

University of California  
Berkeley

College of Engineering  
Department of Electrical Engineering  
and Computer Sciences

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EE225D

Spring, 1999

Psychoacoustics

**Lecture 16**

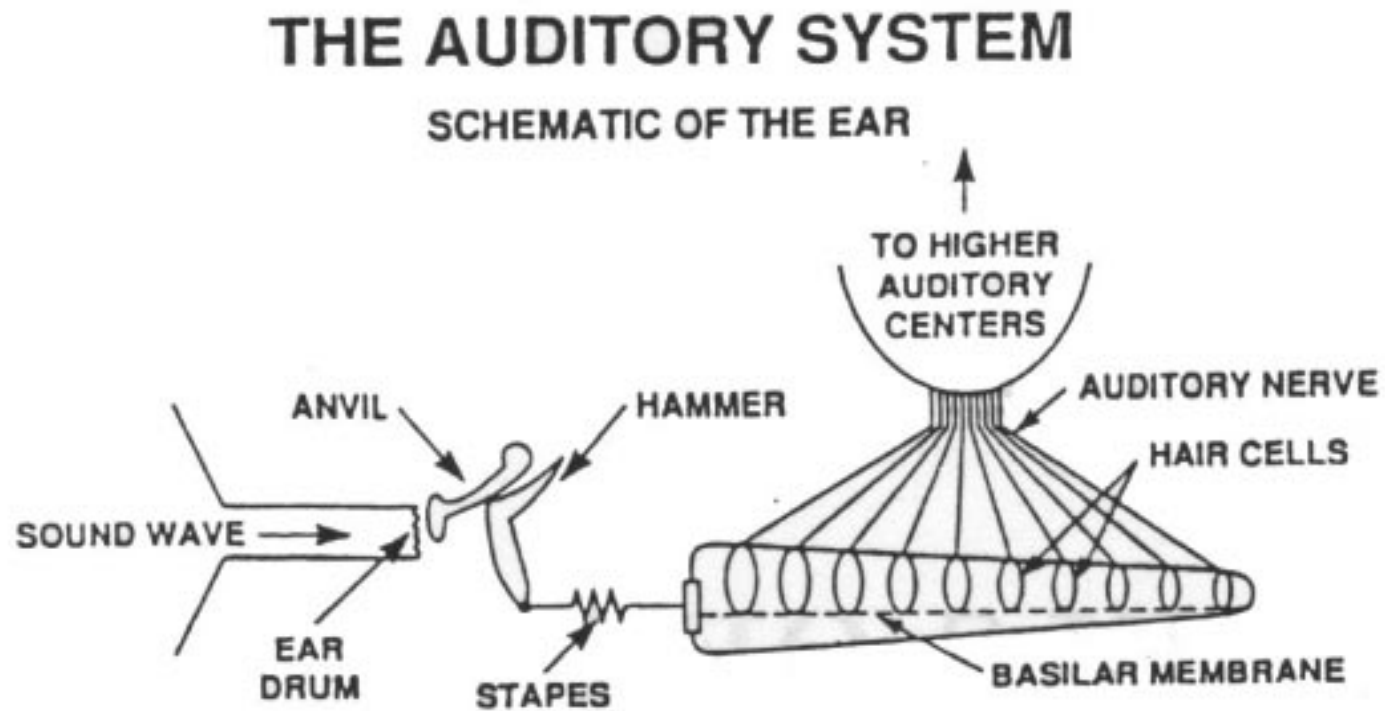


Figure 16.1 : Schematic of the Outer, Middle and Inner Ear.

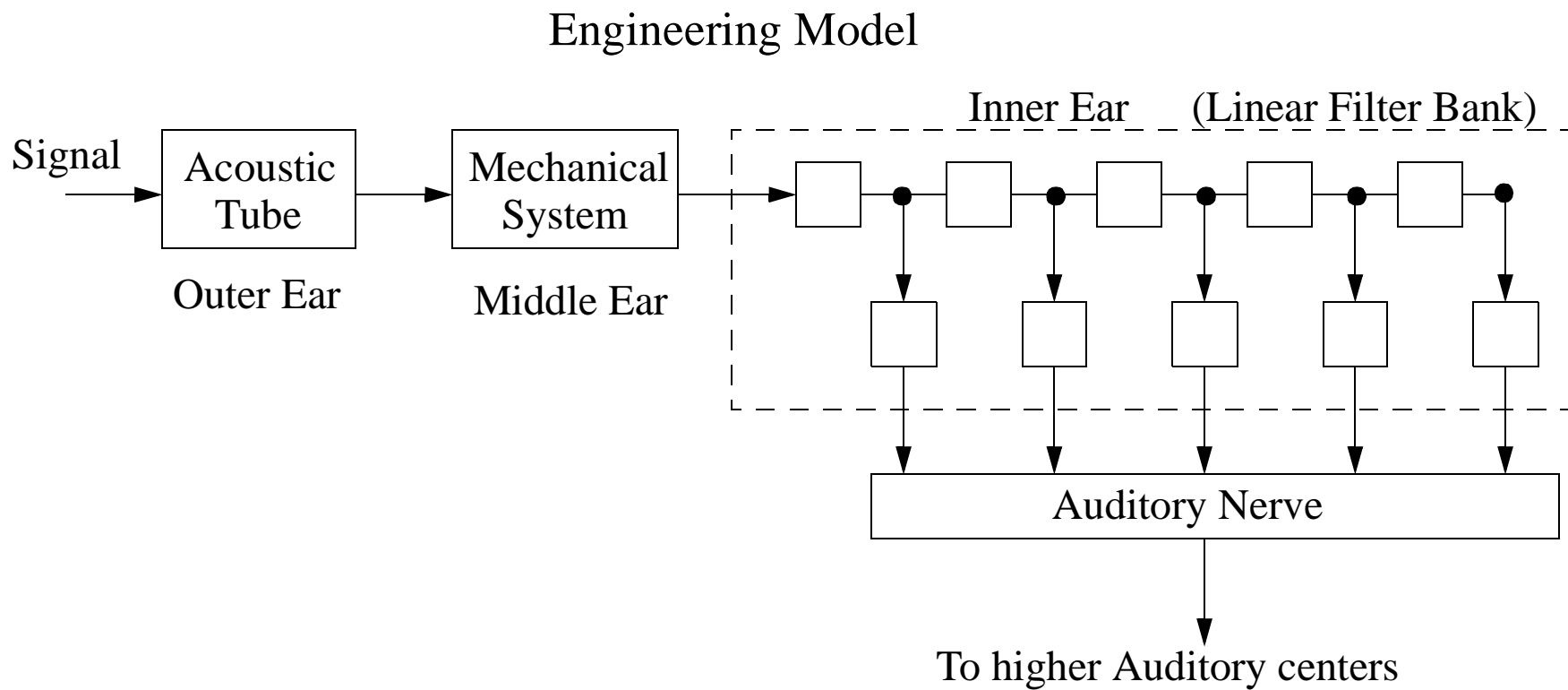


Figure 16.2 : Engineering Model of the Outer, Middle and Inner Ear.

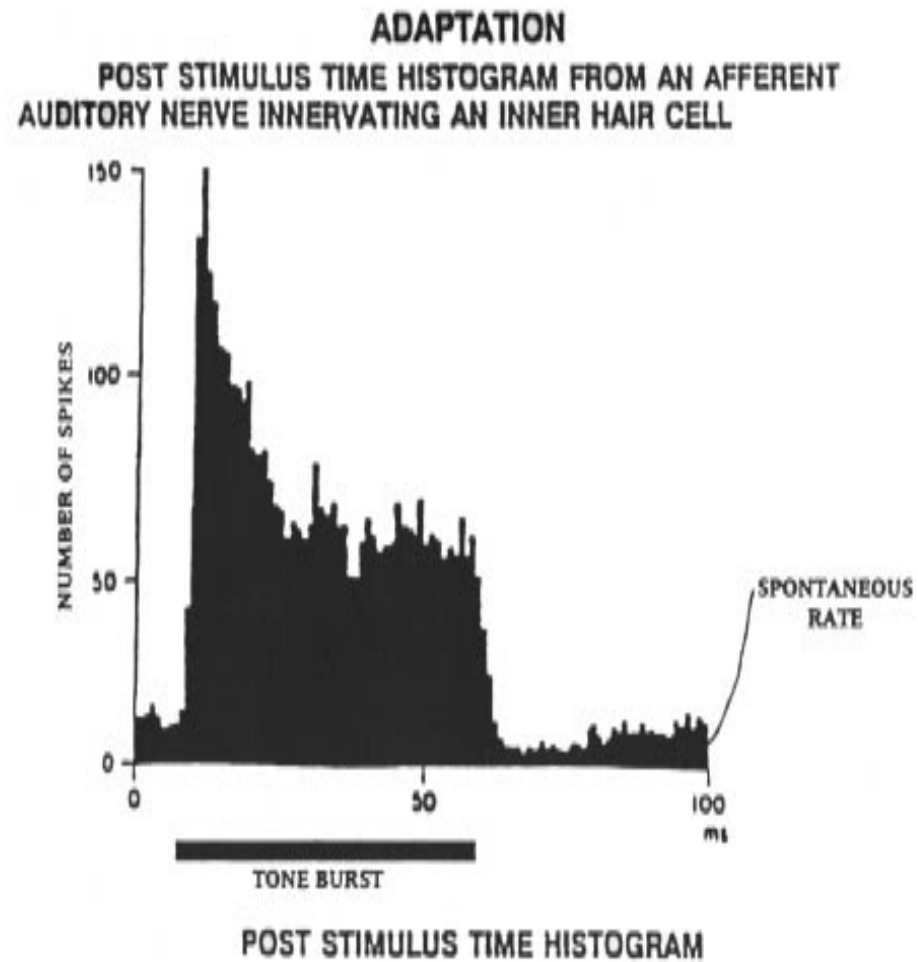
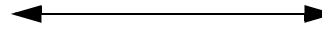


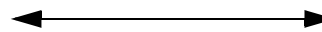
Figure 14.9 : Adaptation by an auditory nerve.

Auditory NeuronsPsychoacoustics

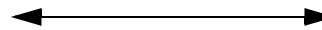
Adaptation



Tuning

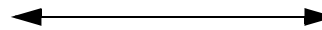


?

Dynamic Range  
~ 20dB

100dB

Masking



? Masking

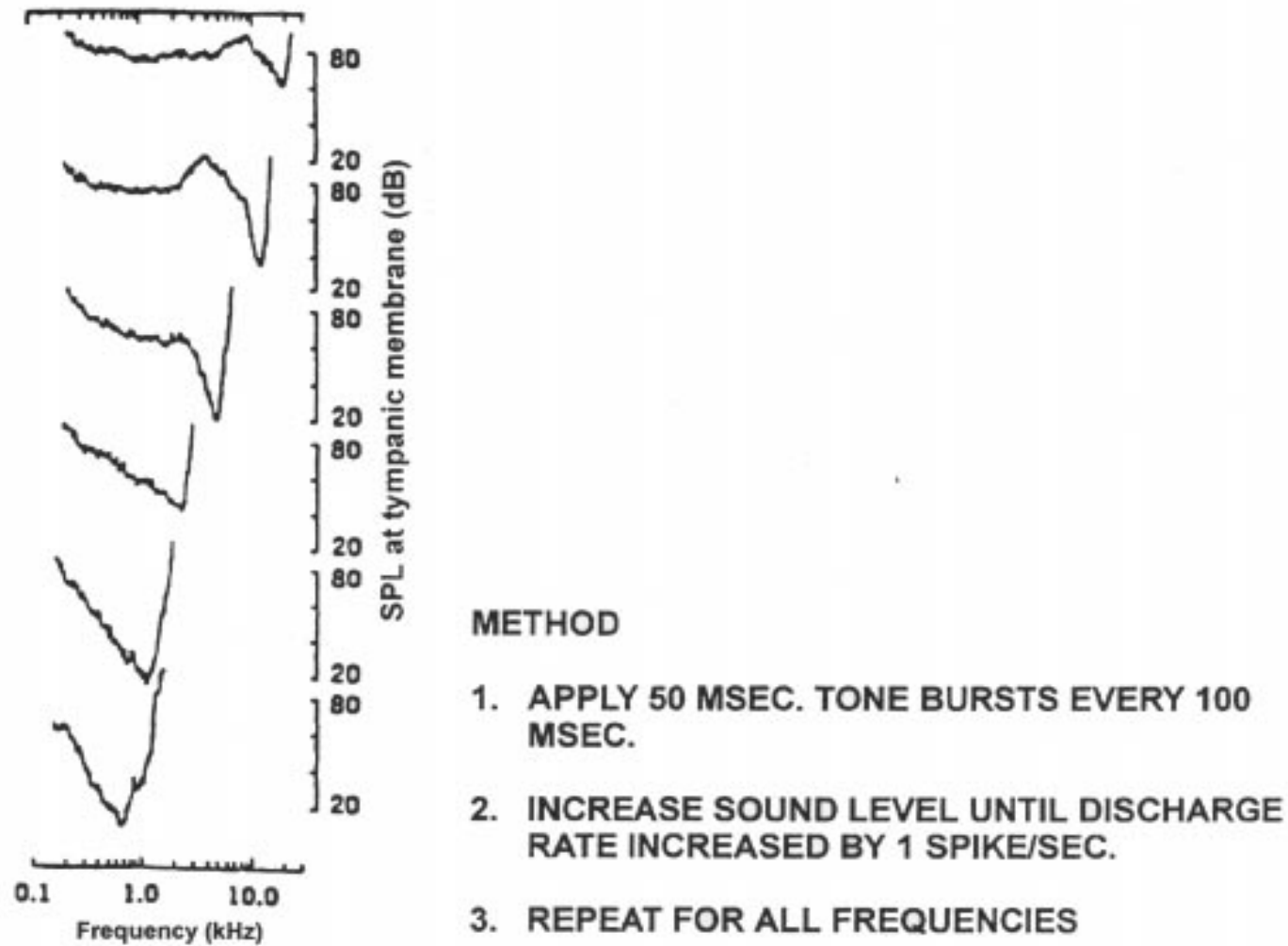


Figure 14.10 : Tuning curves of six auditory nerve fibers.

Objective

Frequency

 $2 \times$ 

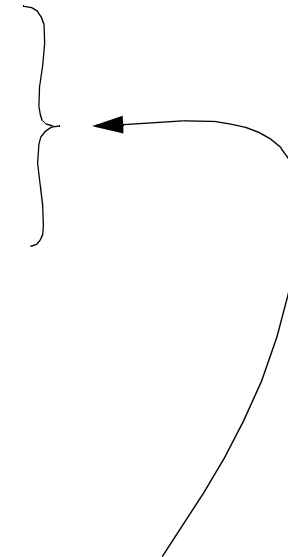
Intensity

Spectrum

Subjective $f$  Pitch $2f$ 

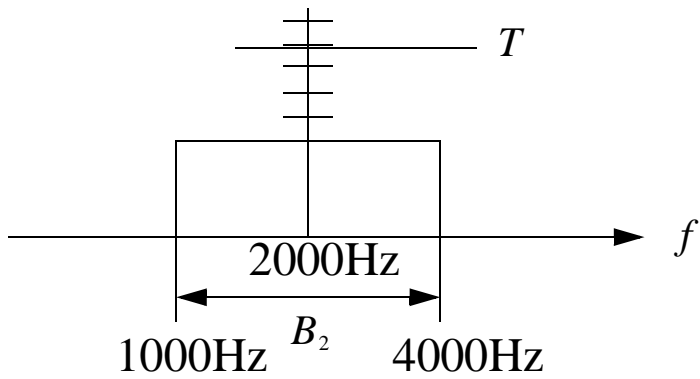
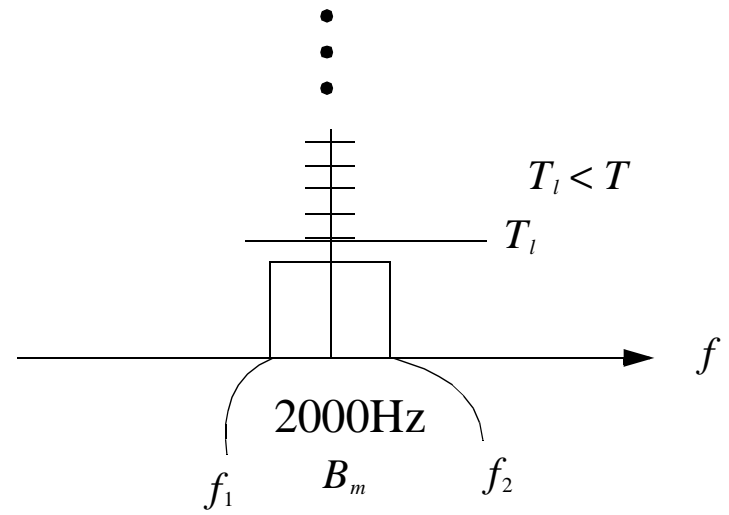
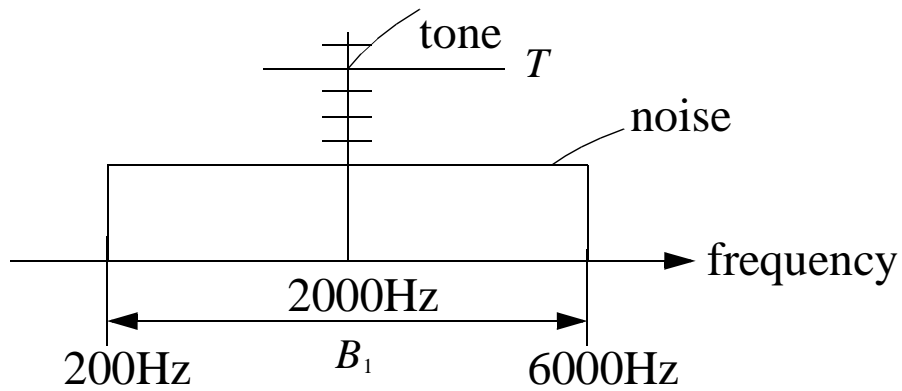
Loudness

Timbre

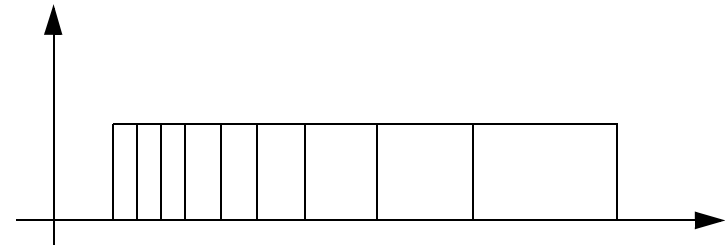
Basic Point

Subjective responses are logarithmically related to objective.

# Critical Bands



⋮





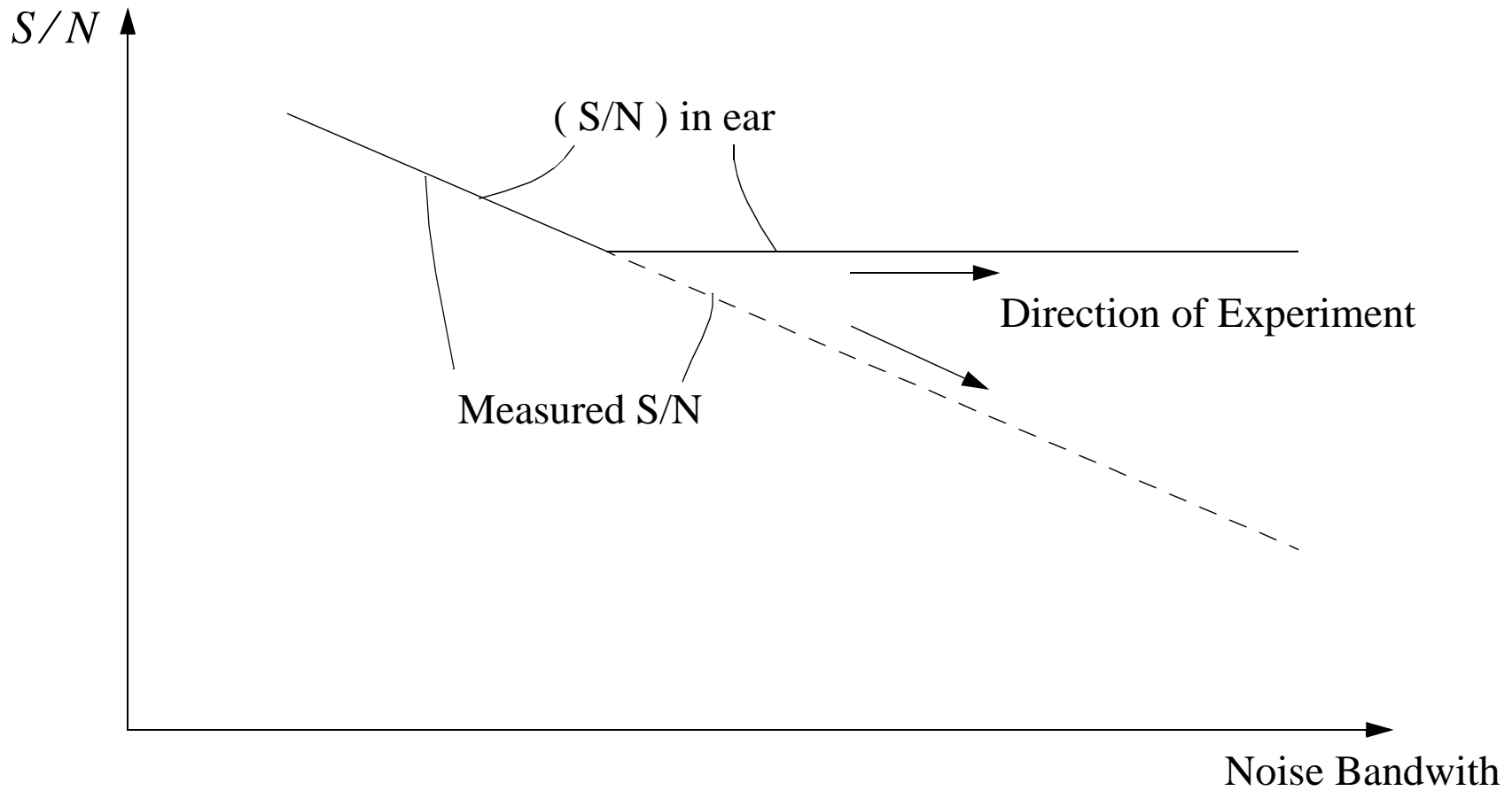


Figure 15.1 : Critical Ratio Experiment.

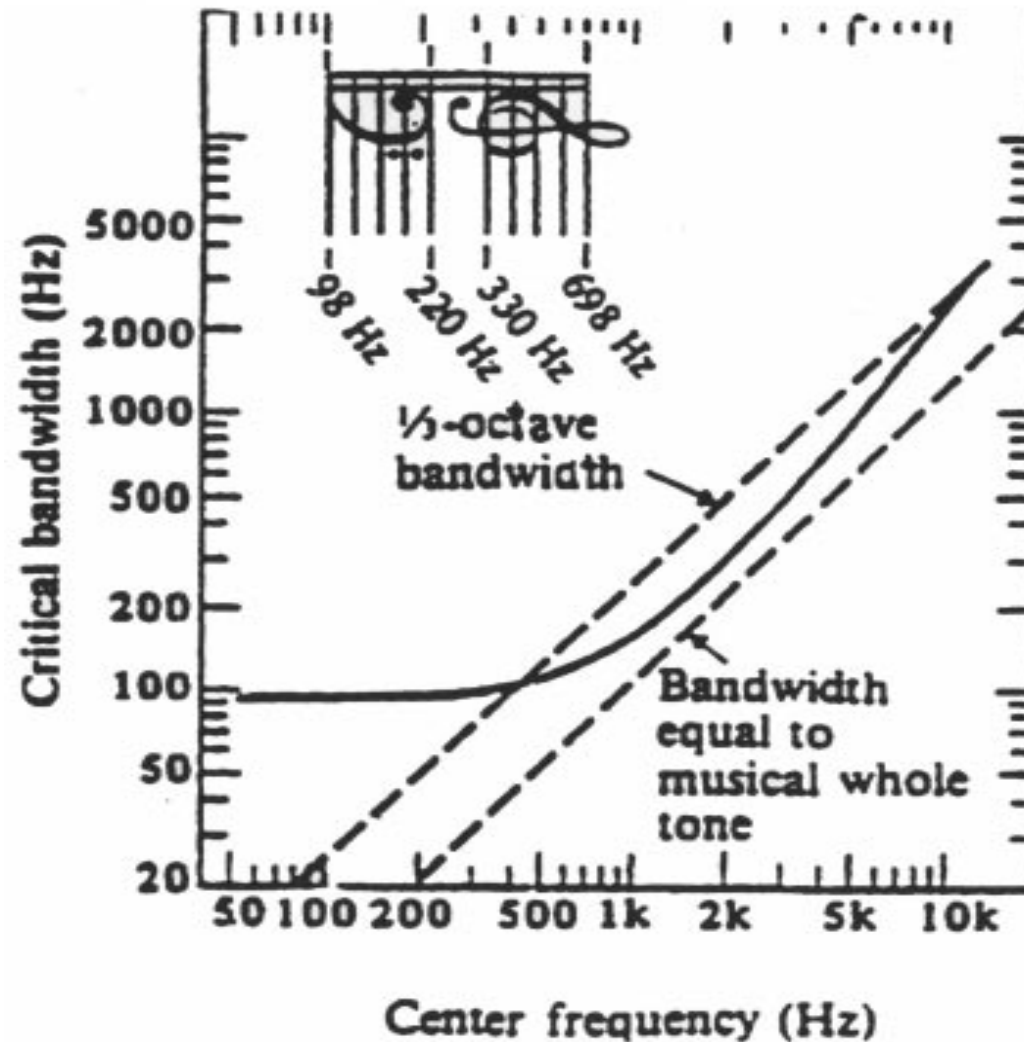
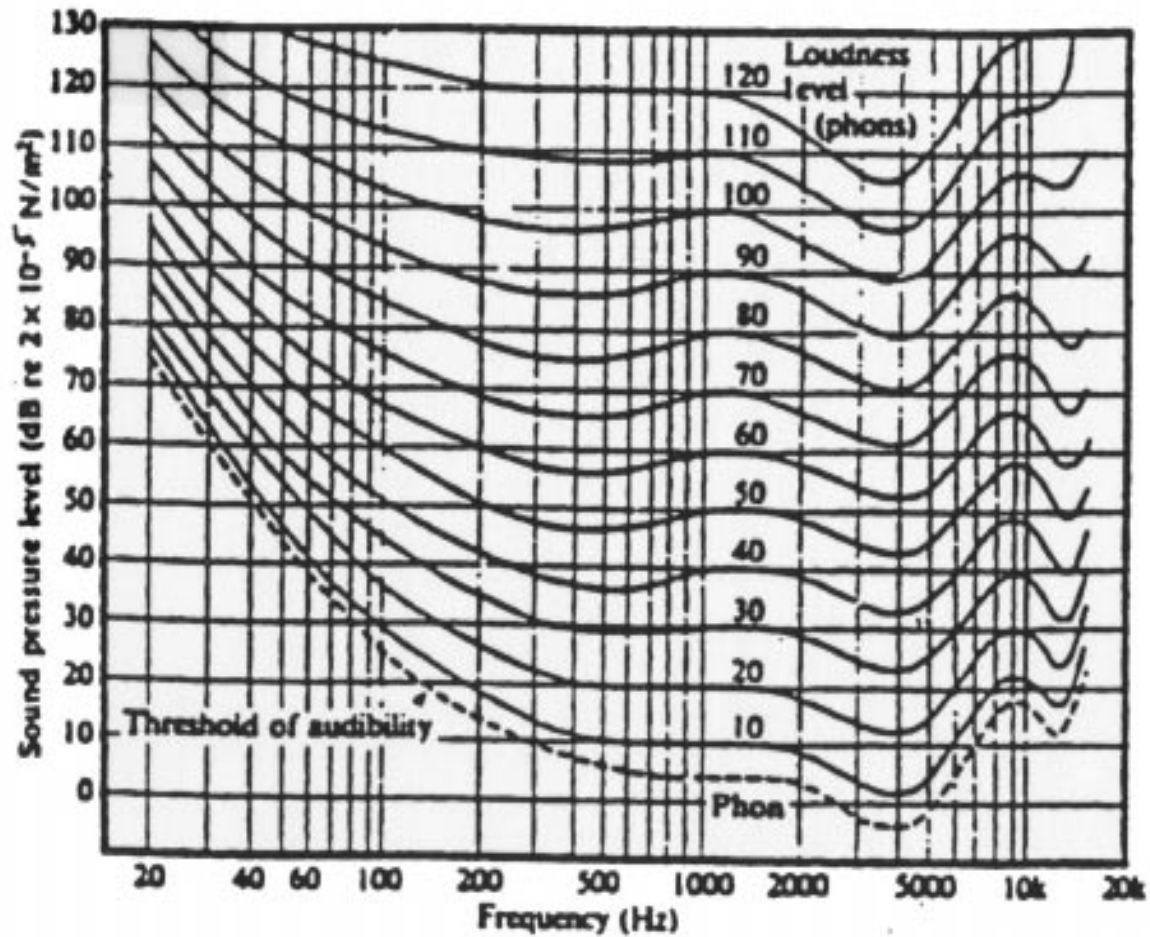


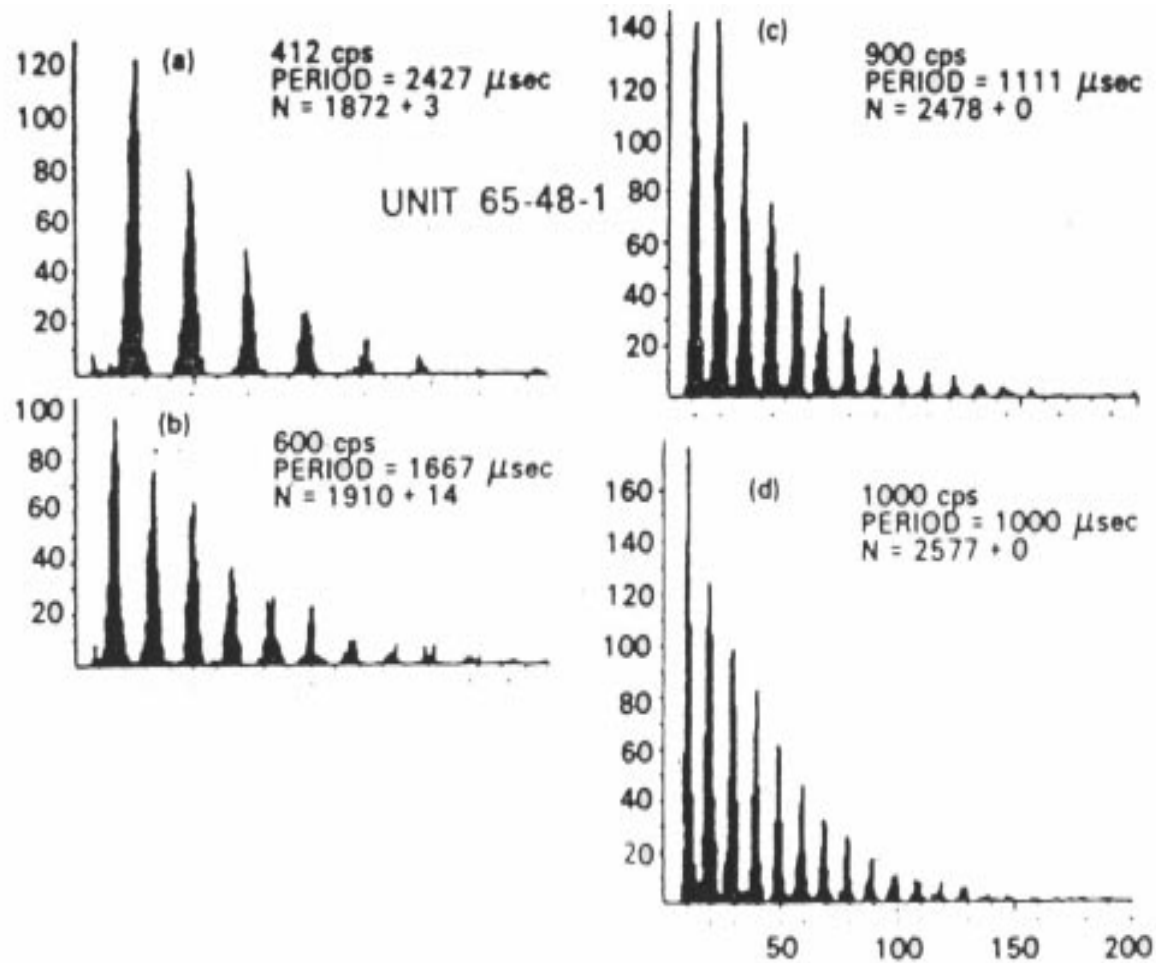
Figure 15.2 : Critical Band vs. Center Frequency.

The solid line represents bandwidth for each frequency, while the dashed lines are provided for comparison.

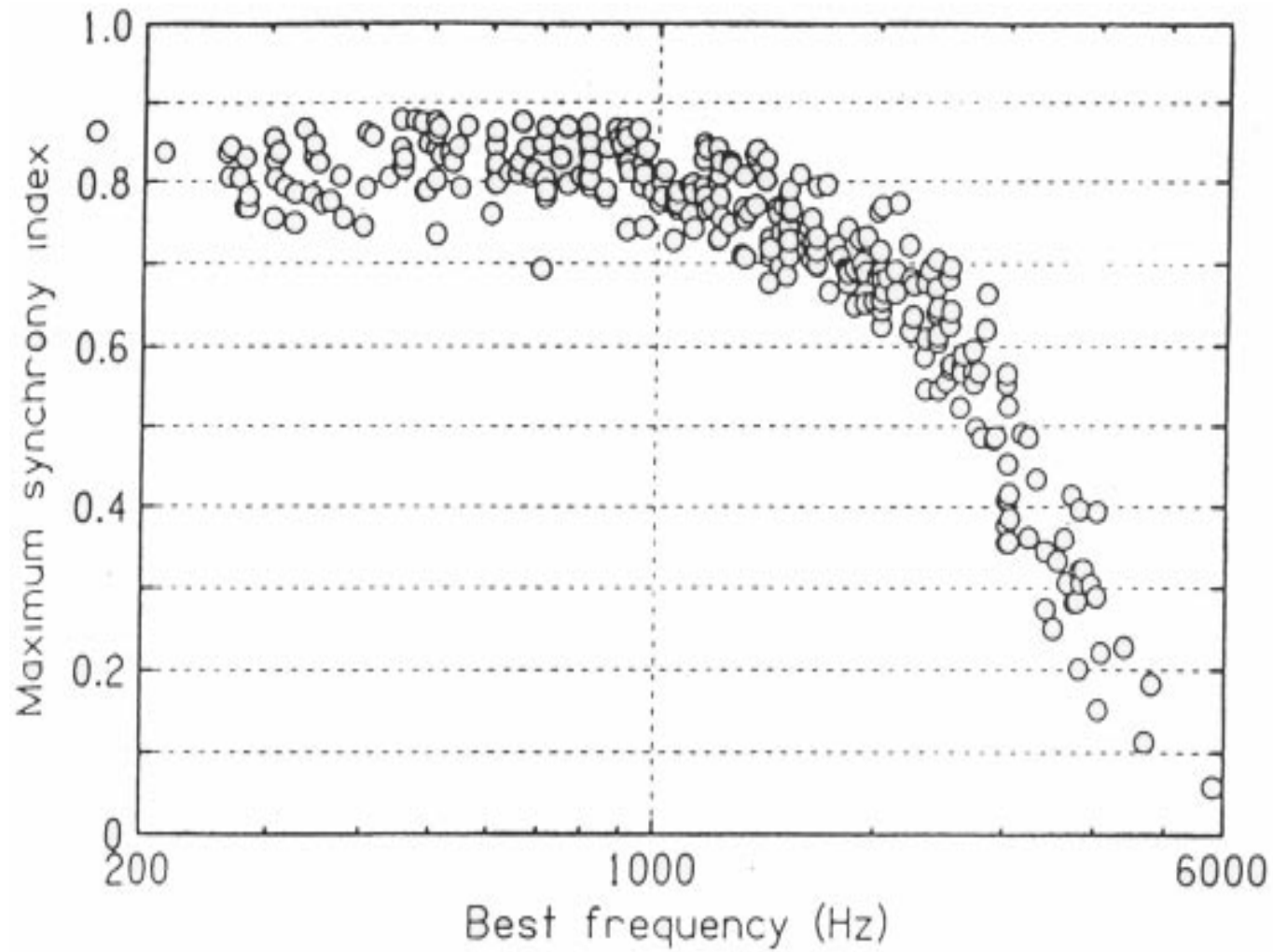


Loudness is a  
function of intensity.

Figure 15.4 : Equal Loudness Curves for Pure Tones.



Interval Histograms for Tone Bursts at Different Frequencies.

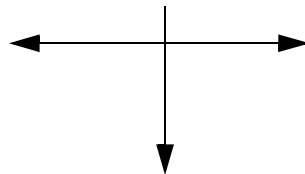


Synchrony Coefficient for 315 Neurons.

Physiologic Fact

Psychoscontic Fact

Synchrony



Good frequency sensitivity

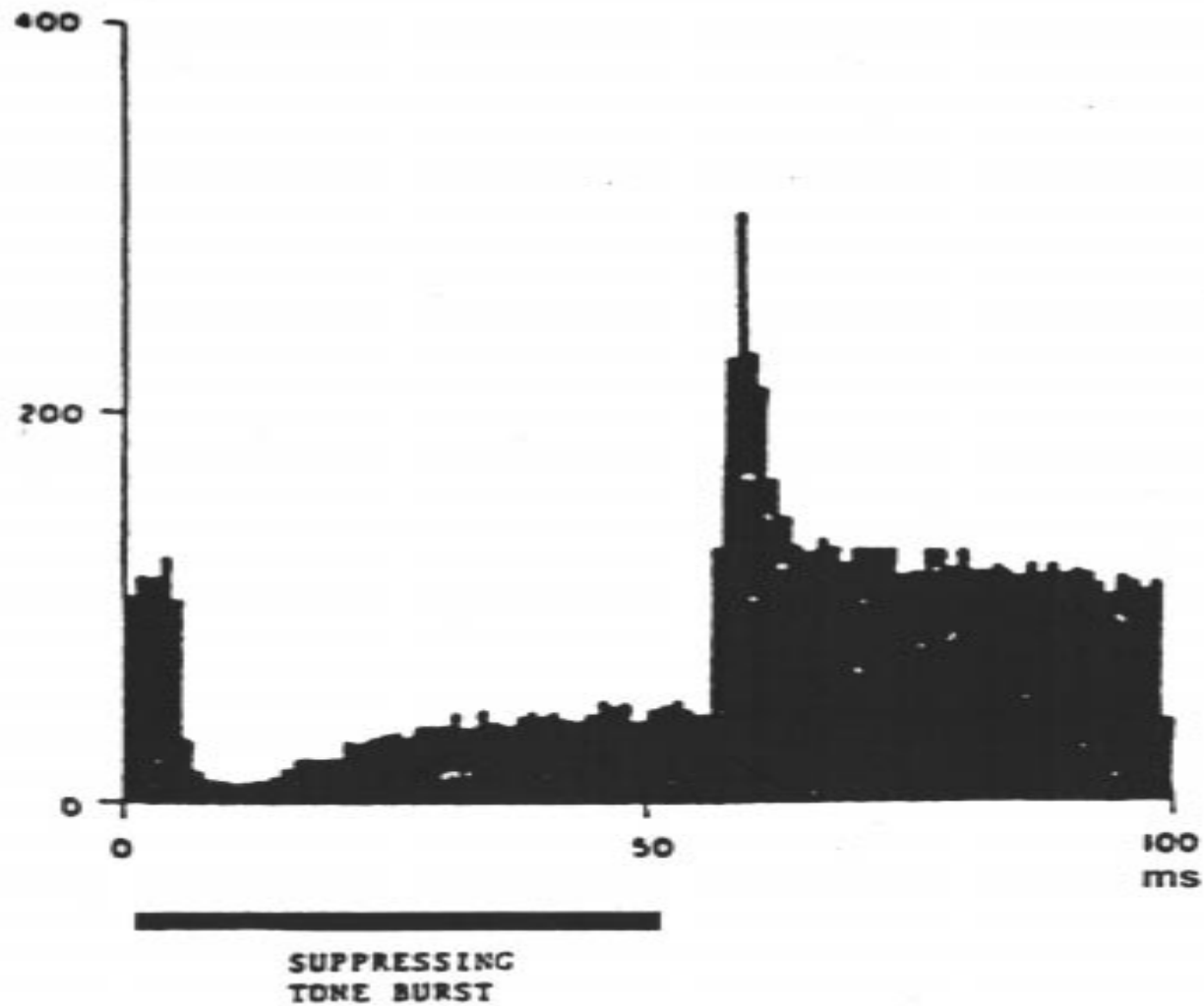


Figure 14.13 : Suppression of a Continuous Tone by a Tone Burst.

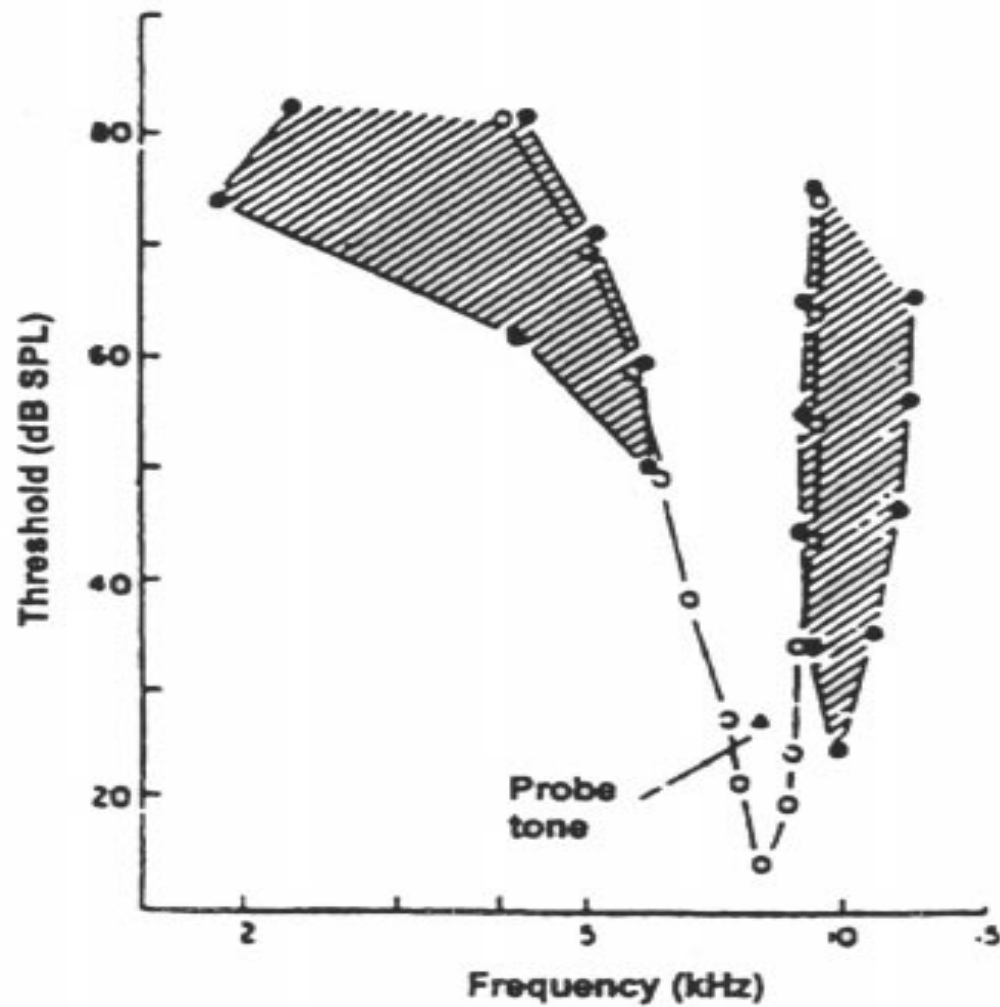


Figure 14.14 : Suppression Regions of an Auditory Nerve Fiber.



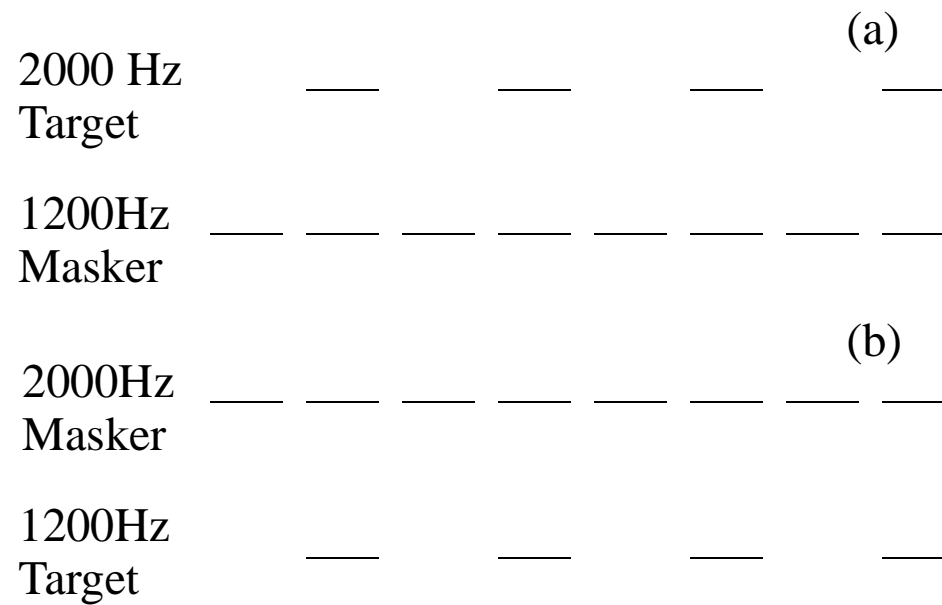


Figure 15.6 : Signals and Maskers for Demonstration 9.

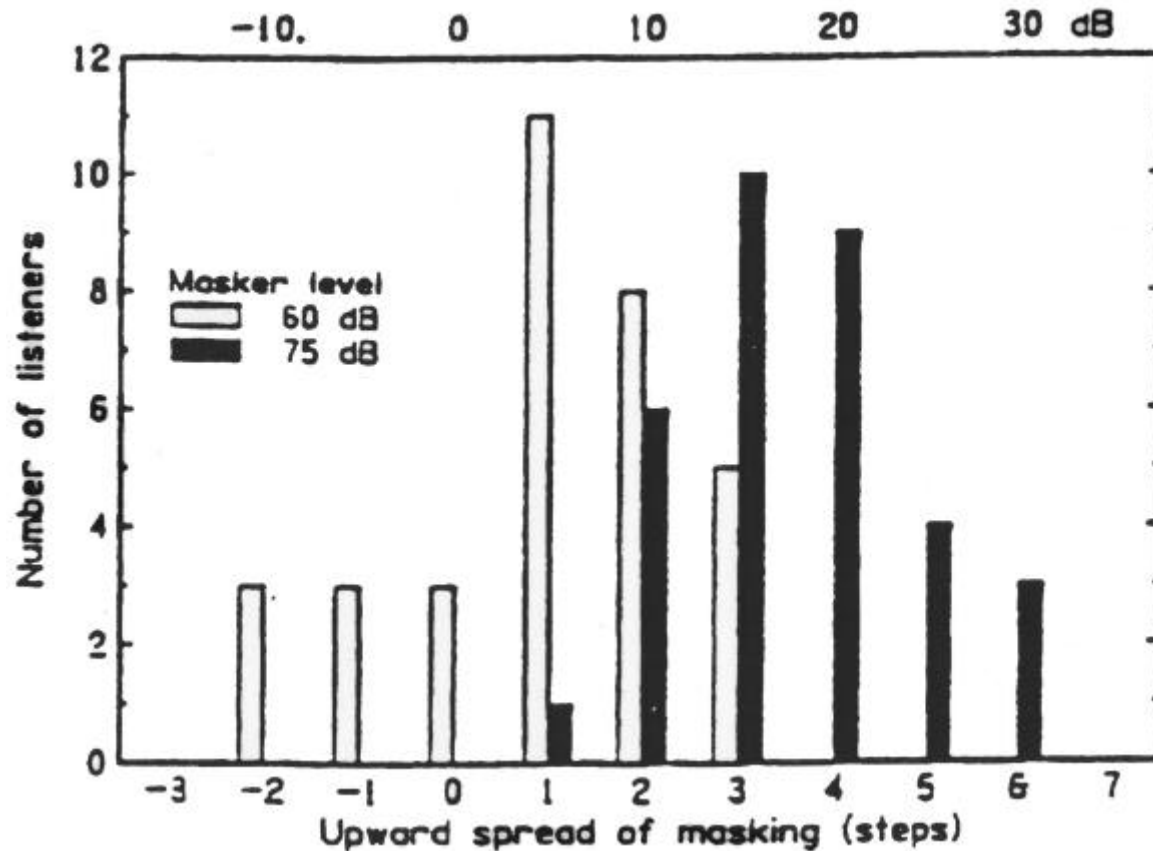


Figure 15.7 : Asymmetry of masking of one tone by another.

For each level (upper horizontal axis), the vertical bars show the number of listeners for whom  $n$  more streams are masked by the lower frequency masker than are masked by the higher frequency masker, where  $n$  is marked on the lower horizontal axis.

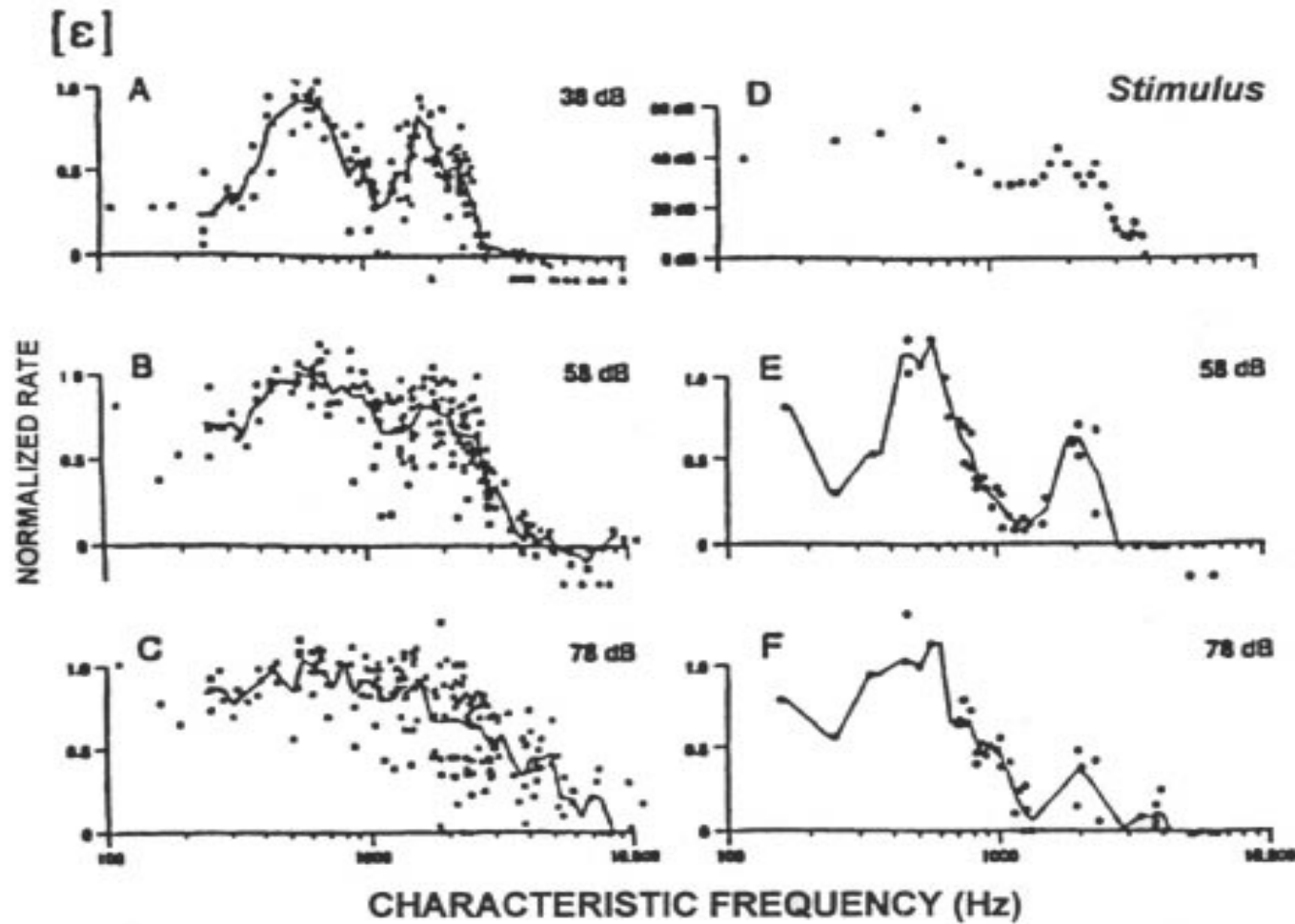
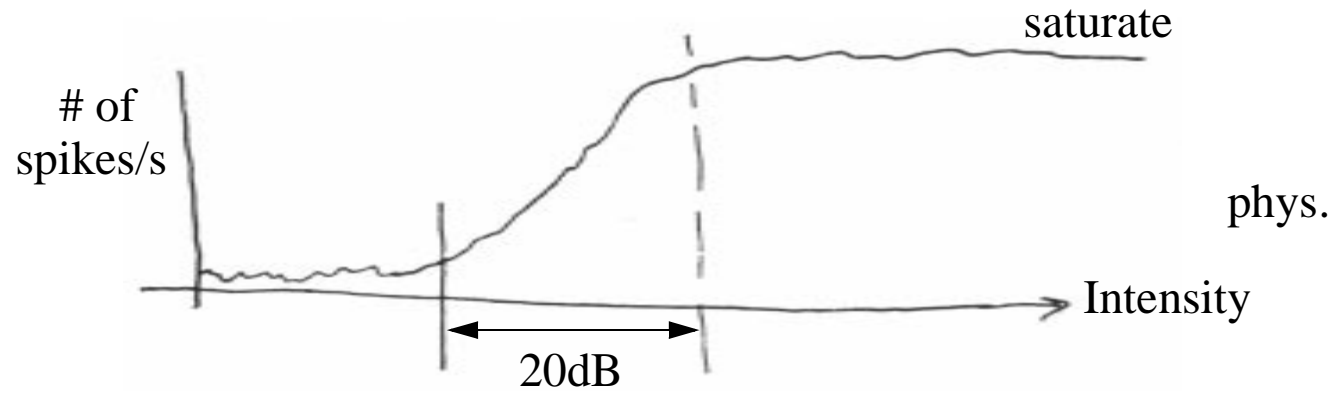


Figure 14.12 : Effect of Input Intensity on the Rates of High Spontaneous Rate Fibers (A, B, C) and Low Spontaneous Rate Fibers (D, E, F).

## Dynamic Range



low, medium, high spontaneous

