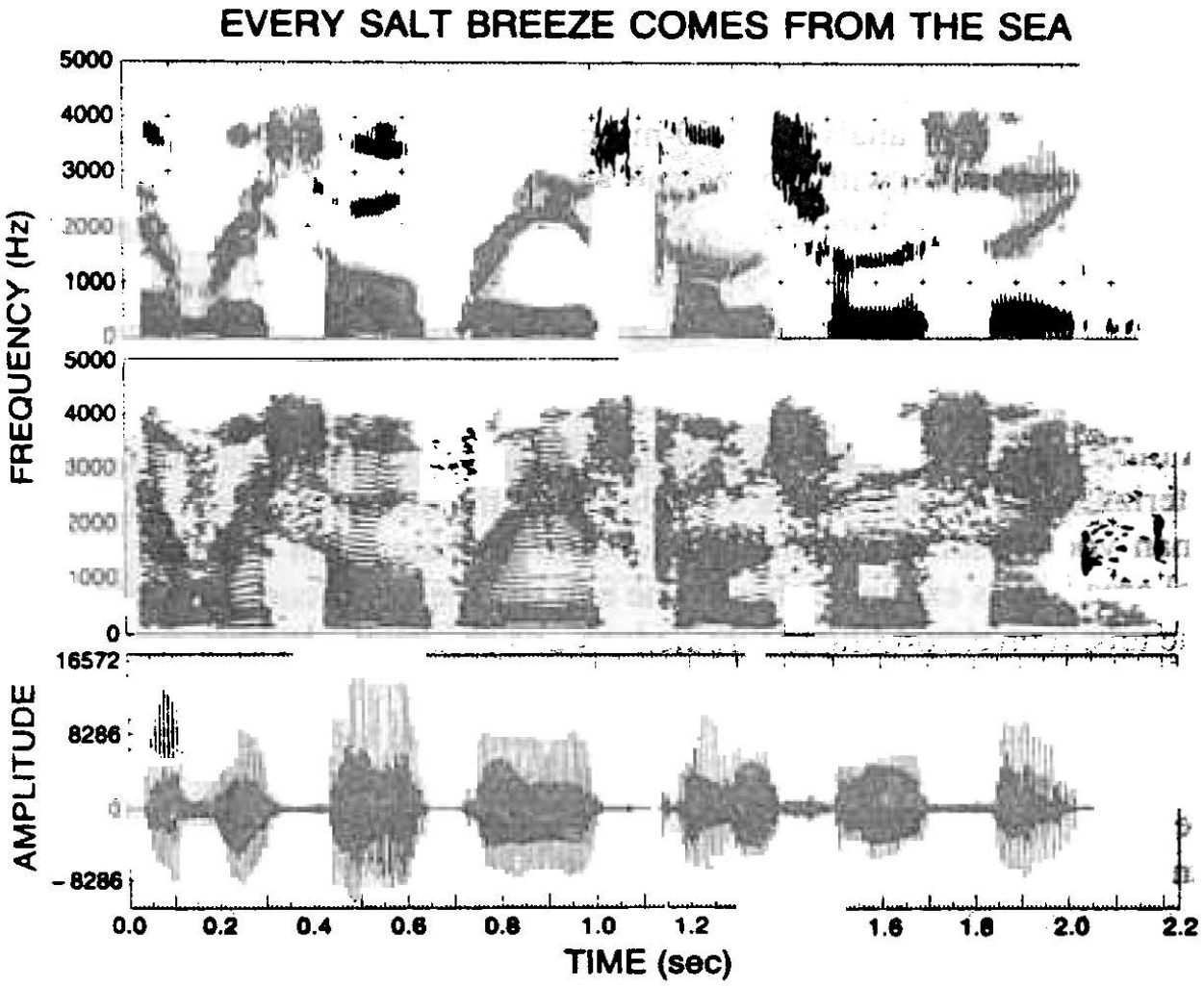


Figure 2.8 Wideband and narrowband spectrograms and speech amplitude for the utterance "Every salt breeze comes from the sea."

Formant Frequencies

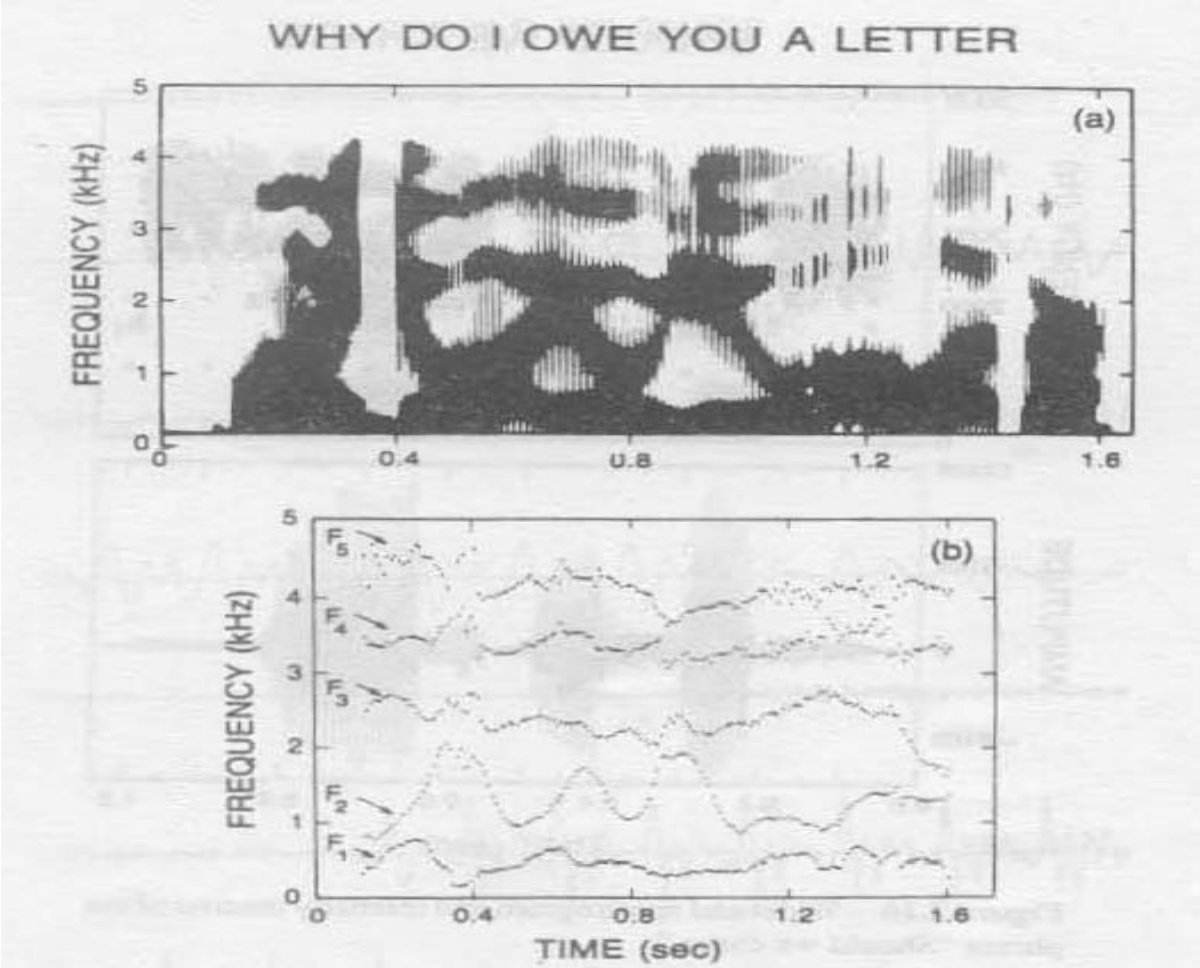


Figure 2.9 Wideband spectrogram and formant frequency representation of the utterance "Why do I owe you a letter" (after Atal and Hanauer [5]).

Time and Time-Frequency Representation of Speech

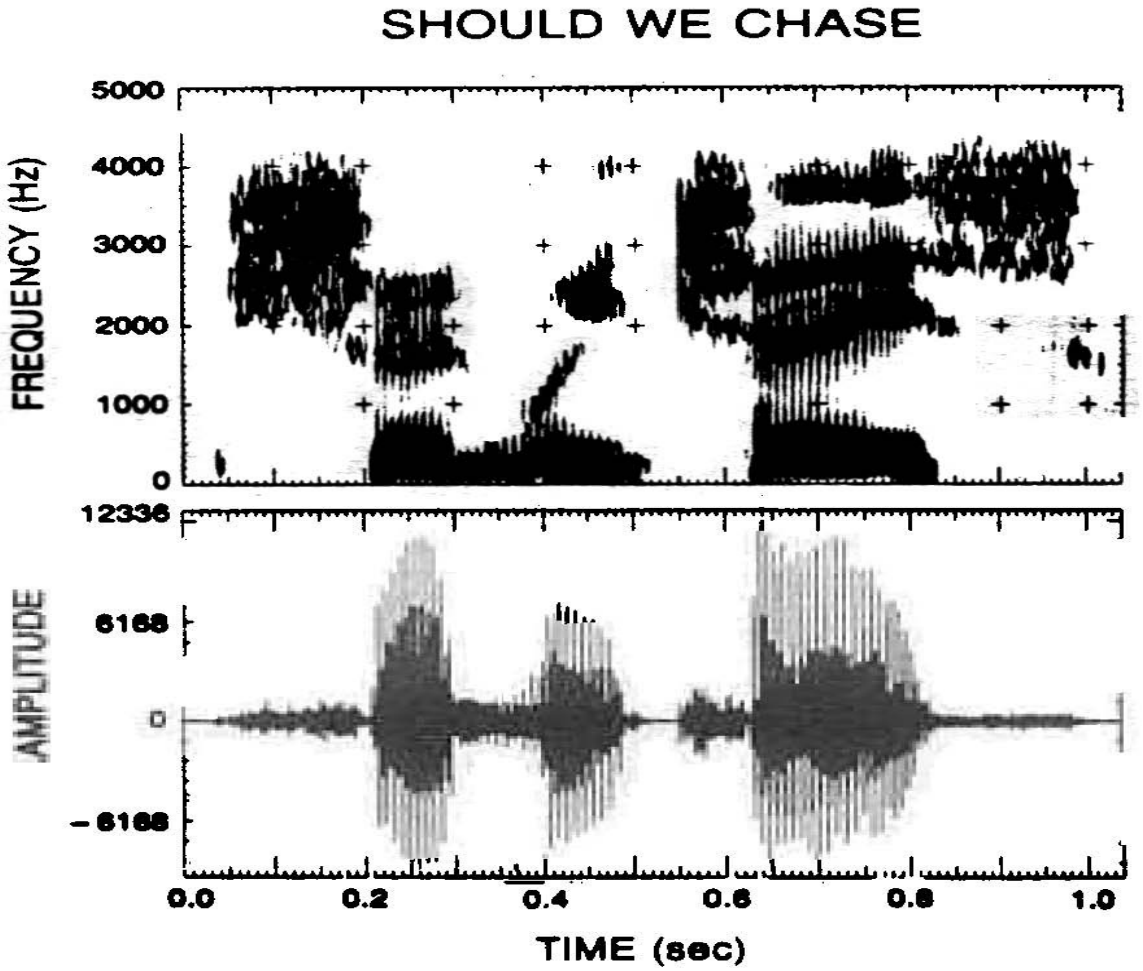


Figure 2.10 Wideband spectrogram and intensity contour of the phrase "Should we chase."

Voiced and Unvoiced Portions of Speech

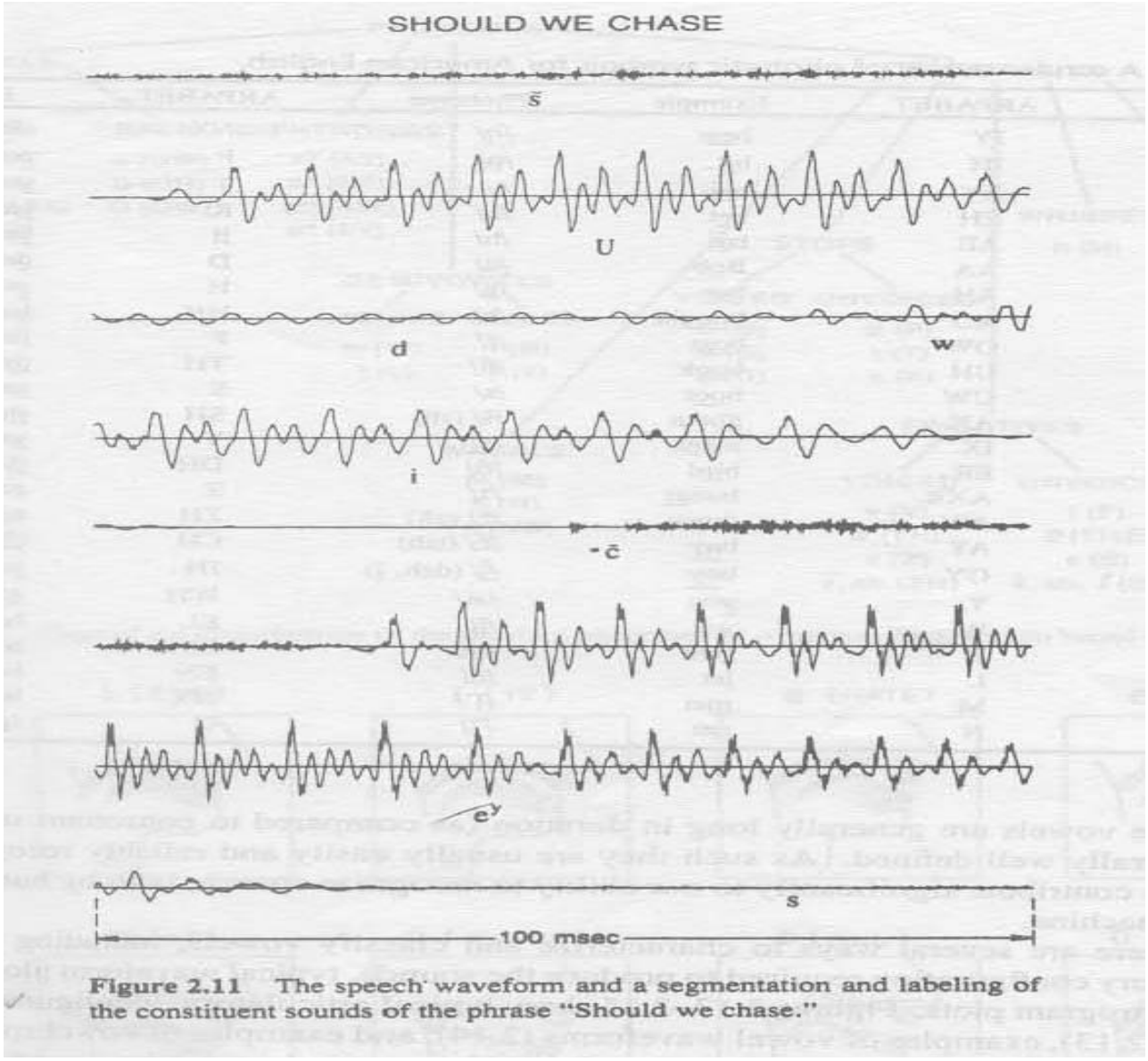


Figure 2.11 The speech waveform and a segmentation and labeling of the constituent sounds of the phrase "Should we chase."

Classification of phonemes

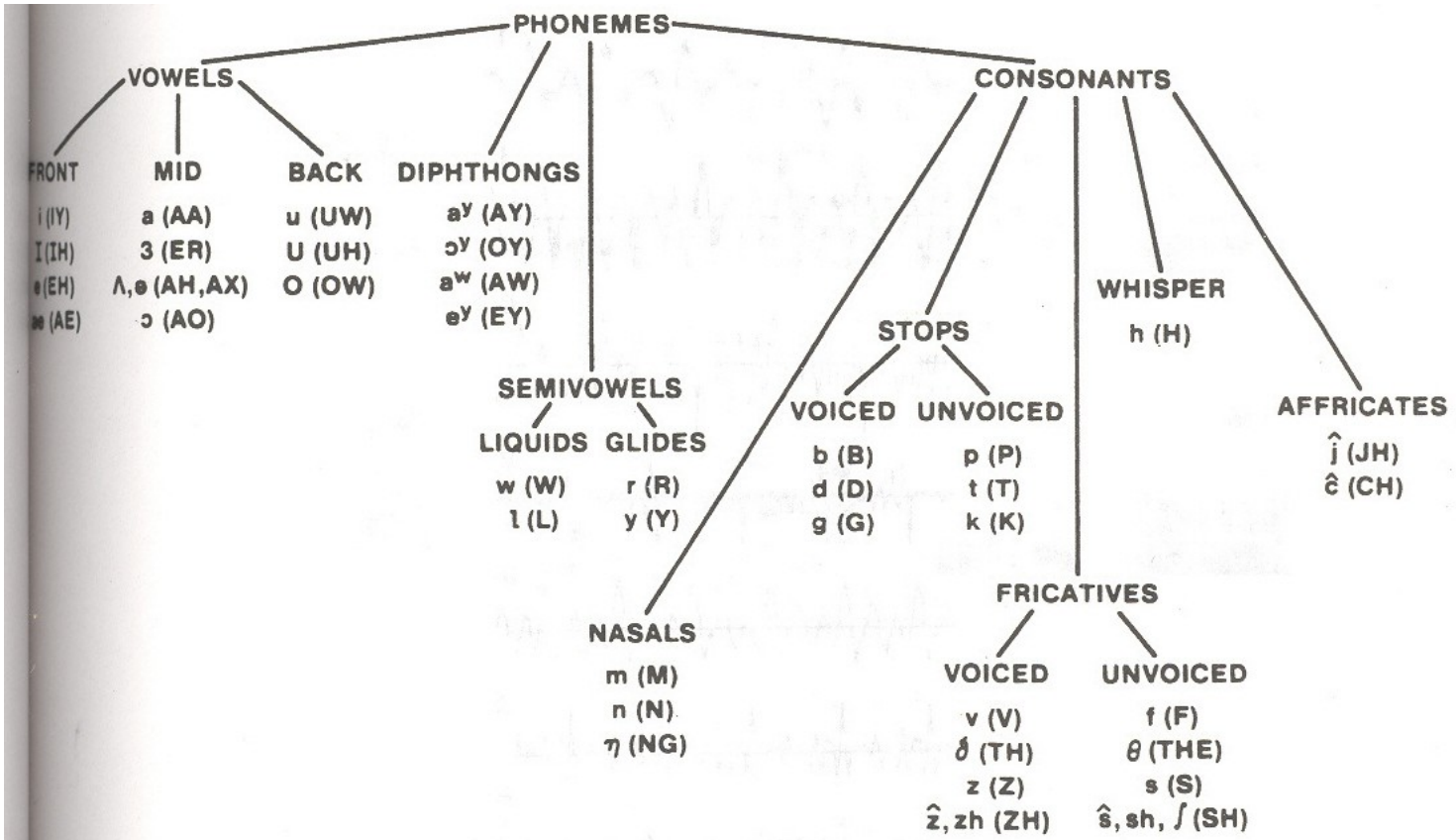


Figure 2.12 Chart of the classification of the standard phonemes of American English into broad sound classes.

Hindi Sound Units

Set of Characters representing Vowel speech sounds

Vowel	Short	/a/(अ)	/i/(इ)	/u/(उ)	/e/(ए)	/o/(ओ)
	Long	/a:/(आ)	/i:/(ई)	/u:/(ऊ)	/e:/(ए)	/o:/(ओ.)
	Diphthongs	/ai/(ऐ)		/au/(औ)		

Set of Characters representing Consonant-Vowel Combinations, where Consonat is any plosive and Vowel is /a/(अ)

Place of articulation	Manner of articulation				Nasals	Semivowels	Fricatives
	Unvoiced		Voiced				
	Unaspirated	Aspirated	Unaspirated	Aspirated			
Velar	/ka/(क)	/kha/(ख)	/ga/(ग)	/gha/(घ)	/kna/(ङ)	--	/ha/(ह)
Palatal	/cha/(च)	/chha/(छ)	/ja/(ज)	/jha/(झ)	/cna/(ञ)	/ya/(य)	/sha/(श)
Retroflex	/Ta/(ट)	/Tha/(ठ)	/Da/(ड)	/Dha(ढ)	/Tna(ण)	/ra/(र)	/shha/(ष)
Denti-Alveolar	/ta/(त)	/tha/(थ)	/da/(द)	/dha/(ध)	/na/(न)	/la/(ल)	/sa/(स)
Bilabial	/pa/(प)	/pha/(फ)	/ba/(ब)	/bha/(भ)	/ma/(म)	/va/(व)	--

Tongue hump for vowel sounds

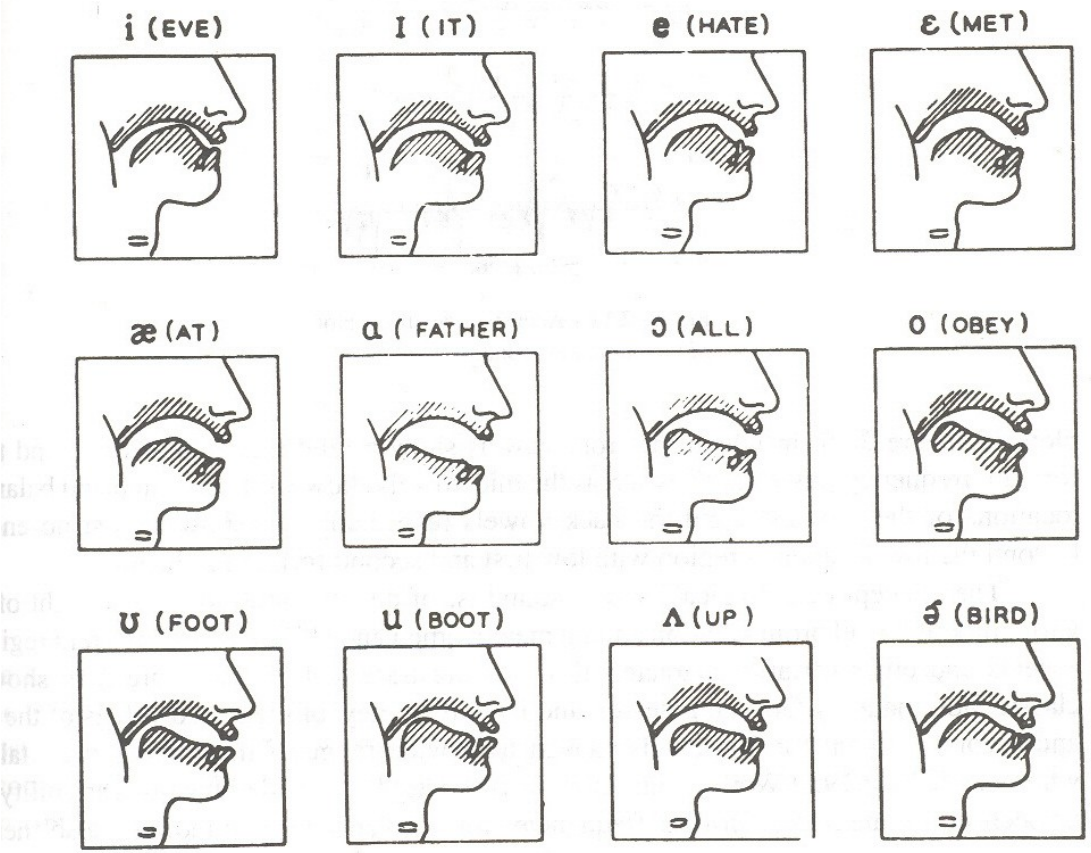


Figure 2.13 Articulatory configurations for typical vowel sounds (after Flanagan [3]).

Waveform plots for vowel sounds

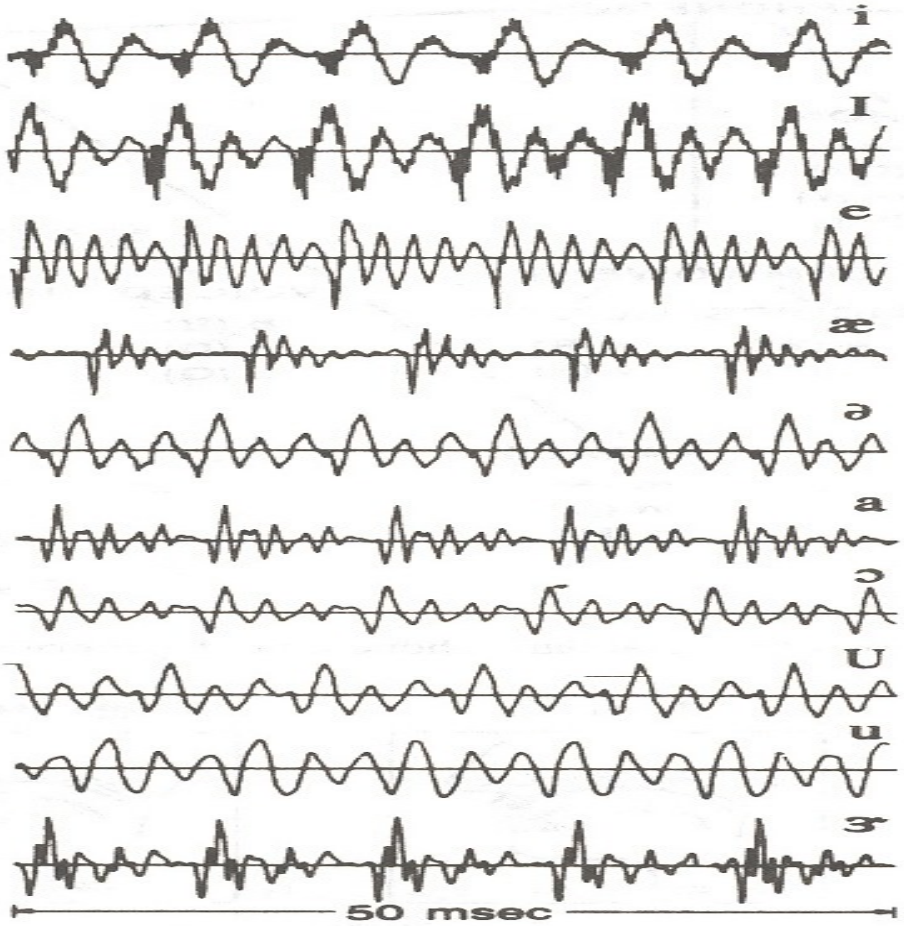


Figure 2.14 Acoustic waveform plots of typical vowel sounds.

Spectrograms for vowel sounds

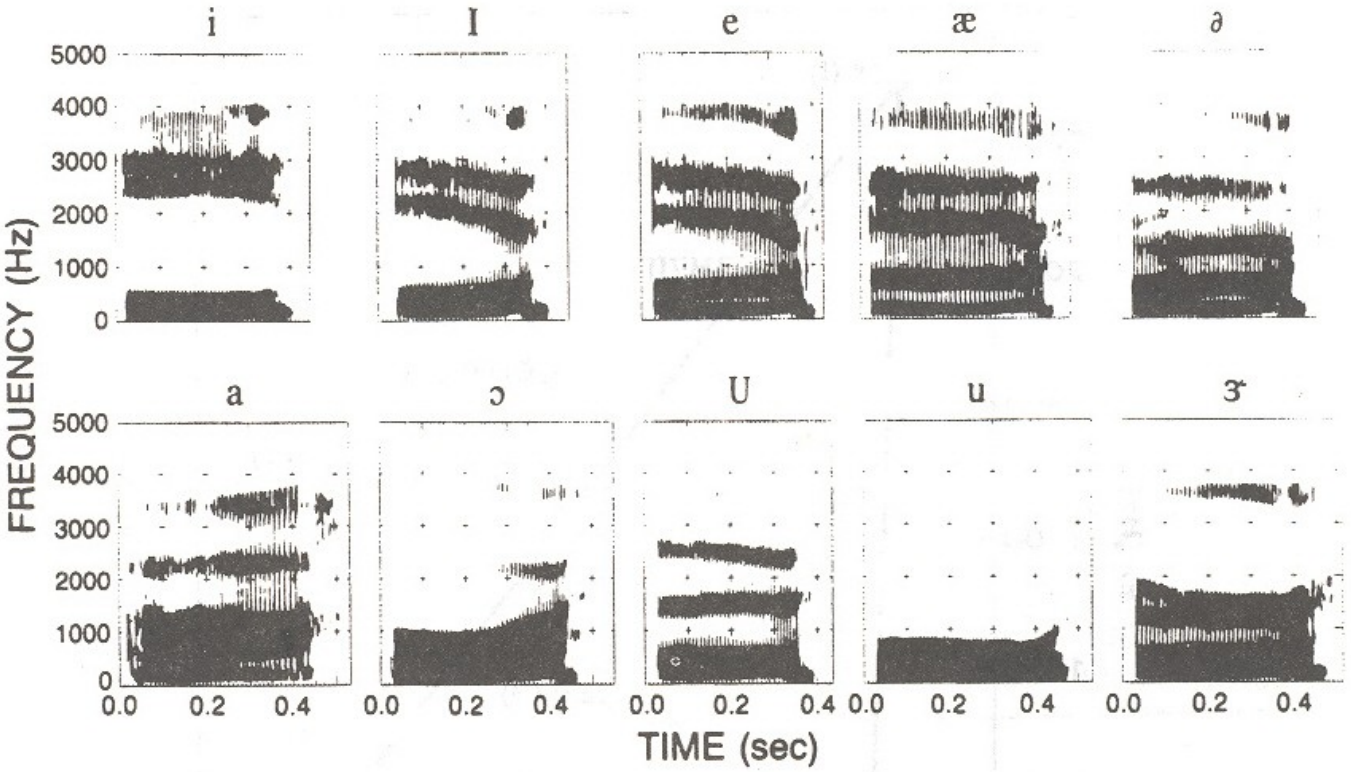


Figure 2.15 Spectrograms of the vowel sounds.

F1-F2 clusters for vowel sounds

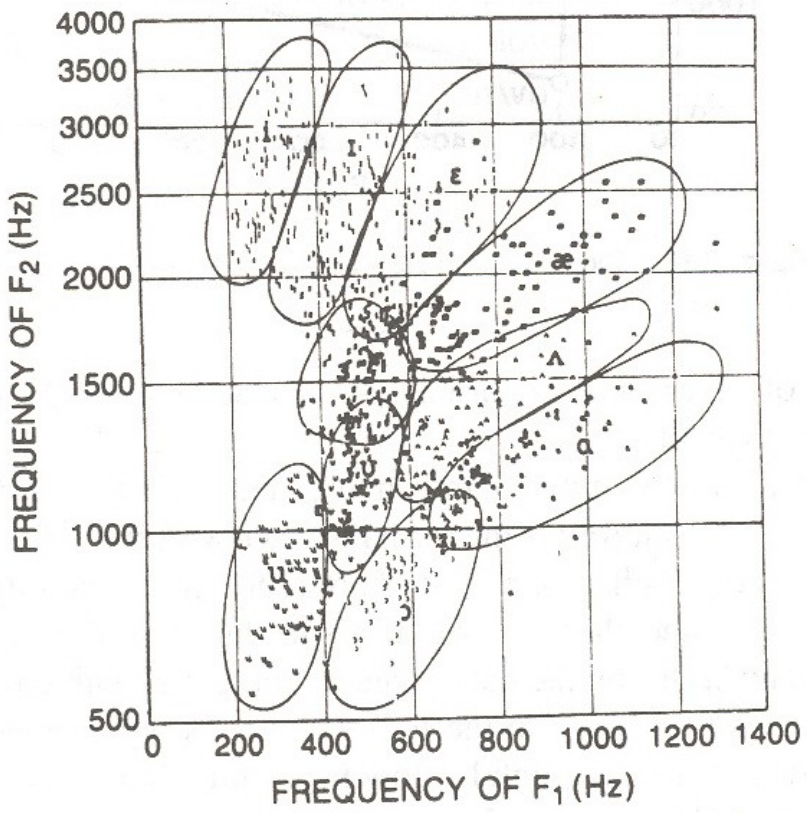


Figure 2.16 Measured frequencies of first and second formants for a wide range of talkers for several vowels (after Peterson & Barney [7]).

F1-F2 centroids for vowel sounds

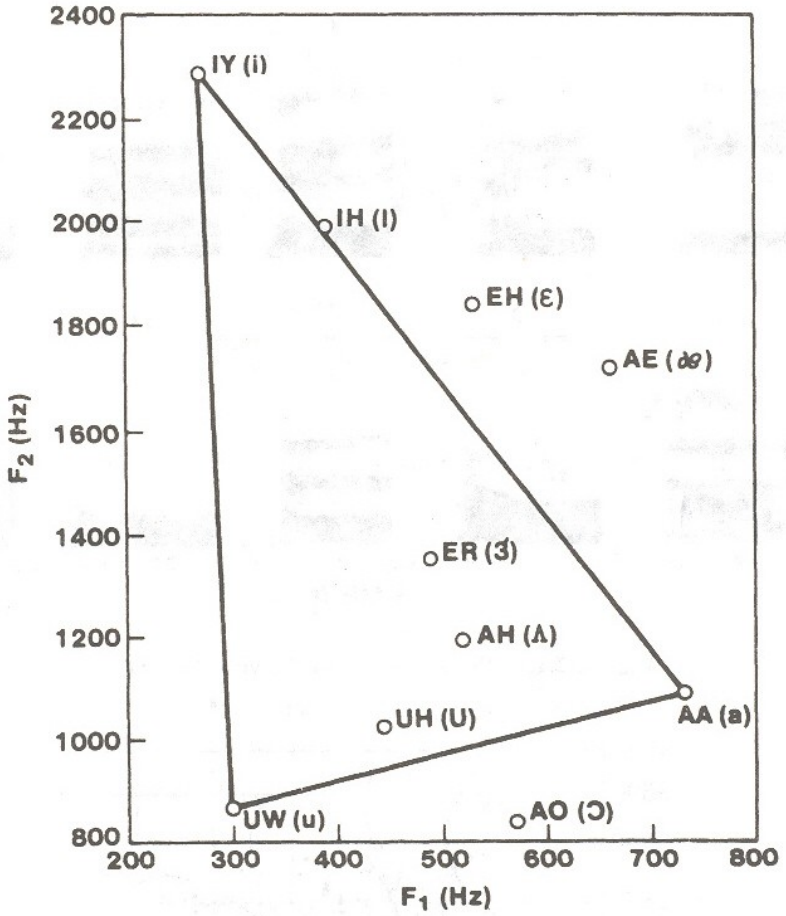


Figure 2.17 The vowel triangle with centroid positions of the common vowels.

Formant frequencies for typical vowels

TABLE 2.2. Formant frequencies for typical vowels.

ARPABET Symbol for Vowel	IPA Symbol	Typical Word	F_1	F_2	F_3
IY	/i/	beet	270	2290	3010
IH	/ɪ/	bit	390	1990	2550
EH	/ɛ/	bet	530	1840	2480
AE	/æ/	bat	660	1720	2410
AH	/ʌ/	but	520	1190	2390
AA	/a/	hot	730	1090	2440
AO	/ɔ/	bought	570	840	2410
UH	/ʊ/	foot	440	1020	2240
UW	/u/	boot	300	870	2240
ER	/ɝ/	bird	490	1350	1690

Spectrograms for diphthongs

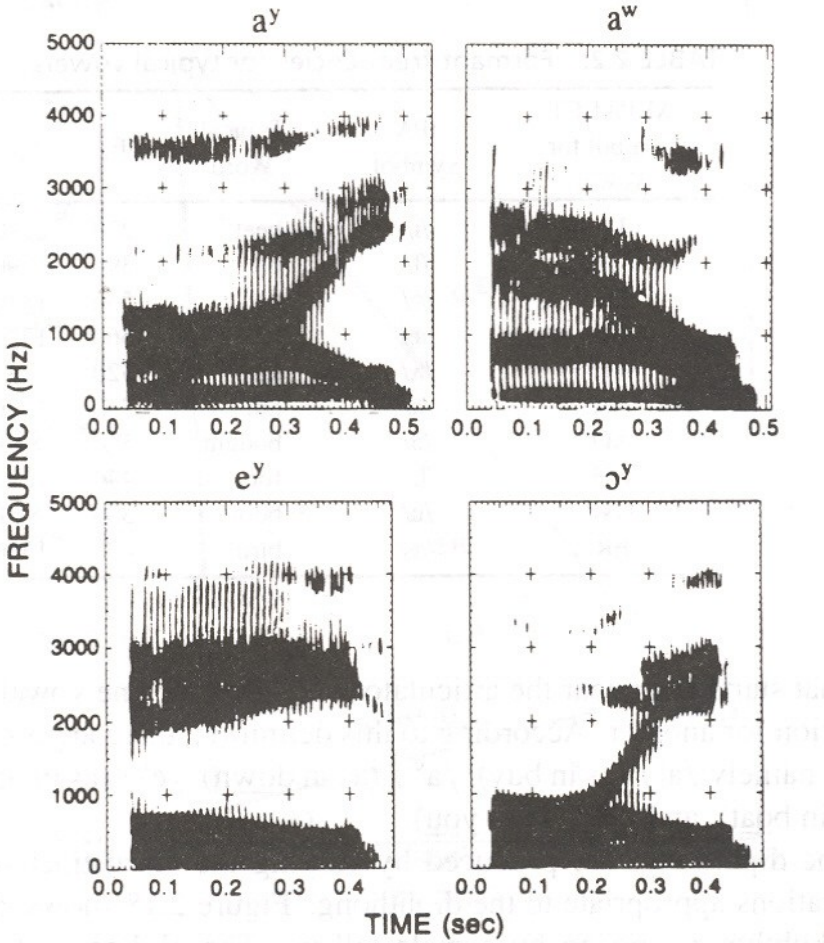


Figure 2.18 Spectrogram plots of four diphthongs.

Nasal sounds

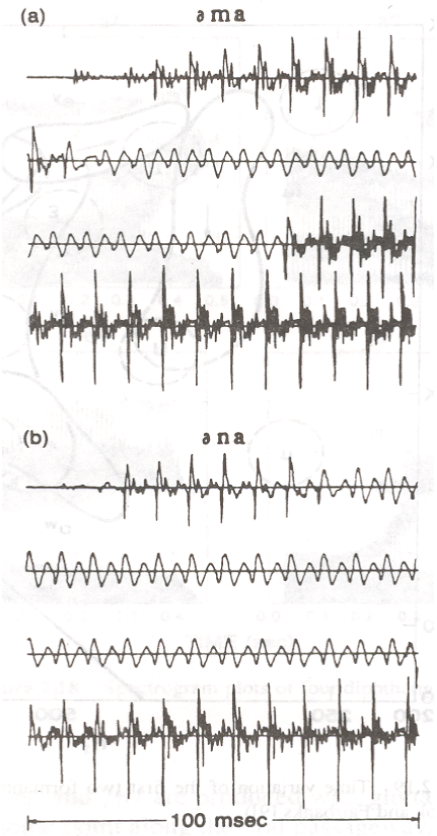


Figure 2.20 Waveforms for the sequences /ə-m-a/ and /ə-n-a/.

Spectrograms of nasal sounds

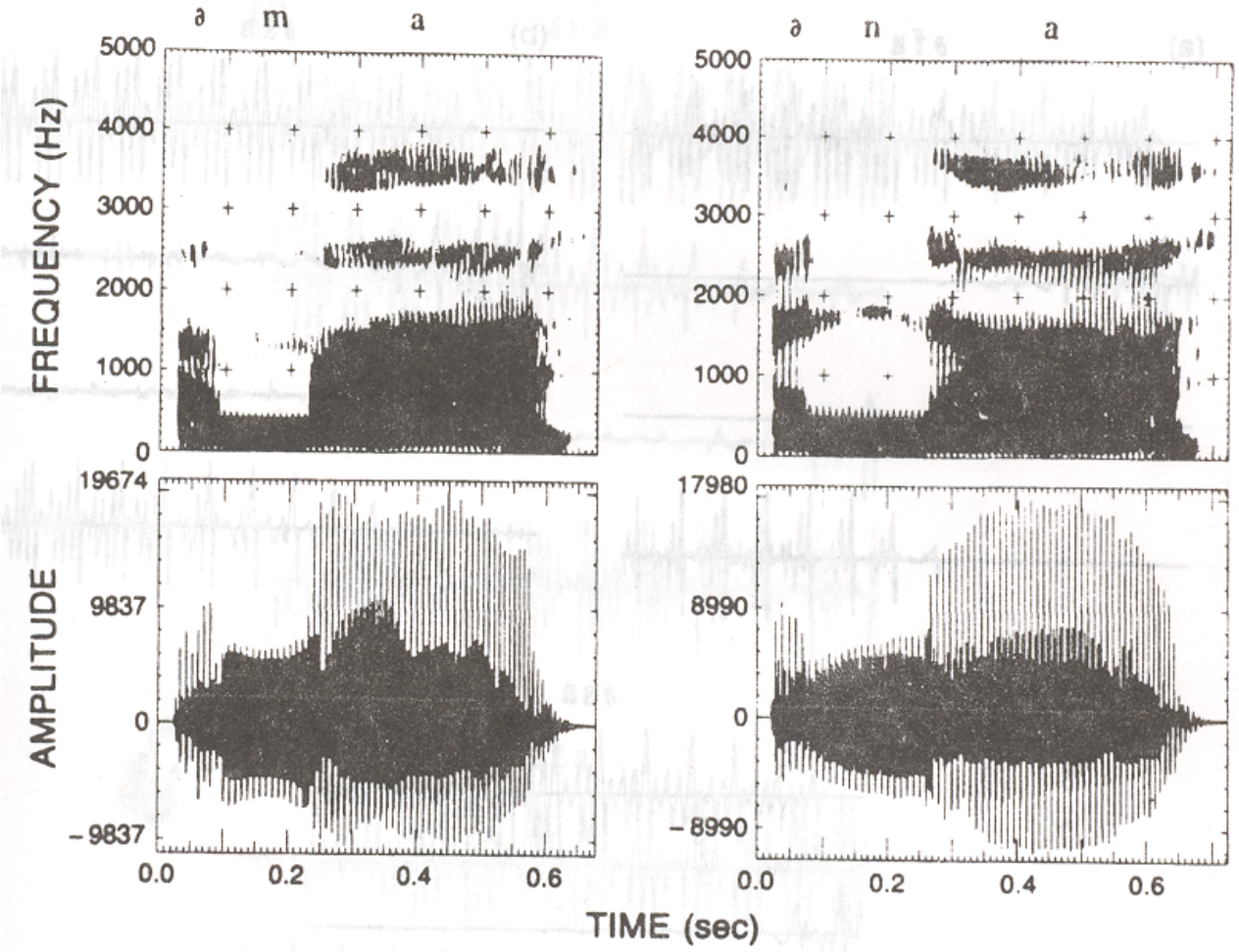


Figure 2.21 Spectrograms of the sequences /ə-m-a/ and ə-n-a/.

Unvoiced Fricatives (/f/. /s/, /sh/)

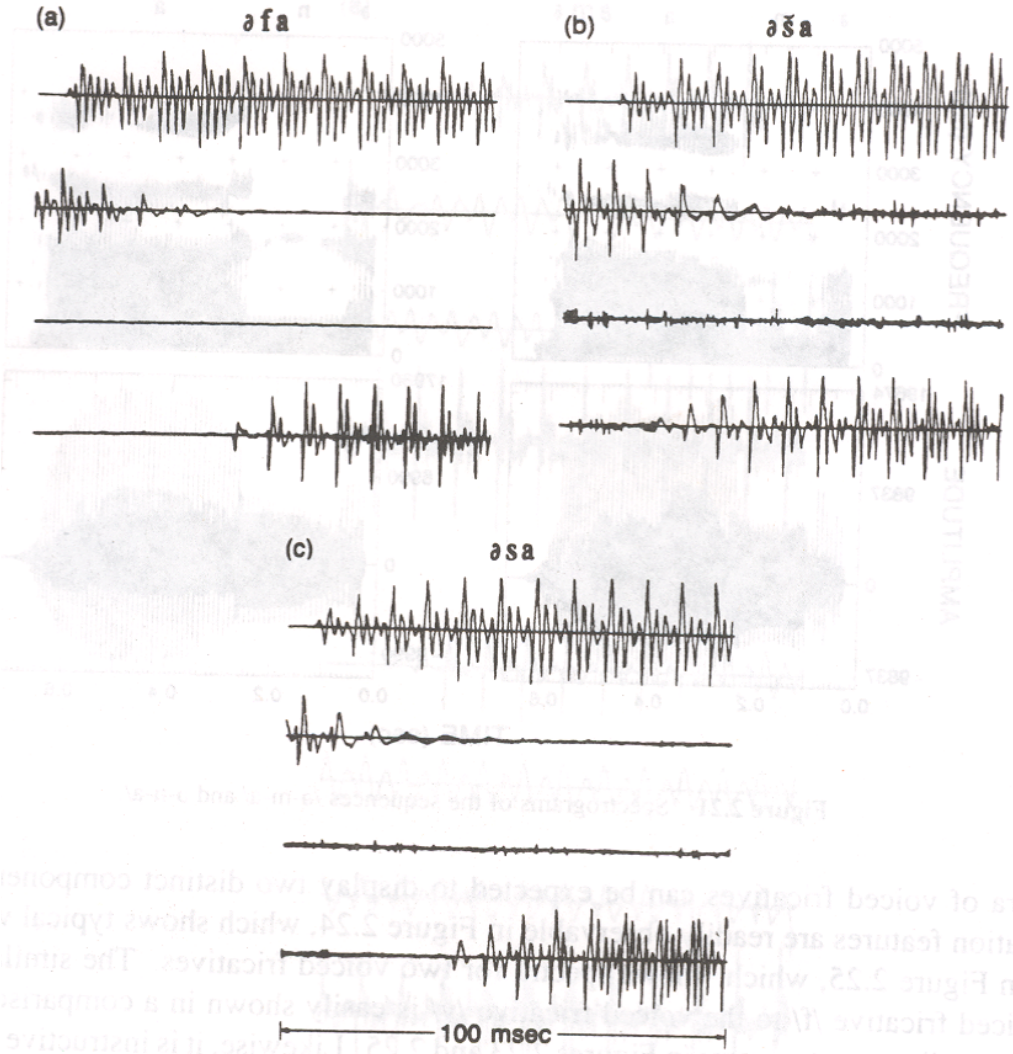


Figure 2.22 Waveforms for the sounds /f/, /s/ and /sh/ in the context /ə-x-a/ where /x/ is the unvoiced fricative.

Spectrograms of Unvoiced Fricatives (/f/, /s/, /sh/)

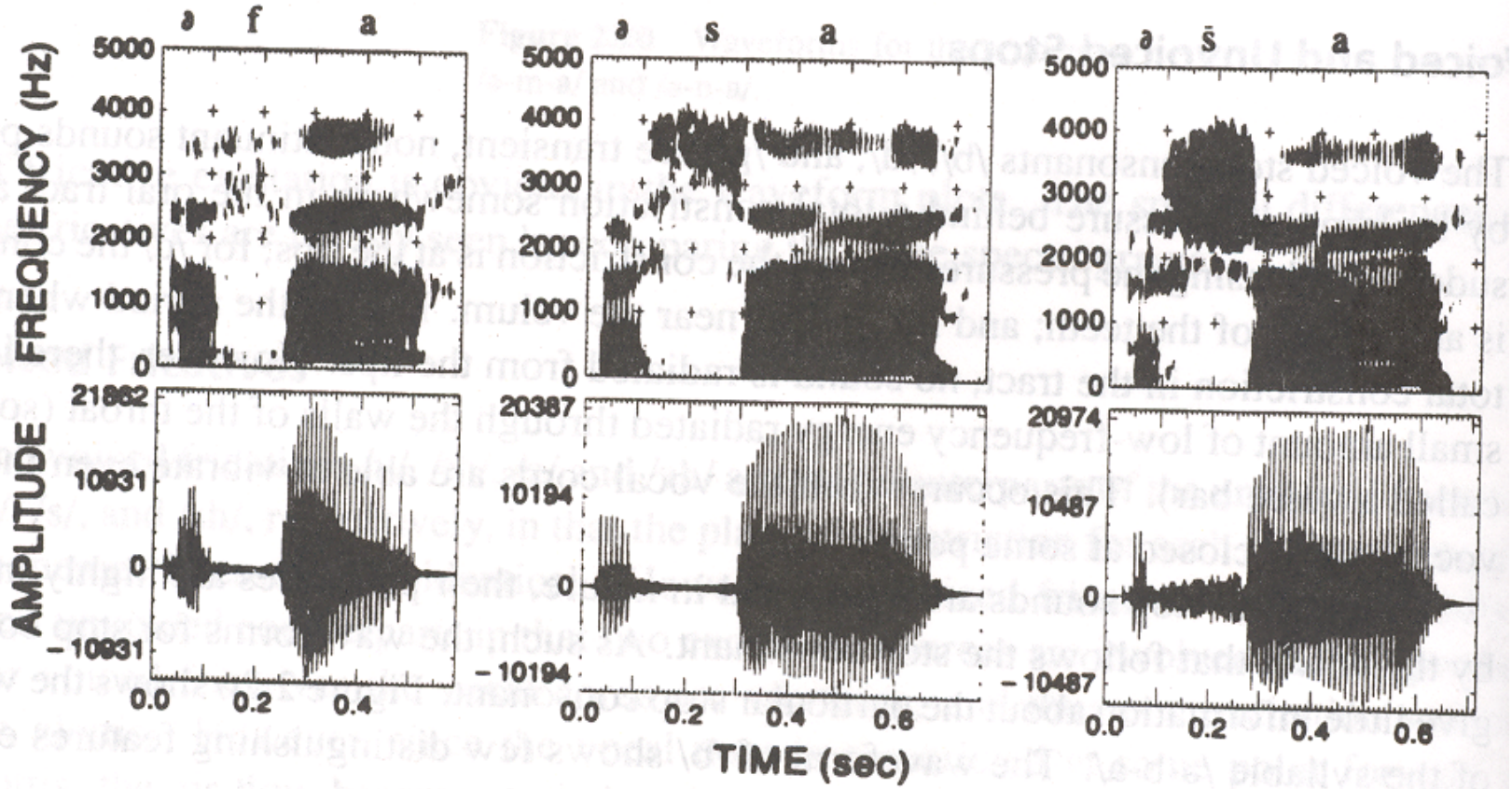


Figure 2.23 Spectrogram comparisons of the sounds /ə-f-a/, /ə-s-a/ and /ə-sh-a/.

Voiced fricatives (/v/, /z/)

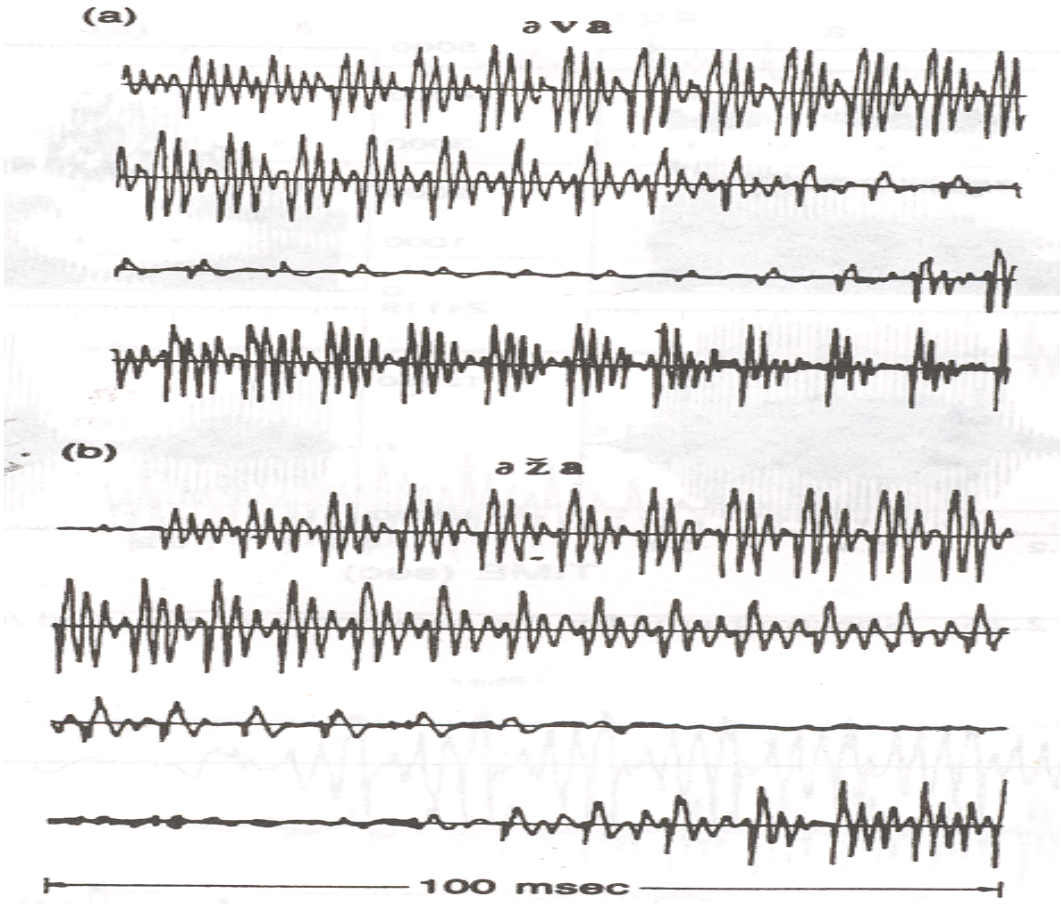


Figure 2.24 Waveforms for the sequences /ə-v-a/ and /ə-zh-a/.

Spectrograms for voiced fricatives (/v/, /z/)

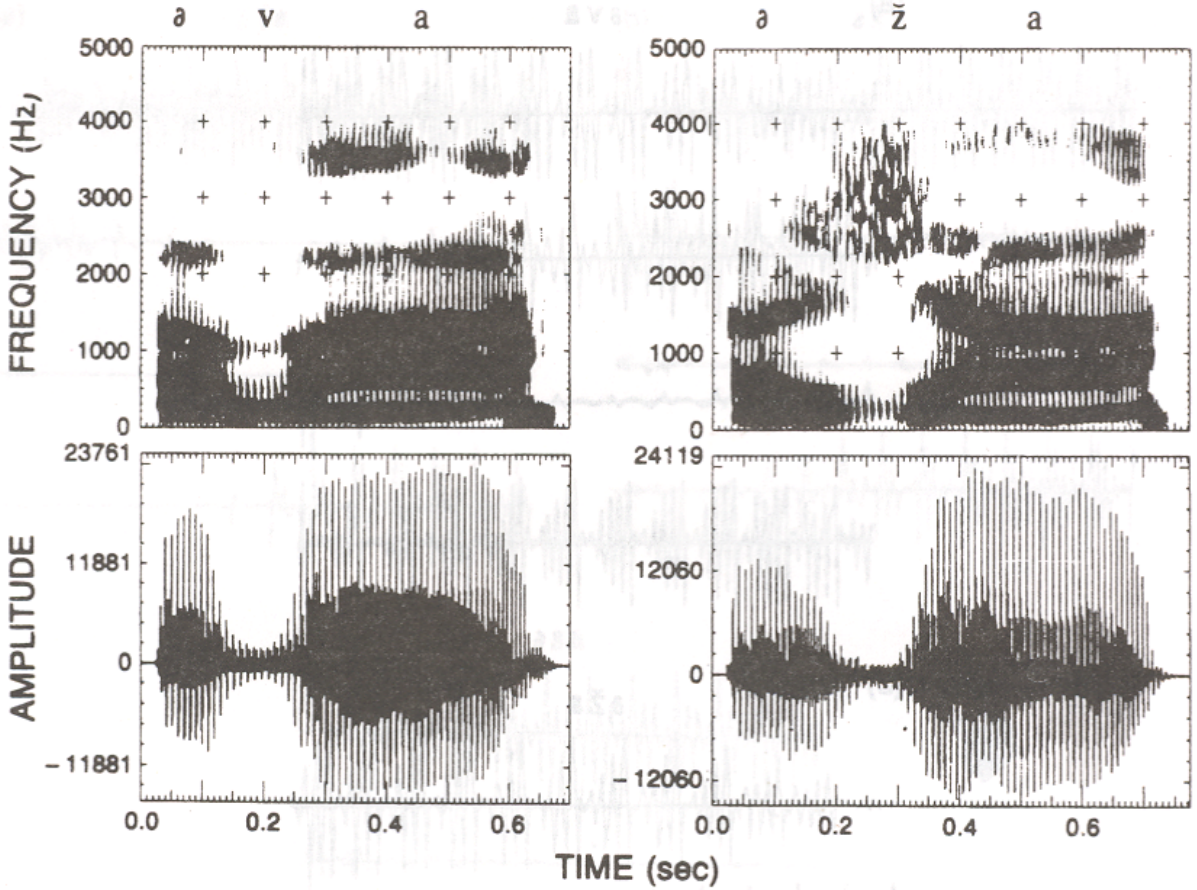


Figure 2.25 Spectrograms for the sequences /ə-v-a/ and /ə-zh-a/.

Waveform for voiced stop (/b/)

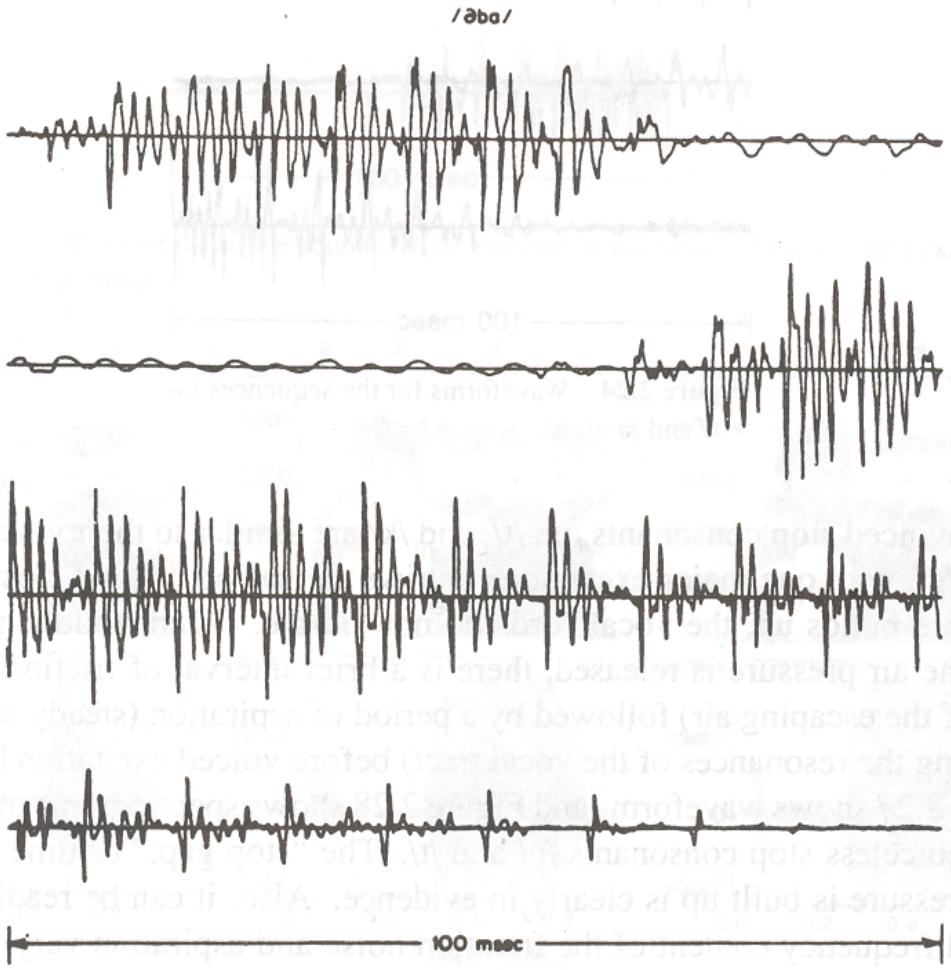


Figure 2.26 Waveform for the sequence /ə-b-a/.

Waveforms of unvoiced constants (/p/, /t/)

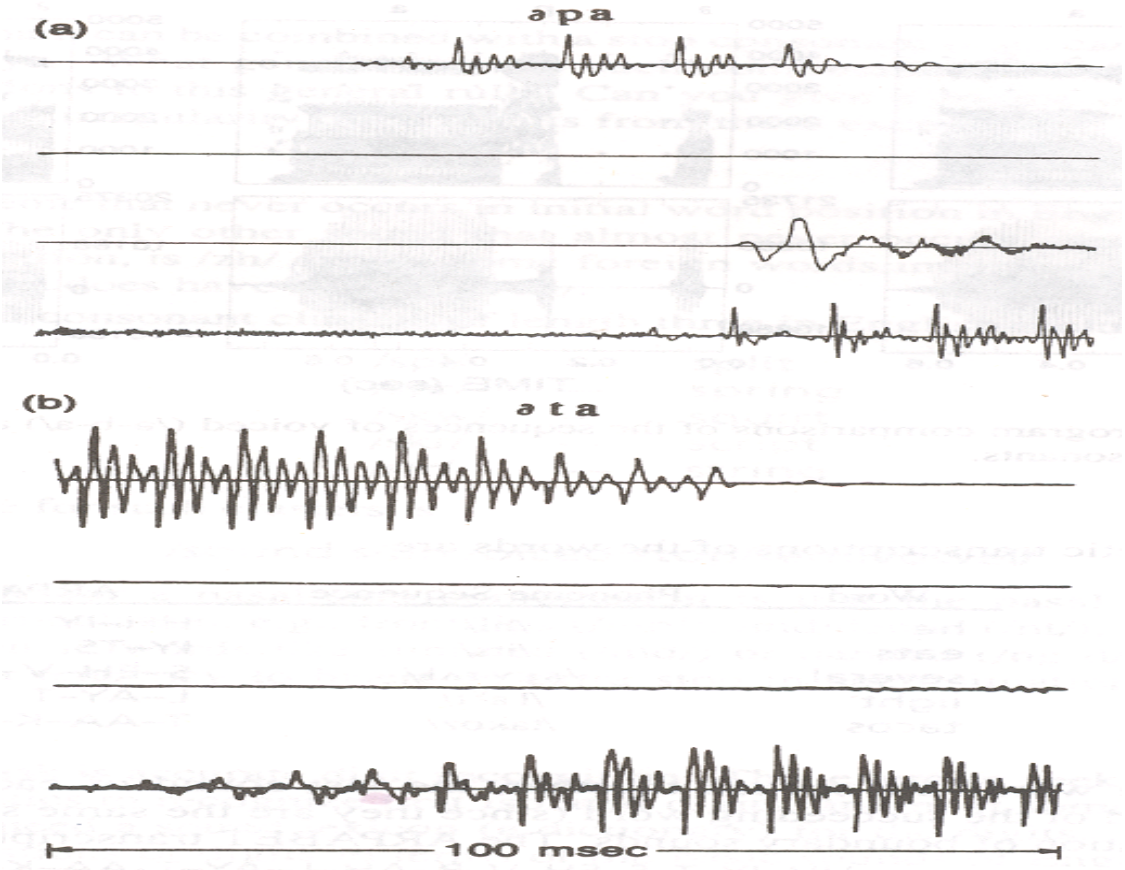


Figure 2.27 Waveforms for the sequences /ə-p-a/ and /ə-t-a/.

Spectrograms for stop consonants

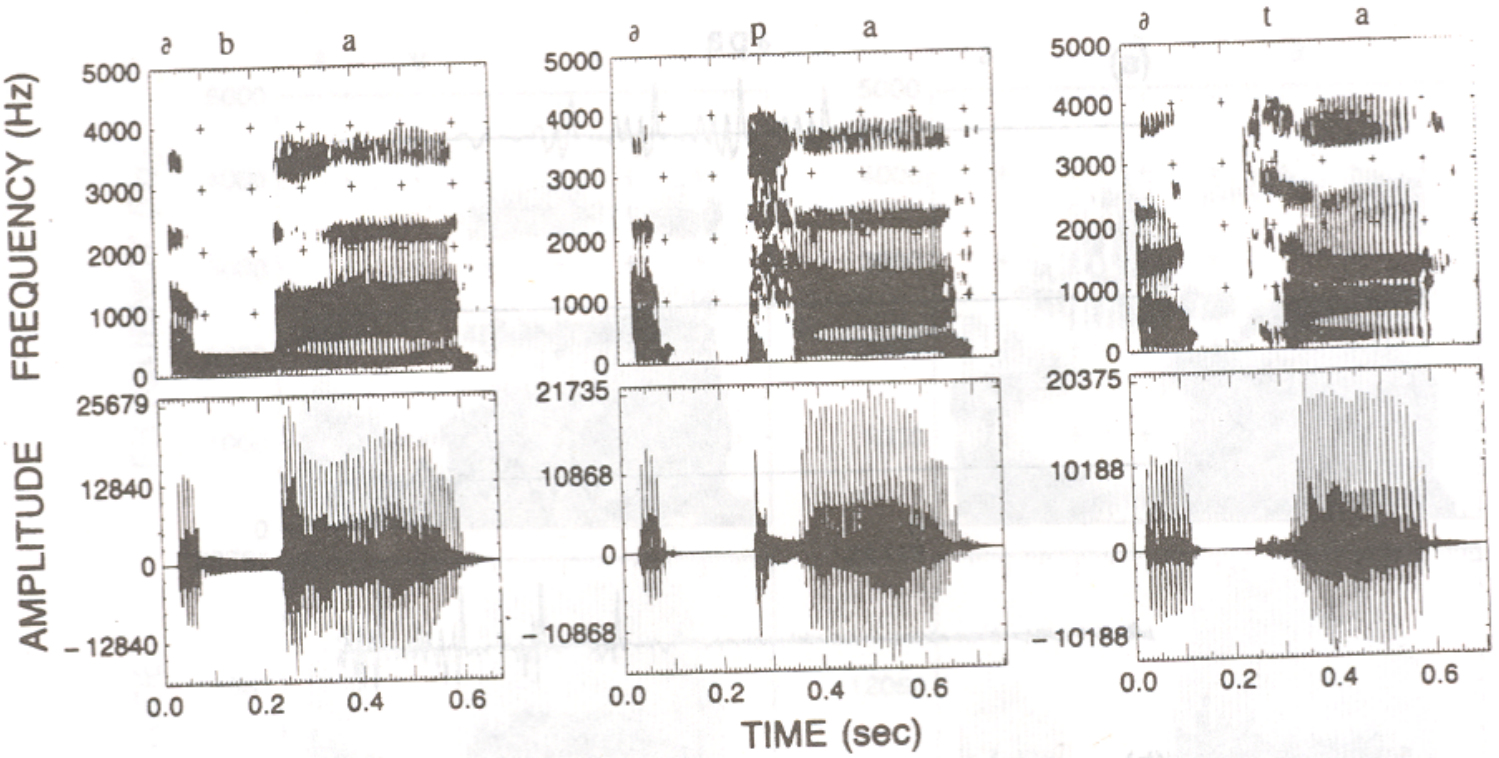
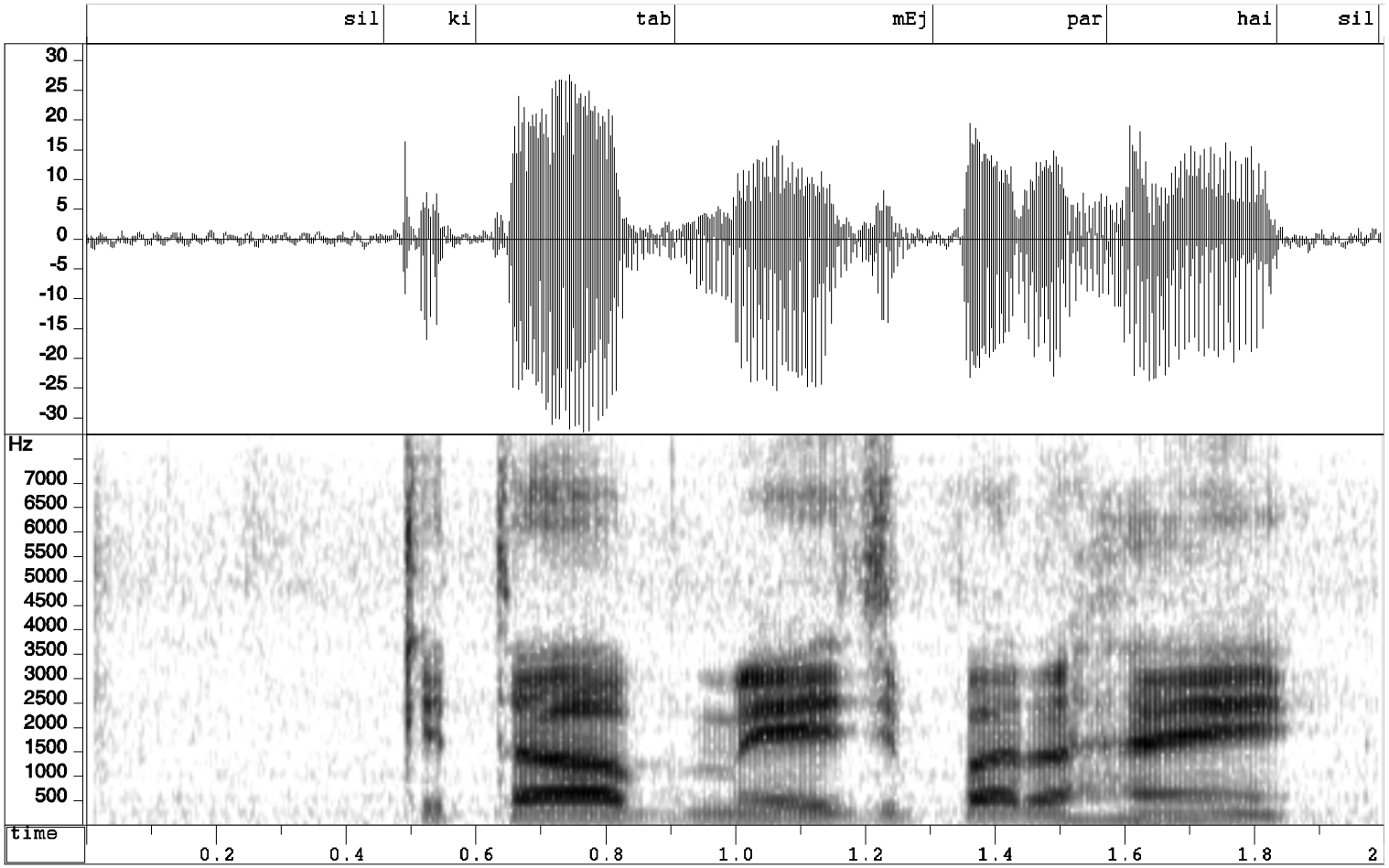


Figure 2.28 Spectrogram comparisons of the sequences of voiced (/ə-b-a/) and voiceless (/ə-p-a/ and /ə-t-a/) stop consonants.


sil
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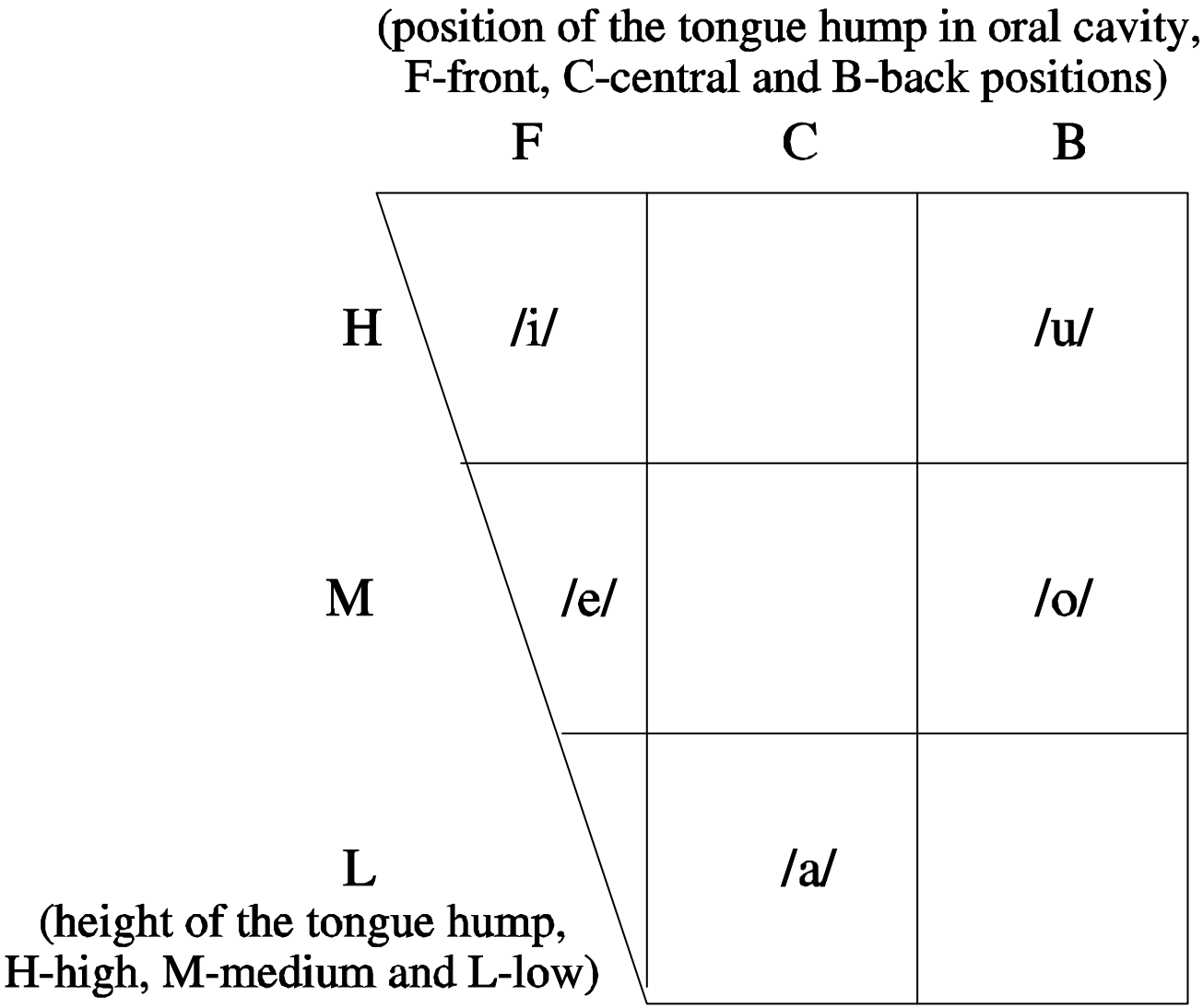
-30
Hz
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
time
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2

Vowel diagram



Spectrograms of isolated digits

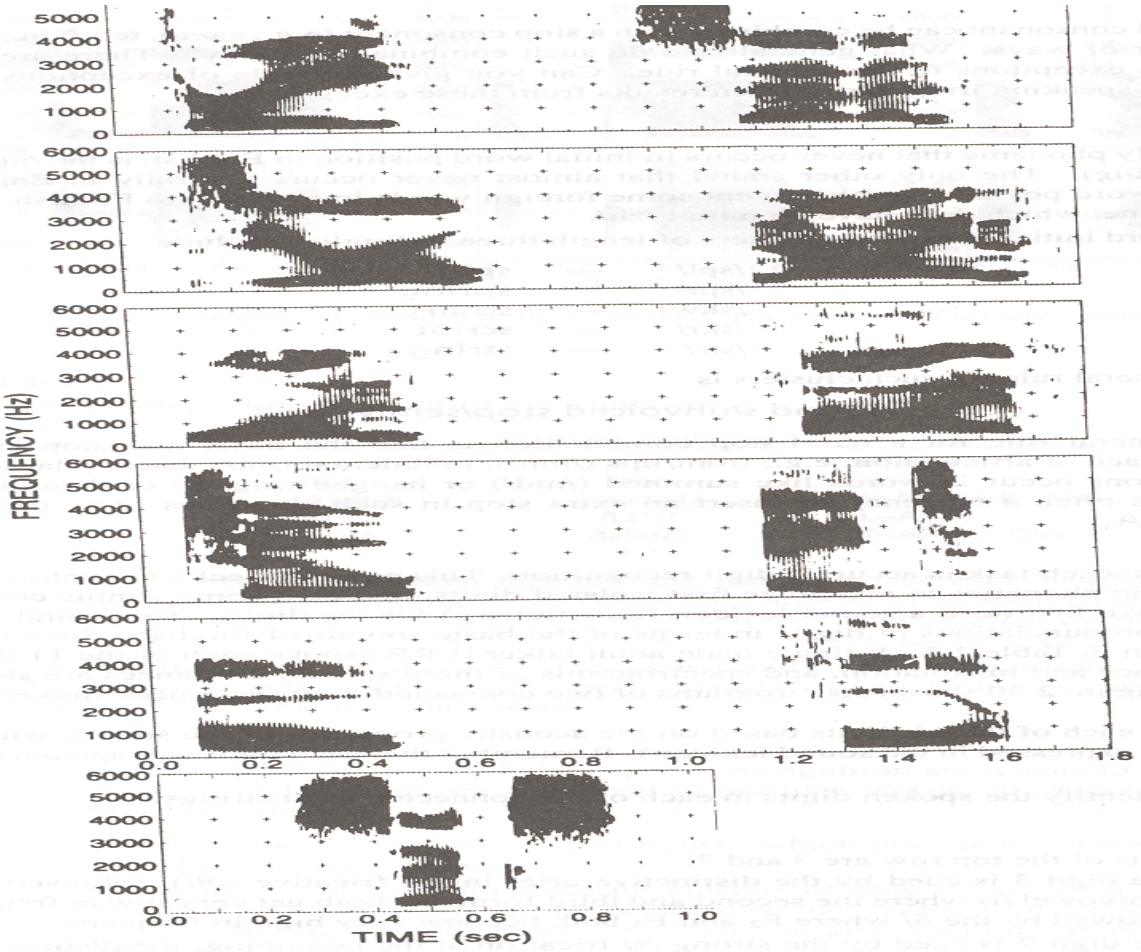


Figure 2.29 Spectrograms of the 11 isolated digits, 0 through 9 plus oh, in random sequence.

Spectrograms of two connected digit sequences

TABLE 2.3. Sound Lexicon of Digits

Word	Sounds	ARPABET
Zero	/z I r o/	Z–IH–R–OW
One	/w ʌ n/	W–AH–N
Two	/t u/	T–UW
Three	/θ r i/	TH–R–IY
Four	/f o r/	F–OW–R
Five	/f aʸ v/	F–AY–V
Six	/s I k s/	S–IH–K–S
Seven	/s ɛ v ə n/	S–EH–V–AX–N
Eight	/eʸ t/	EY–T
Nine	/n aʸ n/	N–AY–N
Oh	/o/	OW

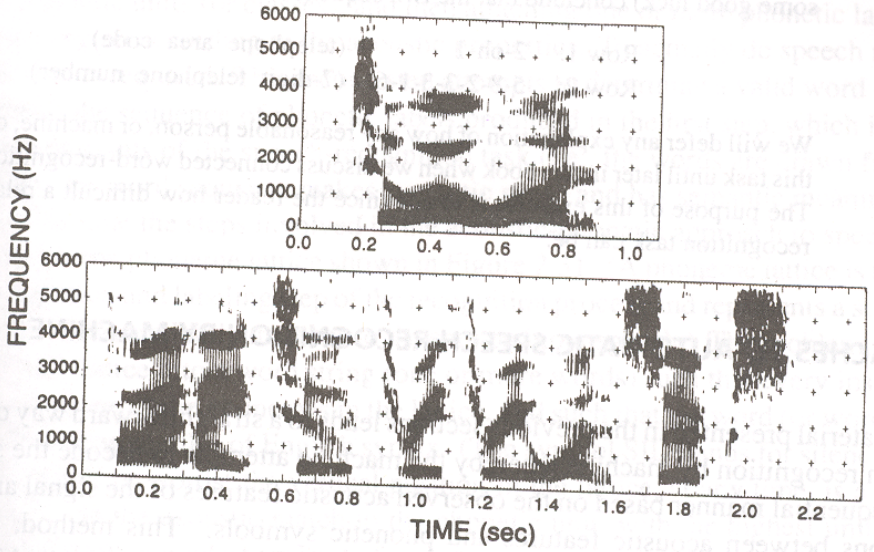


Figure 2.30 Spectrograms of two connected digit sequences.