

Auditory Demonstrations

A.J. M. Houtsma
Institute for Perception Research (IPO)
Eindhoven, The Netherlands

T.D. Rossing
Northern Illinois University
DeKalb, IL, U.S.A.

W. M. Wagenaars
Institute for Perception Research (IPO)
Eindhoven, The Netherlands

Prepared at the Institute for Perception Research (IPO)
Eindhoven, The Netherlands
Supported by the Acoustical Society of America

Table of Contents

Introduction

Section I. Frequency Analysis and Critical Bands		
Cancelled Harmonics		Shift of Virtual Pitch
Critical Bands by Masking		Masking Spectral and Virtual Pitch
Critical Bands by Loudness		Virtual Pitch with Random Harmonics
Comparison		Strike Note of a Chime
		Analytic vs Synthetic Pitch
Section II. Sound Pressure, Power, Loudness		
The Decibel Scale		C. Repetition Pitch
Filtered Noise		Scales with Repetition Pitch
Frequency Response of the Ear		D. Pitch Paradox
Loudness Scaling		Circularity in Pitch Judgment
Temporal Integration		
Section III. Masking		Section V. Timbre
Asymmetry of Masking by Pulsed Tones		Effect of Spectrum on Timbre
Backward and Forward Masking		Effect of Tone Envelope on Timbre
Pulsation Threshold		Change in Timbre with Transposition
		Tones and Tuning with Stretched Partials
Section IV. Pitch		Section VI. Beats, Combination Tones, Distortion, Echoes
A. Pitch of Pure Tones		Primary and Secondary Beats
Dependence of Pitch on Intensity		Distortion
Pitch Salience and Tone Duration		Aural Combination Tones
Influence of Masking Noise on Pitch		Effects of Echoes
Octave Matching		
Stretched and Compress Scales		Section VII. Binaural Effects
Difference Limen or JND		Binaural Beats
Linear and Logarithmic Tone Scales		Binaural Lateralization
Pitch Streaming		Masking Level Differences
		An Auditory Illusion
B. Pitch of Complex Tones		
Virtual Pitch		

Introduction

In 1978, a set of auditory demonstration tapes was released by the Laboratory of Psychophysics of Harvard University. These demonstrations had been prepared by a team led by Prof. David M. Green and were sponsored by a grant from the National Science Foundation. The tape set, which contained 20 recorded demonstrations on psycho acoustics plus an explanatory booklet, became so popular that all copies were quickly distributed and tape sets were no longer available.

In 1984, the Acoustical Society of America's Committee on Education in Acoustics requested T. D. Rossing and W. D. Ward to look into the feasibility of re-issuing the "Harvard tapes." A decision was made to update the demonstration material and to issue it on a high-quality sound reproduction medium. The Institute for Perception Research (IPO) in Eindhoven was engaged to produce the audio material. Both the Eindhoven University of Technology and the Philips Company, the joint sponsors of the IPO, made manpower available for the project. Philips Polygram and Philips & Dupont Optical Co. (PDO) agreed to handle the digital tape mastering and the production of a compact disc. Northern Illinois University supported the project through a grant for improvement of undergraduate education. The Acoustical Society of America agreed to provide further financial backing of the project.

Many people in the United States and Europe have contributed to the realization of this project. A preliminary scenario by T. D. Rossing was developed through frequent discussions with A.J.M. Houtsma and W. M. Wagenaars, who composed and synthesized the audio material with 16-bit digital techniques. Th. de Jong of IPO provided invaluable technical assistance. The narration by Prof. Ira J. Hirsh was recorded at the Central Institute for the Deaf in Saint Louis. Speech samples in Demonstrations 4 and 25 were provided by, respectively, J. t'Hart and Dr. Sanford Fidell. The instrumental scales of Demonstration 30 were played by bassoonist B. van den Brink of the Brabant Orchestra. The text booklet ("libretto") was written by T.D. Rossing and A.J.M. Houtsma. A trial version of the demonstrations was field-tested and critically reviewed by D.E. Hall, W. M. Hartmann, and W. D. Ward, which let to substantial improvements. Special thanks go to the IPO director H. Bouma, to G. van Hoeyen of Philips Polygram, and to A. Rehnberg and G.J.A. Vogelaar of PDO for their enthusiastic administrative and technical support.

The 39 demonstrations on this compact disc have been put on separate tracks. Each demonstration can easily be found by cuing the CD player to the desired number. Demonstrations in Section I through VI have been designed for typical classroom use. The demonstrations of Section VII must be heard through headphones to obtain the desired effects.