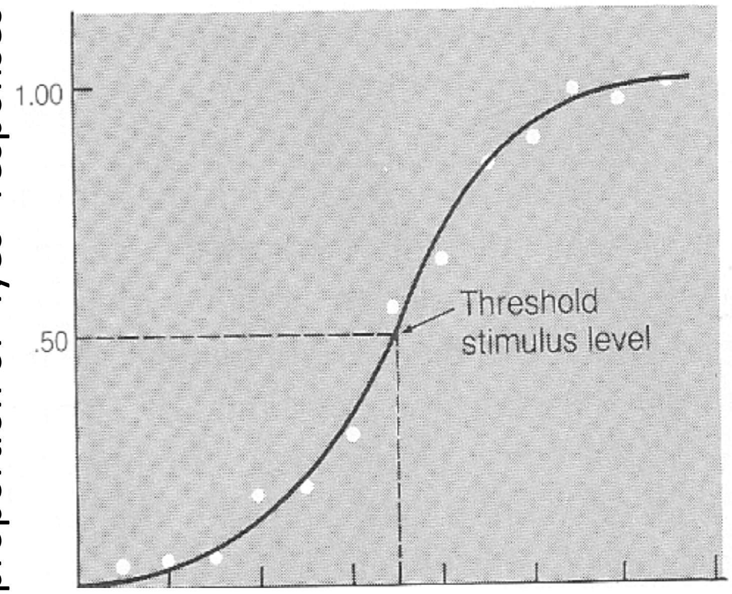
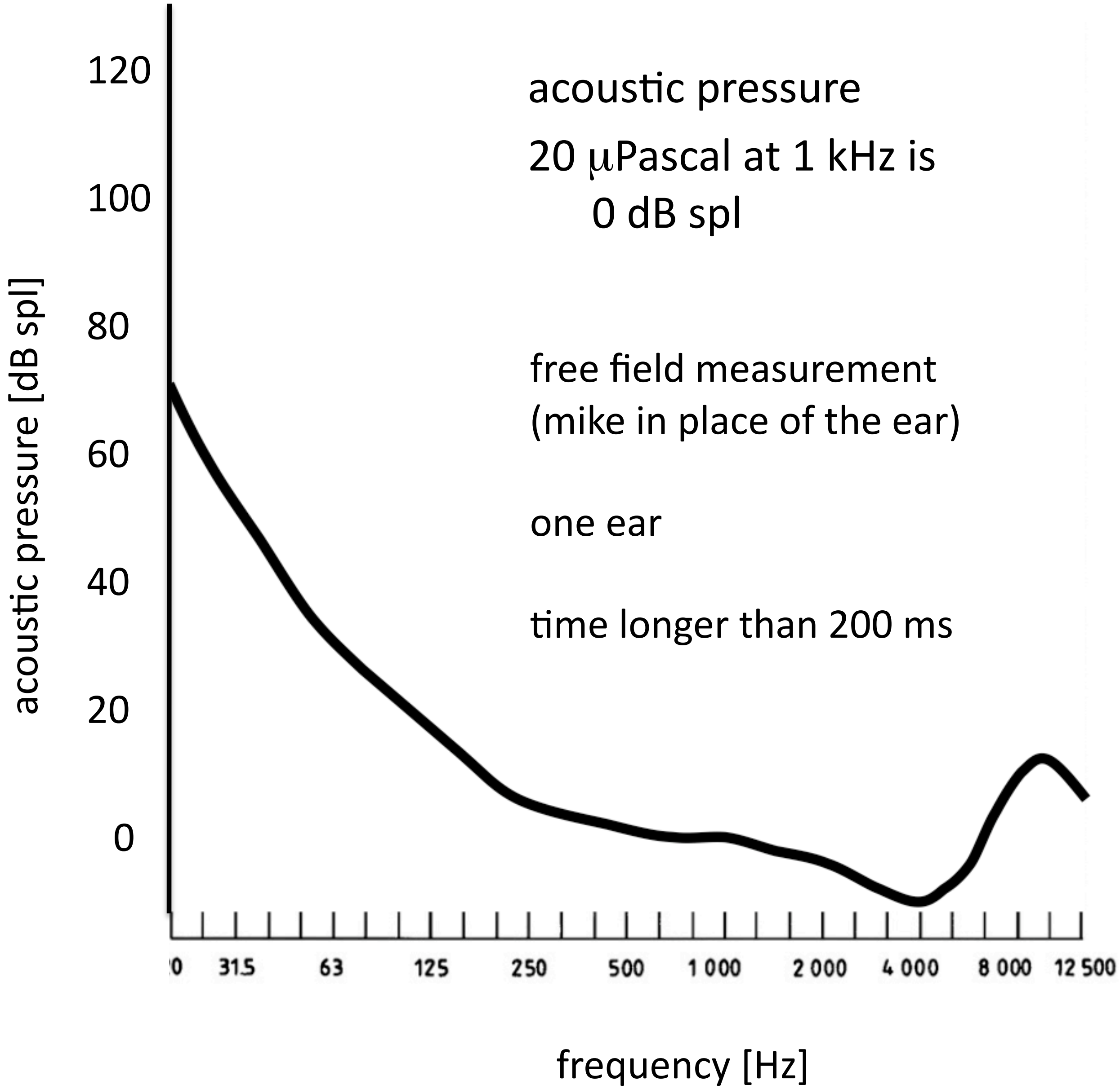
Detection (do you hear it?)

proportion of “Iyes” responses



sound pressure level

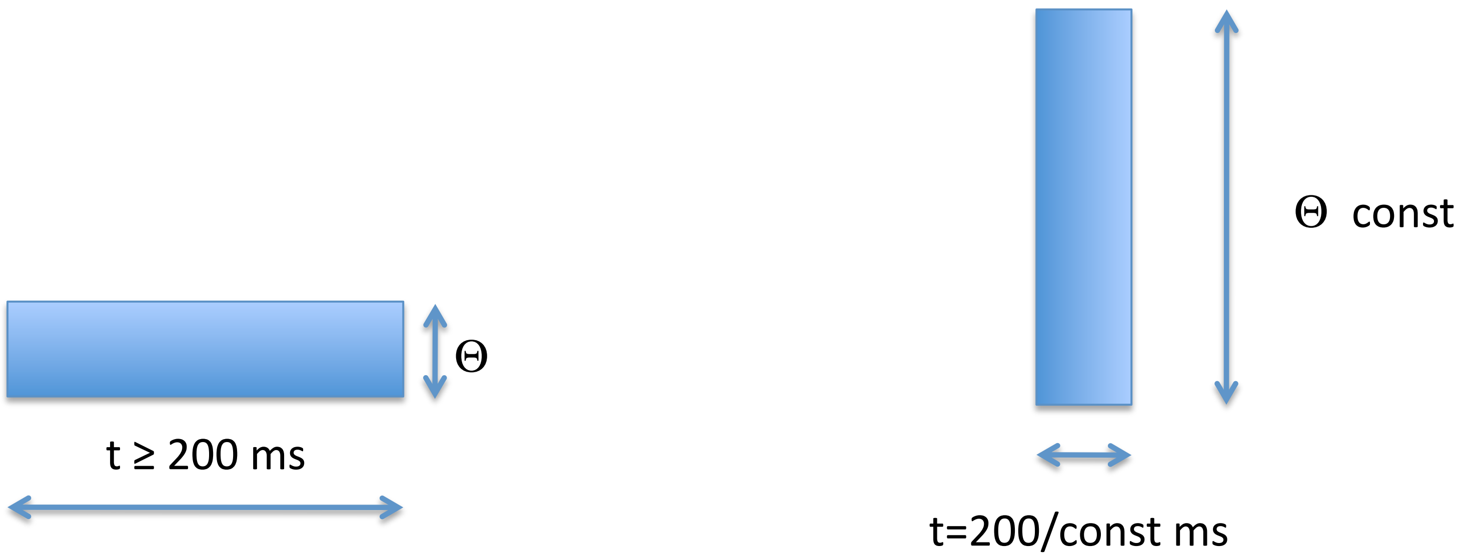
at 1 kHz, the hearing threshold represents 0 dB spl



acoustic pressure
20 μPascal at 1 kHz is
0 dB spl
free field measurement
(mike in place of the ear)
one ear
time longer than 200 ms
acoustic pressure [dB spl]
120
100
80
60
40
20
0
31.5
63
125
250
500
1 000
2 000
4 000
8 000
12 500
frequency [Hz]

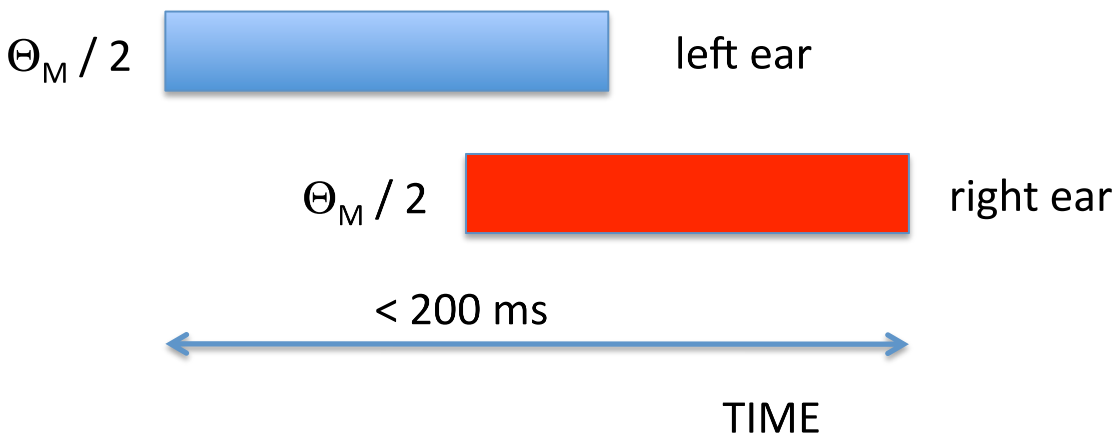
Hearing threshold for short signals

- for tones shorter than 200 ms, the total energy in the signal determines the threshold



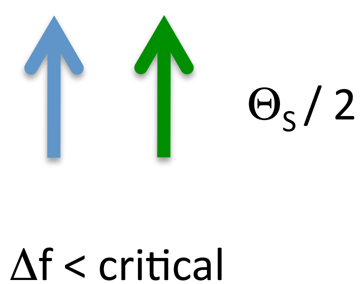
- when signal in both ears, the threshold $\Theta_B = \Theta_M / 2$

  the tones do not have to occur simultaneously as long as within 200 ms

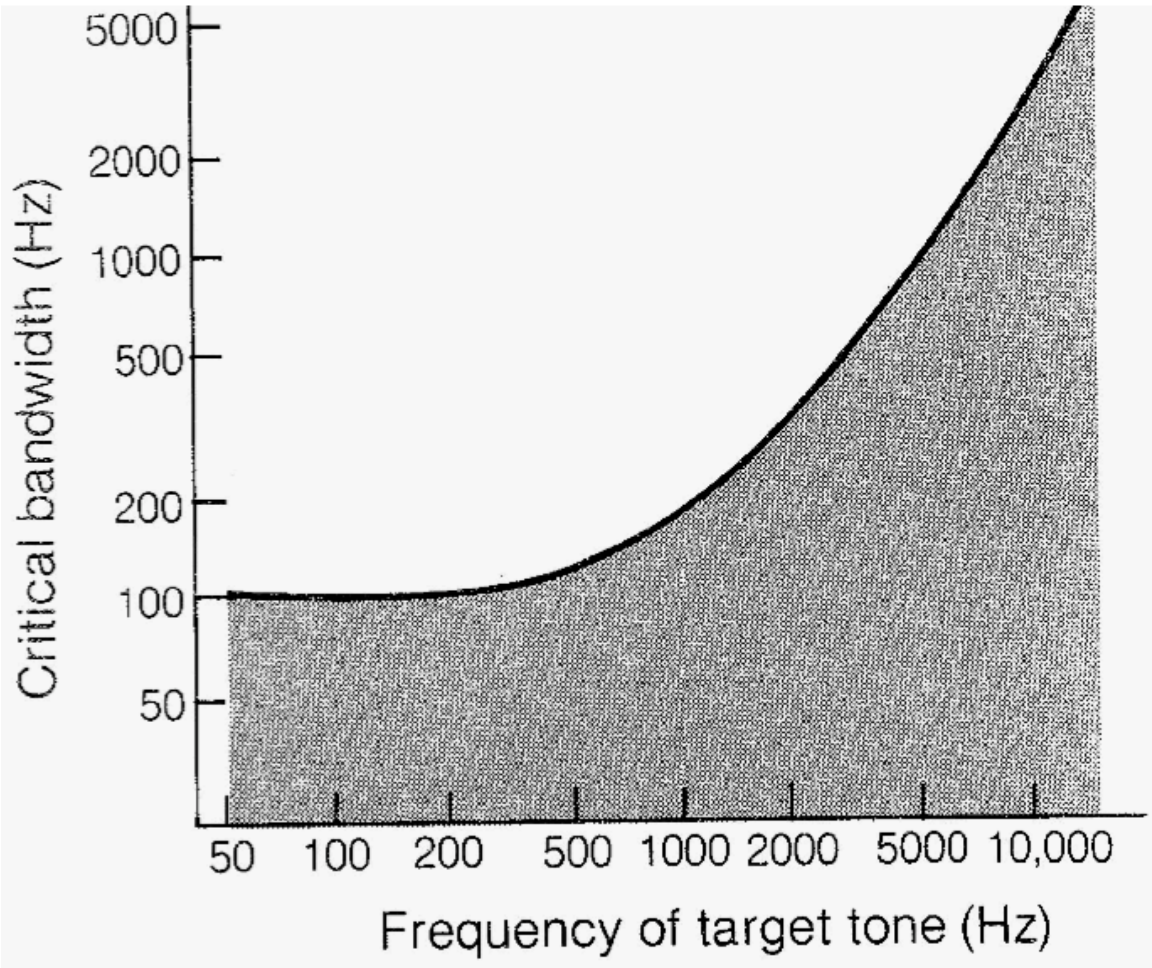


- when two tones in one ear, the threshold $\Theta_D = \Theta_S / 2$,

  as long as the signals are "close" in frequency



“Close” in frequency = within “critical bandwidth”



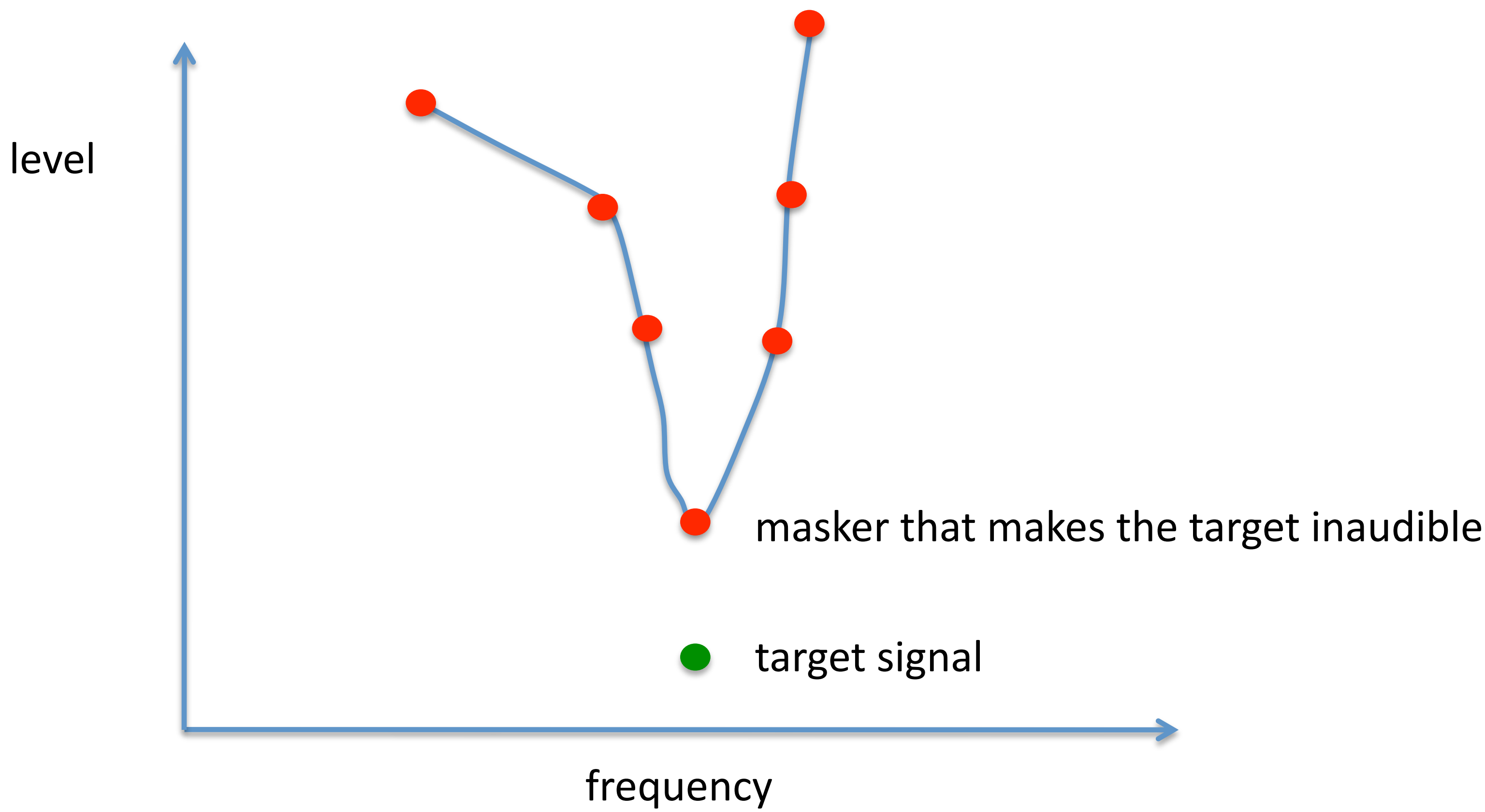
Threshold of hearing

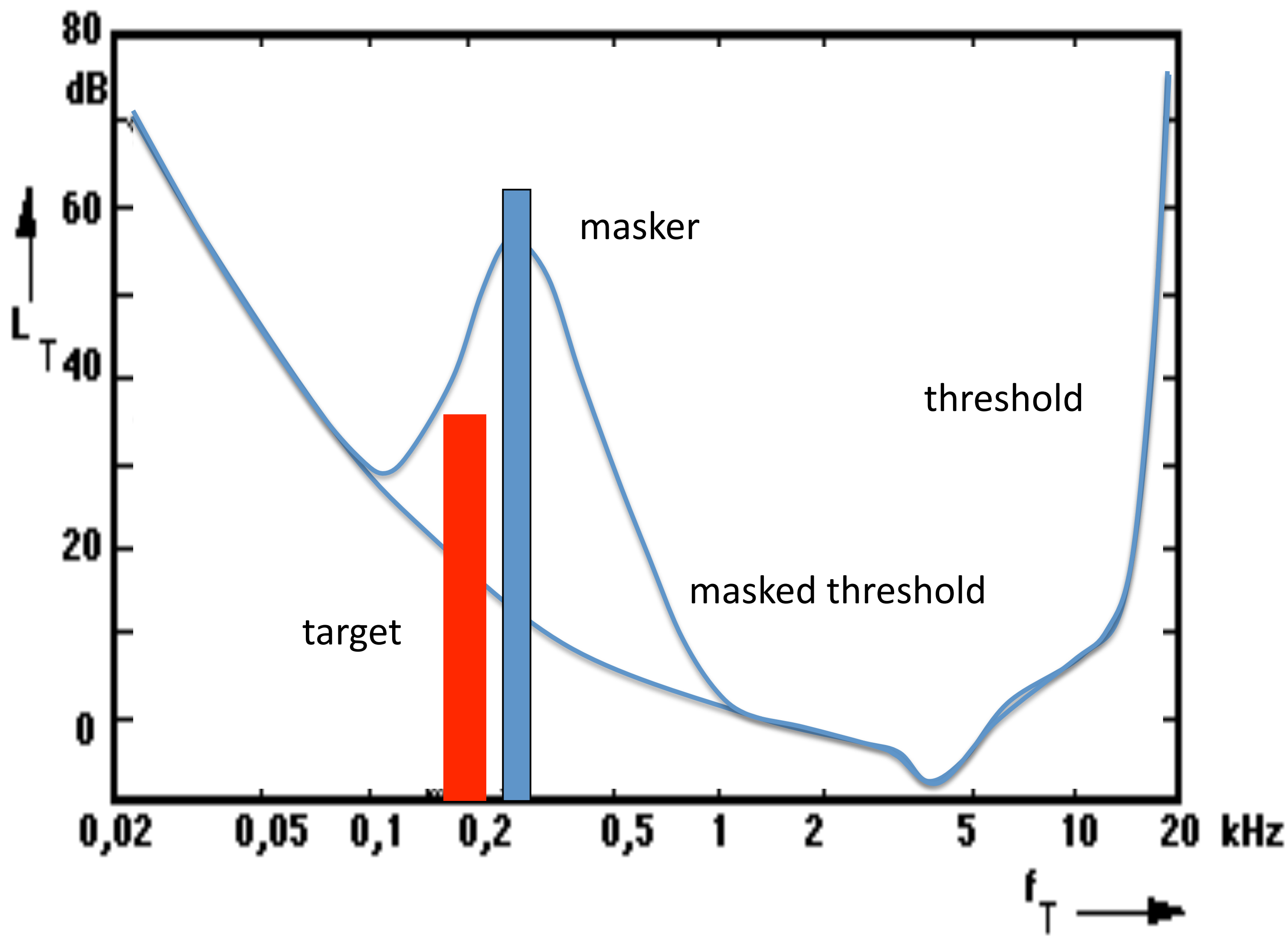
- Signal within “critical interval” (about 200 ms) is being integrated
- Signals within “critical band” (dependent on frequency) are being integrated

- **Critical time-frequency region ??????**

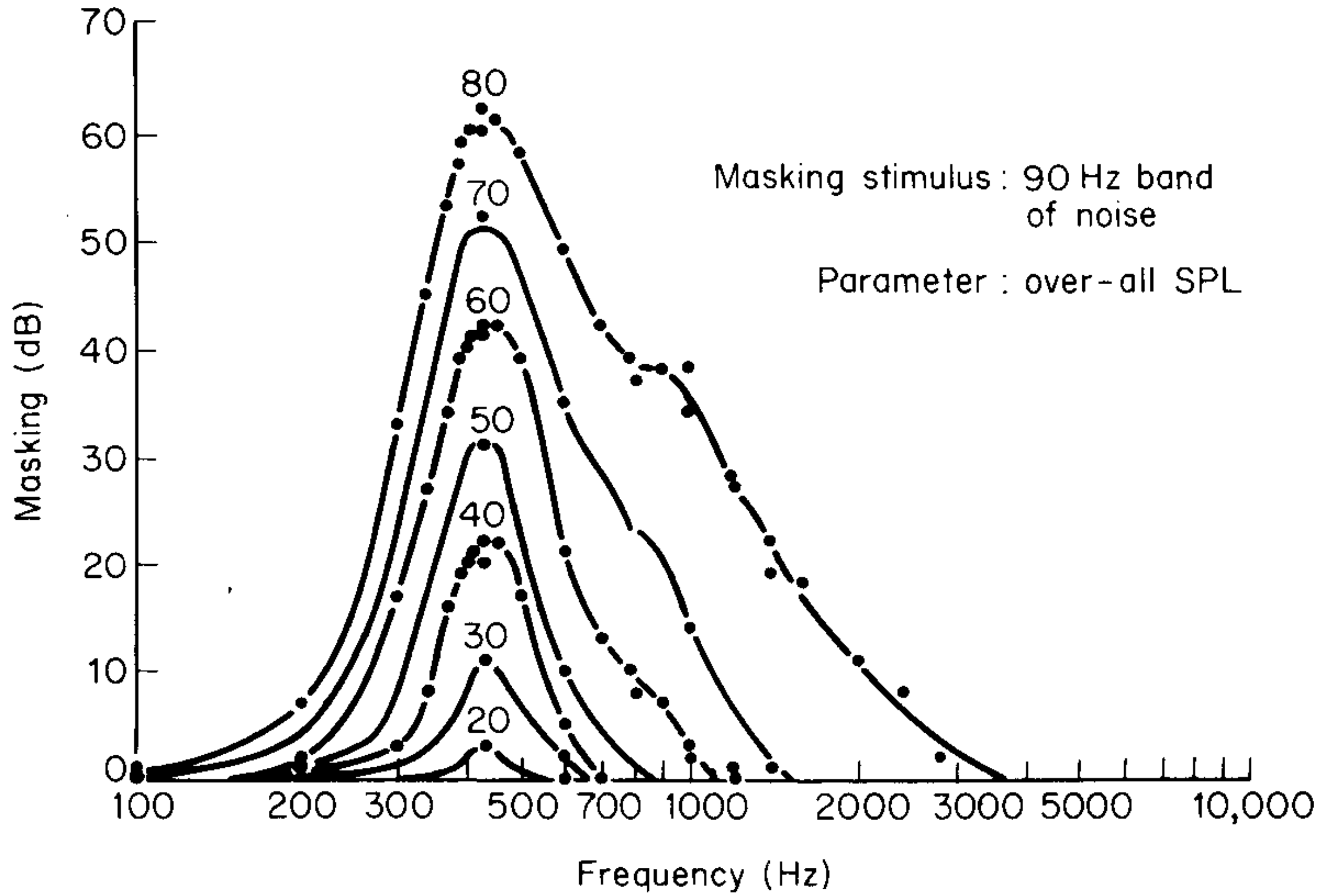
Listening for one signal (target) in presence of another (masker)

Q: Do you hear the target in the presence of the masker ?




80
dB
60
40
20
0
L_T
masker
threshold
masked threshold
target
0,02
0,05
0,1
0,2
0,5
1
2
5
10
20
kHz
f_T

Masked audiogram



3.1 Masked audiograms for a narrow band of noise centred at 410 Hz. Each curve shows the elevation in pure-tone threshold as a function of frequency for a particular level of the masking noise. From Egan and Hake (1950), by permission of the authors and *J. Acoust. Soc. Am.*

Psychophysical tuning curves

Effect of a signal on a perceptual system:

what does it take to eliminate the effect by masking?

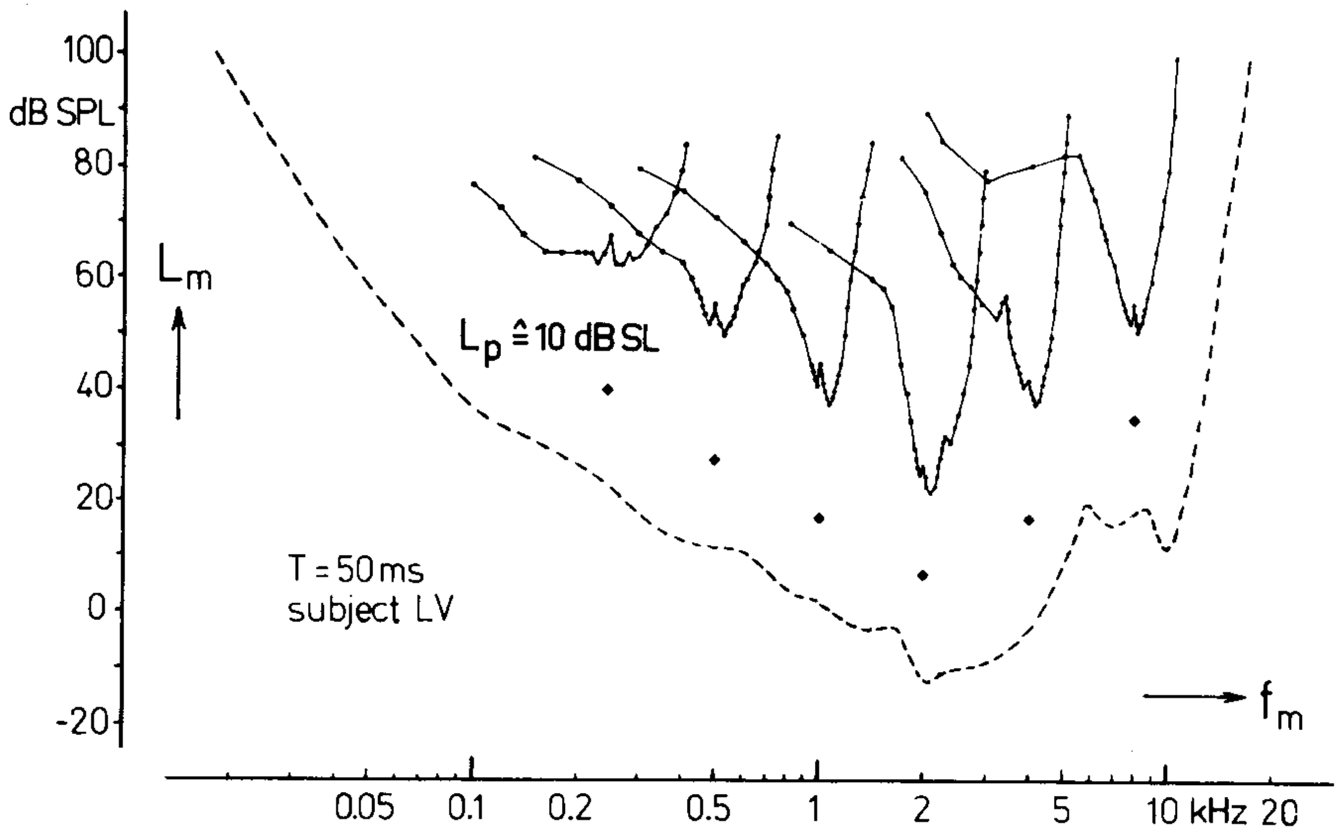
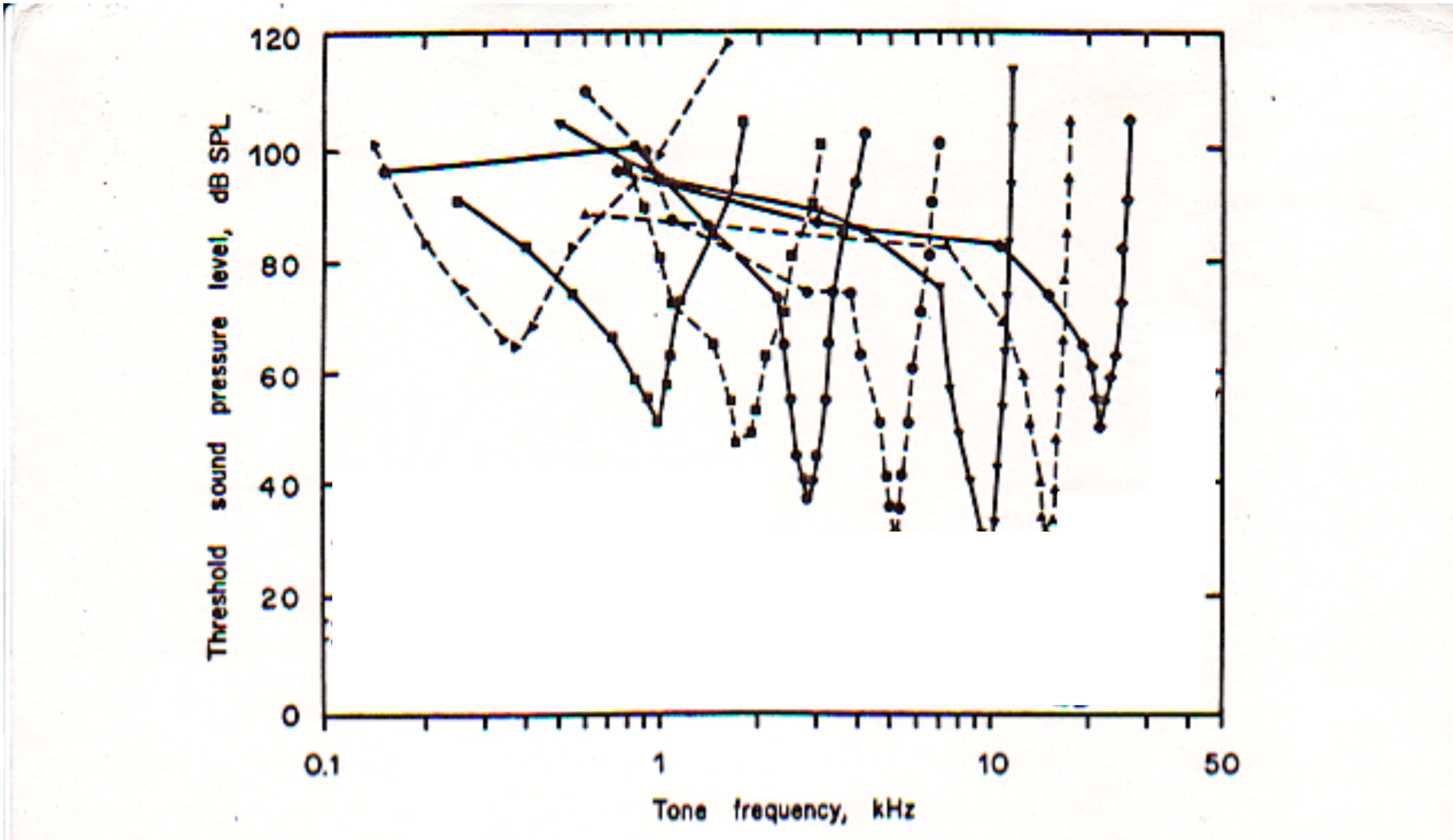
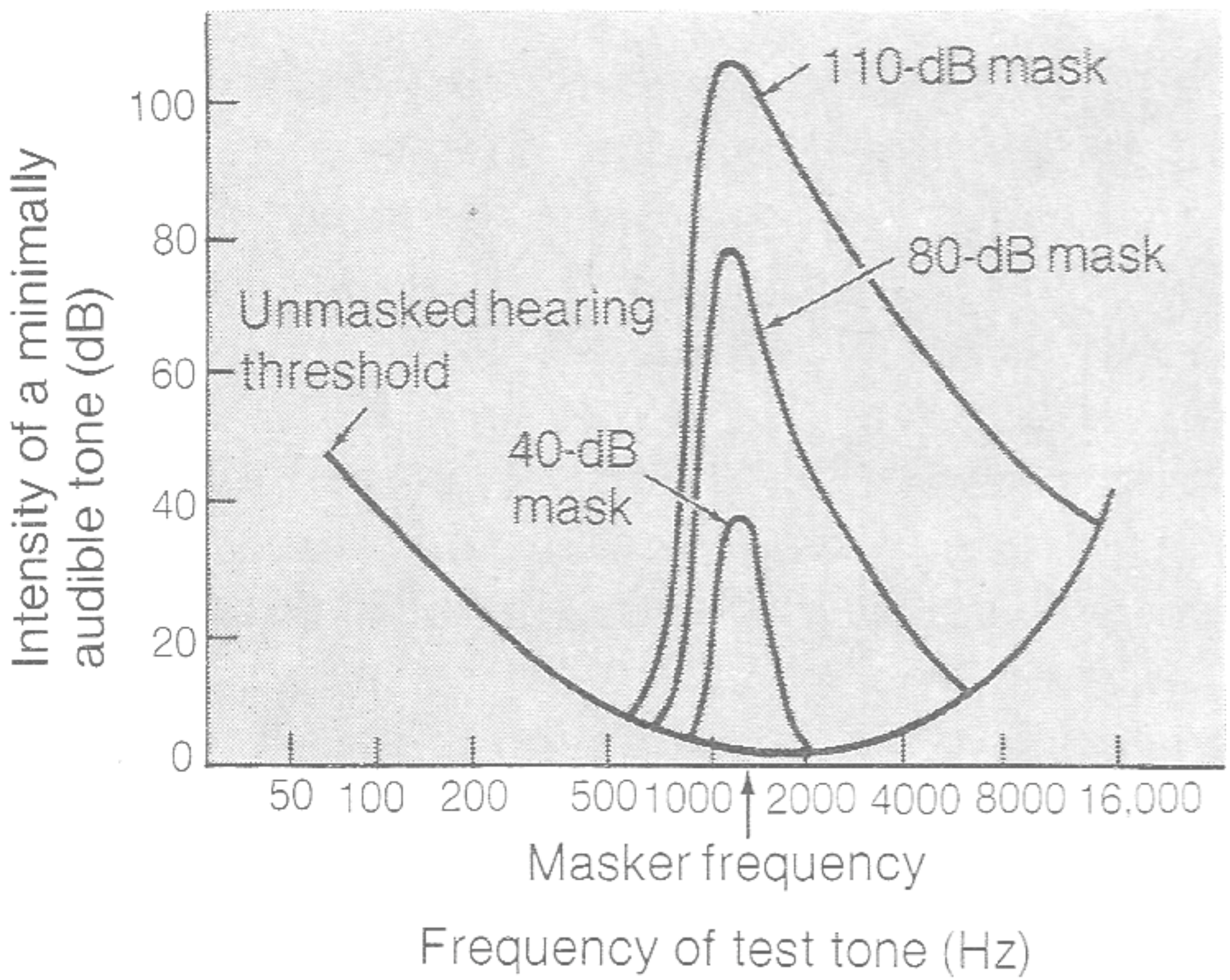


FIG. 3.3 Psychophysical tuning curves (PTCs) determined in simultaneous masking, using sinusoidal signals at 10 dB SL. For each curve the solid diamond below it indicates the frequency and level of the signal. The masker was a sinusoid which had a fixed starting phase relationship to the brief, 50 ms, signal. The masker level required for threshold is plotted as a function of masker frequency (logarithmic scale). The dashed line shows the absolute threshold for the signal. From Vogten (1974), by permission of the author.

Basilar Membrane Tuning Curves

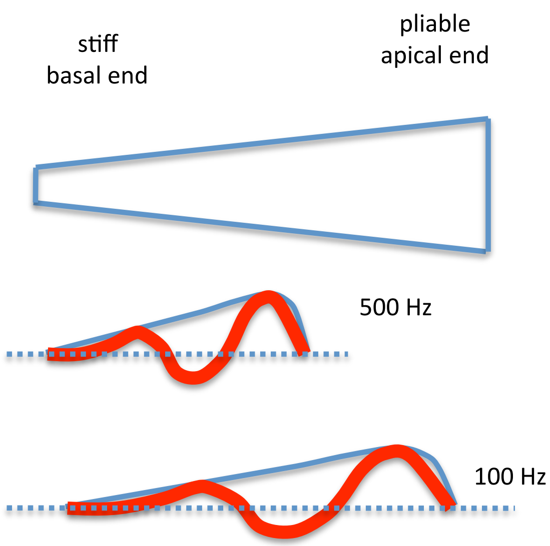


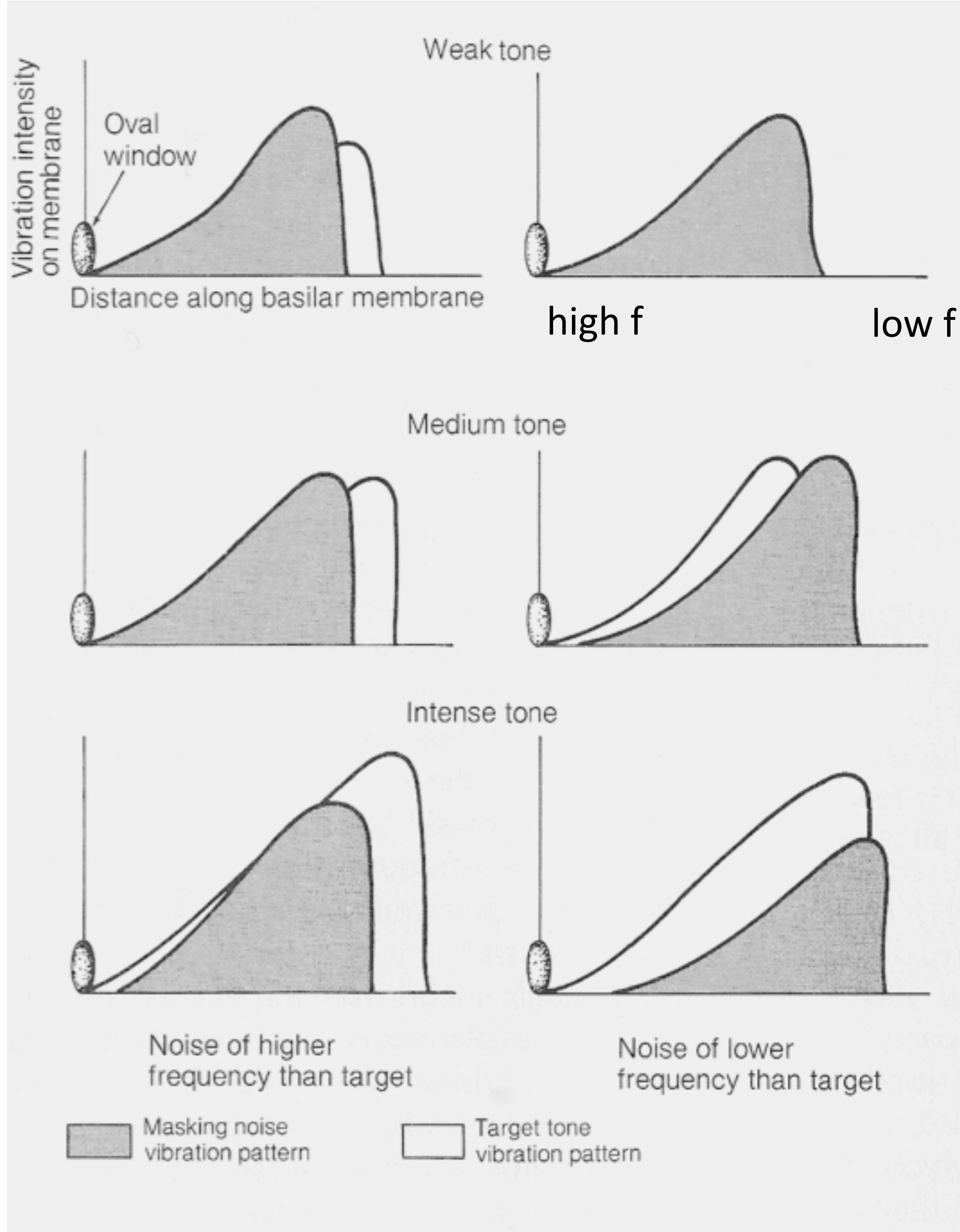
Stronger maskers mask more (high) frequencies



Basilar membrane:

- low frequency sound excites most of basilar membrane
- high frequency sound excites only a small part of it

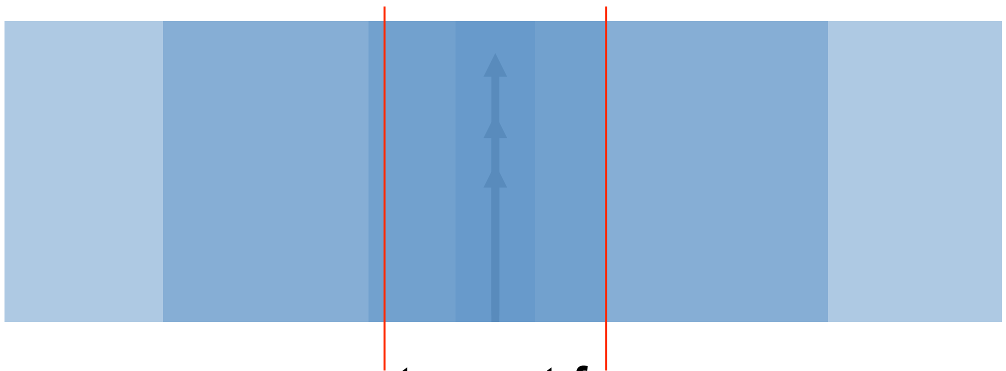




Most (but not all) simultaneous masking can be explained by peripheral physiology.

Simultaneous Masking (Fletcher 1940)

band-pass filtered
noise centered at f

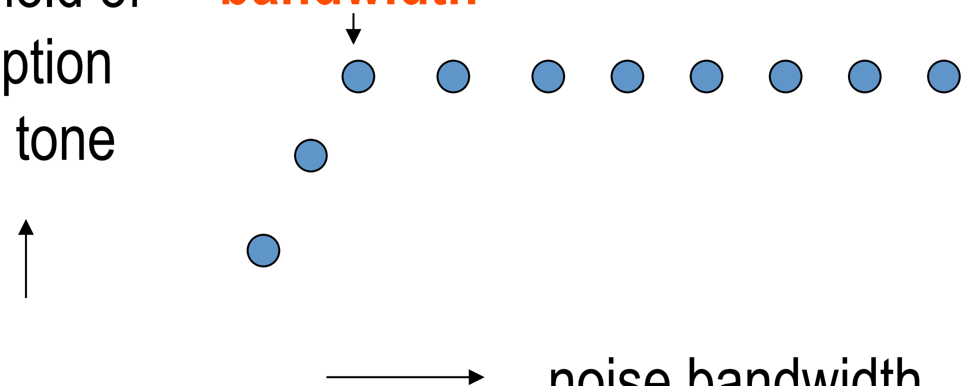


tone at f

what happens outside the critical band does not affect decoding of the sound in the critical band

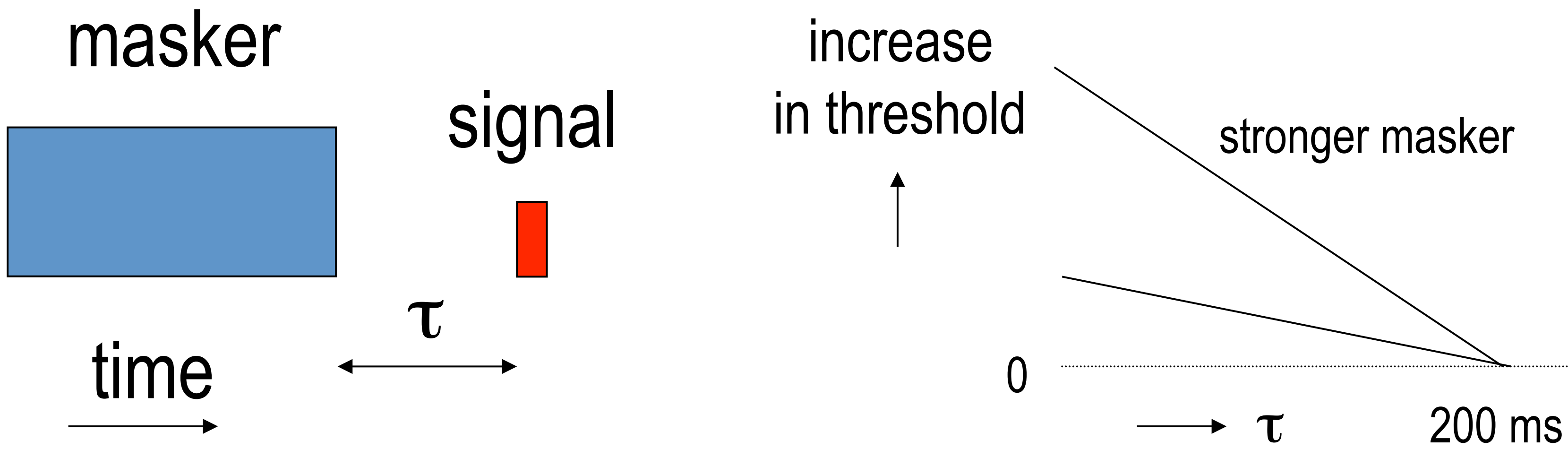
critical
bandwidth

threshold of
perception
of the tone



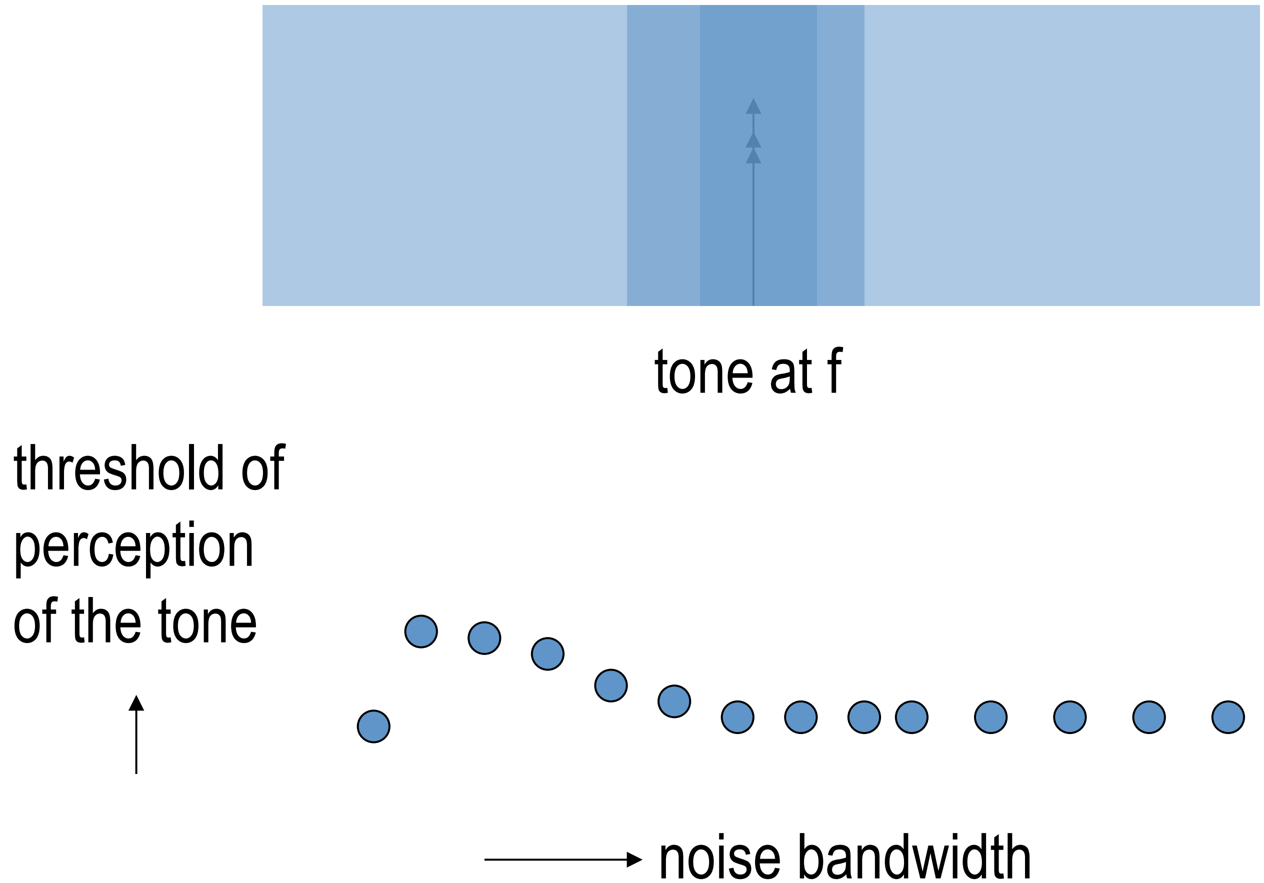
noise bandwidth

Masking in Time



- suggests ~200 ms buffer (critical interval) in auditory system
  - **what happens outside the critical interval, does not affect detection of signal within the critical interval**

band-pass filtered noise
modulated in time (sinusoidal or random modulator, 10-50 Hz frequency)



Co-modulated noise outside the critical band makes detection of the tone easier!!!