

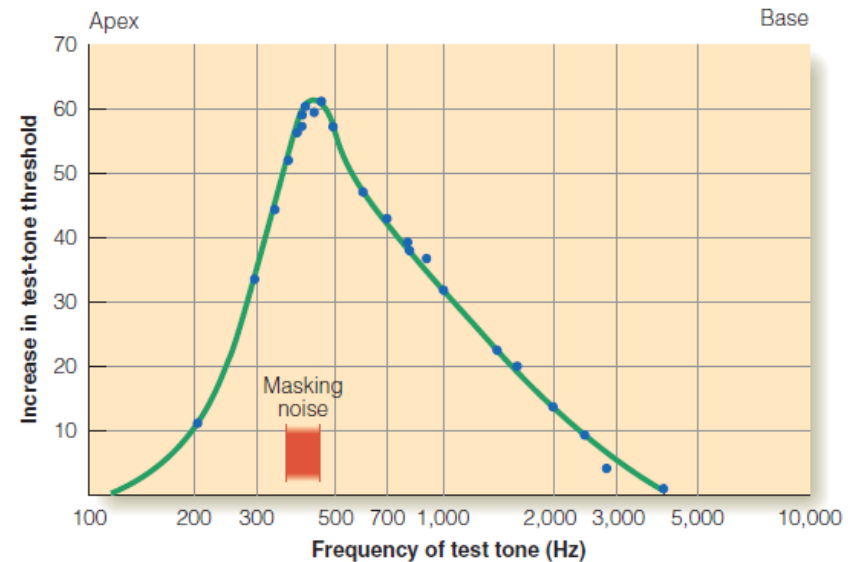
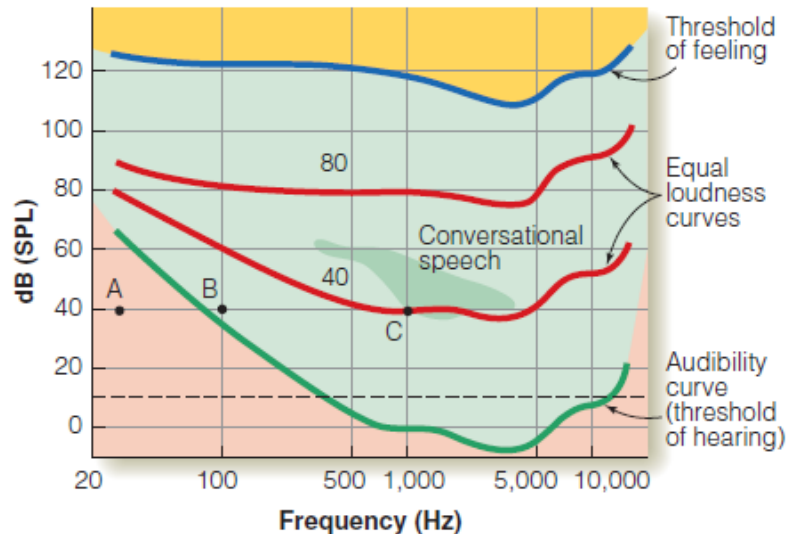
휴먼인터페이스 미디어 Human Interface Media

강의 3
소리의 지각

2020년 가을

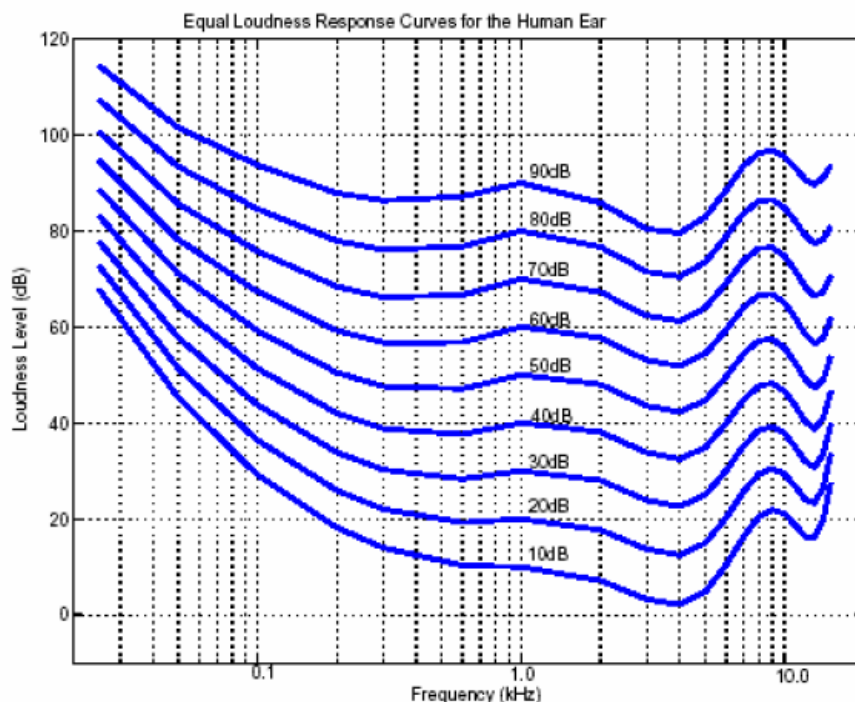
사람의 청각 특성

- 가청주파수:
- 가청 진폭 :
- 사람이 느끼는 소리의 크기 음압과 주파수에 따라 달라진다.
- 청각 마스킹(Auditory Masking):



같은 크기의 소리?

- Fletcher-Munson Curves: Equal loudness curves that display the relationship between perceived loudness (“Phons”, in dB) for a given stimulus sound volume (“Sound Pressure Level”, also in dB), as a function of frequency

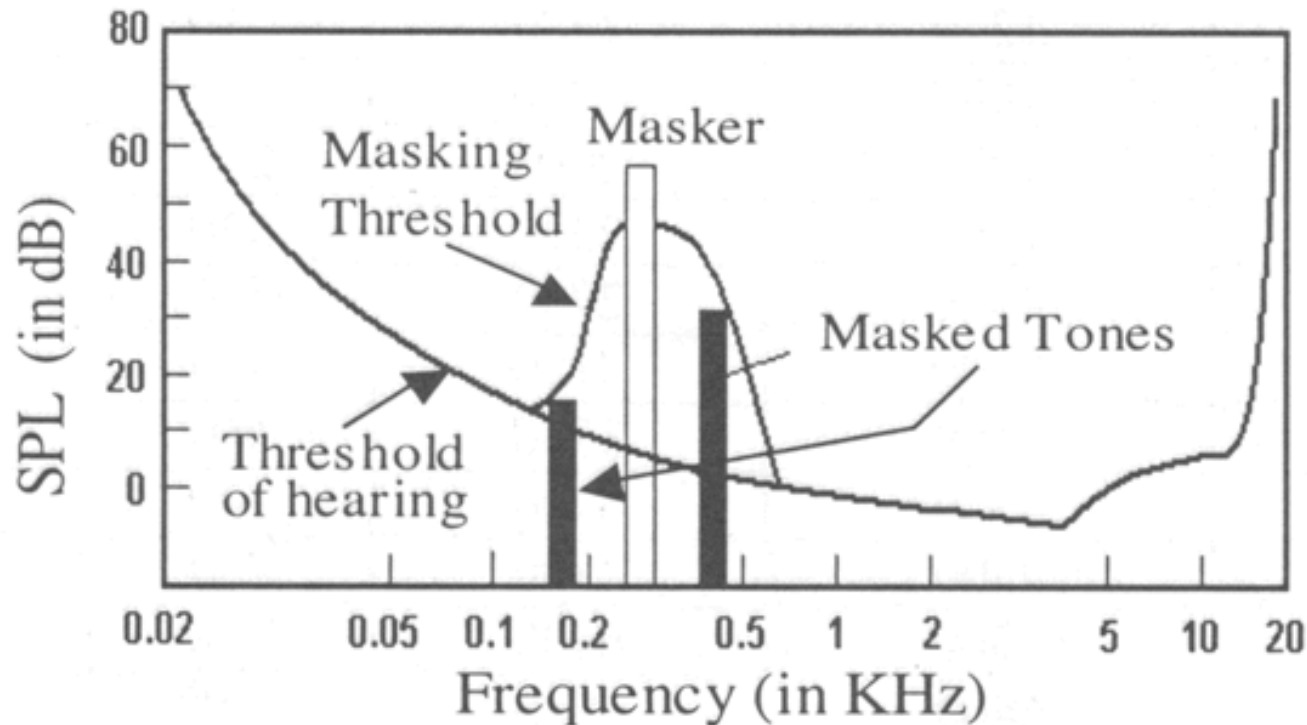


Fletcher-Munson Curves (re-measured by Robinson and Dadson)

- The bottom curve shows what level of pure tone stimulus is required to produce the perception of a 10 dB sound
- All the curves are arranged so that the perceived loudness level gives the same loudness as for that loudness level of a pure tone at 1 kHz

주파수 마스크링

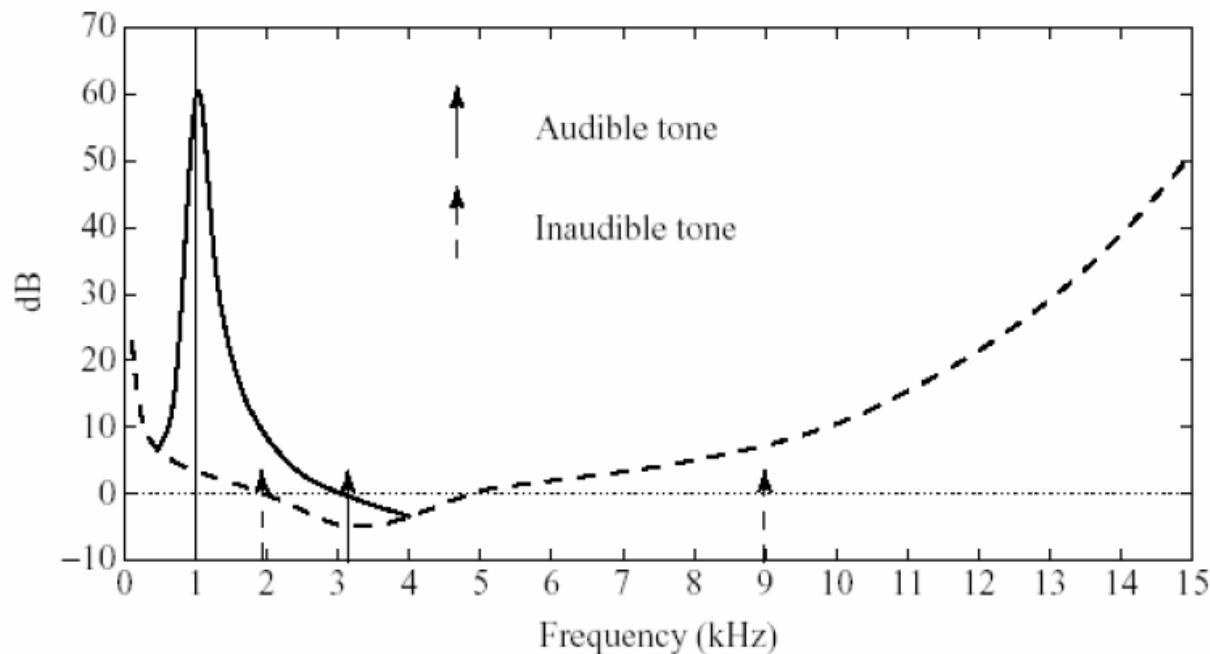
- 소리 크기가 큰 톤이 있으면 그보다 낮은 인접 소리는 잘 안 들린다.
- 소리의 크기가 클수록 마스크링 대역은 넓어진다.



주파수 마스킹 곡선

Frequency masking is studied by playing a particular pure tone, say 1 kHz again, at a loud volume, and determining how this tone affects our ability to hear tones nearby in frequency

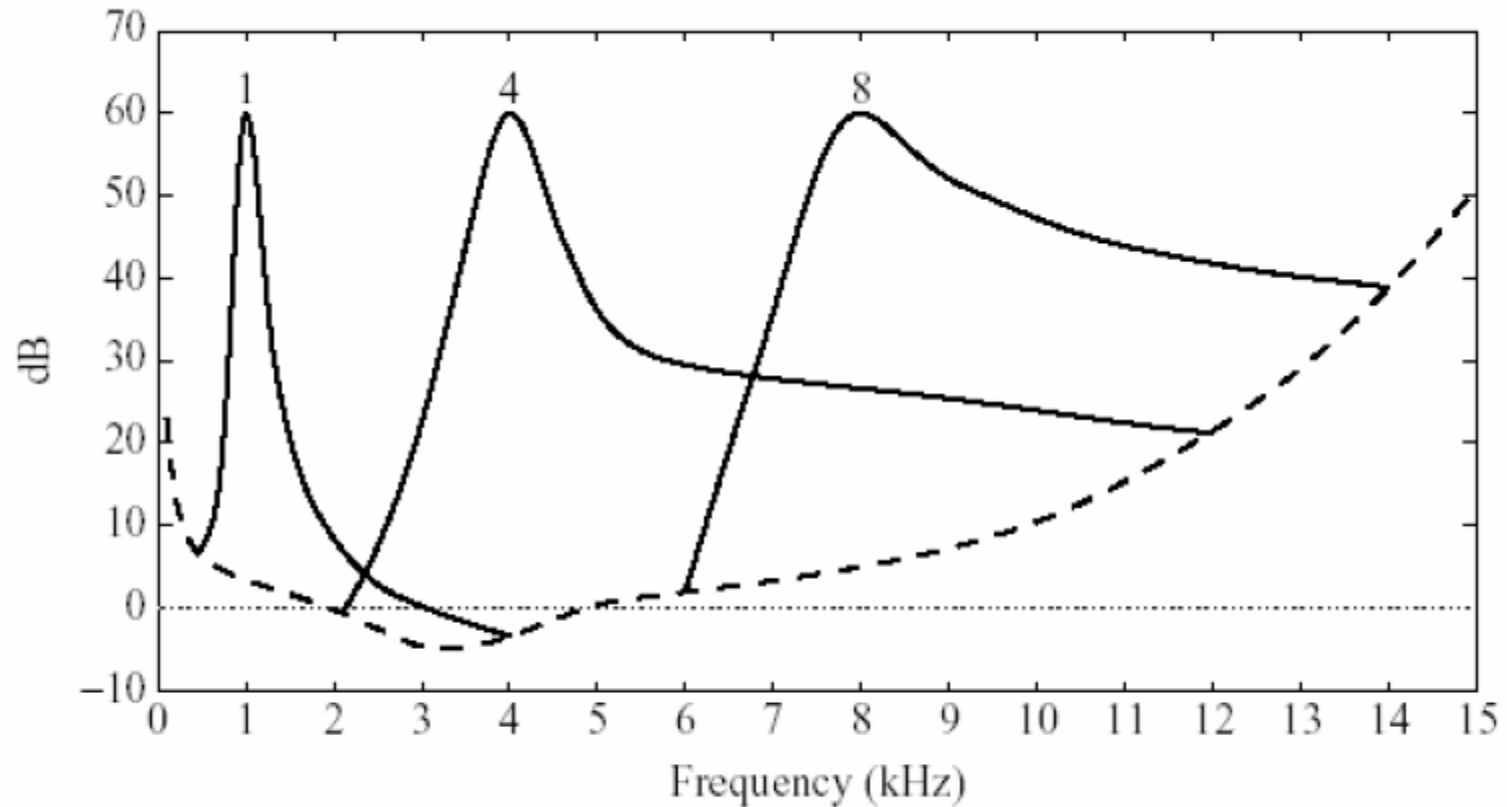
- one would generate a 1 kHz masking tone, at a fixed sound level of 60 dB, and then raise the level of a nearby tone, e.g., 1.1 kHz, until it is just audible



Audible level for a single masking tone (1 kHz)

Demo

주파수 마스킹 곡선



Effect of masking tone at three different frequencies

임계 대역 (Critical Band)

Critical bandwidth represents the ear's resolving power for simultaneous tones or partials

- At the low-frequency end, a critical band is less than 100 Hz wide, while for high frequencies the width can be greater than 4 kHz

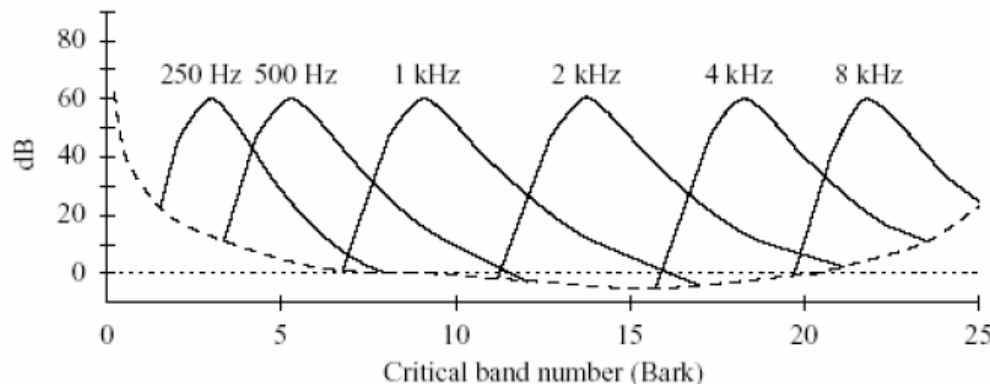
Experiments indicate that the critical bandwidth:

- for masking frequencies < 500 Hz: remains approximately constant in width (about 100 Hz)
- for masking frequencies > 500 Hz: increases approximately linearly with frequency

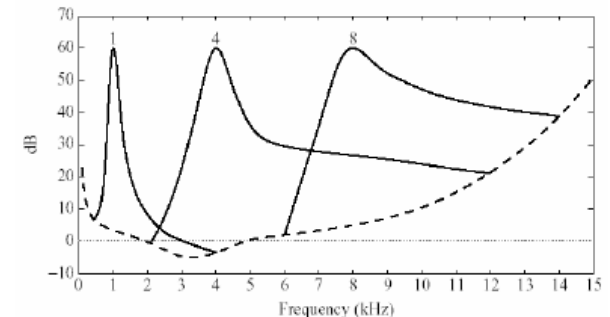
Band #	Lower Bound (Hz)	Center (Hz)	Upper Bound (Hz)	Bandwidth (Hz)
1	-	50	100	-
2	100	150	200	100
3	200	250	300	100
4	300	350	400	100
5	400	450	510	110
6	510	570	630	120
7	630	700	770	140
8	770	840	920	150
9	920	1000	1080	160
10	1080	1170	1270	190
11	1270	1370	1480	210
12	1480	1600	1720	240
13	1720	1850	2000	280
14	2000	2150	2320	320
15	2320	2500	2700	380
16	2700	2900	3150	450
17	3150	3400	3700	550
18	3700	4000	4400	700
19	4400	4800	5300	900
20	5300	5800	6400	1100
21	6400	7000	7700	1300
22	7700	8500	9500	1800
23	9500	10500	12000	2500
24	12000	13500	15500	3500
25	15500	18775	22050	6550

바크 스케일 (Bark Scale)

- Bark unit is defined as the width of one critical band, for any masking frequency
- The idea of the Bark unit: every critical band width is roughly equal in terms of Barks



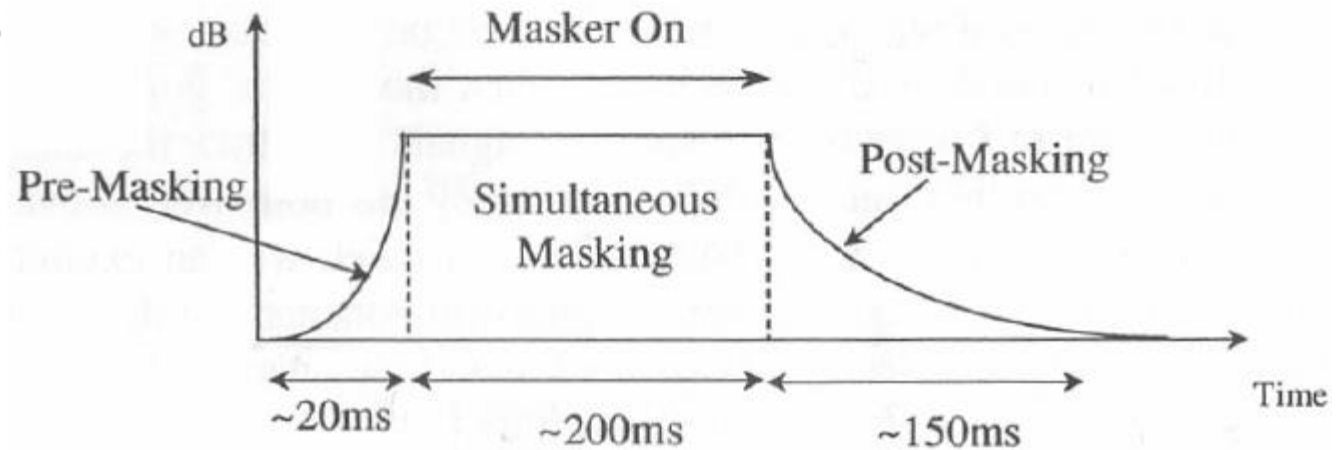
Effect of masking tones, expressed in Bark units



Effect of masking tone expressed in frequencies

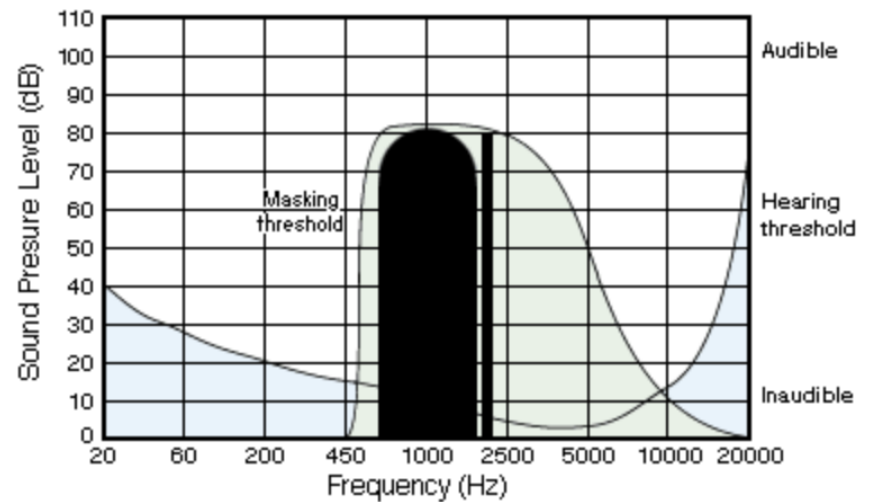
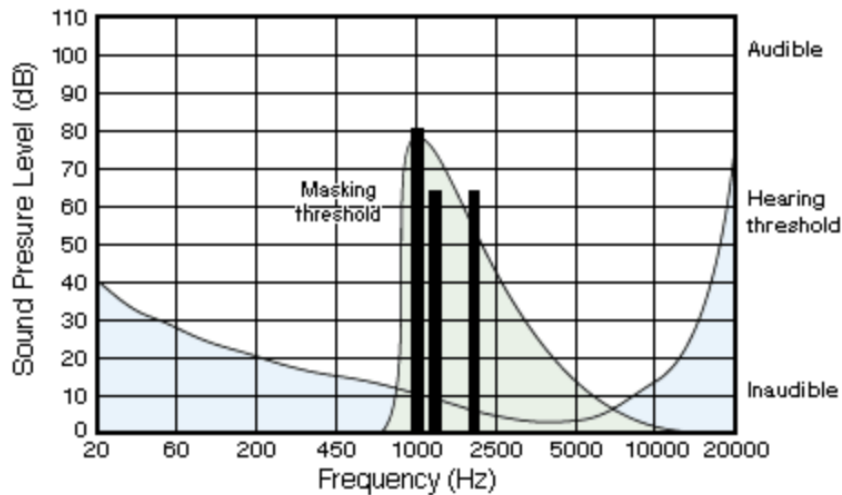
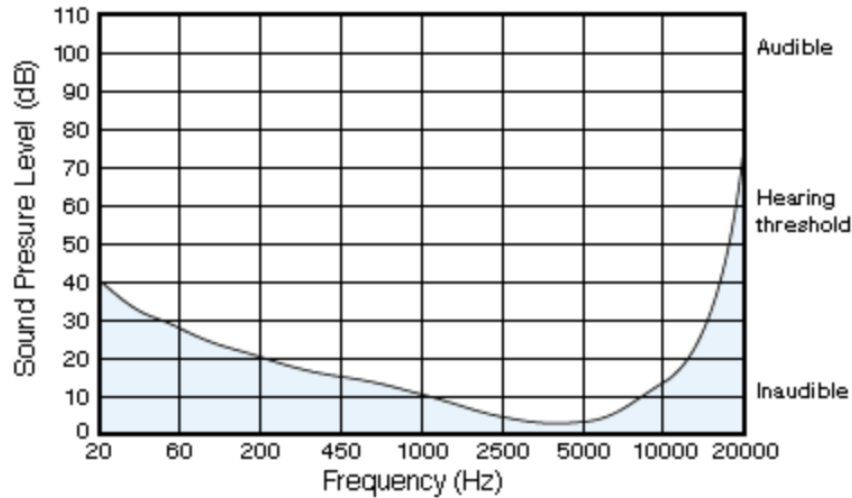
순시 마스크링 (Temporal Masking)

- Phenomenon: any loud tone will cause the hearing receptors in the inner ear to become *saturated* and require time to recover
- The following figures show the results of Masking experiments

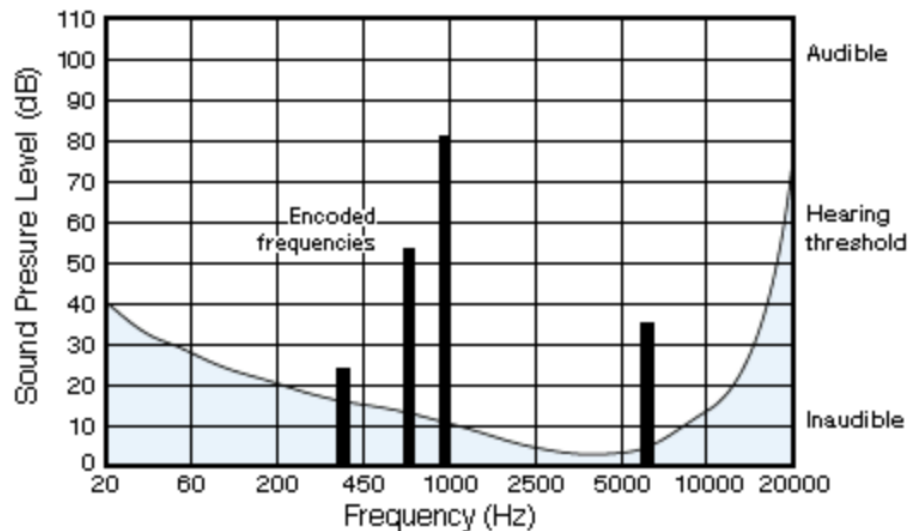
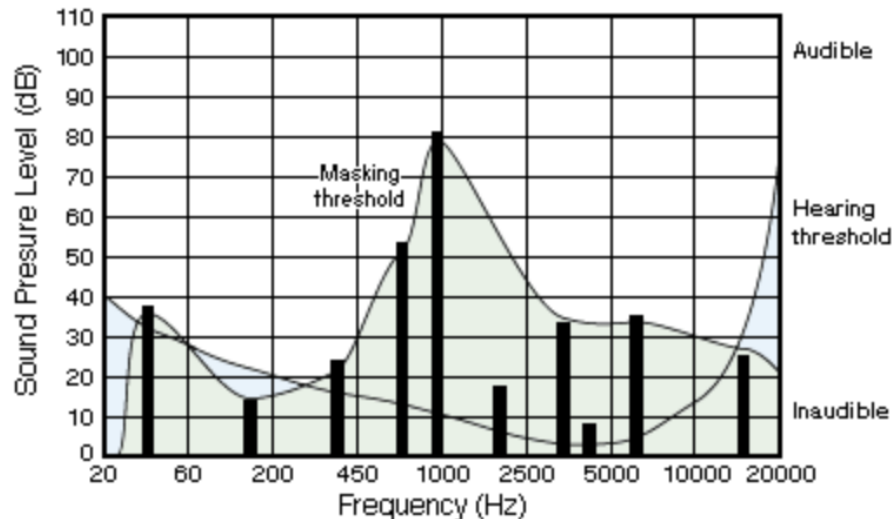


- The louder is the test tone, the shorter it takes for our hearing to get over hearing the masking

Psychoacoustics



Psychoacoustics



Summary

- Human Sound perception
 - Equal Loudness Curve
 - Auditory Masking
 - Critical Band & Bark Scale
- Psychoacoustics