2010 청각학회 보청기 W/S

Selection and Fitting

울산의대 서울아산병원 | 이비인후과학교실 이 광 선

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*HA Selection

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Factors to Consider in Selection of HA

General Considerations

- Age
- Configuration and Degree of hearing loss
- Auditory environment
  - Educational environment
  - Special needs
- Style
  - Body
  - BTE
  - ITE/ITC
  - CIC
  - Open Canal

Optional Functions

- Channels
  - Multichannel
- Feedback cancellation
- Digital noise reduction
- Directional microphone
- Automatic program
- Data Logging
- Extended high frequency gain
- FM/Remote Control

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HA Selection in Children

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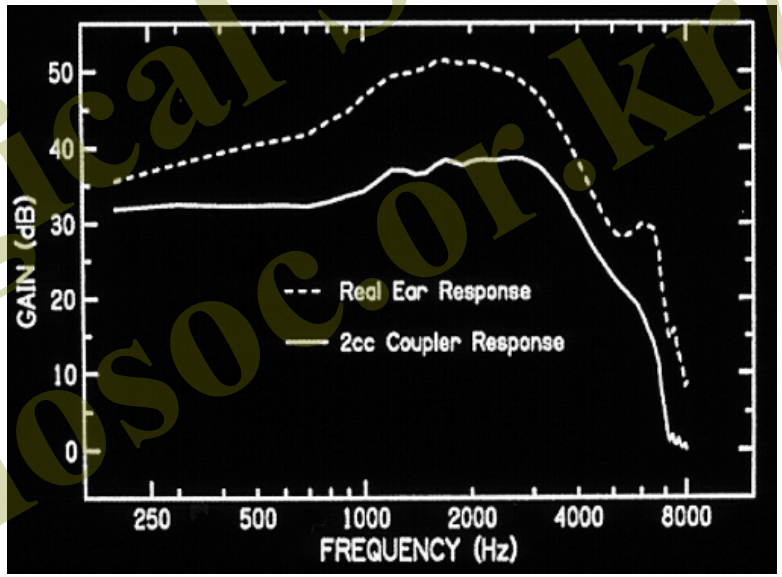
- Small Ear Canal
  - RECD
  - Limited Earmold Options
- Practical Issues
  - Size of baby's ear
  - Hearing Aid Size
  - Retention



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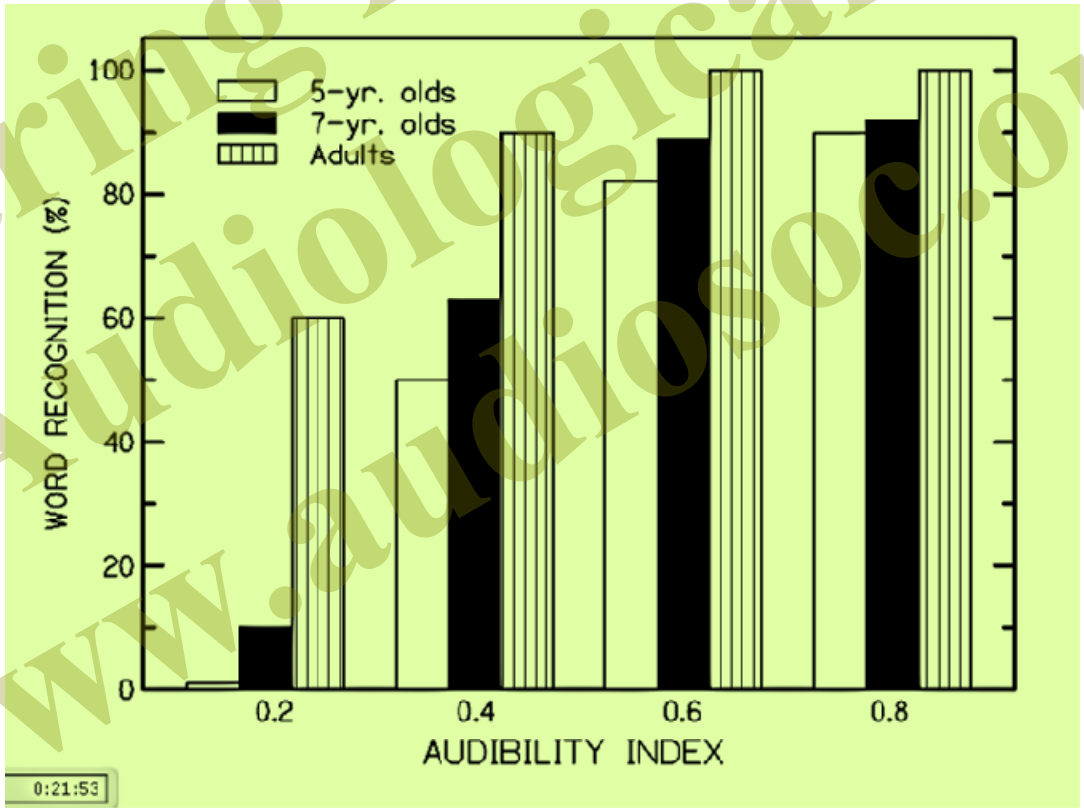
Children Require

Higher SPLs for equivalent word recognition in 4-word sentences

(Stelmachowicz, Hoover, Lewis, Kortekaas, & Pittman, 2000)



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Effects of Distance and Noise Children with Normal Hearing

AGE group	Word Rec. Quiet/Close (1.8 meters)	Word Rec. Noise/Far (7 meters)
4 years	88.3%	67%
5 years	94.3%	84%
6 years	98%	87.6%
Adult	99.3%	97%

(Johnson, 1999)

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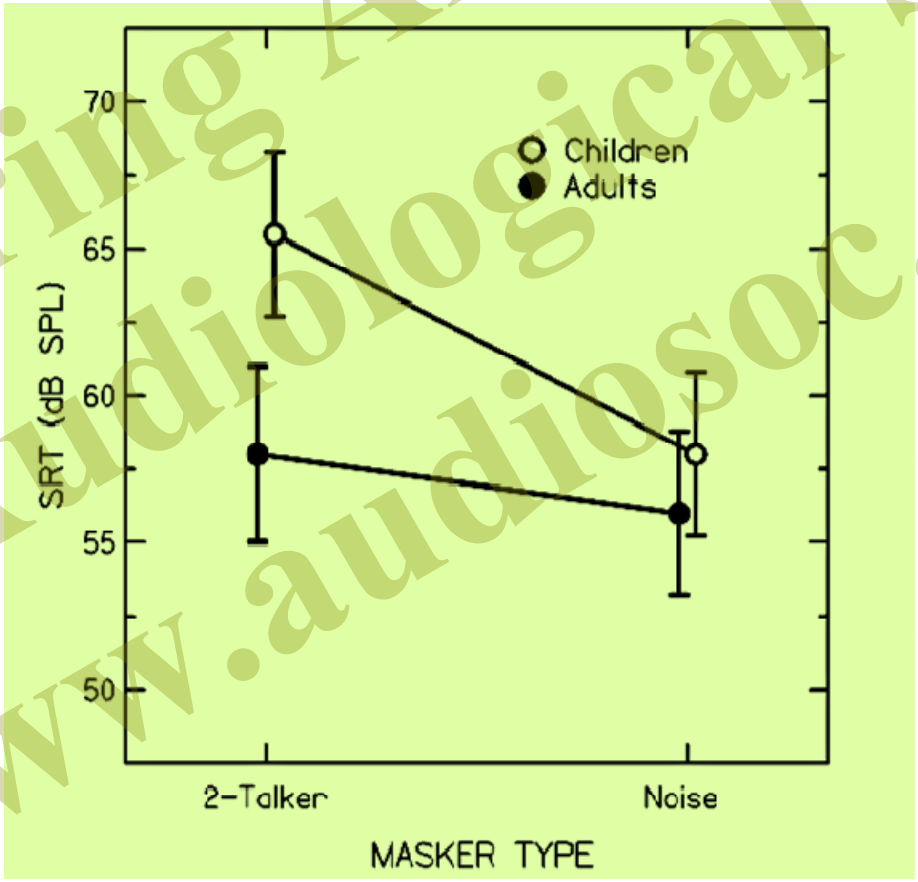
Children Require

Higher SNRs for equivalent spondee recognition

(Hall, Grose, Buss, & Dev, 2002)



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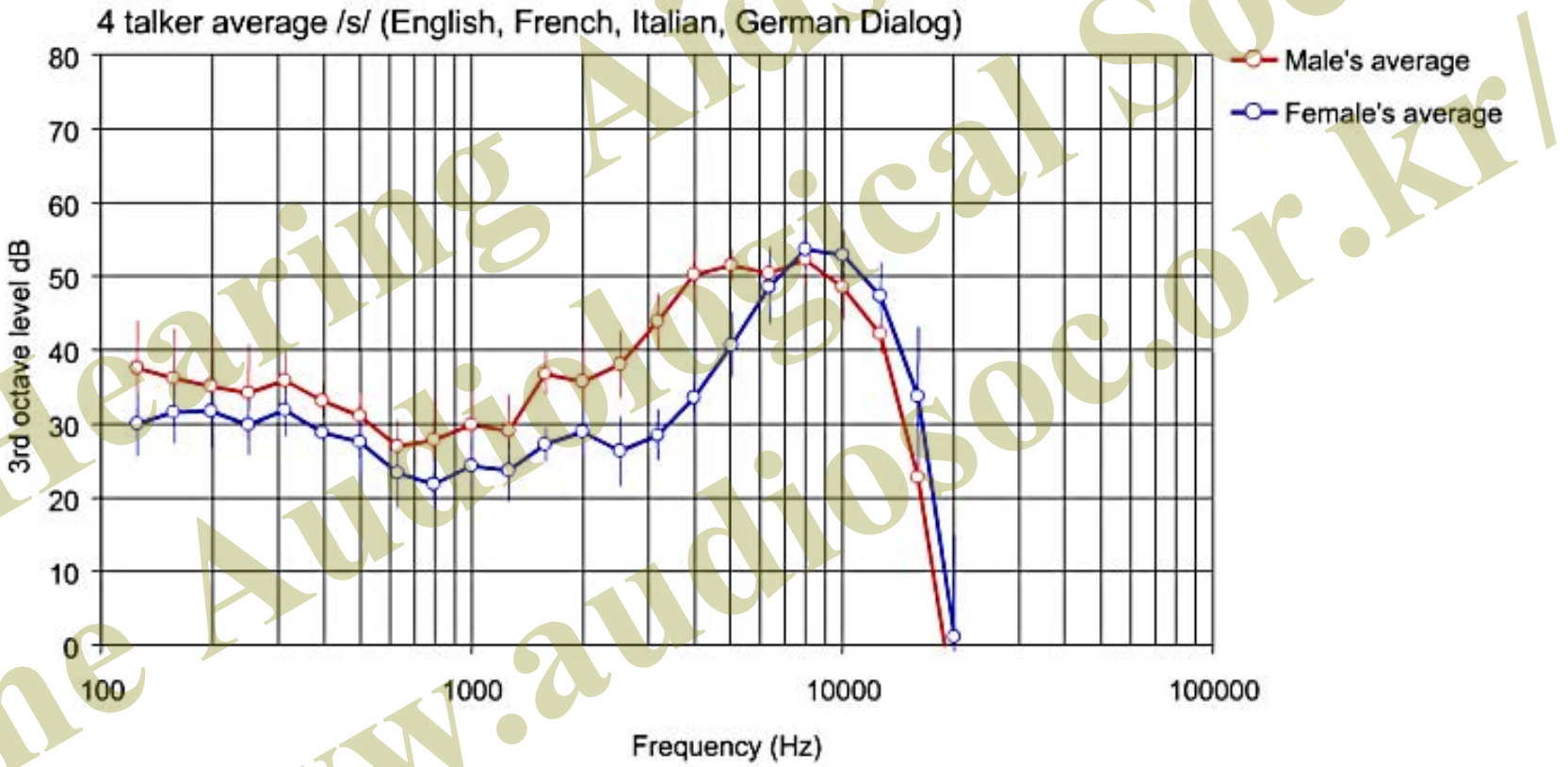
Average /s/



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Children Need

- Higher signal-to-noise ratio (Hall et al, 2002)
- Lower reverberation times (Neuman et al, 1983)
- Less able to make use of context (Nittrouer & Boothroyd, 1990)
- Depend more on audibility of high frequency amplification
- High frequency audibility to develop proper speech and language skills (Stelmachowicz et al, 2002)

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- Access to high frequencies
- FM/Remote control
- Feedback cancellation
- Digital noise reduction
- Multiple bands for flexible gain response

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Data Logging

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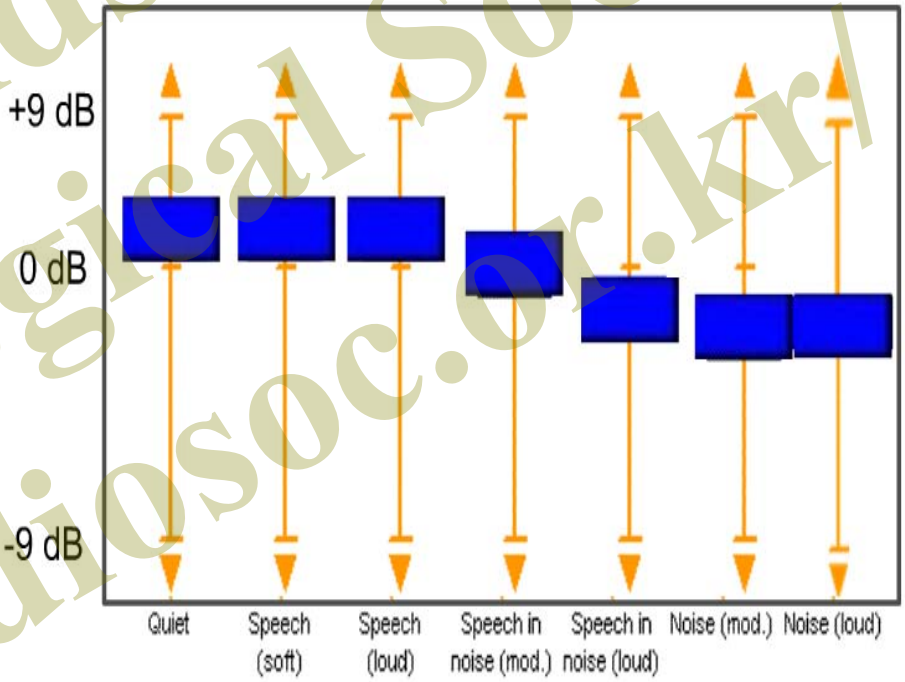
Automatic Program Switching

Classify Setting and Apply Pre-Set Gain

Classify the Environment



User Preferences

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Bluetooth Latency

- TV speaker to ear : 10ms
- Bluetooth(A2DP transmitter) to streamer (3.83 Mhz) to HA: 250 ms
- Today's Bluetooth codec is inefficient and would result in delays of 100 ms or more
- Consumer electronics industry will introduce a more efficient codec for TV transmission

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HA Selection in Adults

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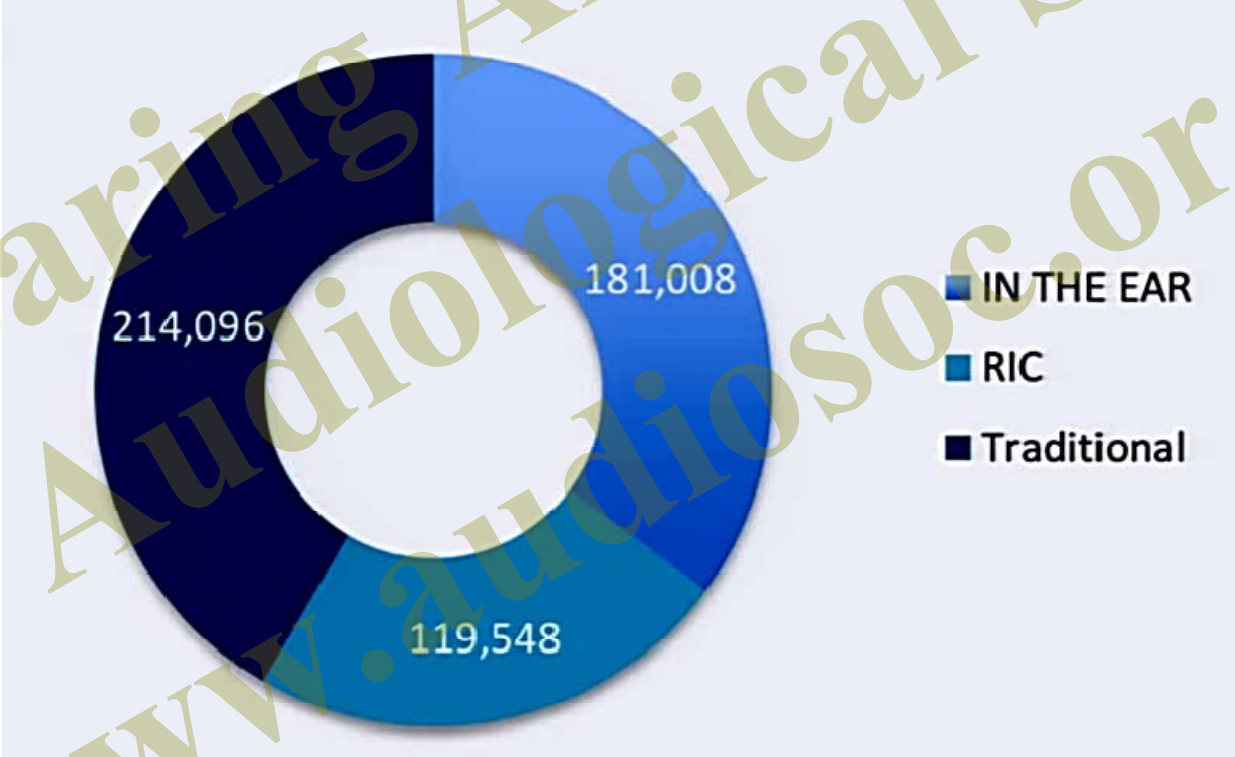
Which technologies make the biggest difference?

- Open fit "receiver in the canal(RIC)" BTE device



2009 US commercial trends

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Receivers in the Canal (RIC)
= Open Canal (OC) Fitting
= Open Fitting

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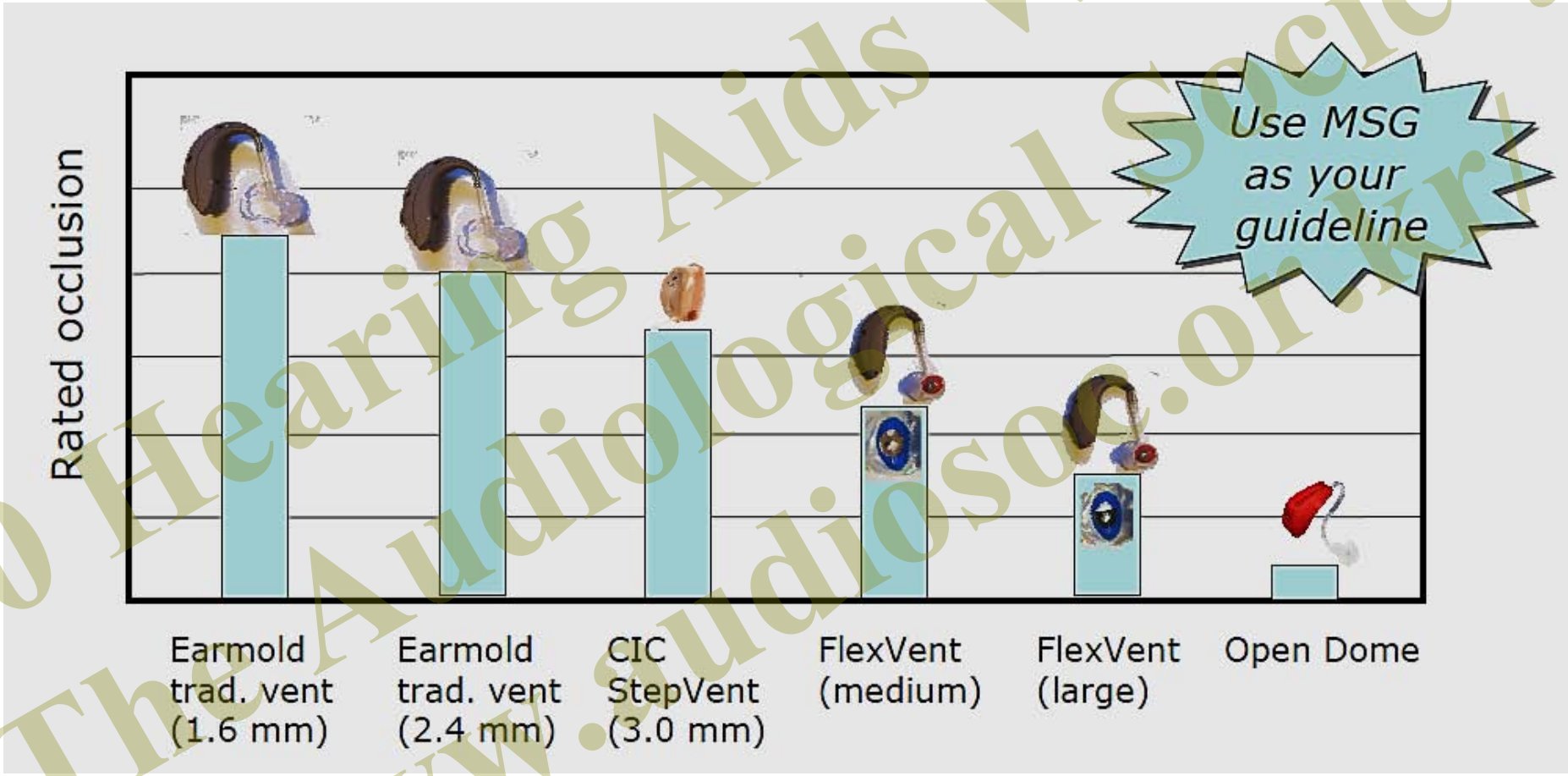
Occlusion Decreases with Open Solutions



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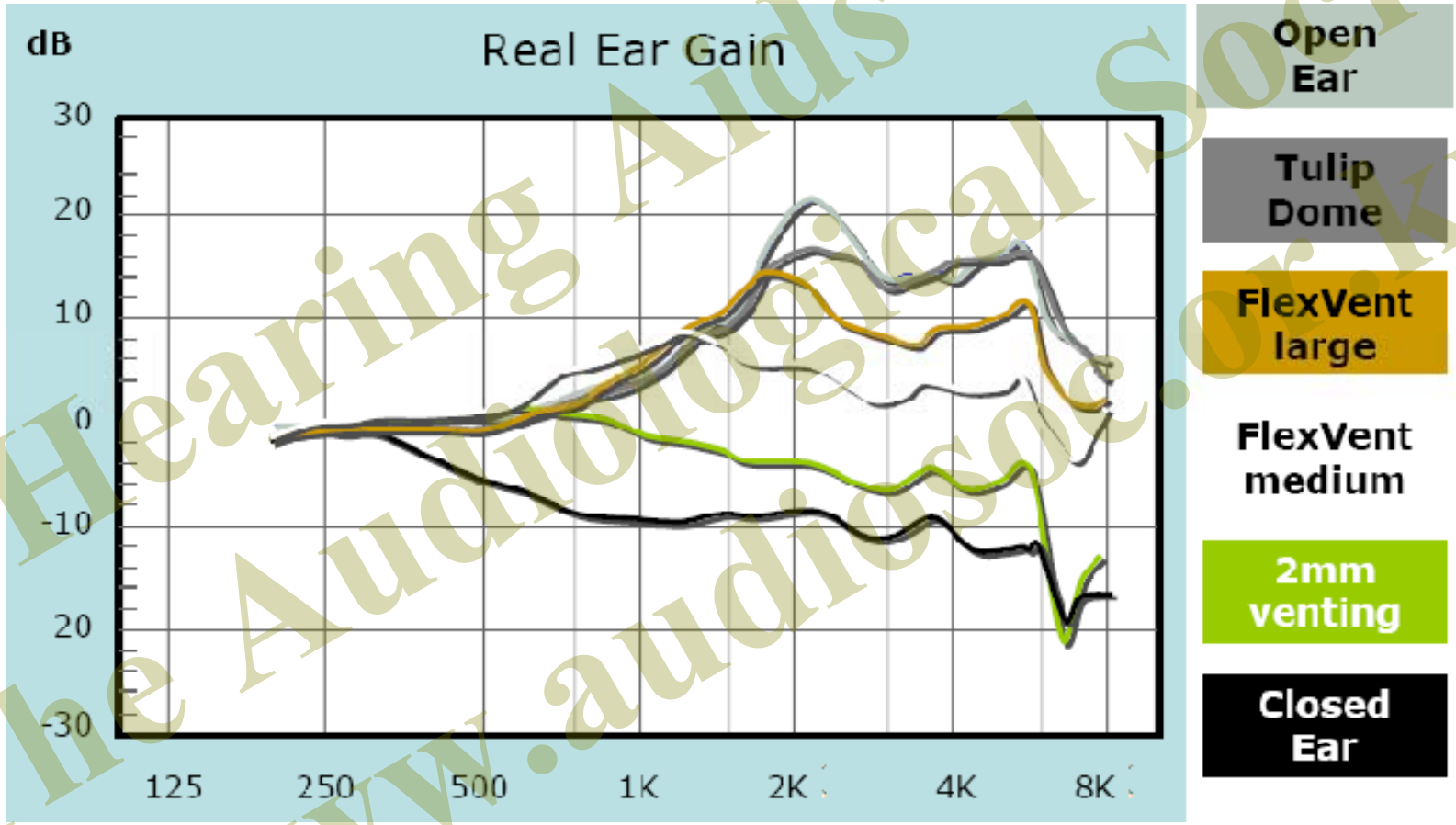
Open Ear Resonse



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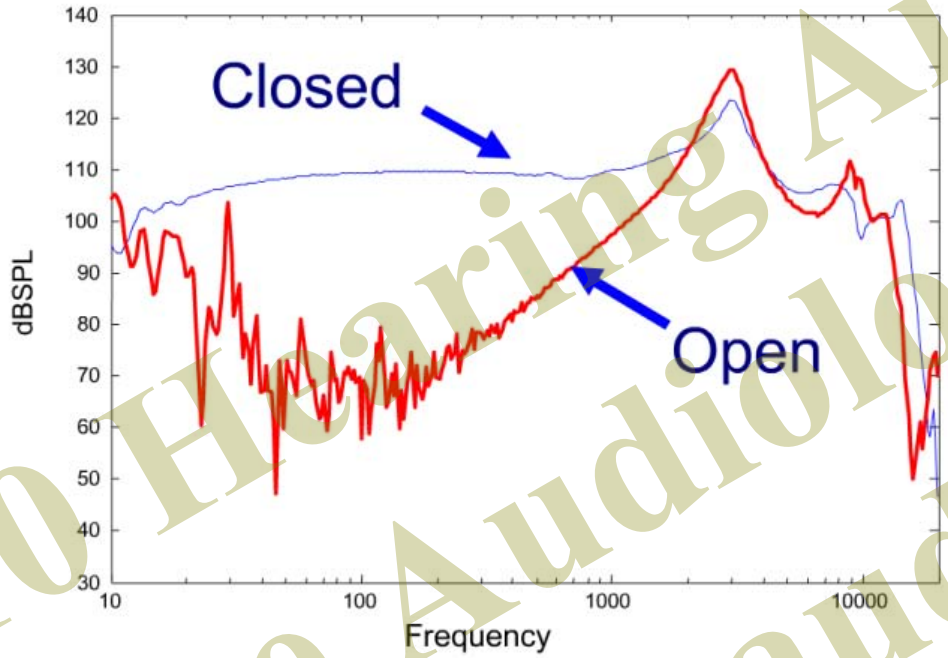
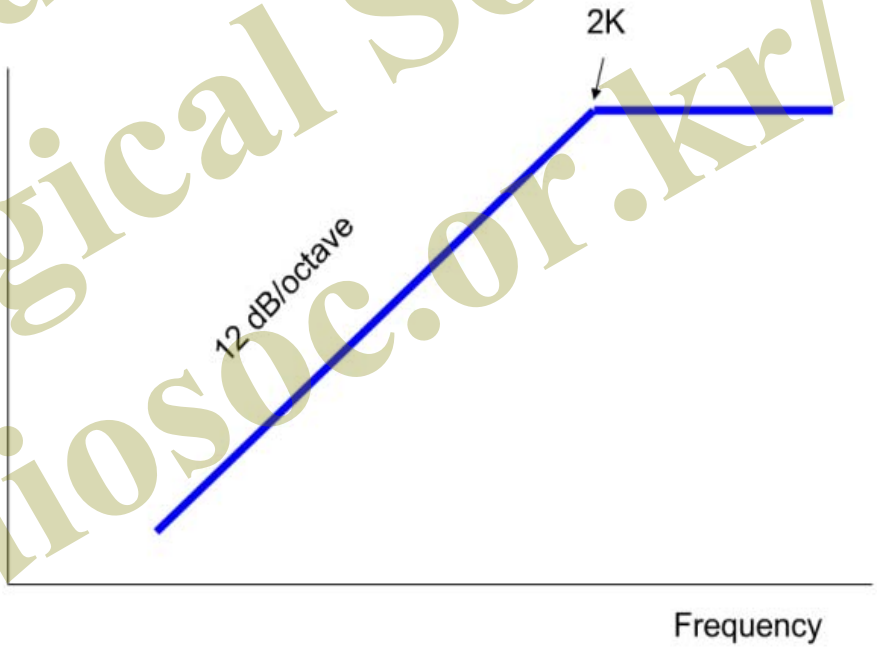
Output – Open vs Closed





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Open Fitting Candidacy

Audiometric criteria

- Low frequency thresholds better than 40 dB HL
- Unusual audiometric configurations with areas of normal hearing (e.g. reverse slope, cookie bite)

Otologic considerations

- TM perforations, chronic EOM, outer ear malformation, etc

Other considerations

- Preference related to comfort and occlusion
- Sound quality preference
- Cosmetics

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OC Fittings: Benefits

- Alleviate occlusion
- Improved sound quality due to use of natural low frequency signal
- Comfortable fit
- Improved cosmetics compared to many styles

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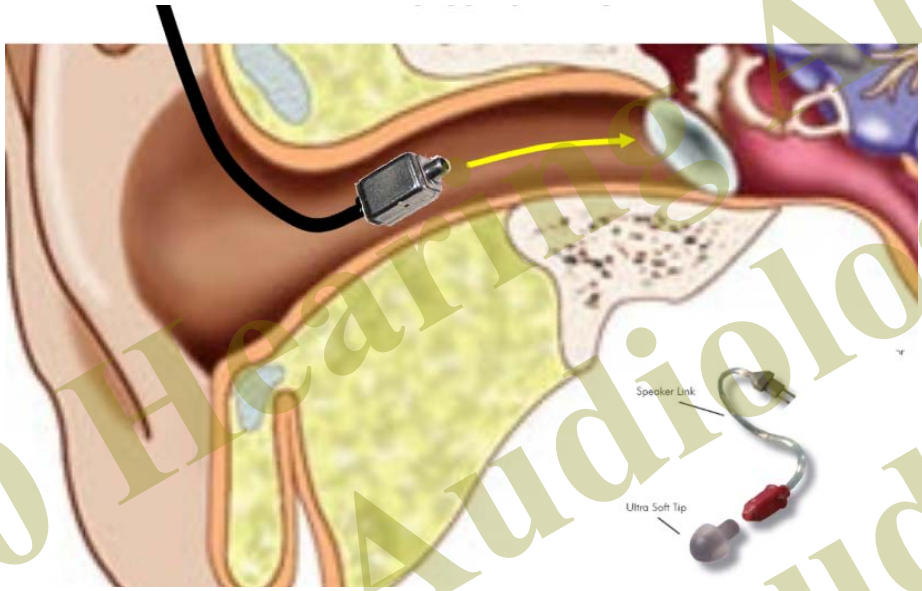
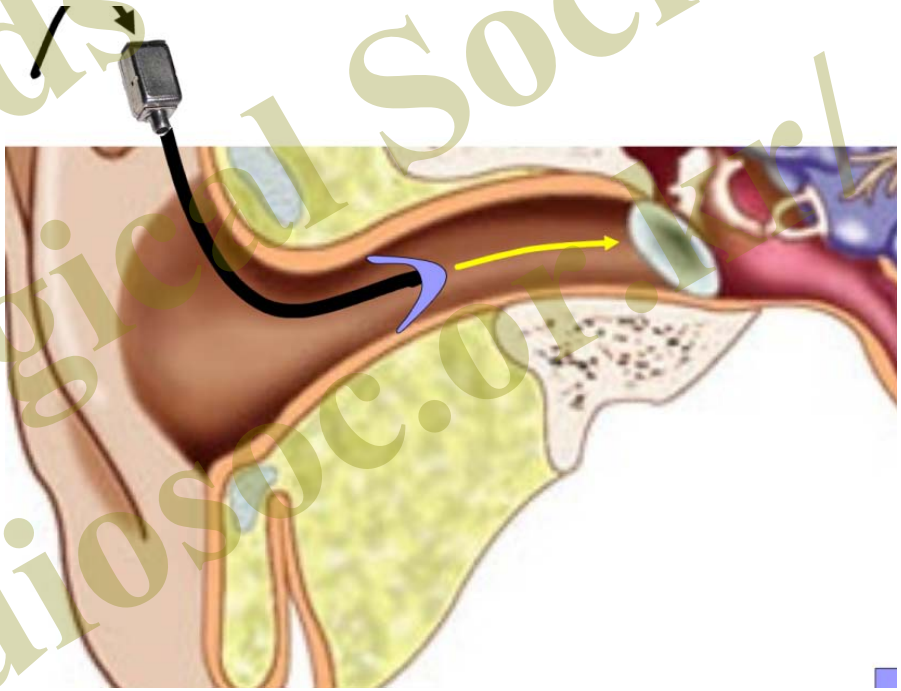
RIC vs Thin Tube





Trivia: Thin tube is 0.8mm diameter, and a #13 tube is 1.98mm

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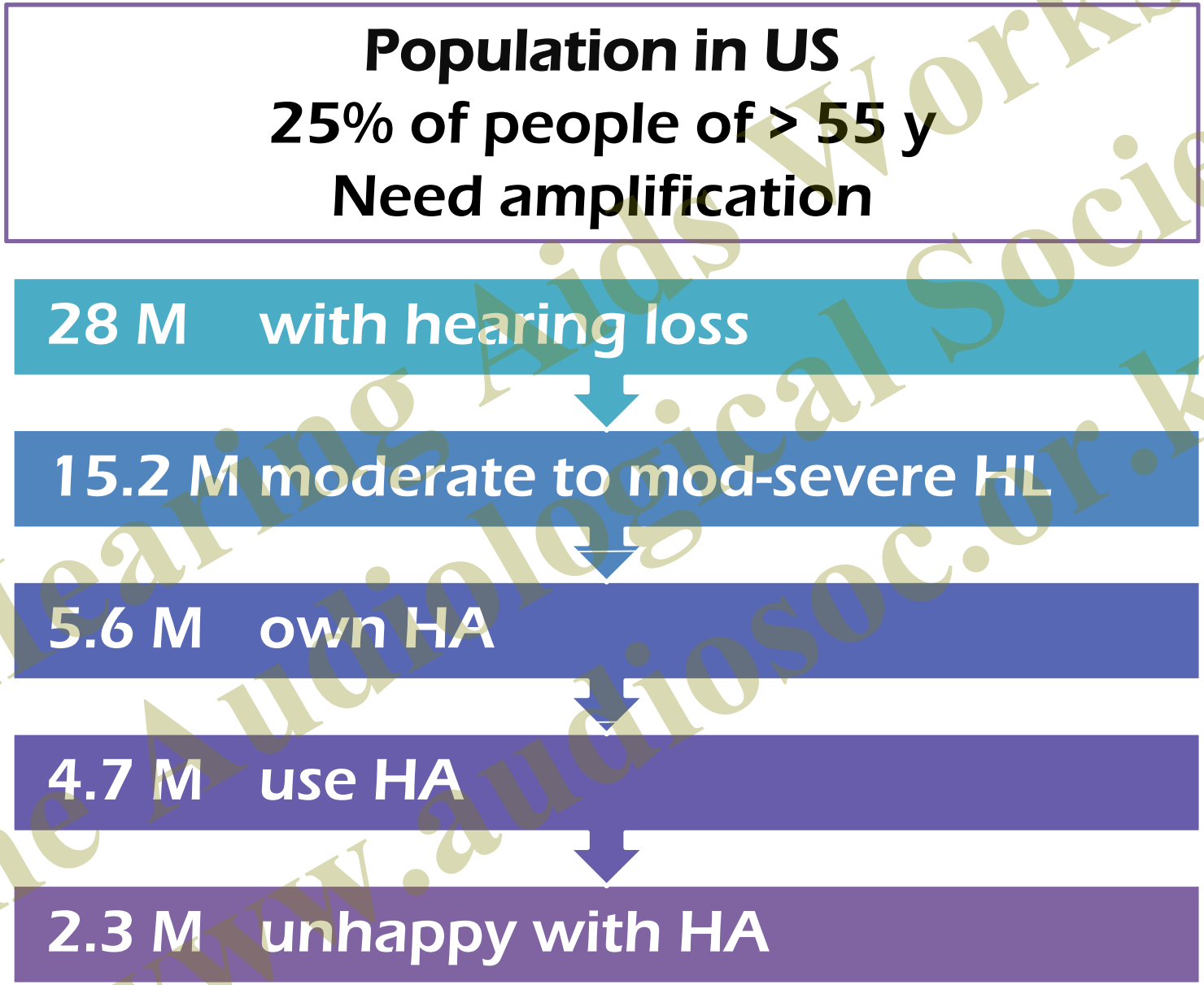

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Absolute Expectations

- Functional on a daily basis
- Feedback free under normal use conditions
- Physically comfortable to wear
- Ability to hear soft and conversational levels of speech in quiet environments.
- Comfortable to wear in louder, noisier environments.

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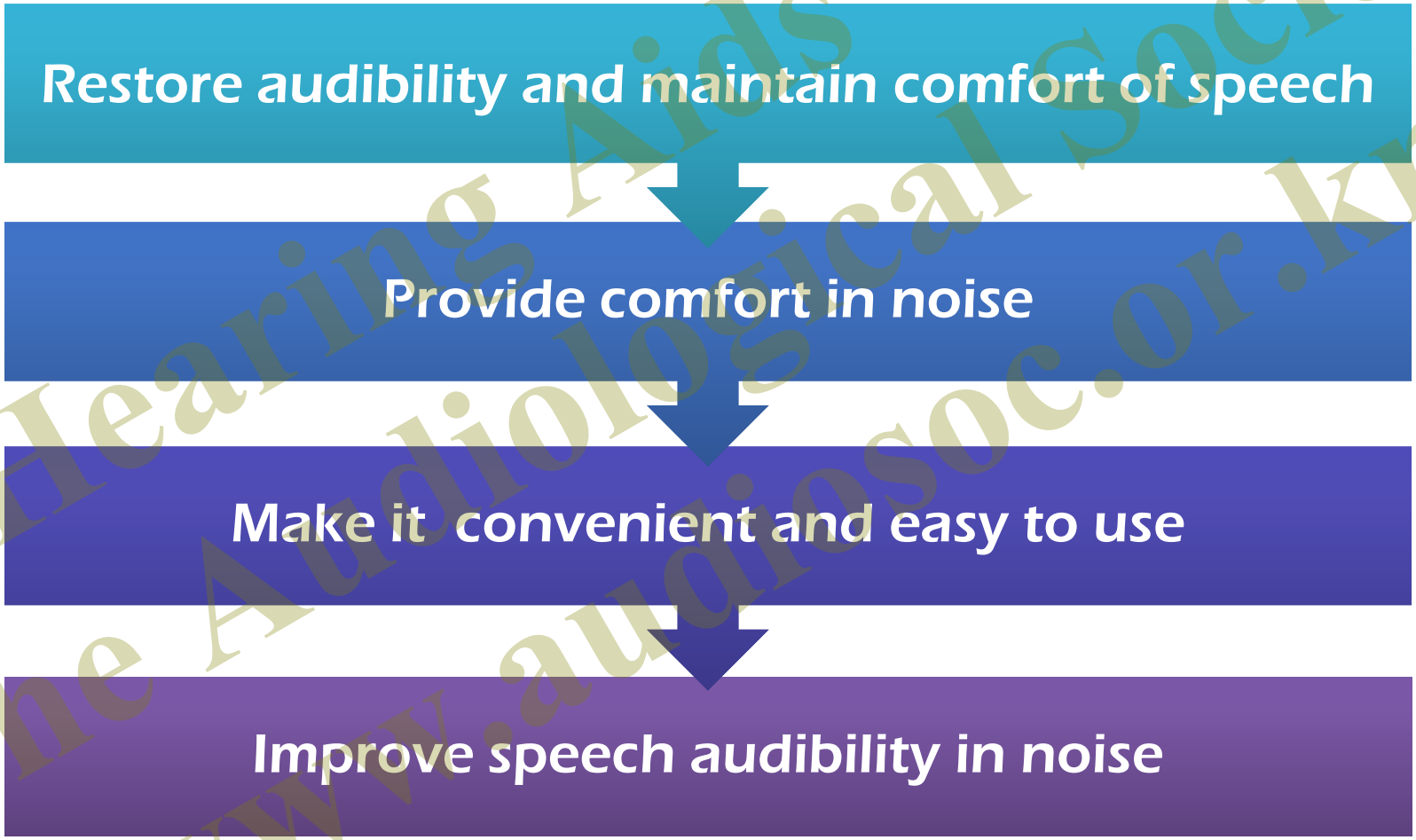
What we do on the day of fitting



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Basic Goal of Fitting

- Amplify soft sounds to compensate for hearing loss
  - 1/3 gain for mild to moderate
  - ½ gain for moderate to severe
- Prevent loud sounds from becoming uncomfortable
  - Too loud will prevent someone from being able to wear devices
- Need to verify through
  - Direct measurement: Real-ear is direct
  - Indirect measurement: Performance or questionnaire is indirect

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Fitting Rationales

- Why would someone want something different?

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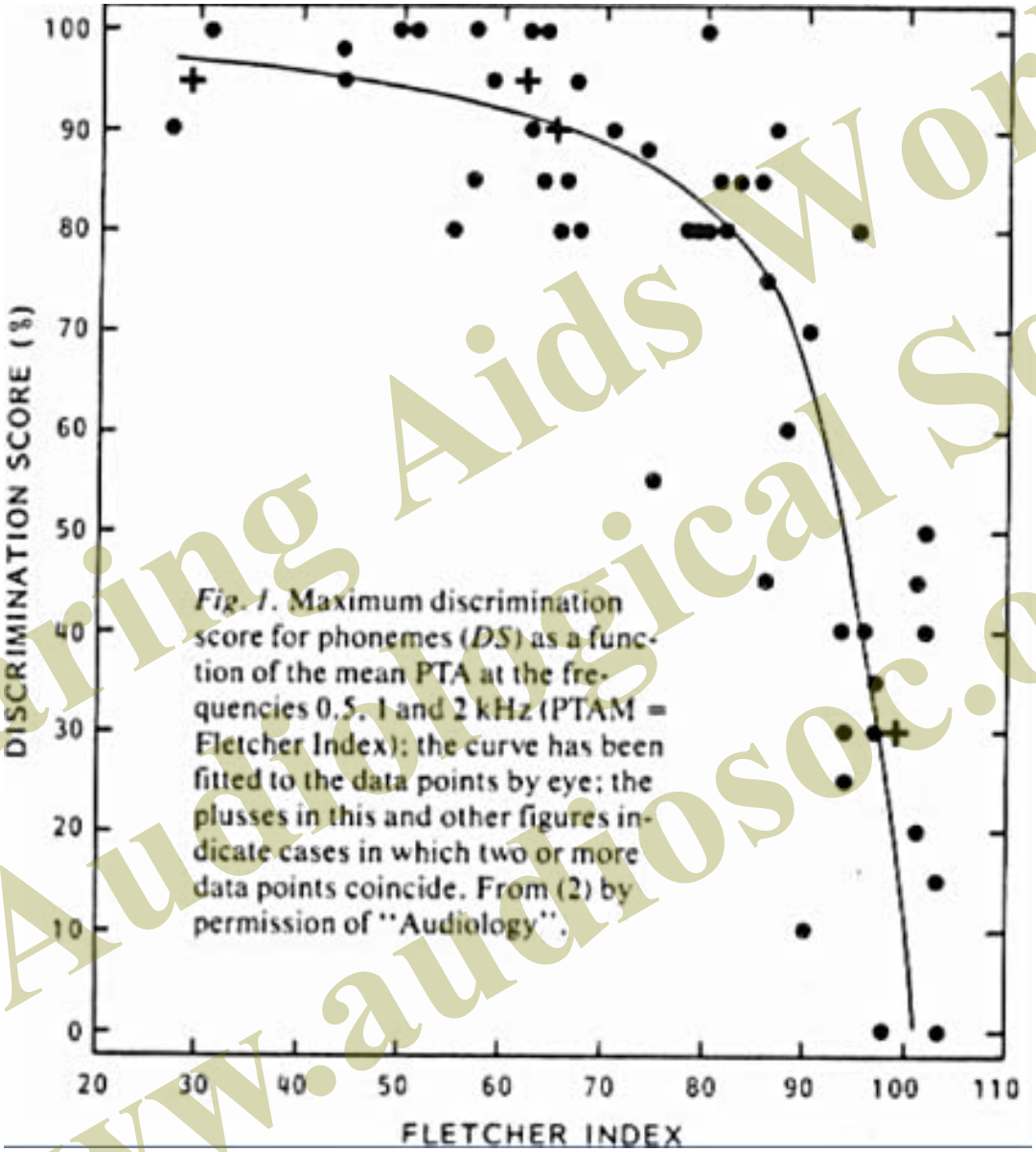

Maximum speech discrimination as a function of average hearing loss (Lamore,Verweij & Brocaar, 1990)

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Individual Differences in . . .

- Spectral Preference
- Loudness/Audibility Trade Off
- Loudness Perception
- Adaptation Process
- Signal of Interest
- Psychoacoustic Integrity
- Cognitive Processing

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Things Know before HA Fitting

- Hearing thresholds for pure tones
- Ability to understand speech in quiet and noise
- Patient's "acceptance" of background noise
- Loudness discomfort levels
- Cognitive function
- Expectations
- Motivation to use hearing aids

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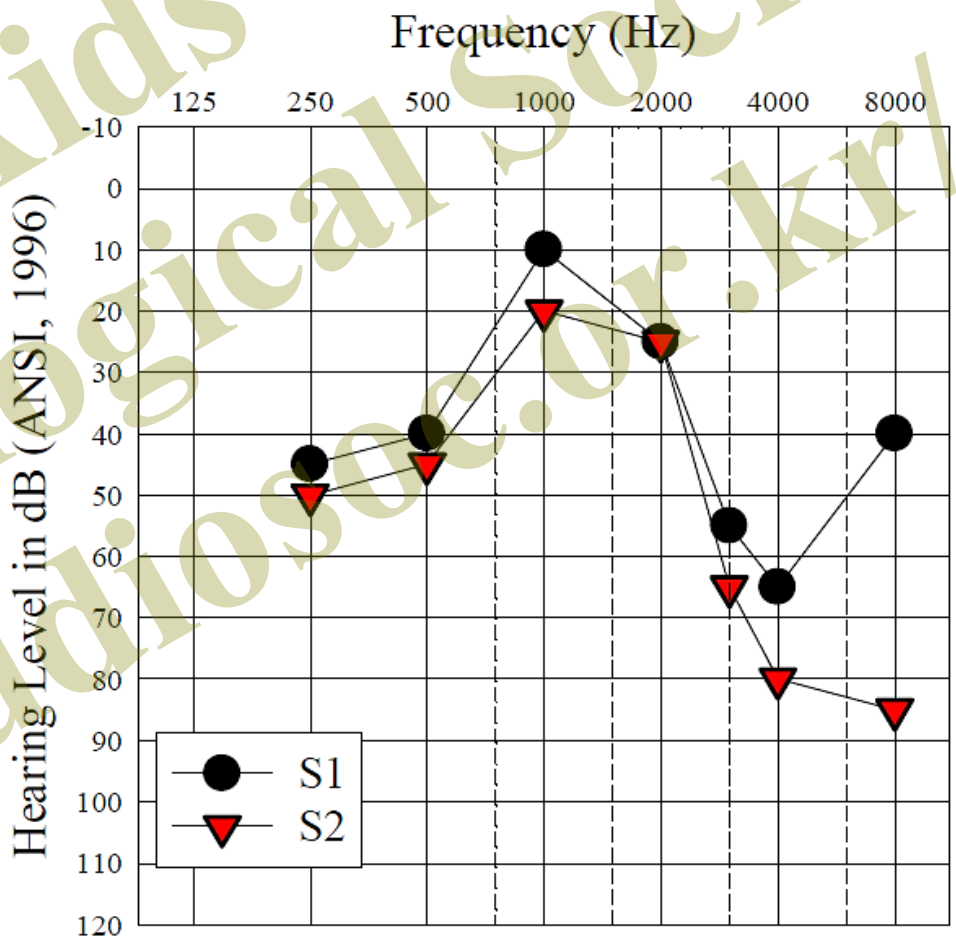
Similar audios don't always mean similar cochlear function (or understanding)

- S1 (circles) word rec = 92%
- S2 (triangles) word rec = 42%



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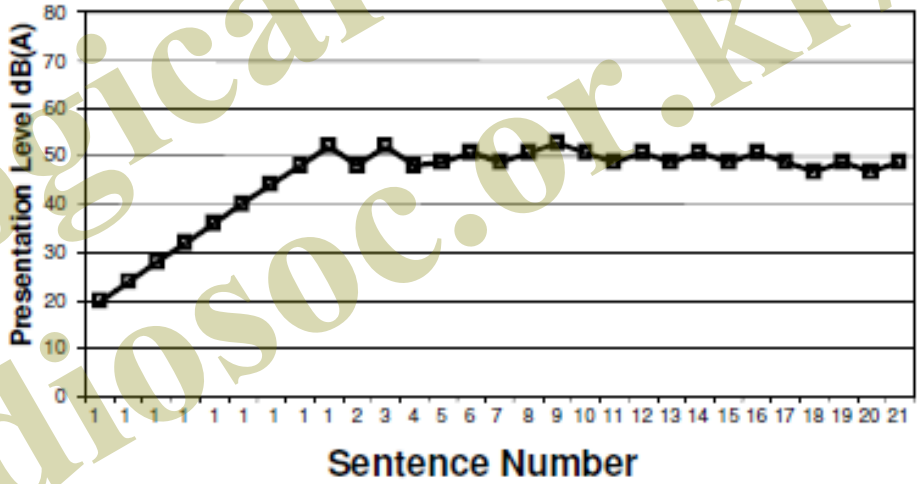
HINT Threshold

- There are 12, 20-sentence lists of short simple sentences.
- Step-size for 1st 4 sentences is 4 dB
- Step-size for the rest of sentences is 2 dB
- Reception Threshold for Sentences (RTS) is computed for sentences 5 to 21



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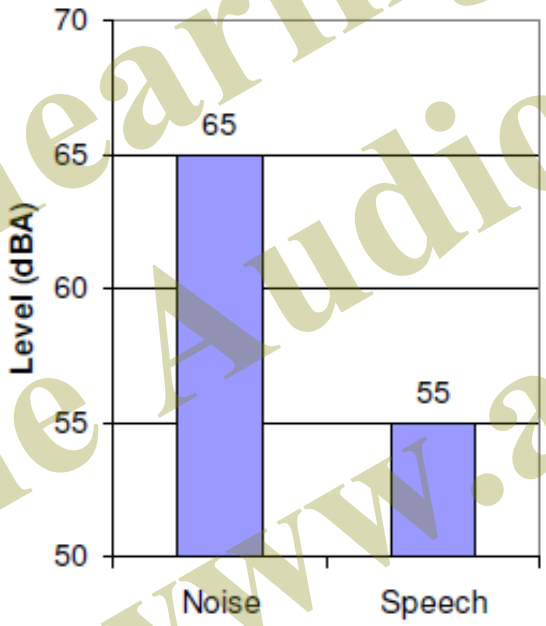
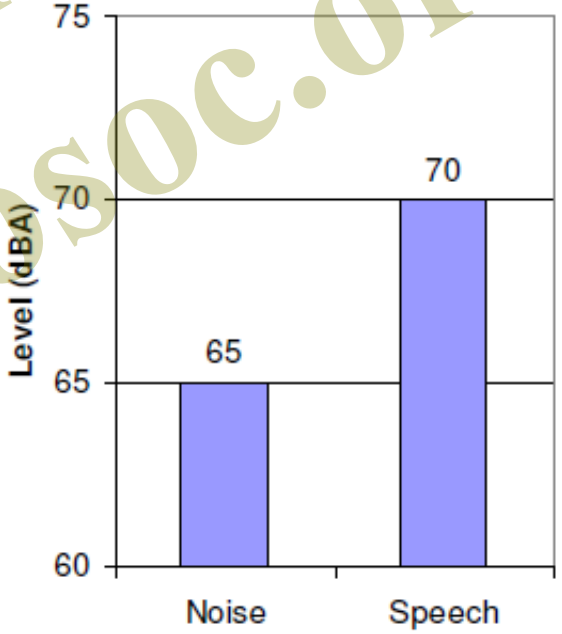
Calculating SNR in HINT

$$\frac{\text{Level of Speech} - \text{Level of Noise}}{\text{Signal-to-Noise Ratio}}$$



-10 dB SNR



5 dB SNR

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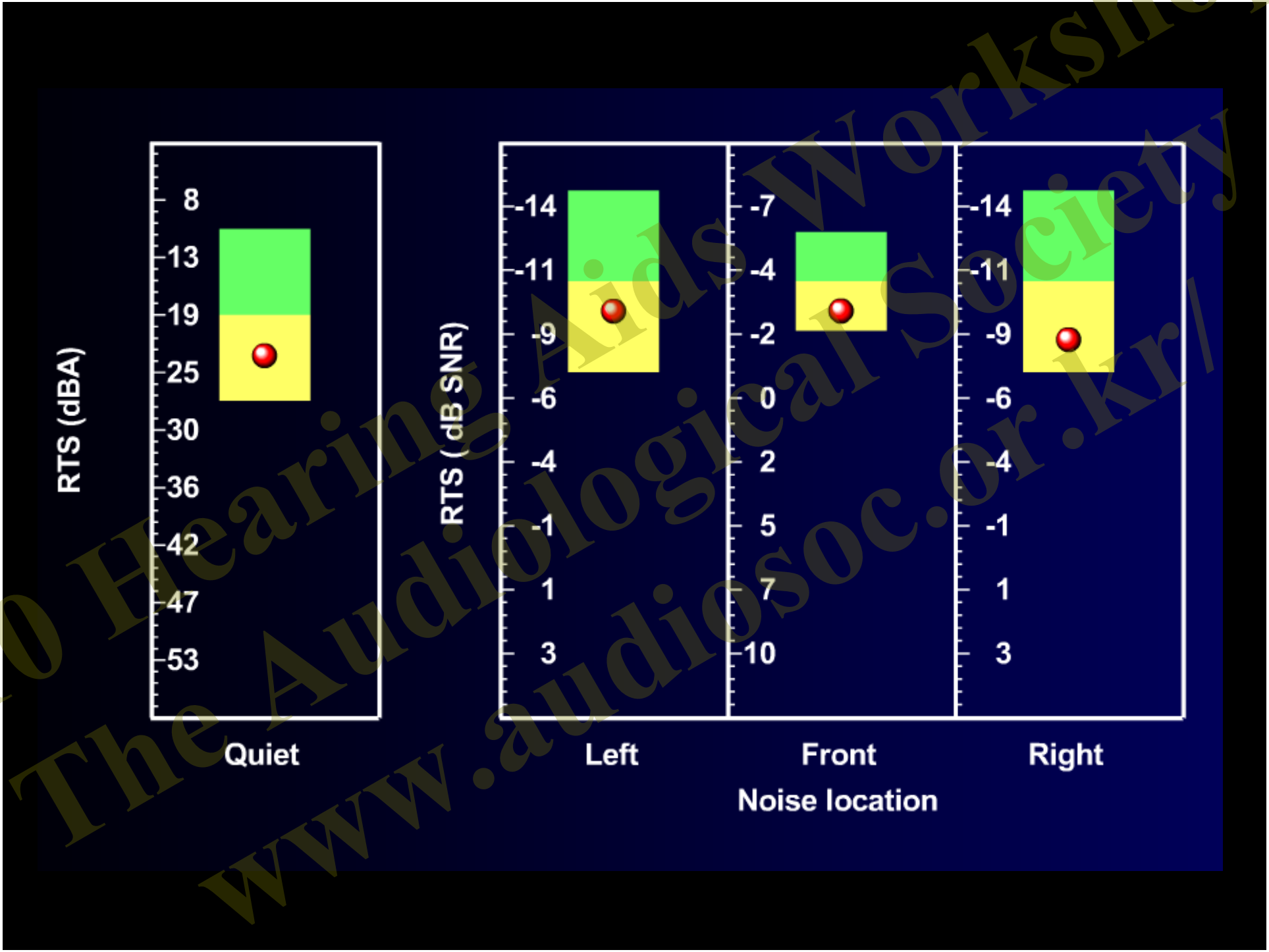

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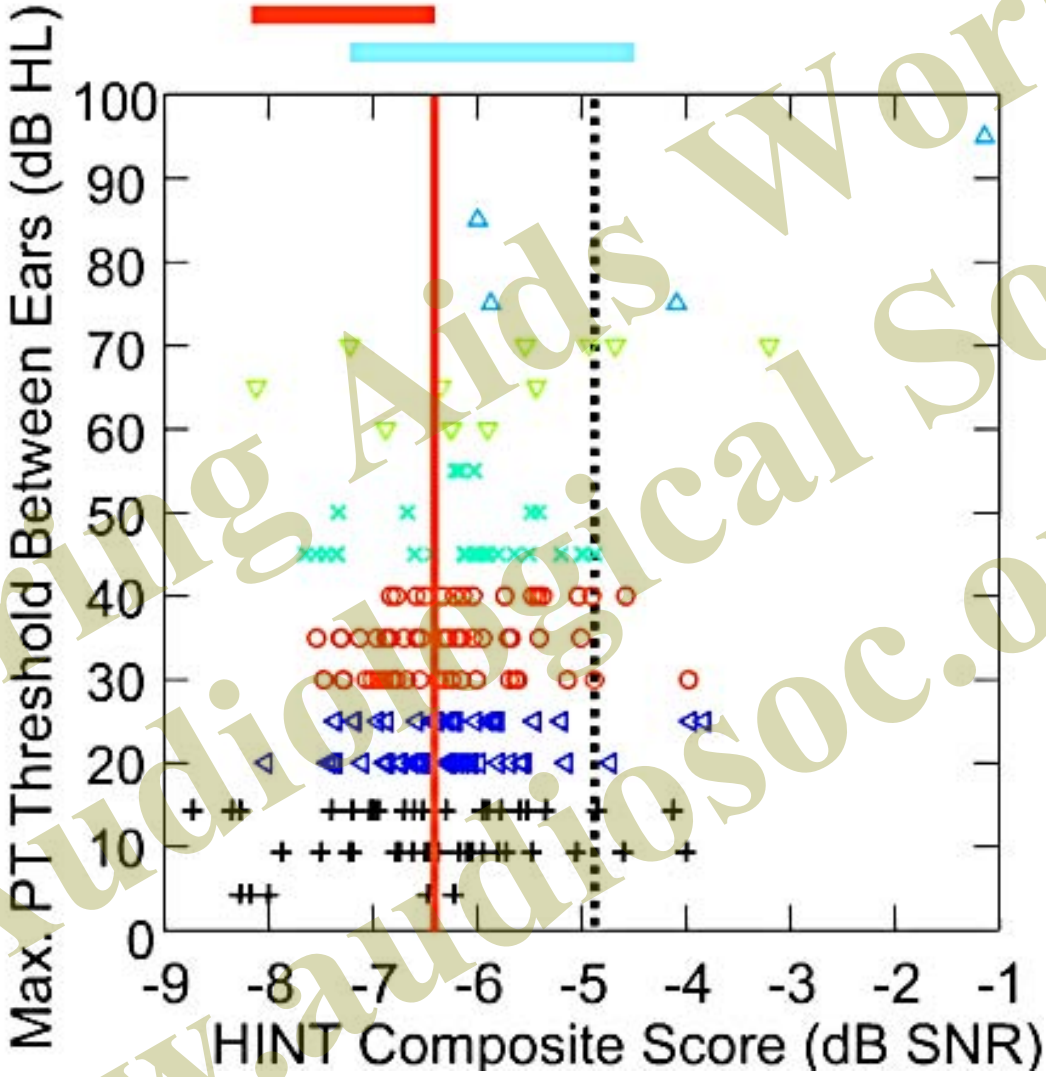

- HINT composite noise scores (n=215). Groups sorted by maximum pure tone thresholds for illustration.

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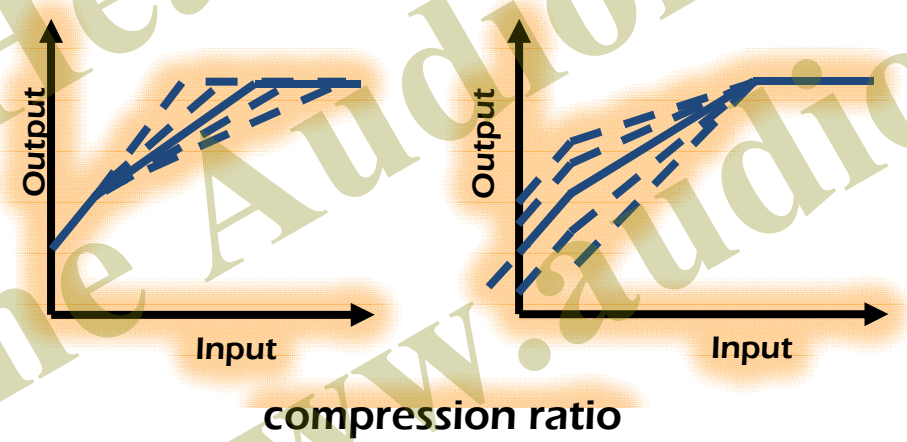
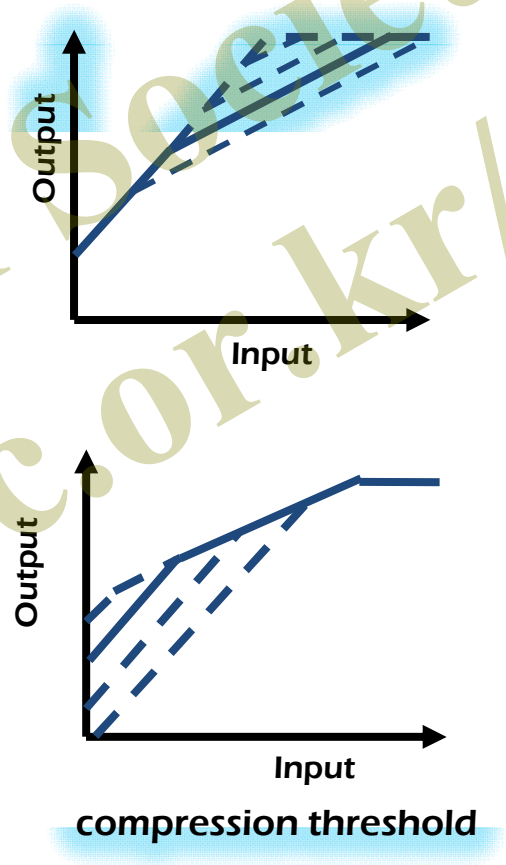
- Overall gain (VCW)
- Channel gain
- Time constants
- Frequency response shape
- Amount of compression



compression ratio



compression threshold

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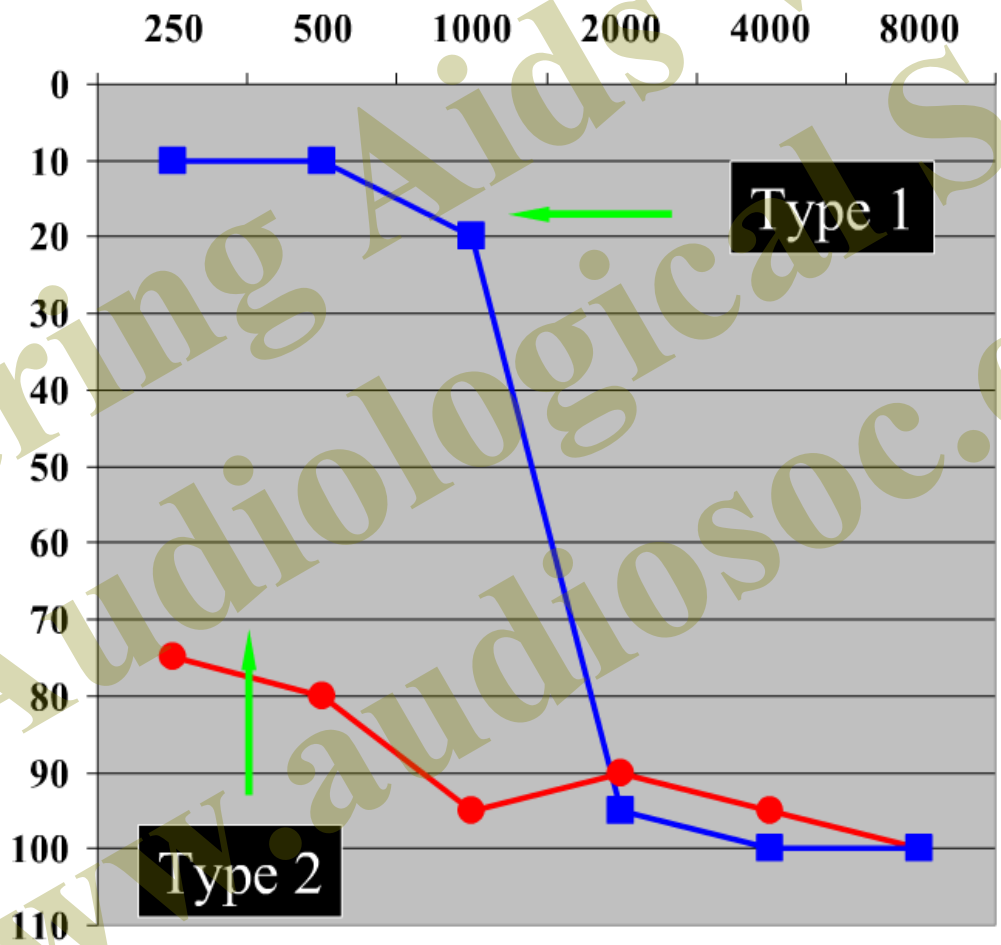
What Do We Mean by Severe/Profound SNHL?



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Nature of Severe/Profound SNHL

- Inter-patient variability goes up for greater hearing losses
- The greater the damage, the more variable
  - Not just Outer Hair Cell loss, but
    - Inner Hair Cell loss ("Dead Zones")
    - Membrane disruptions
    - Neural cell death
    - Mechanical & metabolic disruptions
    - Disrupted coordination

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In severe SNHL, what need to consider?

- Is a hearing aid effective?
- What are the optimal CRs and frequency response?
- What about frequency transposition devices?
- Do they have a cochlear dead region?
- Will the dead region effect the fitting?

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Unique Characteristics of Profound/Severe HL

- Elevated thresholds
- Very restricted dynamic range
- Distortion – poor scores on speech in noise testing (poor frequency resolution)

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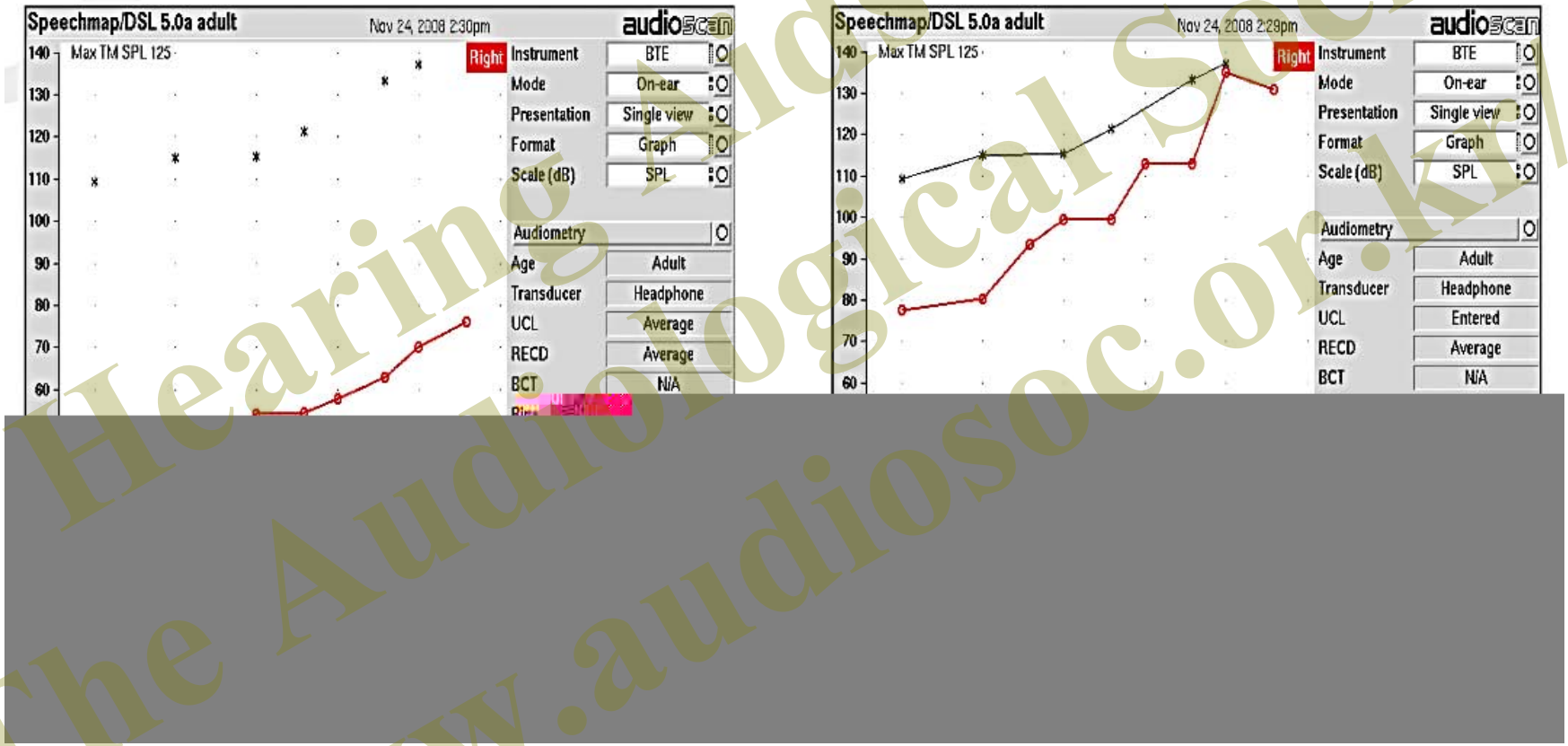
Restricted Dynamic Range



Mild Hearing Loss

Severe Hearing Loss

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Dead Regions and Hearing Aids

- Sounds arriving at Dead Region are not audible
- Amplification in DR may sound distorted
- Limited Dynamic Range

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- Ski Slope Hearing Loss
- Severe SNHL
- Low Frequency SNHL

*Special Fitting Populations

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Ski Slope Hearing Loss

- Key Research Findings
  - Beyond moderate SNHL in HF, improved audibility may not always improve speech understanding
  - At times, attempts at full audibility may decrease speech understanding

Ching et al. (1998)/Hogan & Turner (1998)

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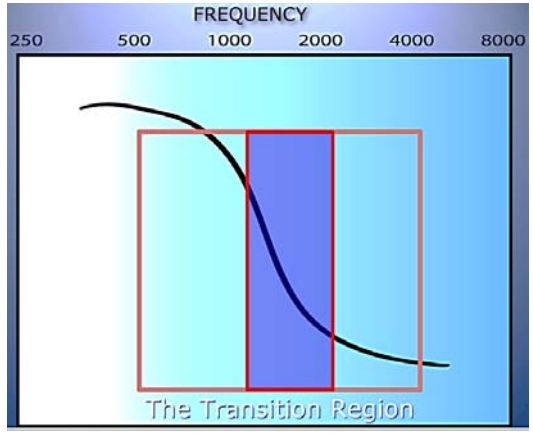
Goal of SKI fittings

- Maintain comfort
- Maintain acceptable sound quality in quiet
  - no dramatic frequency responses
  - vented fitting
- Modest audibility enhancement
  - focused on transition region
  - will be appreciated in quiet
  - may be quite helpful in noise



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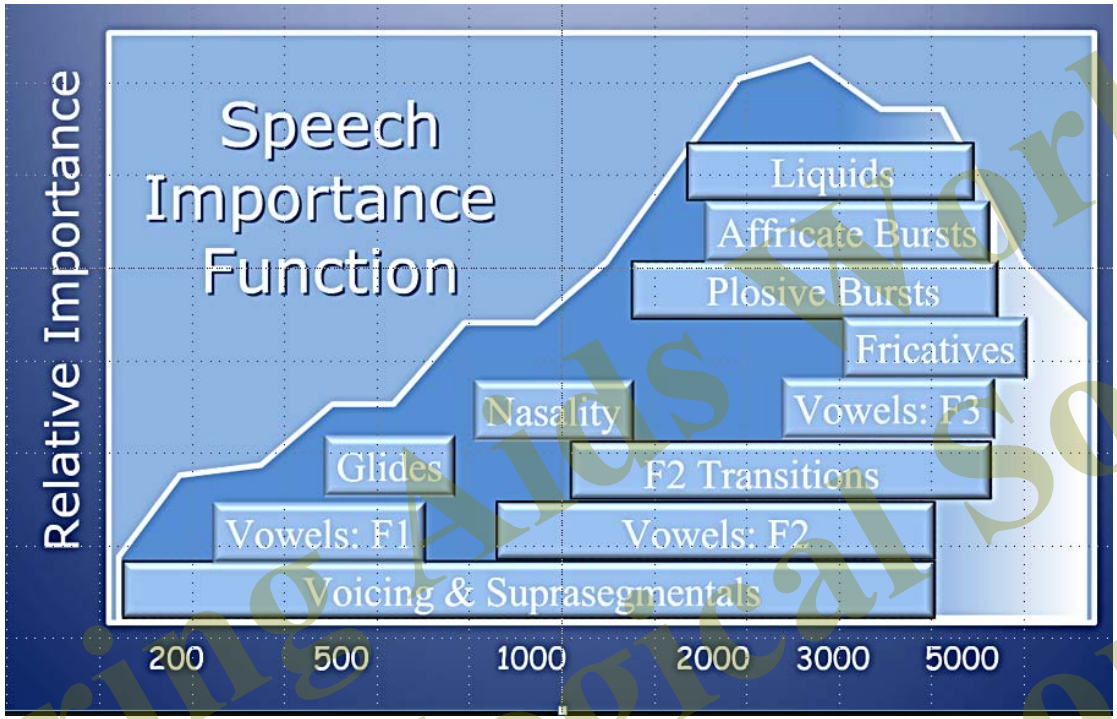
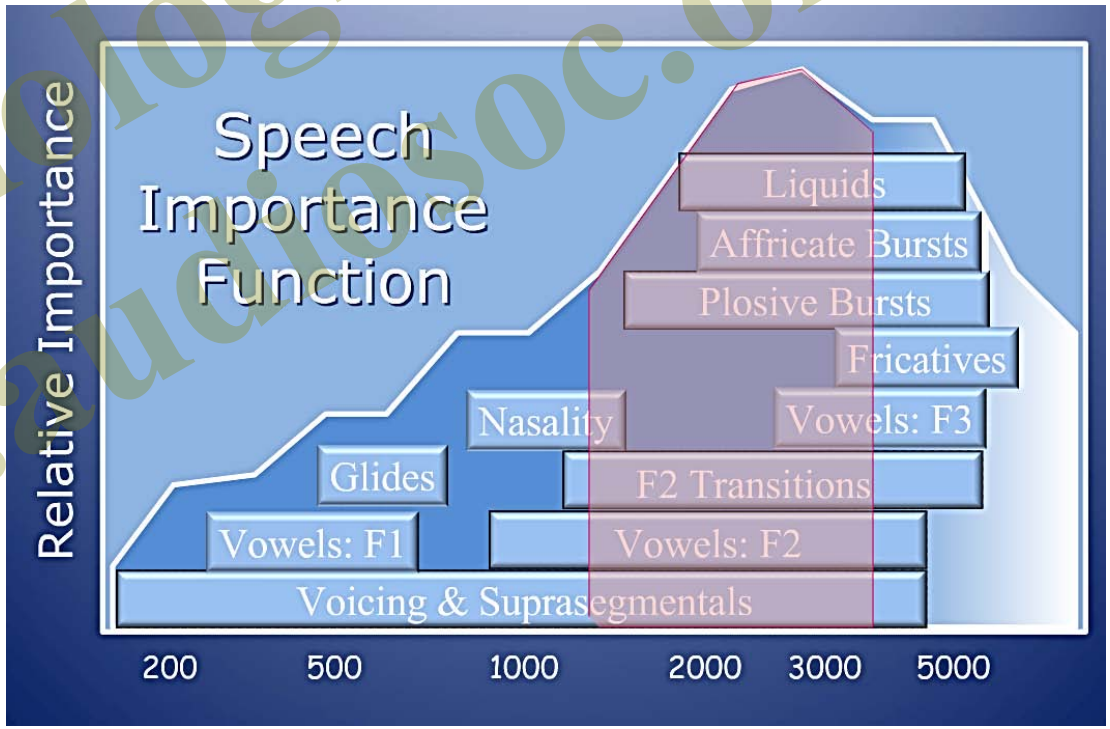


Transition Region



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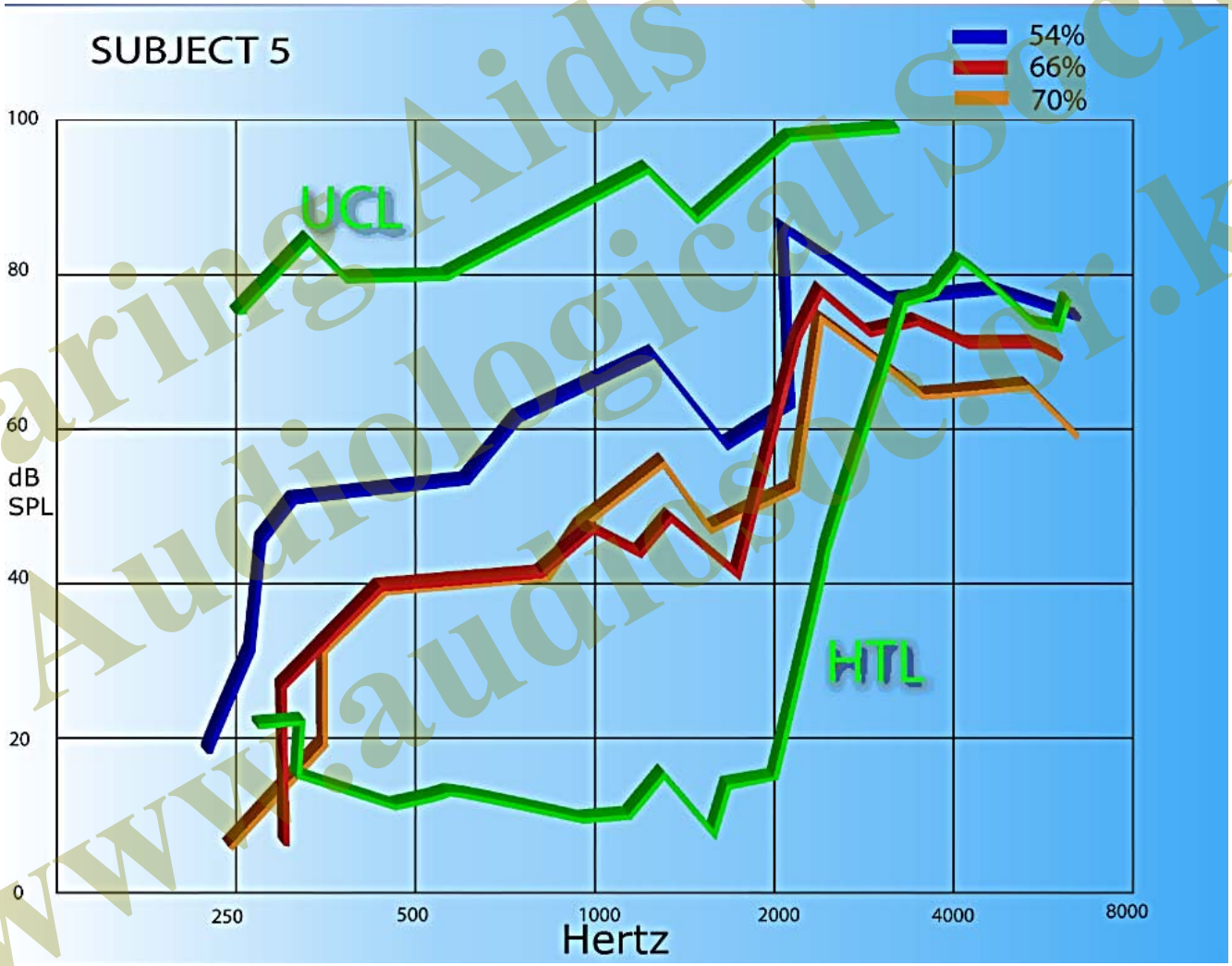
Aided Speech Spectra

(Skinner, 1980)



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Hearing Aids in Ski

- Even the most aggressive prescriptive fitting formula do not recommend more than 25 dB gain in HFs.
- Improving HF audibility from 10 to 20 dB increased speech intelligibility by 30% on average. (Ching, et al, 2001).
- Listeners with severe hearing loss have tremendous variability on speech intelligibility scores

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- Ski Slope Hearing Loss
- Severe SNHL
- Low Frequency SNHL

*Special Fitting Populations

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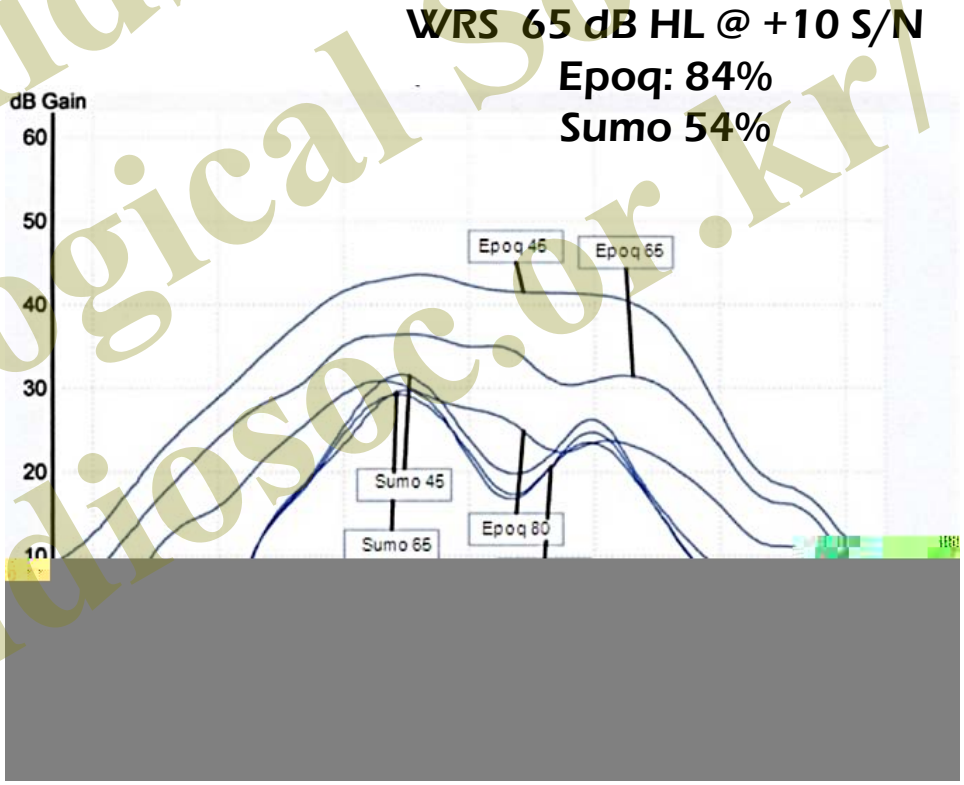
- if there is hearing above 1 kHz.
- . . .must be “power MCNL” approach



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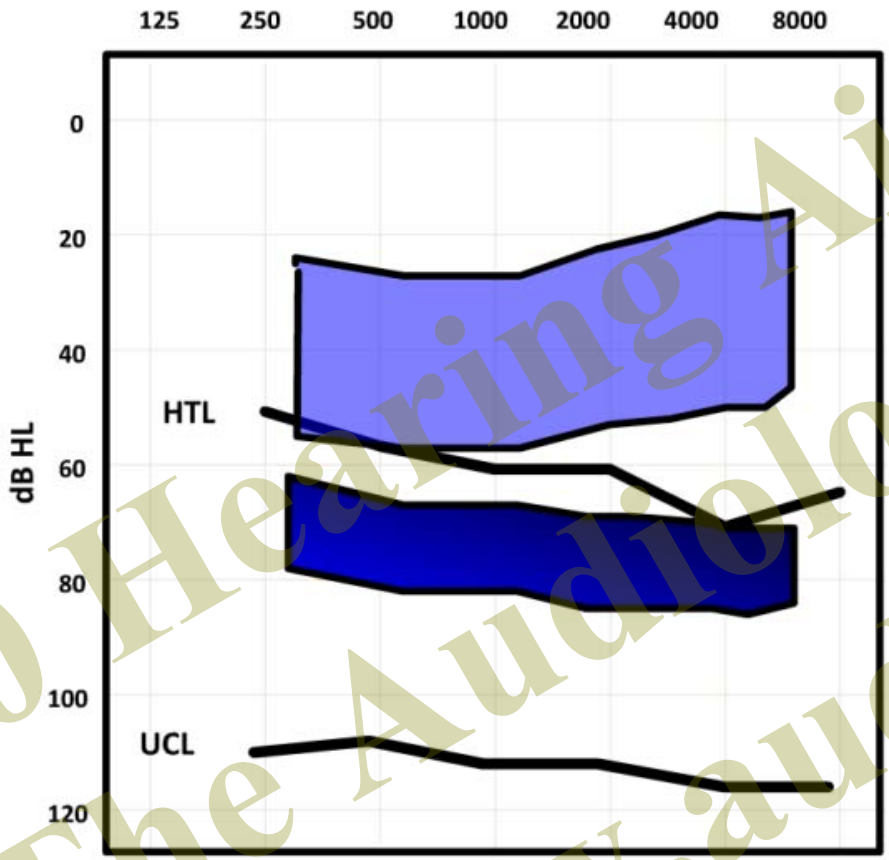
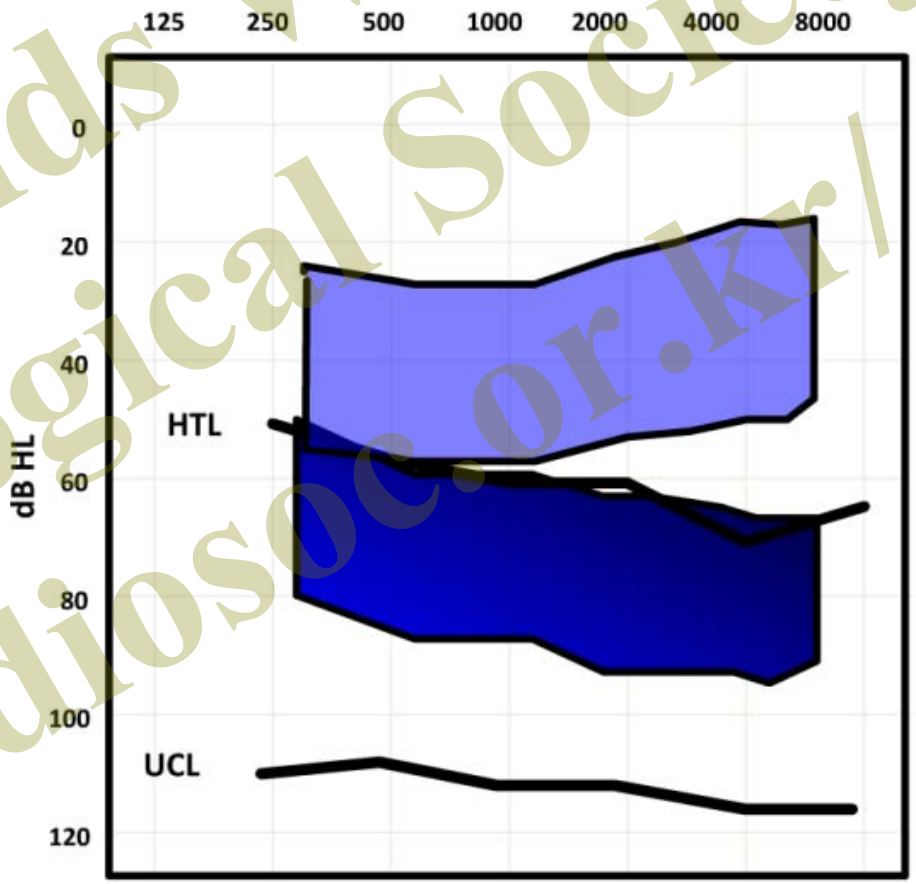
Short Release Time



Long Release Time



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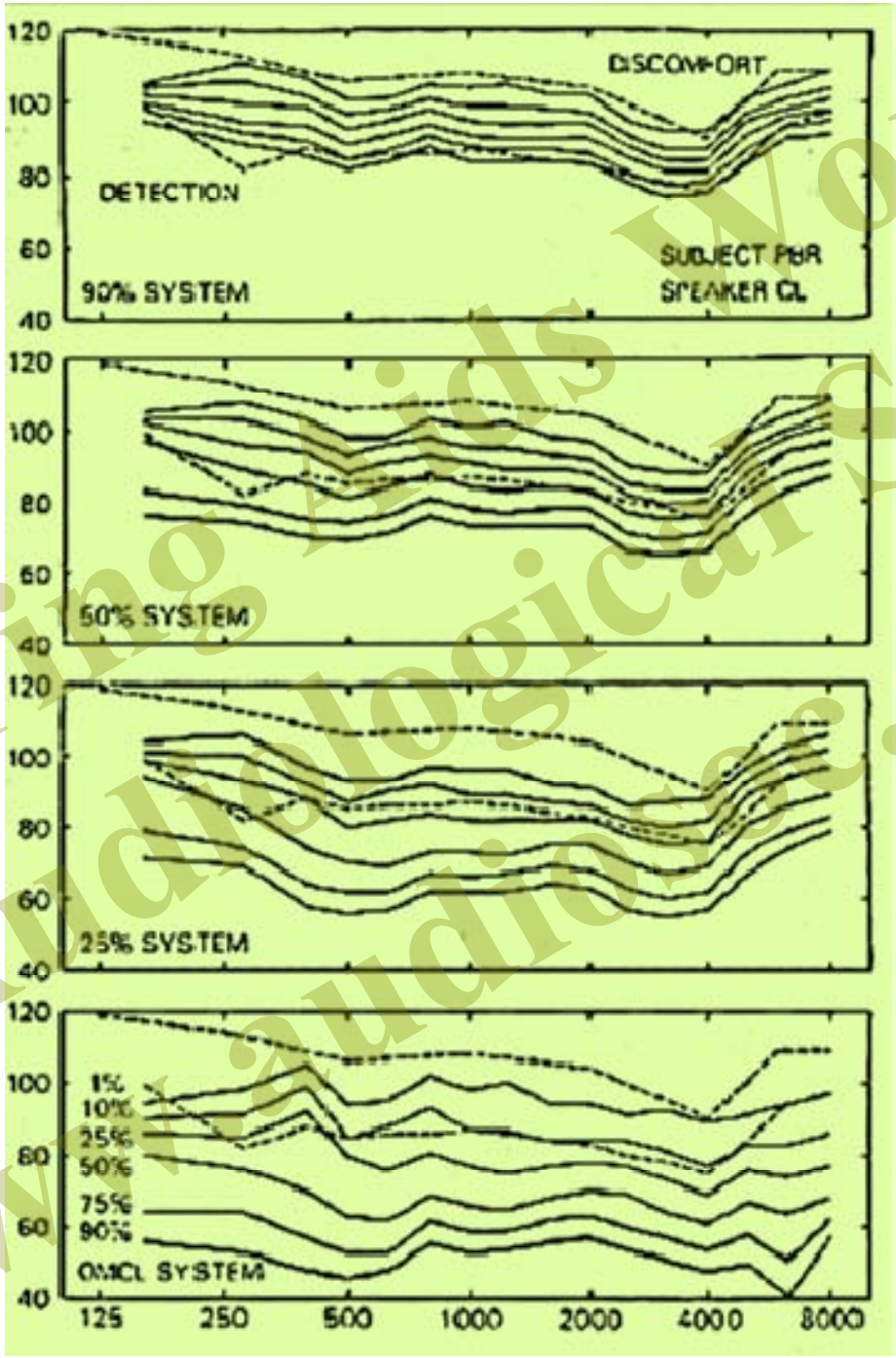
Fast acting compression



(De Gennaro, Braida, Durlach, 1986)

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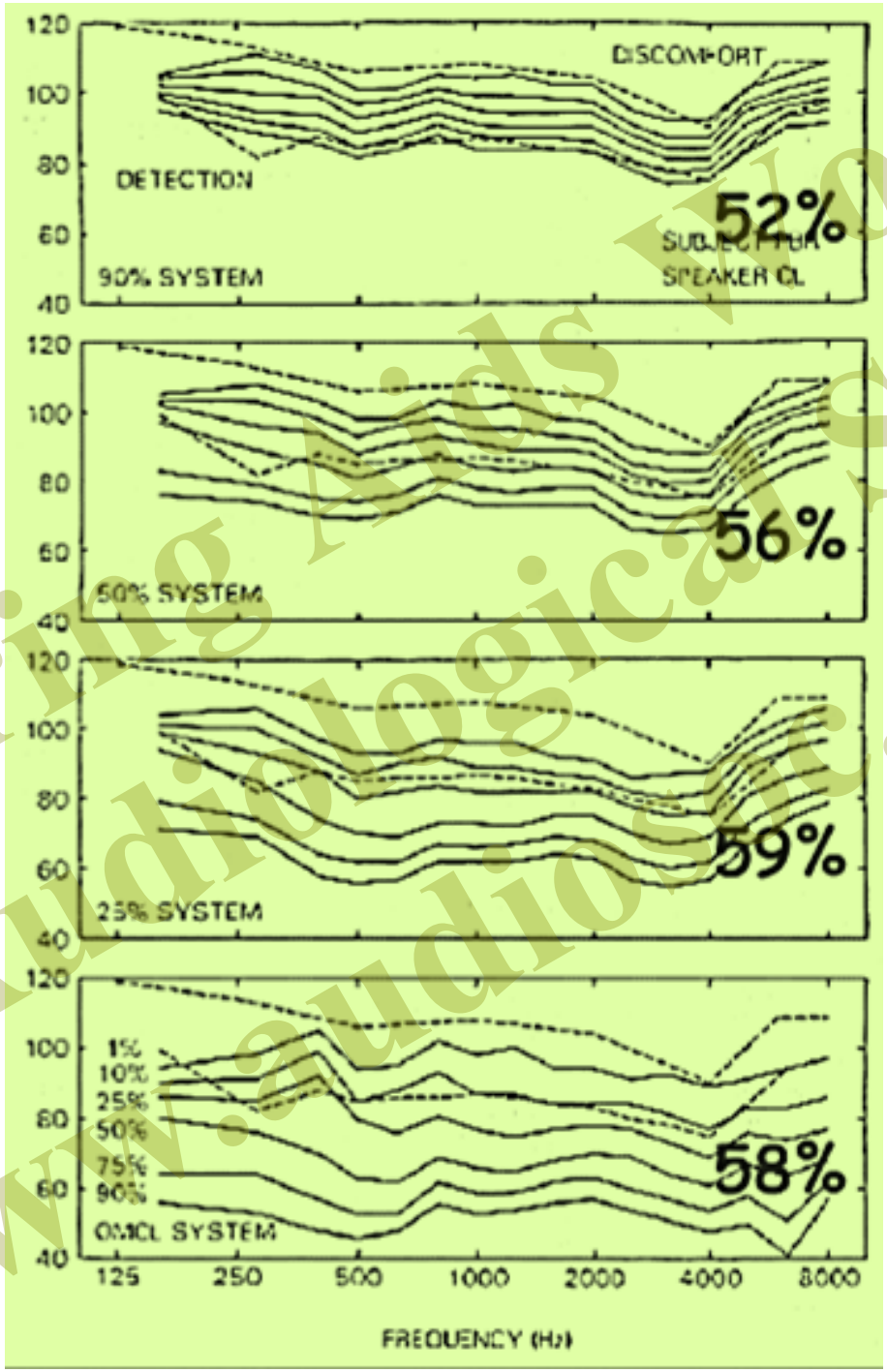
Fast acting compression



(De Gennaro, Braida, Durlach, 1986)

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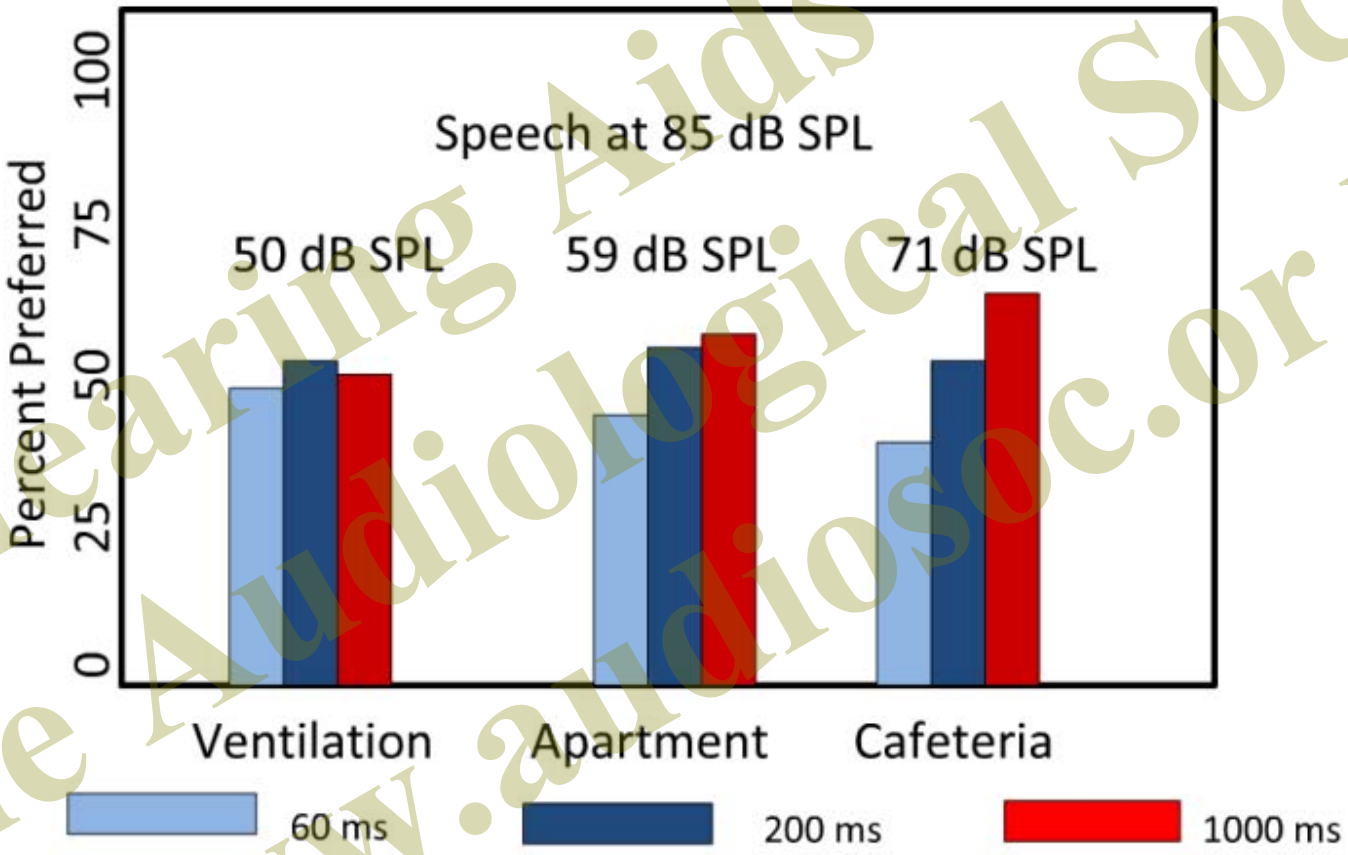
Release Time Preferences



Neuman et al., 1995

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Managing Severe Losses

1. Fit modern "WDRC" hearing aids
2. Employ frequency lowering scheme:
   - Frequency compression (non-linear frequency lowering) – Phonak Sound Recover
   - Frequency shifting (linear frequency lowering) – Widex Auto Extender
3. Cochlear Implant

Allow the patient to choose the preferred bandwidth

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Selection and Fitting

울산의대 서울아산병원 | 이비인후과학교실 이 광 선

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