

Contents

| | |
|---|-----|
| Contributors | v |
| Preface | vii |
| 1 Frequency selectivity in the auditory periphery | |
| G. K. YATES | 1 |
| 1 Introduction | 1 |
| 2 The middle ear | 2 |
| 3 Inner ear | 4 |
| A Anatomy | 4 |
| B Steady state electrical potentials | 6 |
| C Gross stimulus-related potentials | 7 |
| D Basilar membrane motion | 11 |
| E Intracellular responses from hair cells | 30 |
| F Cochlear acoustic emissions | 37 |
| 4 Conclusion and summary | 39 |
| References | 41 |
| 2 The neurophysiological basis of frequency selectivity | |
| J. O. PICKLES | 51 |
| 1 Introduction | 51 |
| 2 History of our ideas on neural frequency selectivity | 52 |
| 3 The foundations of neural frequency selectivity | 53 |
| A Frequency selectivity in the auditory nerve | 53 |
| B Frequency selectivity in the auditory central nervous system | 74 |
| C Comparison of responses in the different stages of the auditory system | 79 |
| 4 Frequency resolution as a function of type and intensity of stimulation | 81 |
| A Frequency resolution to different stimuli | 81 |
| B Frequency resolution as a function of stimulus intensity | 86 |
| C Frequency resolution to the stimuli used in tests of psychophysical frequency selectivity | 89 |
| 5 Auditory nerve responses to speech sounds | 94 |
| A Mean-rate analysis | 94 |
| B Temporal analysis | 96 |
| C Conclusions | 102 |
| 6 The dynamic range problem | 102 |

| | | |
|---|--|-----|
| 7 | Frequency resolution in impaired cochleae | 105 |
| A | Changes in the frequency selectivity of cochlear responses | 105 |
| B | Changes in the auditory nerve | 107 |
| 8 | Conclusions and summary. | 111 |
| | References | 112 |

3 Auditory filters and excitation patterns as representations of frequency resolution

| | |
|--|-----|
| R. D. PATTERSON and B. C. J. MOORE | 123 |
| 1 Introduction | 123 |
| A The original critical band | 124 |
| 2 The shape of the auditory filter | 126 |
| A The limitations of the rectangular filter shape. | 126 |
| B The measurement of the auditory filter shape | 128 |
| C Off-frequency listening | 129 |
| D The rounded-exponential filter shape | 132 |
| E The measurement of filter asymmetry | 138 |
| 3 Variation of the filter shape with centre frequency, age, and level | 139 |
| A Variation with centre frequency | 139 |
| B Variation with age | 140 |
| C Variation with level | 143 |
| 4 Other methods for determining the auditory filter shape | 145 |
| A Band-limiting experiments | 145 |
| B Two-tone masking experiments | 145 |
| C Rippled-noise experiments | 147 |
| 5 Separating frequency selectivity from processing efficiency | 150 |
| 6 Psychophysical tuning curves | 152 |
| A Variation of PTC shape with signal frequency and level | 153 |
| B Beats | 155 |
| C Combination tones | 157 |
| D Off-frequency listening | 158 |
| 7 Using the excitation-pattern model to explain the effect of stimulus level on PTCs | 163 |
| A Sensation level and the width of the PTC tip. | 163 |
| B Level-dependent excitation patterns and the PTC | 165 |
| C The overall influence of level effects | 166 |
| 8 Recommended method for measuring PTCs | 168 |
| 9 Masked audiograms and excitation patterns | 169 |
| 10 Summary and conclusions | 172 |
| Acknowledgements | 174 |
| References | 174 |

| | | |
|----------|---|-----|
| 4 | The use of nonsimultaneous masking to measure frequency selectivity and suppression | |
| | B. C. J. MOORE and B. J. O'LOUGHLIN | 179 |
| 1 | Introduction — reasons for studying nonsimultaneous masking | 179 |
| 2 | Major differences between simultaneous and nonsimultaneous masking | 181 |
| | A Suppression 'effects' in nonsimultaneous masking | 181 |
| | B Enhanced tuning in nonsimultaneous masking | 183 |
| 3 | How suppression may explain the differences between simultaneous and nonsimultaneous masking | 187 |
| | A Suppression 'effects' | 187 |
| | B Enhanced frequency selectivity in nonsimultaneous masking | 189 |
| 4 | The role of cues | 191 |
| 5 | Off-frequency listening and its role in PTCs | 197 |
| | A The concept of 'off-frequency listening' | 197 |
| | B Demonstrations of the effects of off-frequency listening | 198 |
| | C The effect of slope changes with level | 204 |
| | D Off-frequency listening and spectral spreading | 206 |
| | E Conclusions | 207 |
| 6 | The decay of masking in forward masking | 207 |
| 7 | An alternative explanation for differences in tuning between simultaneous and forward masking | 214 |
| 8 | Problems with the pulsation-threshold method | 216 |
| 9 | The nature of suppression: distributed attenuation or simple attenuation | 220 |
| 10 | Magnitude of suppression as a function of the relative level of the suppressed tone | 231 |
| 11 | Suppressive interactions between components | 233 |
| 12 | The enhancement of frequency selectivity produced by suppression | 236 |
| 13 | General conclusions | 242 |
| | Acknowledgements | 244 |
| | References | 244 |
| | | |
| 5 | The role of frequency selectivity in the perception of loudness, pitch and time | |
| | B. C. J. MOORE and B. R. GLASBERG | 251 |
| 1 | Introduction: the excitation pattern | 251 |
| 2 | Loudness | 255 |
| | A Definition and measurement of loudness | 255 |
| | B A model for calculating loudness | 256 |
| | C Loudness as a function of loudness level | 257 |
| | D Loudness as a function of bandwidth | 257 |
| | E General discussion on loudness | 263 |

| | | |
|---|---|-----|
| 3 | Relationship of frequency selectivity to frequency discrimination of pure tones | 264 |
| A | Variation of predicted and obtained values of the DLF with Frequency | 267 |
| B | Frequency difference limens for short-duration tones | 270 |
| C | Comparison of frequency and intensity DLs for monaural and dichotic modes of presentation. | 273 |
| D | The detection of combined changes in frequency and intensity | 275 |
| E | Evidence from hearing-impaired patients. | 276 |
| F | General conclusions on the relationship between frequency selectivity and frequency discrimination. | 278 |
| 4 | The role of frequency selectivity in the perception of the pitch of complex tones. | 279 |
| A | The audibility of partials in complex tones. | 282 |
| B | Evidence favouring the pattern recognition models | 284 |
| C | Difficulties for the pattern recognition models. | 287 |
| D | How is information about the components signalled to the pitch extractor? | 290 |
| E | A model for the pitch perception of complex tones | 291 |
| 5 | Relation of temporal acuity to frequency selectivity. | 297 |
| 6 | General conclusions | 301 |
| | Acknowledgements | 302 |
| | References | 302 |

6 Frequency resolution in hearing-impaired listeners

| | | |
|---------------------|--|-----|
| R. S. TYLER. | | 309 |
| 1 | Introduction | 309 |
| A | Conductive hearing loss. | 310 |
| B | The requirement of a change in threshold. | 310 |
| C | Appropriate levels to compare normal and hearing-impaired listeners. | 310 |
| D | The amount of masking or the masked threshold? | 311 |
| 2 | Masking of pure tones by broadband noise | 312 |
| A | Introduction | 312 |
| B | Review | 312 |
| C | Summary | 322 |
| 3 | The spread of masking | 322 |
| A | Introduction | 322 |
| B | Review | 323 |
| C | Summary | 332 |
| 4 | Psychoacoustical tuning curves | 332 |
| A | Introduction | 332 |
| B | Review | 333 |
| C | Summary | 340 |
| 5 | Spectrally complex maskers | 341 |

| | | | |
|----------|---|---|------------|
| | A | Introduction | 341 |
| | B | Review | 341 |
| | C | Summary | 347 |
| 6 | | Nonsimultaneous masking | 347 |
| | A | Introduction | 347 |
| | B | Review | 348 |
| | C | Summary | 351 |
| 7 | | Loudness and the critical bandwidth. | 351 |
| | A | Introduction | 351 |
| | B | Review | 353 |
| | C | Summary | 355 |
| 8 | | Stapedius-reflex critical bandwidths. | 357 |
| | A | Introduction | 357 |
| | B | Review | 357 |
| | C | Summary | 359 |
| 9 | | Conclusions | 360 |
| | A | Individual differences | 360 |
| | B | Differential diagnosis | 361 |
| | C | Clinical application. | 361 |
| | D | Relationship to other auditory abilities | 362 |
| | | Acknowledgements | 363 |
| | | References | 363 |
| 7 | | Frequency selectivity and the perception of speech | |
| | | S. M. ROSEN and A. J. FOURCIN. | 373 |
| | 1 | Introduction and orientation | 373 |
| | 2 | Basic articulatory and acoustic properties of speech | 374 |
| | | A Functional anatomy. | 374 |
| | | B Acoustic features | 381 |
| | | C Three caveats | 389 |
| | 3 | The role of frequency selectivity in normal and impaired speech perception | 392 |
| | | A Static and dynamic fundamental frequency patterns | 393 |
| | | B Static spectral patterns | 418 |
| | | C Dynamic patterns of spectral change | 448 |
| | | D Masking of speech by extraneous sounds | 457 |
| | 4 | Compensating for impaired frequency selectivity | 465 |
| | | A Formant separation by ear | 466 |
| | | B Spectral pattern sharpening | 467 |
| | | C Spectral transposition | 470 |
| | | D Fundamental frequency pattern simplification and mapping | 471 |
| | | E Choosing appropriate frequency emphasis | 473 |
| | | F Increasing the signal-to-noise ratio. | 473 |
| | 5 | Final comments | 474 |
| | 6 | Suggestions for further reading. | 475 |
| | | Acknowledgements | 475 |
| | | References | 476 |
| | | Index | 489 |