

Contents

Preface	xi
1 About this Book	1
1.1 Phonetics in a Nutshell	1
1.2 The Structure of this Book	6
1.3 Terminology	7
1.4 Demonstrations and Exercises	8
2 Articulatory Phonetics	9
2.1 Phonation at the Larynx	9
2.2 Basic Articulatory Terms	10
2.3 The Articulation of Consonants	13
2.3.1 Place of articulation	14
2.3.2 Manner of articulation	14
2.3.3 Other classification schemes	17
2.4 The Articulation of Vowels	19
3 Phonetic Transcription	23
3.1 Consonants	26
3.1.1 Plosives	28
3.1.2 Nasals	28
3.1.3 Fricatives	28
3.1.4 Affricates	29
3.1.5 Approximants	30
3.2 Vowels	31
3.3 Diacritics and Other Symbols	35
3.4 Transcription of General American English	37
3.4.1 Consonants	37
3.4.1.1 Aspiration, voicing, and devoicing	37
3.4.1.2 Coarticulation	38
3.4.1.3 Consonantal release	39
3.4.1.4 Flaps and taps	40
3.4.1.5 Glottal plosives	41

8.3.2	What information can be seen in a spectrum?	149
8.3.3	“Windowing” in spectral analysis	150
8.3.3.1	The relation between window size and spectral resolution	153
8.3.3.2	The relation between resolution in the time and frequency domains	154
8.3.4	Other spectral representations: Waterfall and spectrogram	155
8.3.5	The LPC spectrum	158
9	The Source-Filter Theory of Speech Production	162
9.1	Resonance	163
9.1.1	Resonating frequencies of cylindrical tubes	163
9.1.2	Resonating frequencies of non-cylindrical tubes	167
9.2	Damping	169
9.3	Filters	170
9.4	Source and Filter of the Vocal Apparatus	173
9.4.1	Vocal tract filter	174
9.4.2	Radiation at the lips and nostrils	175
9.5	Formants	177
9.5.1	Formant frequencies	178
10	Acoustic Characteristics of Speech Sounds	182
10.1	Vowels	182
10.2	Consonants	186
10.2.1	(Central) Approximants	186
10.2.2	Fricatives	189
10.2.3	Plosives	192
10.2.4	Nasals	194
10.2.5	Lateral approximants	197
10.2.6	Affricates	199
10.3	Summary	199
10.4	Variability and Invariance	200
10.4.1	A theory of acoustic invariance	201
11	Syllables and Suprasegmentals	208
11.1	Syllables	208
11.2	Stress	210
11.3	Length	215
11.4	Tone and Intonation	218
11.4.1	Tone	218
11.4.2	Intonation	221
12	Physiology and Psychophysics of Hearing	226
12.1	The External Ear	227

12.2	The Middle Ear	228
12.2.1	Increase in pressure in the middle ear	228
12.2.2	Sound attenuation in the middle ear	229
12.2.3	Pressure equalization in the tympanic cavity	230
12.3	The Inner Ear	231
12.3.1	Pressure waves in the cochlea	233
12.3.2	The basilar membrane as an oscillating body	234
12.3.3	Resonance theory	234
12.3.4	Objections to the resonance theory	235
12.3.5	Traveling wave theory	235
12.4	The Structure of the Basilar Membrane	237
12.4.1	Outer hair cells	237
12.4.2	Inner hair cells	238
12.4.3	Frequency coding along the basilar membrane	239
12.4.4	Oto-acoustic emissions	240
12.5	Auditory Frequency Scales	242
12.5.1	Linear scales	242
12.5.2	Logarithmic scales	242
12.5.3	Mel scale	243
12.5.4	Bark scale	244
12.5.5	Equivalent rectangular bandwidth (ERB) scale	245
12.6	Auditory Loudness Scales	247
12.7	Auditory Time Scales	248
13	Speech Perception	251
13.1	Vowels	252
13.1.1	Extrinsic versus intrinsic normalization	254
13.2	Consonants	257
13.2.1	Approximants	257
13.2.2	Fricatives	258
13.2.3	Nasals	259
13.2.4	Plosives	260
13.3	Contributions of the Motor Theory of Speech Perception	263
13.3.1	Categorical perception	265
13.3.2	Is speech “special”?	269
13.3.2.1	Non-speech perception	272
13.3.2.2	Animal perception	273
13.4	The Role of Linguistic Experience in Speech Perception	274
13.5	Summary	278
Appendix A		280
A.1	Mass, Force, and Pressure	280
A.2	Energy, Power, and Intensity	282

A.3	The Decibel (dB)	285
A.3.1	RMS amplitude	286
A.3.2	RMS amplitude and loudness	289
A.3.3	Calculations with dB values	292
Appendix B		295
B.1	Physical Terminology	295
B.2	Mathematical Notations	297
Appendix C		300
C.1	Formant Frequency Values	300
C.2	Fundamental Frequency Values	301
References		302
Index		309