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The University of Manchester

VOICES in the waiting room

Age related hearing loss

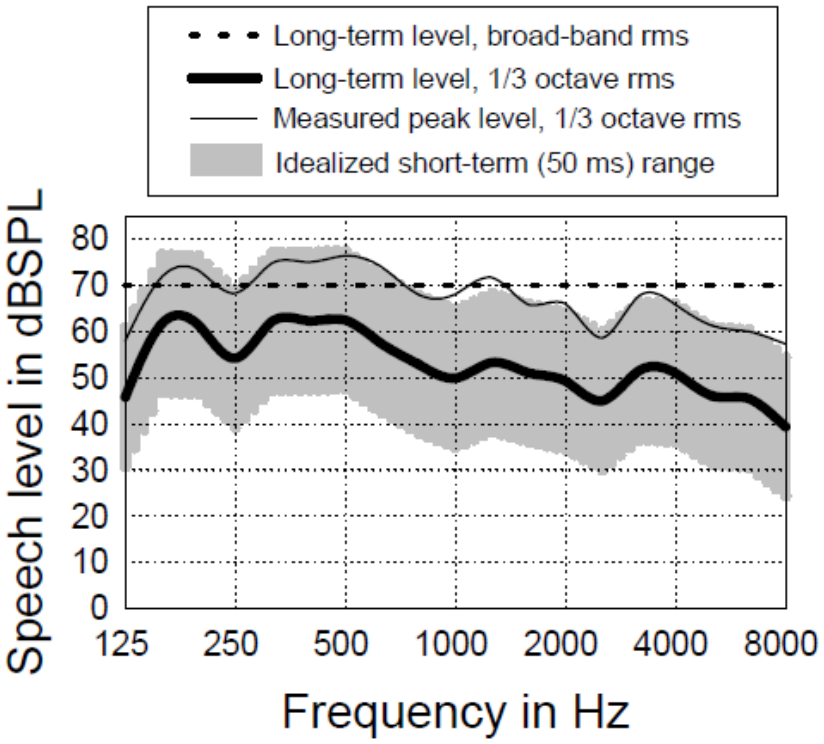
Dr Tim Wilding tim.wilding@manchester.ac.uk

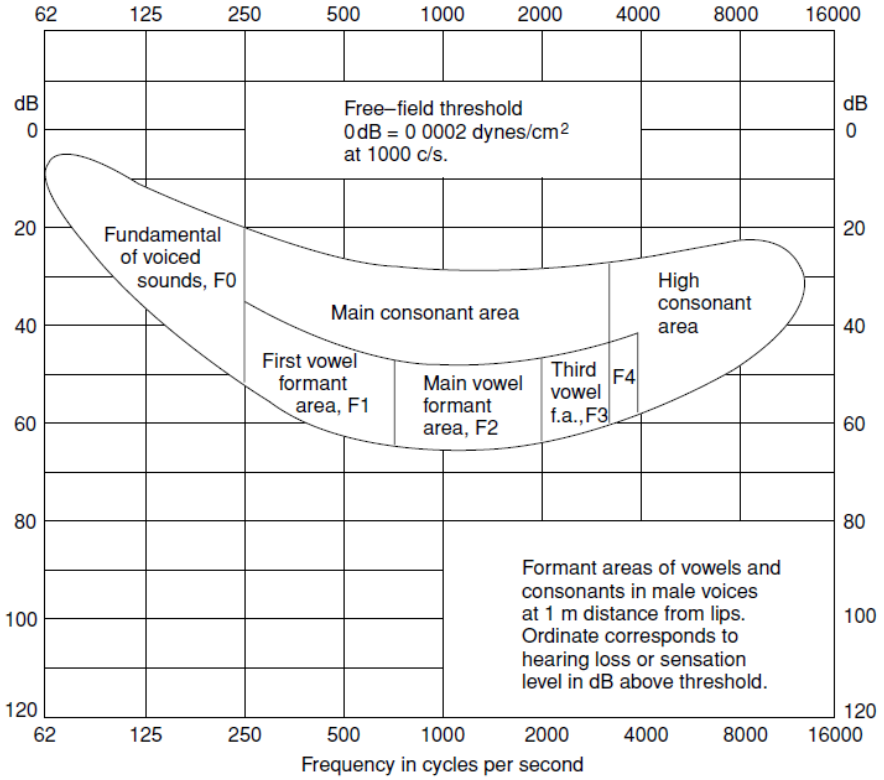
Hearing Impairment

- > 10 million UK residents have a hearing loss
  - 6.4 million > 65 years of age
  - 3.7 million working age (16 - 64 years)
  - By 2031 estimated 14.5 million with hearing loss in the UK
  - WHO predicts that by 2030 adult onset hearing loss will be in the top ten disease burdens in the UK, above diabetes and cataracts
- Hearing Aids
  - 2 million UK residents have hearing aids (1.4 million use them regularly)
  - 6 million UK residents would benefit from hearing aids
  - 4 million people do not have hearing aids would benefit from them

Facts and figures on hearing loss and tinnitus. Action on Hearing Loss (2011)

Speech


Long-term level, broad-band rms
Long-term level, 1/3 octave rms
Measured peak level, 1/3 octave rms
Idealized short-term (50 ms) range
Speech level in dBSPL
80
70
60
50
40
30
20
10
0
125
250
500
1000
2000
4000
8000
Frequency in Hz


62
125
250
500
1000
2000
4000
8000
16000
dB
0
20
40
60
80
100
120
Free–field threshold
0dB = 0 0002 dynes/cm²
at 1000 c/s.
Fundamental
of voiced
sounds, F0
Main consonant area
High
consonant
area
First vowel
formant
area, F1
Main vowel
formant
area, F2
Third
vowel
f.a.,F3
F4
Formant areas of vowels and
consonants in male voices
at 1 m distance from lips.
Ordinate corresponds to
hearing loss or sensation
level in dB above threshold.
Frequency in cycles per second

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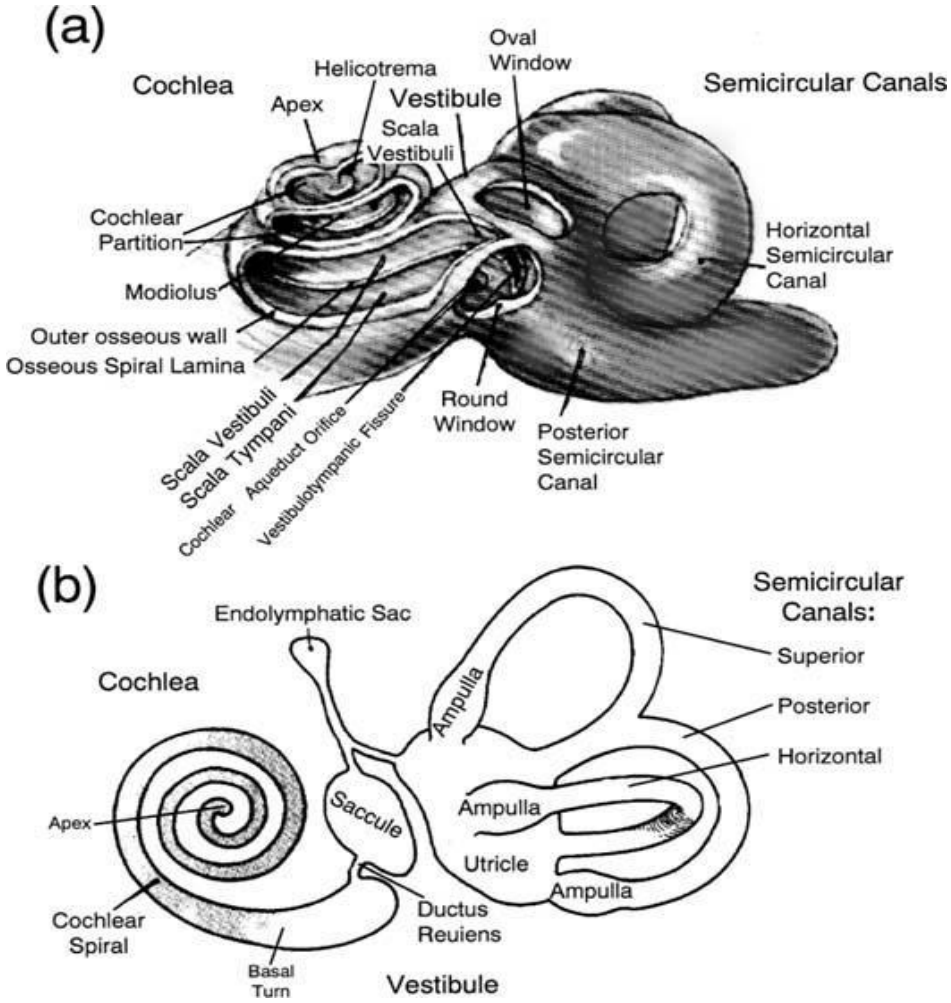
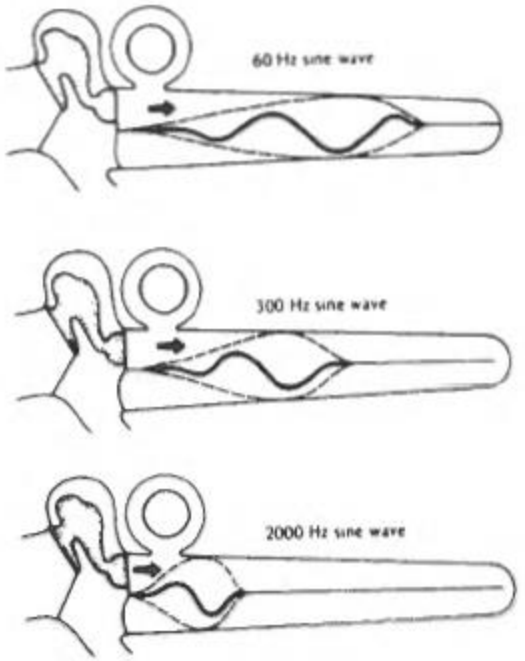
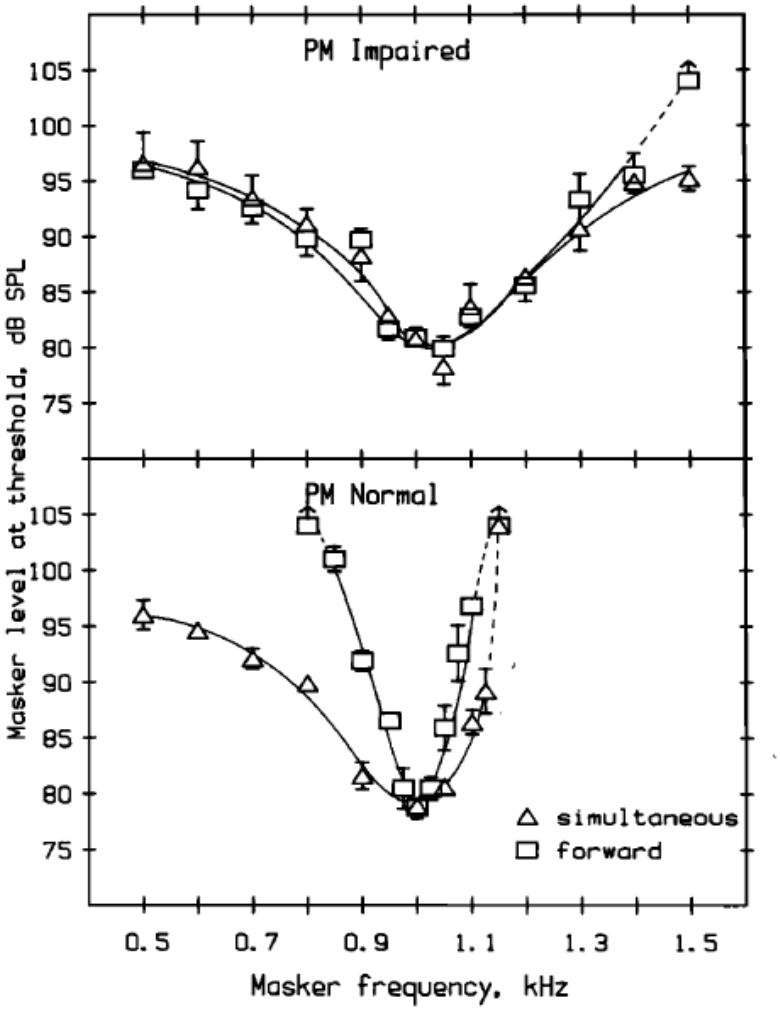




Gelfand (2009) Essentials of Audiology

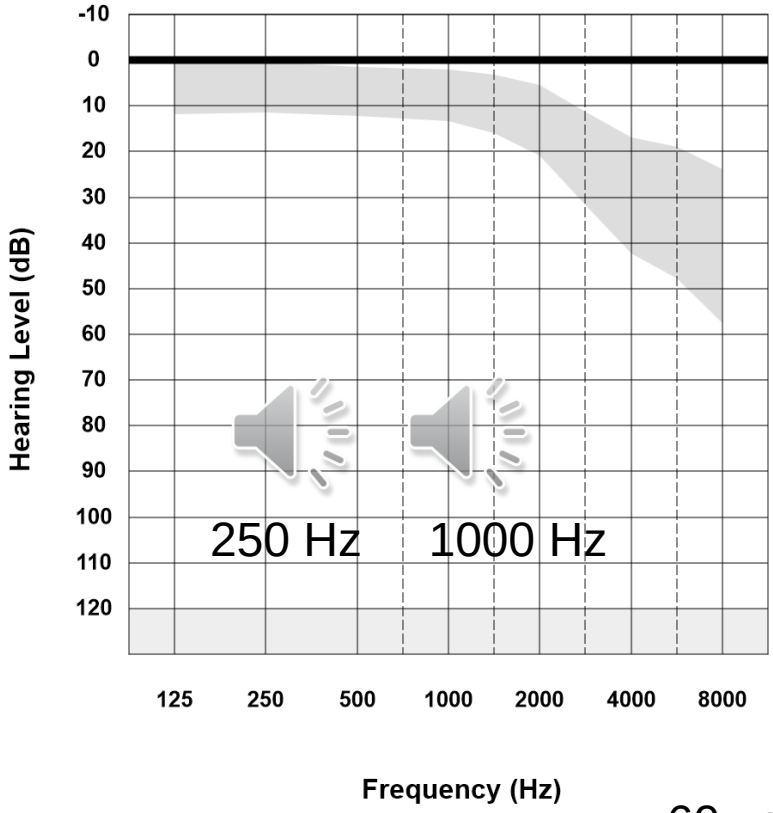
Yost (2000) Fundamentals of Hearing

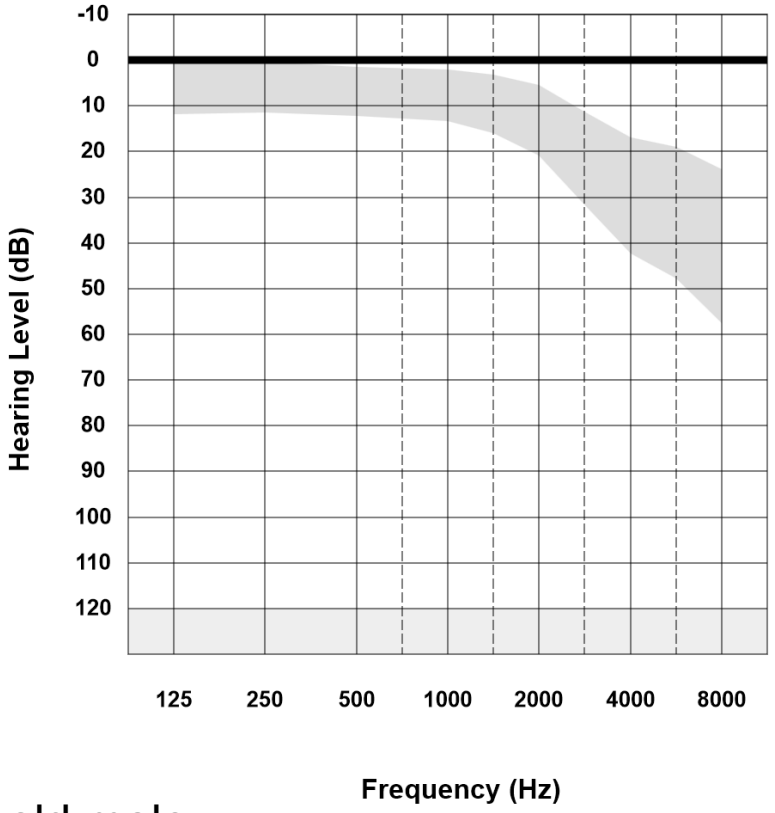
OHC function



Moore and Glasberg (1986) Comparisons of frequency selectivity in simultaneous and forward masking for subjects with unilateral cochlear impairments. JASA, 80 93-107

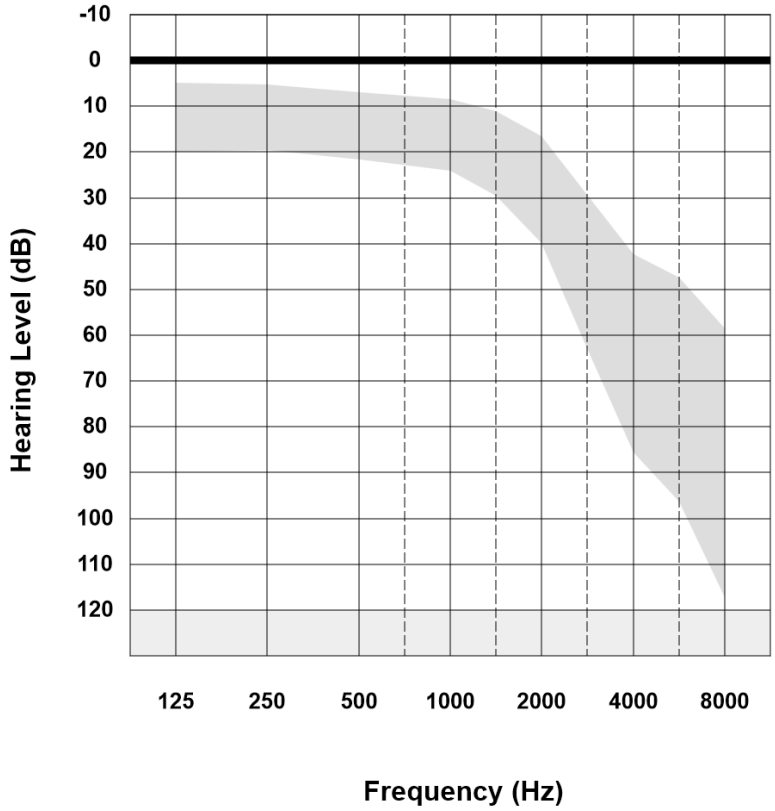
Presbyacusis

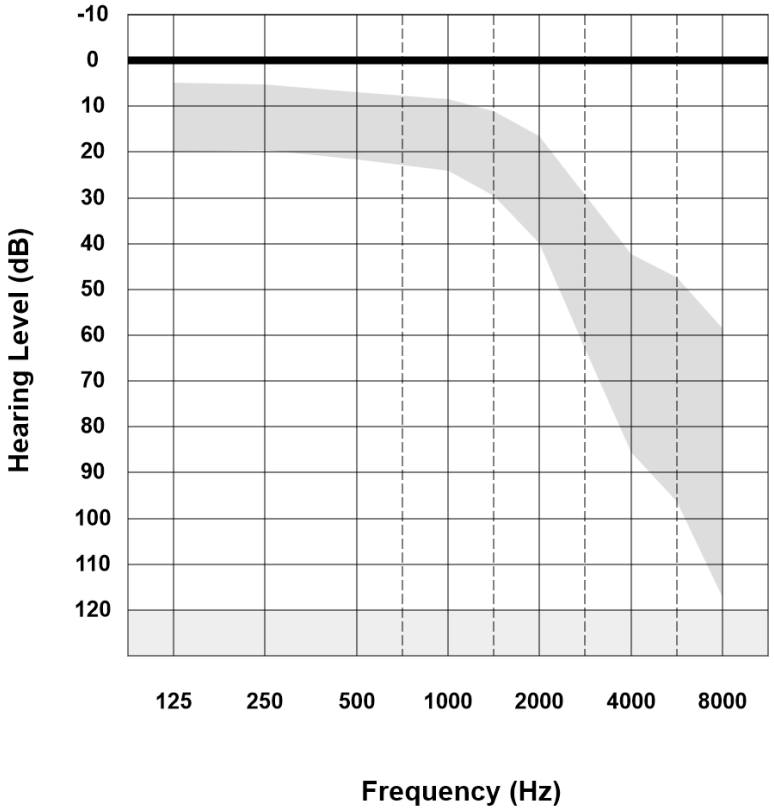




60 year old male

BS EN ISO 7029:2000 Acoustics – Statistical distribution of thresholds as a function of age.





80 year old male

BS EN ISO 7029:2000 Acoustics – Statistical distribution of thresholds as a function of age.

Hearing loss

- Loss of high frequency audibility
- Smearing of frequencies

- Speech in noise (noise may be other speech)
  - (added impact of SNR, reverberation)
  - Reduced audibility of higher frequencies
    - Hearing aids aim to increase audibility but also increase noise (noise reduction and direction microphones)
  - Frequency smearing, hearing aid cannot help as sensory organ deficient

Simulated hearing loss

	Without noise	with noise
Normal Hearing		
Frequency smearing		
Frequency smearing missing high frequency components (mild loss)		
Mild hearing loss (amplitude)		

Research

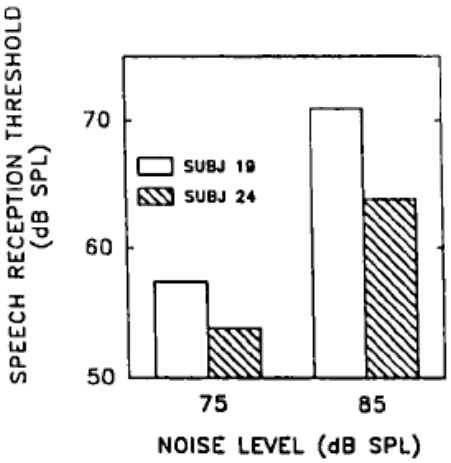
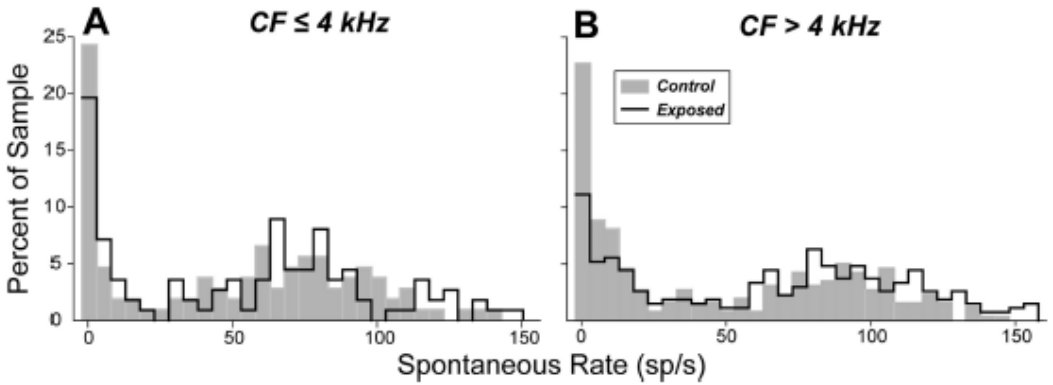


Figure 1. Mean SRTs for two hearing-impaired subjects (with similar audiometric configuration and speech-recognition ability in quiet) at two noise levels (75 and 85 dB SPL).



Loss of auditory nerve fibres without destroying cochlear sensory cells. Thresholds returned to normal but ABR suprathreshold amplitudes reduced.

Low spontaneous firing rate neurons encode AM information at high intensities, whereas high spontaneous rate fibres AM information diminishes around 30 dB above threshold. Cooper et al. (1993) Cochlear nerve fibre responses to amplitude-modulated stimuli: variations with spontaneous rate and other response characteristics. J Neurophysiol 70(1): 370-86

Crandell (1991) Individual differences in speech recognition ability: Implications for hearing aid selection. Ear and Hearing 12 (6) 100S-108S

Furman et al. (2013) Noise-induced cochlear neuropathy is selective for fibres with low spontaneous rates. J Neurophysiol 110:577-586