

The Spectrum of Hearing Impairment

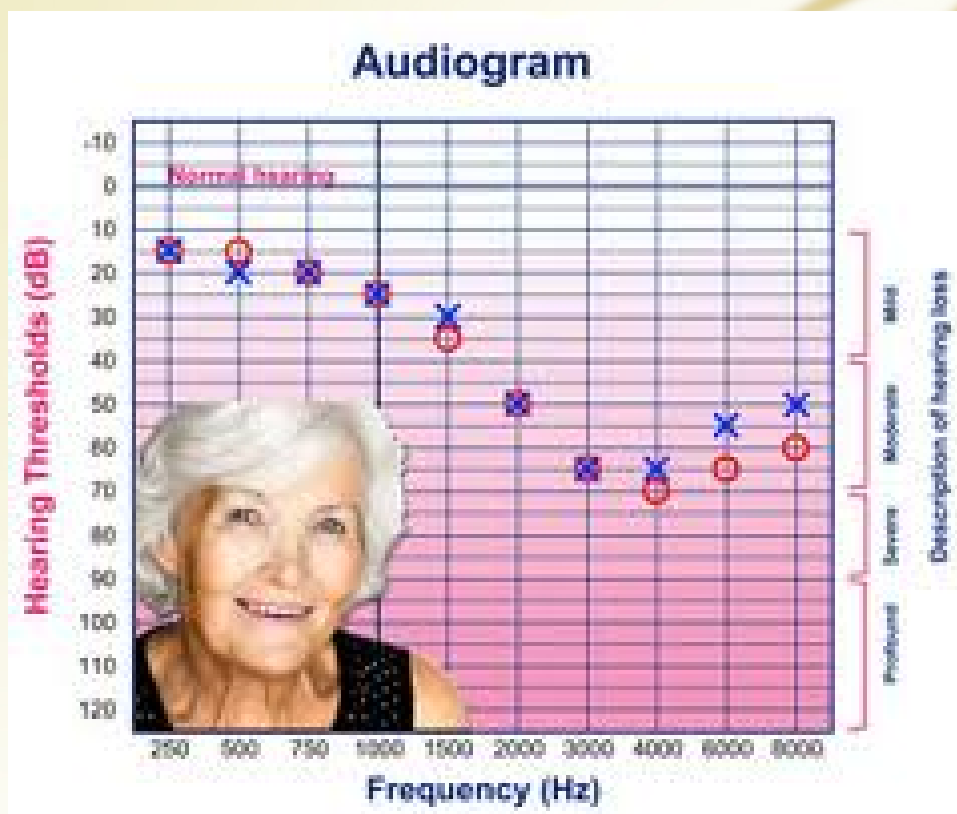
Theresa H. Chisolm, Ph.D.

**Hearing Loss and Healthy Aging:
An IOM-NRC Workshop**

**The Keck Center of the National
Academies
January 13-14, 2014**



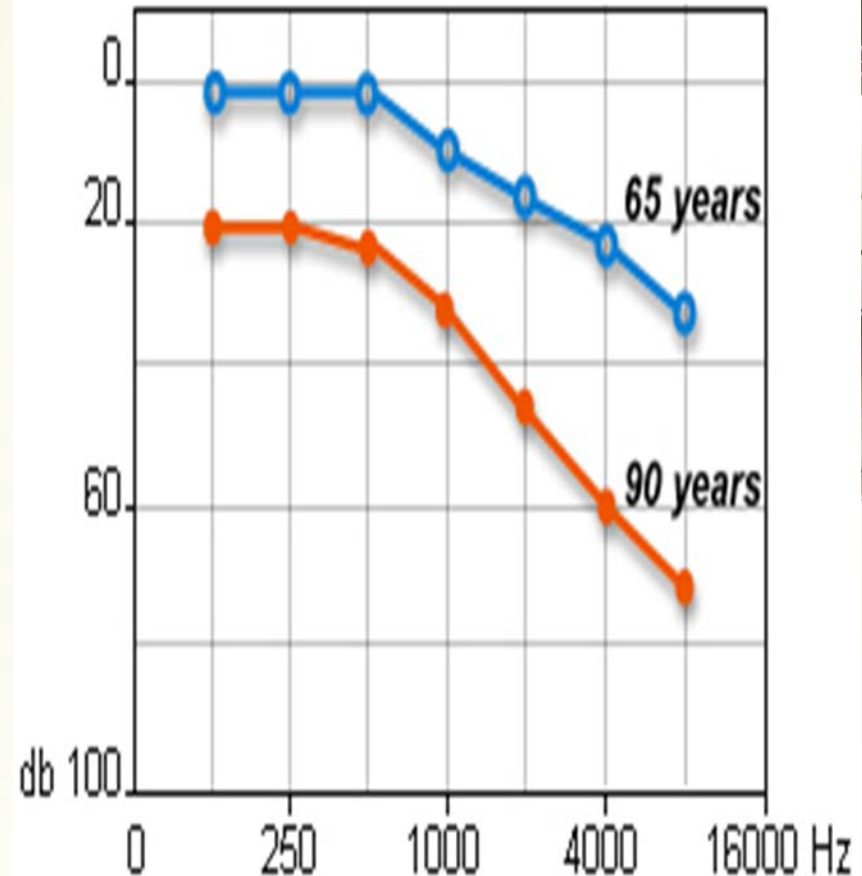
Spectrum of Hearing Impairment in Older Adults



“Blindness separates us from things but deafness separates us from people.” Helen Keller

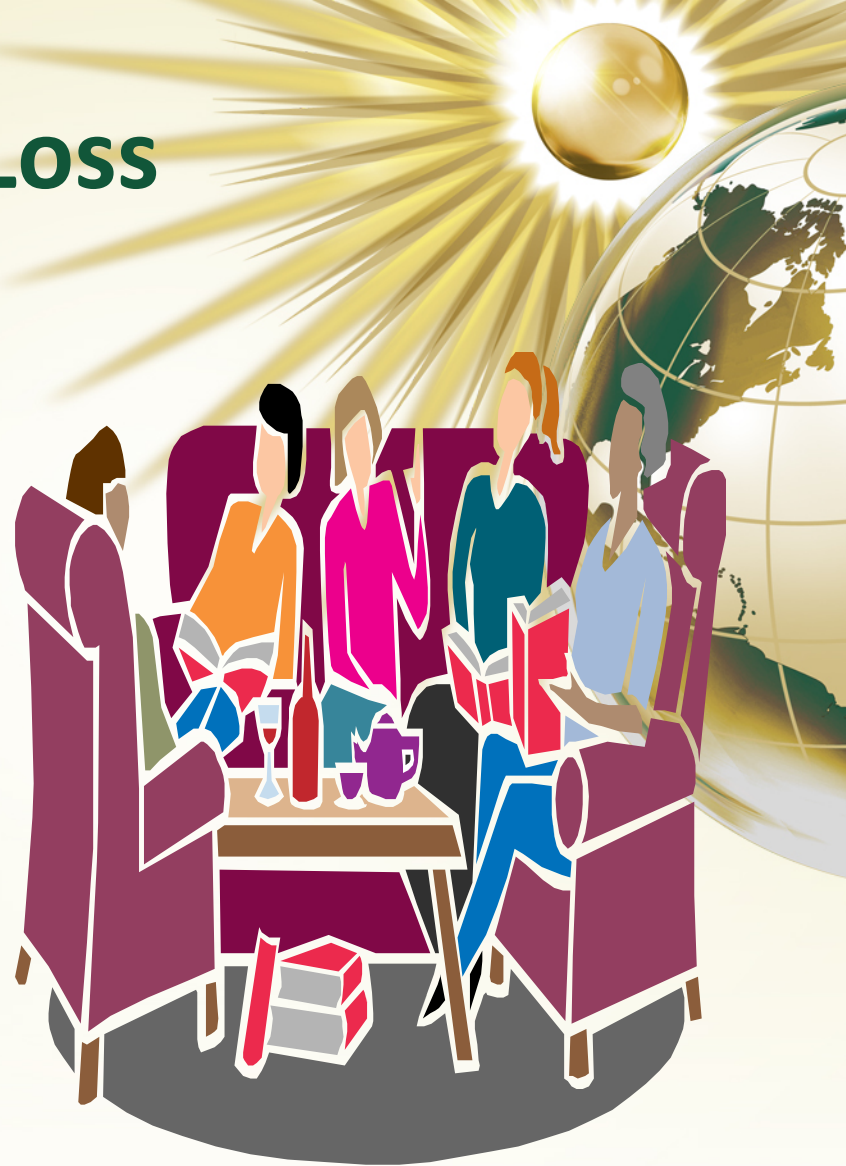
Age-Related Hearing Loss

- Presbycusis, is the slow loss of hearing that occurs as people get older.



Age-Related Hearing Loss

- Elevated thresholds (can't hear soft sounds)
- Reduces speech understanding in noisy and reverberant (echoing) environments
- Interferes with the perception of rapid changes in speech



Common Complaints

- “I can hear people talking but can’t understand what they are saying”

“If they spoke slower (or clearer), I could understand what they are saying”



Age-Related Hearing Loss

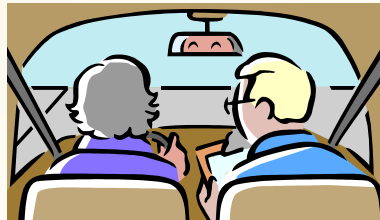
- Communication →



- Frustration
- Associated with
 - Sadness and depression
 - Worry and anxiety
 - Paranoia
 - Emotional turmoil and insecurity
 - National Council on Aging (1999)
- Reduced QoL

Age-Related Hearing Loss

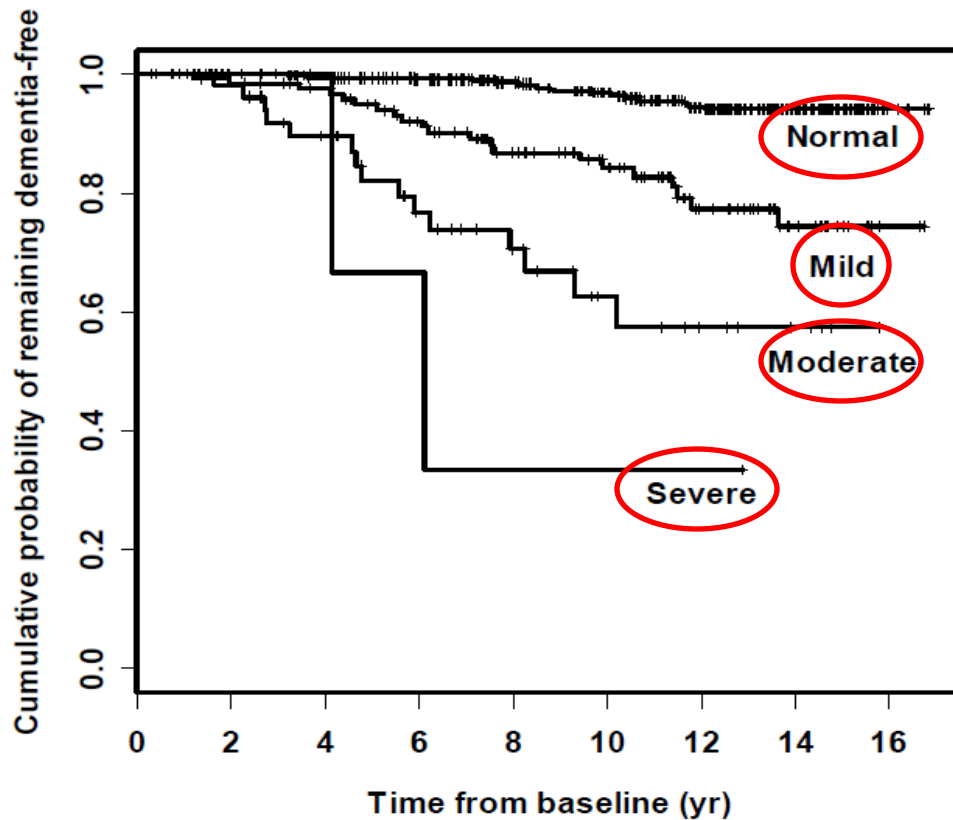
- An increased likelihood of depression:
 - Odds Ratio = 1.8 (95% Confidence Interval: 1.1-2.7)
- Decreased self-sufficiency in Activities of Daily Living:
 - Odds Ratio = 2.1 (95% Confidence Interval: 1.4-3.2)



- (Carabellese, Appollonio, Rozzini et al., 1993)

Hearing Loss & Incident Dementia

Lin et al., Arch Neuro., 2011



Hazard ratio of incident all-cause dementia (compared to normal hearing)^a

	<u>HR</u>	<u>95% CI</u>	<u>p</u>
Mild	1.89	1.00 – 3.58	0.05
Moderate	3.00	1.43 – 6.30	.004
Severe	4.94	1.09 – 22.4	.04

^a Adjusted for age, sex, race, education, DM, smoking, & hypertension

Comparison of Symptoms

(Chartrand, 2001)

Alzheimer's Disease

- Depression, anxiety, disorientation
- Reduced language comprehension
- Impaired memory
- Inappropriate psychosocial responses
- Loss of ability to recognize
- Denial, defensiveness, negativity
- Distrust, suspiciousness of others

Untreated Hearing Loss

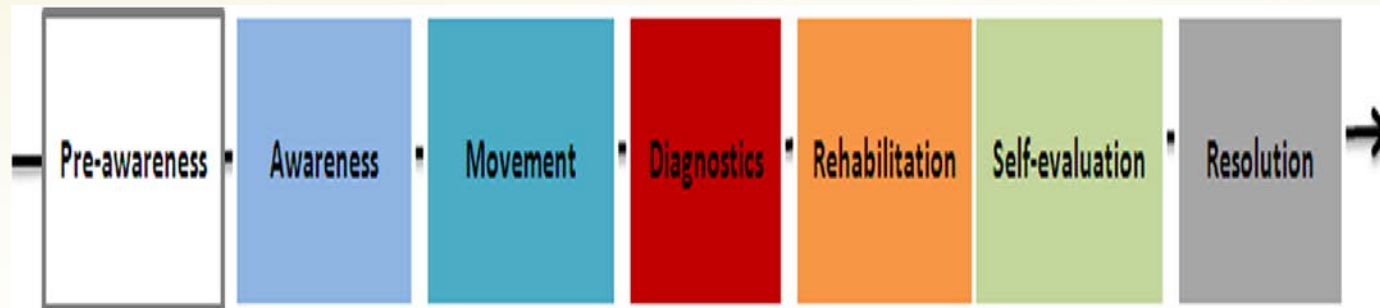
- Depression, anxiety, feelings of isolation
- Reduced communication ability
- Lessened cognitive input
- Inappropriate psychosocial responses
- Lessened mental scores
- Denial, heightened defensiveness, negativity
- Distrust, paranoia re: others are talking about them

Age-Related Hearing Loss

- There is no cure for age-related hearing loss
- Treatments can improve everyday function
- Hearing loss can be effectively managed so that we can continue to live a full and active life.

Managing Hearing Loss for Healthy Aging

- ***Identification***
- ***Belief: Hearing is important and Age-Related HL can be treated***



Managing Hearing Loss for Healthy Aging

American Academy of Audiology's
Evidenced-Based

Guidelines for the Audiologic Management of Adult Hearing Impairment

Valente, M., Abrams, H., et al. (2006).
Audiology Today, 18(5), 44 pages.

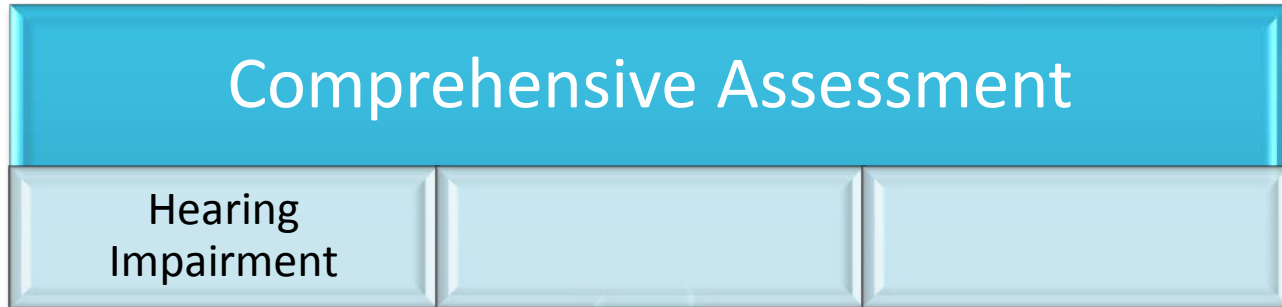
Subsequent Relevant Research

Managing Hearing Loss for Healthy Aging

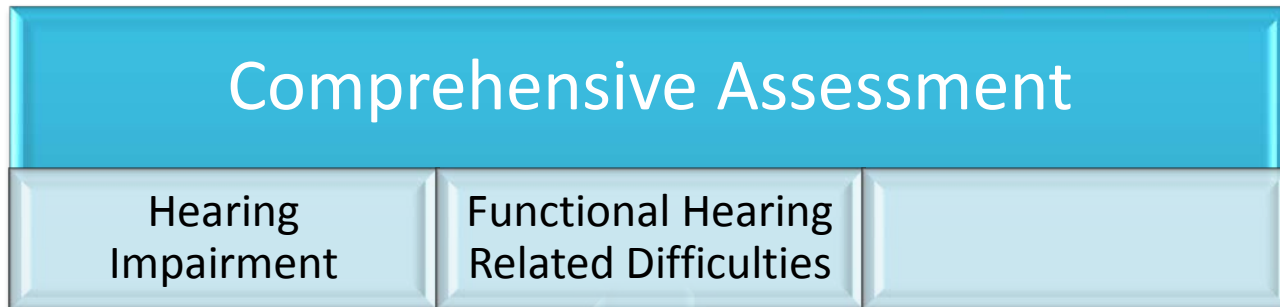


Comprehensive Assessment

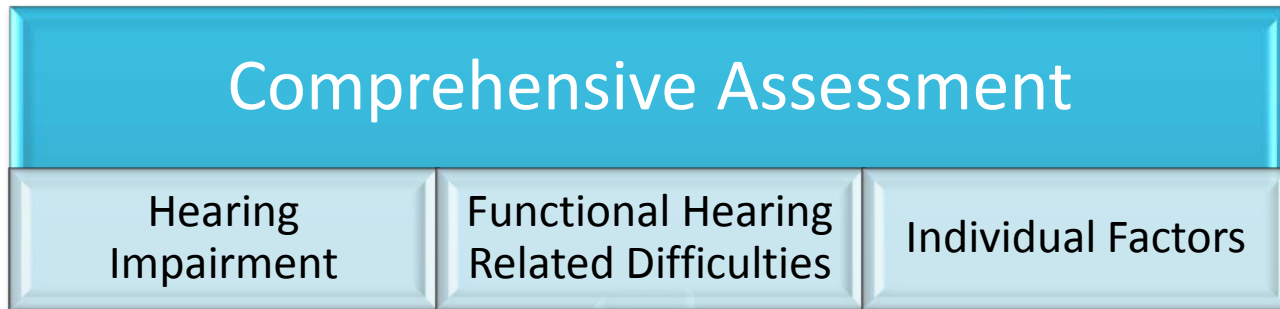
Managing Hearing Loss for Healthy Aging



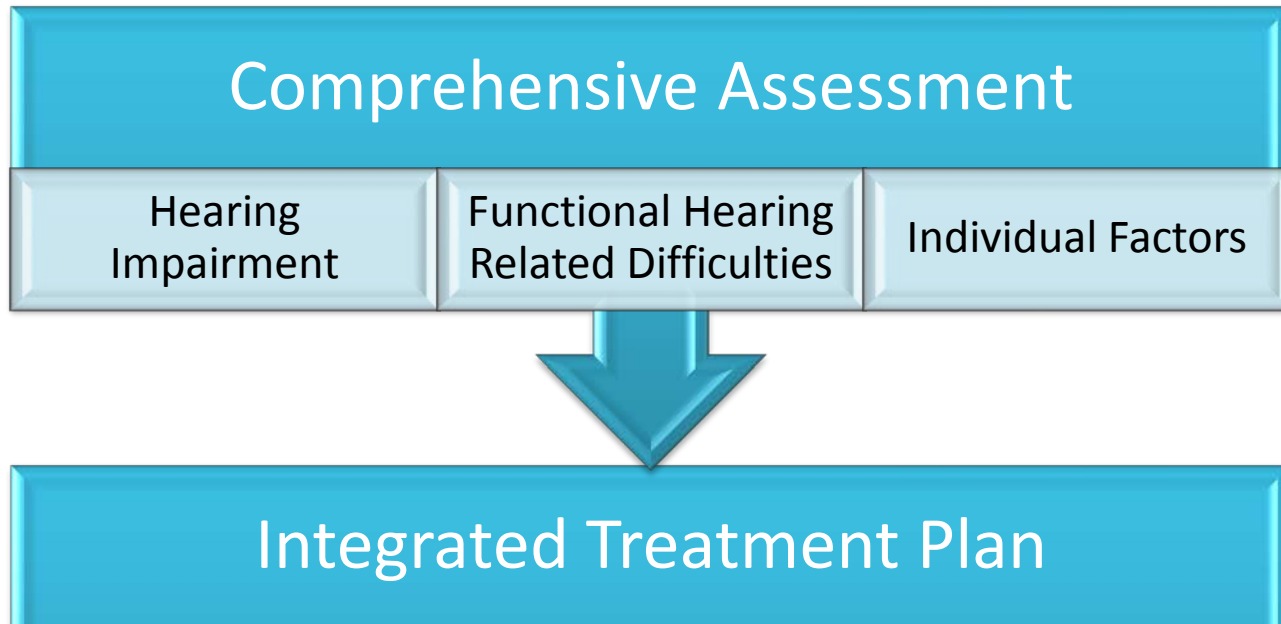
Managing Hearing Loss for Healthy Aging



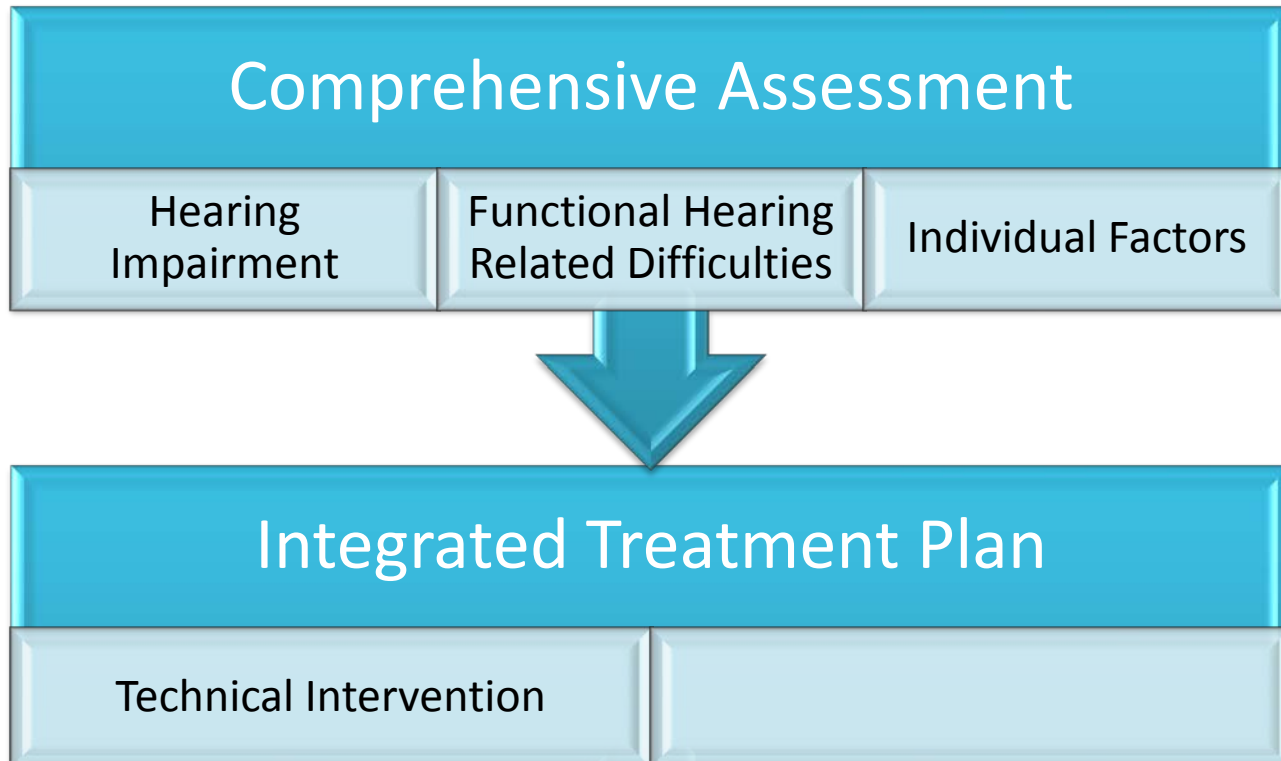
Managing Hearing Loss for Healthy Aging



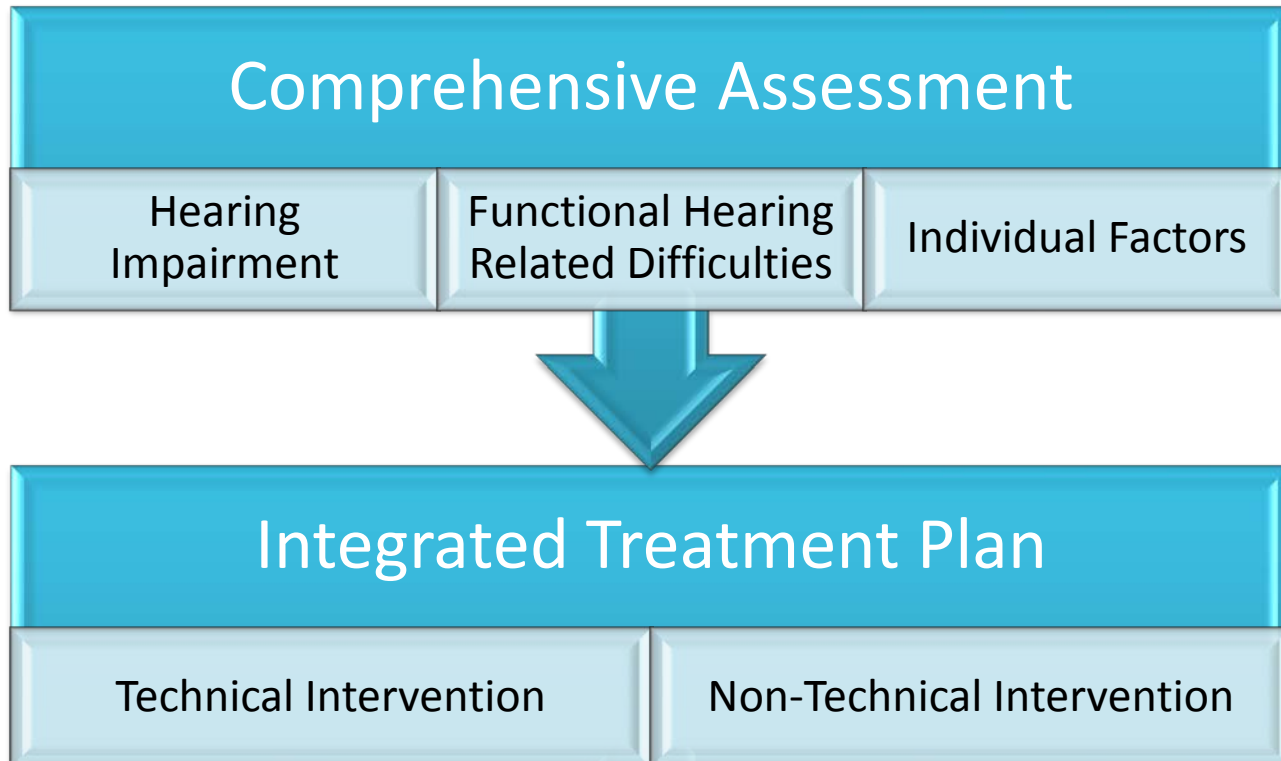
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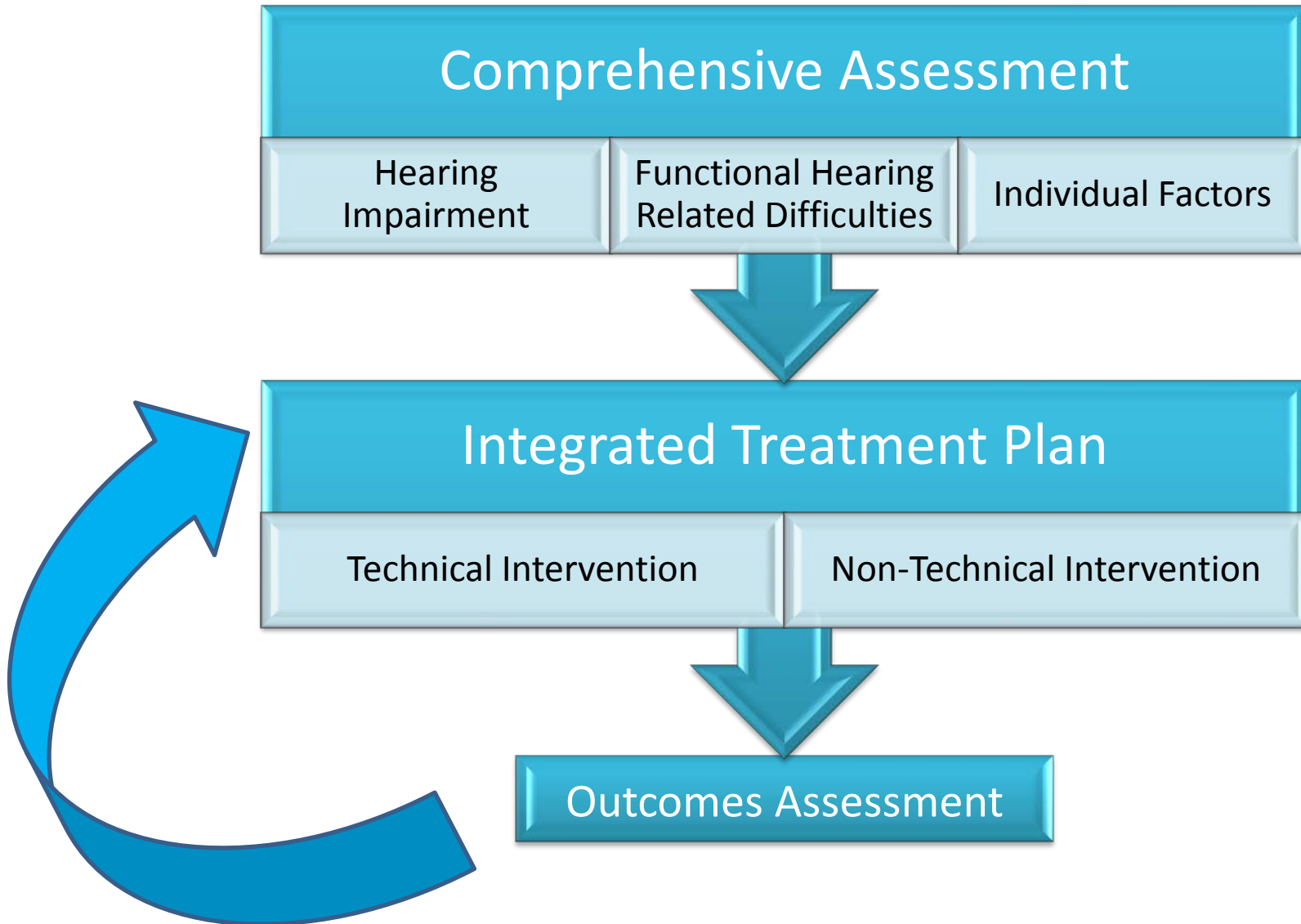
Managing Hearing Loss for Healthy Aging



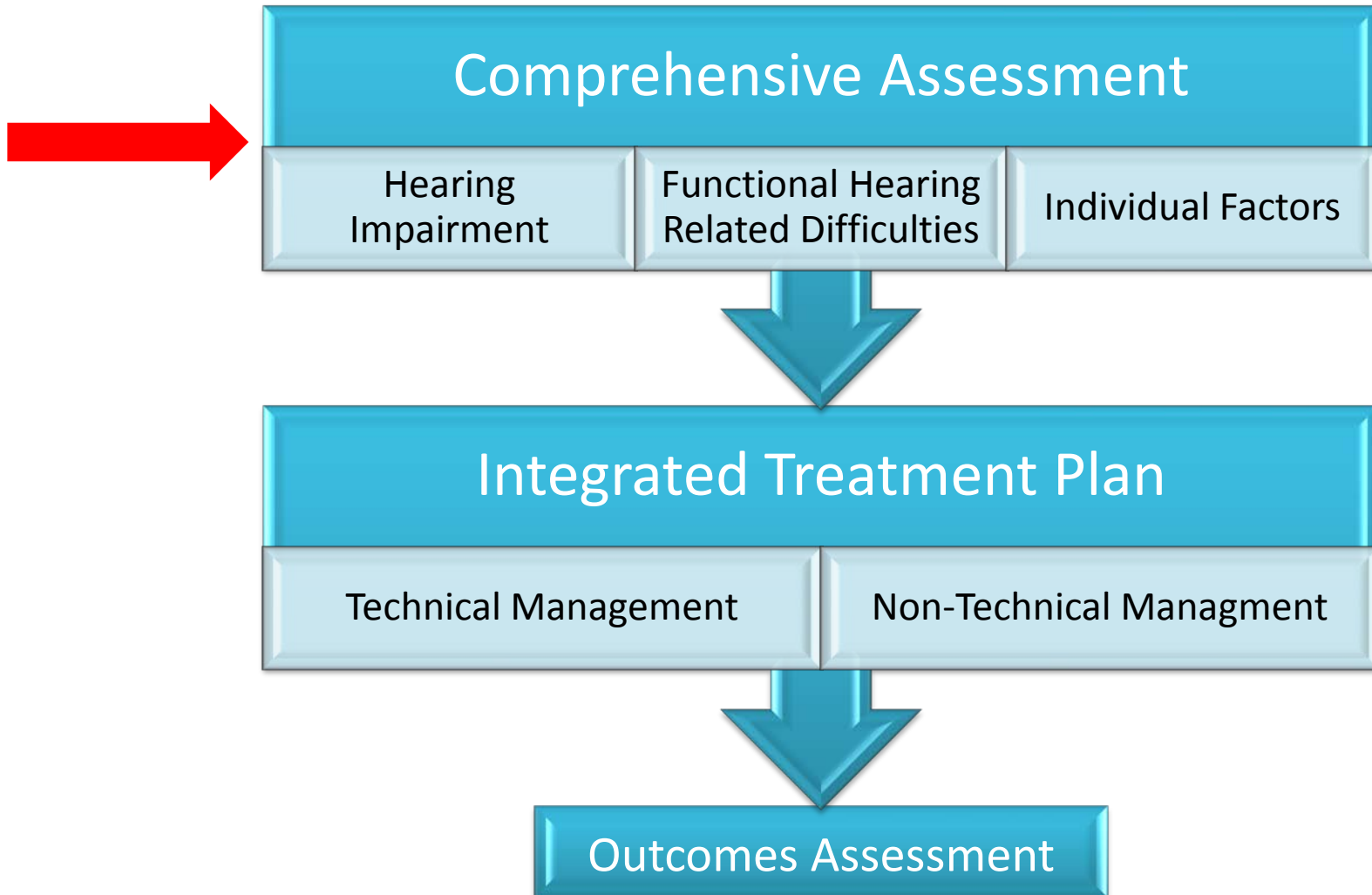
Managing Hearing Loss for Healthy Aging



Managing Hearing Loss for Healthy Aging



Managing Hearing Loss for Healthy Aging



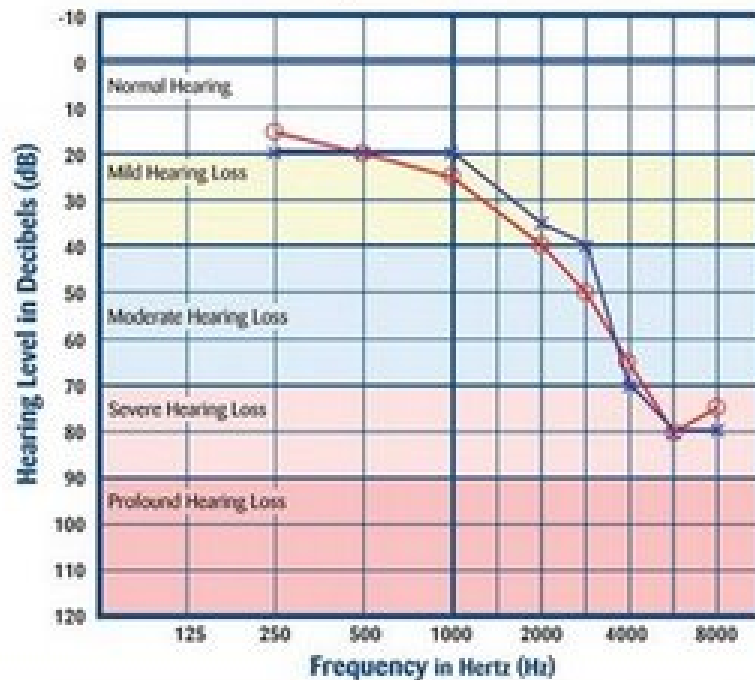
Hearing Impairment



AUDIOGRAM

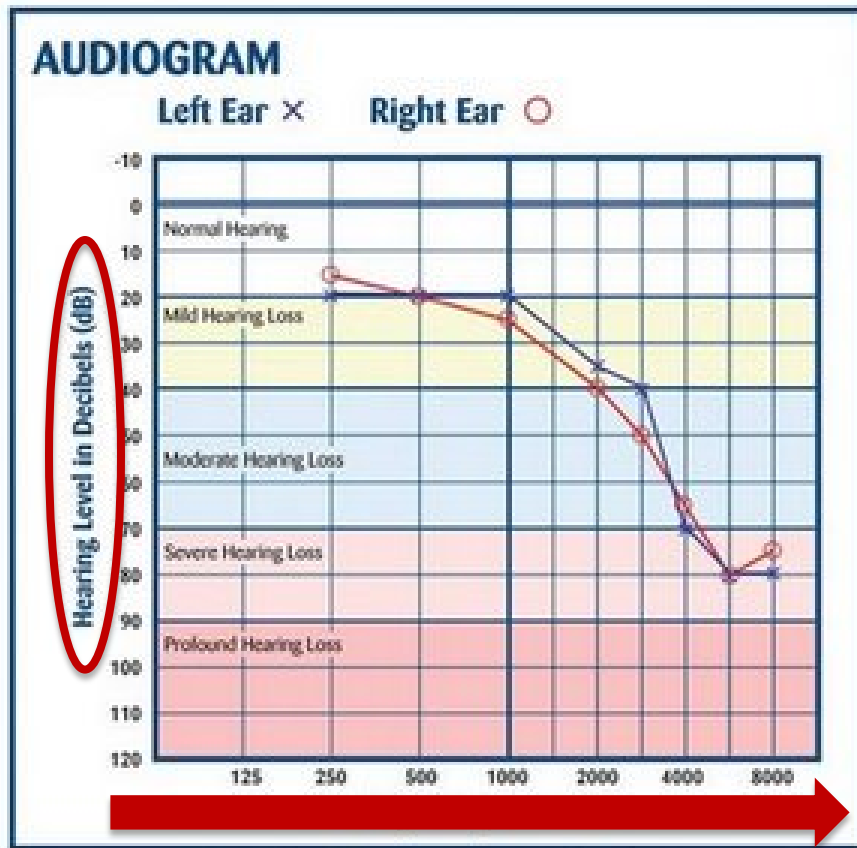
Left Ear ×

Right Ear ○



* An example presbycusis (sloping high-frequency hearing loss) synonymous with the ageing process.

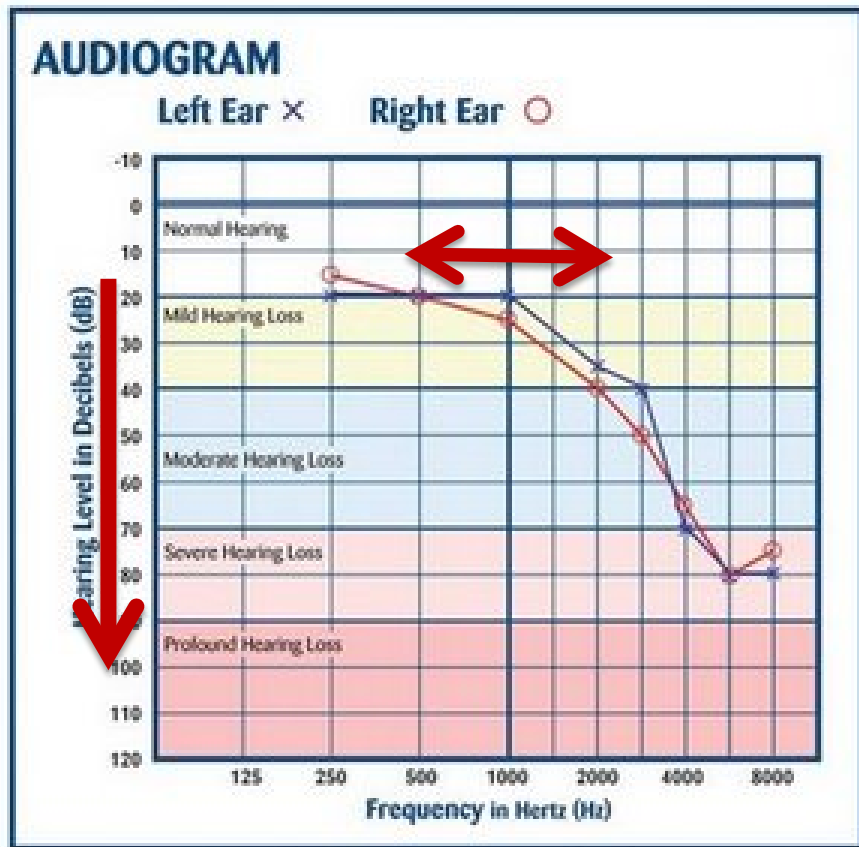
Hearing Impairment



* An example presbycusis (sloping high-frequency hearing loss) synonymous with the aging process.

- The audiogram tells us how sensitive the individual's hearing is
- To different sounds that range from low pitch to high pitch

Hearing Impairment

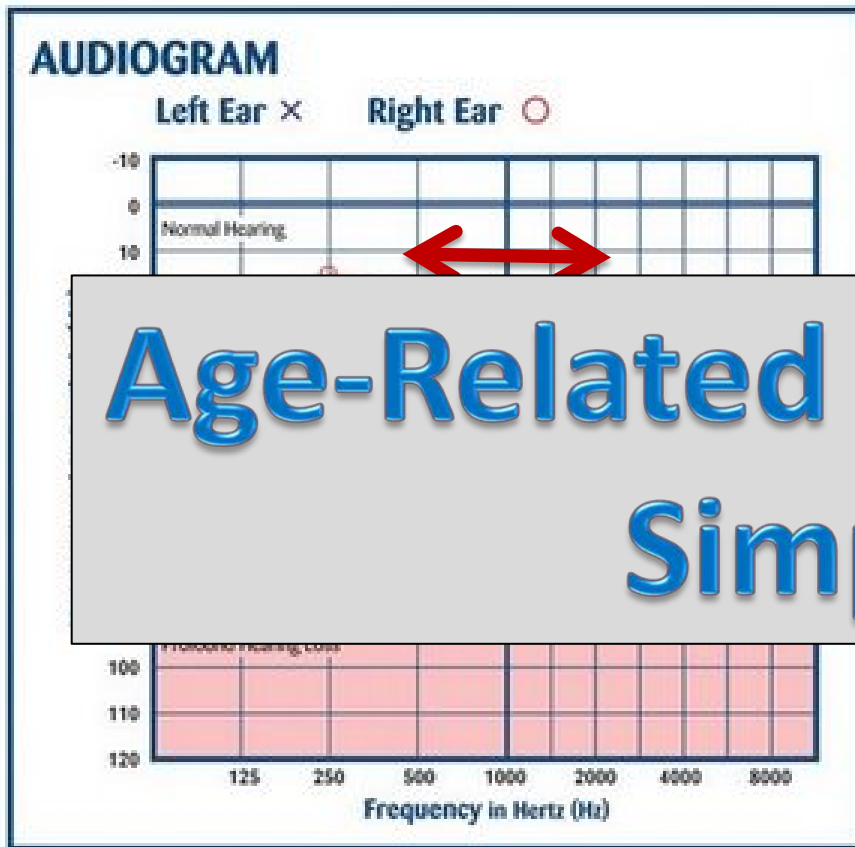


* An example presbycusis (sloping high-frequency hearing loss) synonymous with the aging process.

- Degree of hearing loss from mild to profound
- Pure Tone Average (PTA)
- Calculated by averaging sensitivity thresholds at specific frequencies (Hz)

Hearing Impairment

- Degree of hearing loss from mild to profound



Age-Related HL Not that Simple

thresholds at specific frequencies (Hz)

* An example presbycusis (sloping high-frequency hearing loss) synonymous with the aging process.

Two Components of Hearing Loss

A decorative background in the top right corner featuring a bright sunburst with a golden sphere at its center, and a portion of a globe showing continents and latitude/longitude lines.

Audibility

Distortion

Two Components of Hearing Loss

Audibility

Distortion

Louder
Louder
Louder
Louder
Louder
Louder
Louder
Louder

No matter how loud we make the sounds, there can still be problems with the clarity or the clearness.

Making sound louder is necessary, but not sufficient

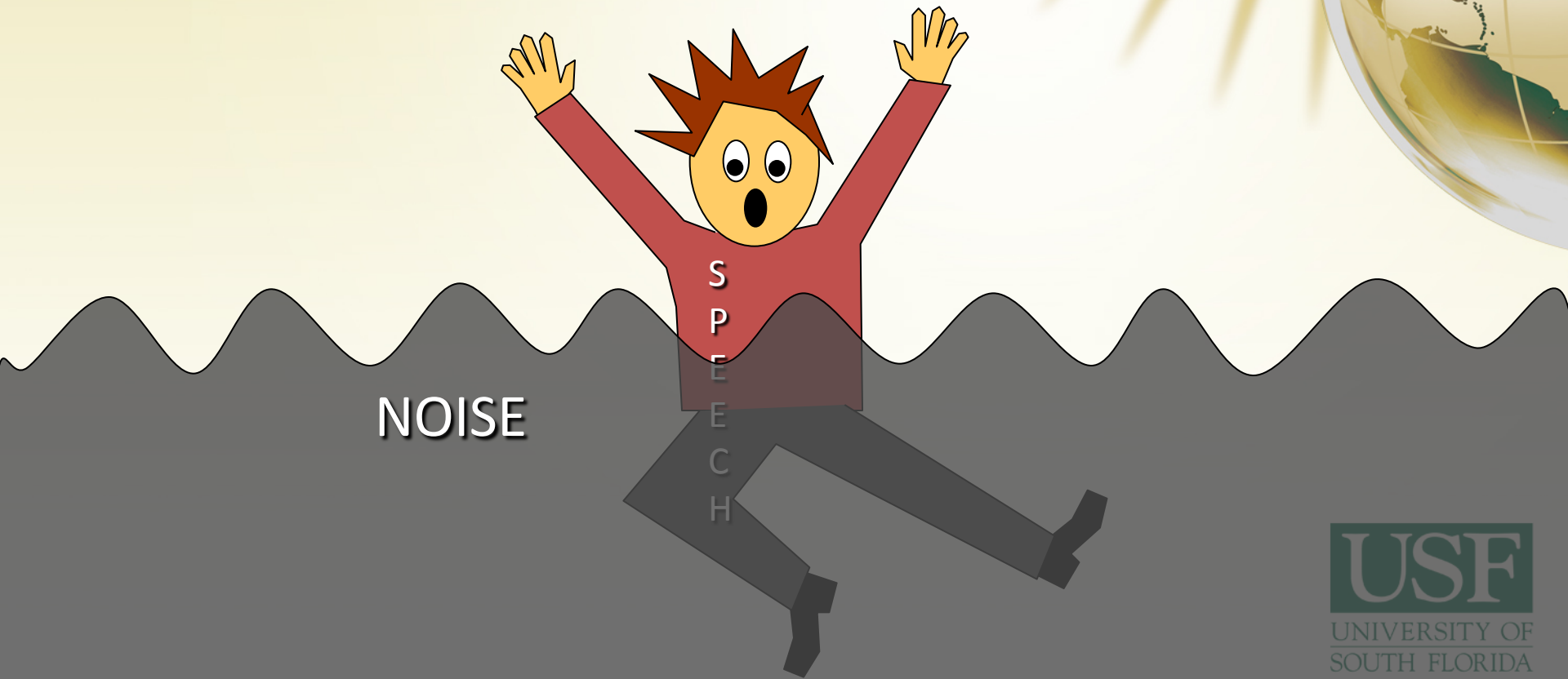
Clearness

Clearness

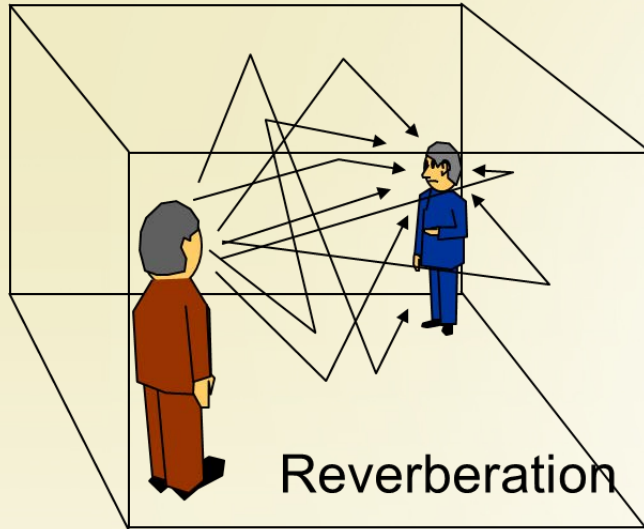
Clarity

External Factors

- Obscures speech sounds
- Distracts the listener



Special Type of Noise



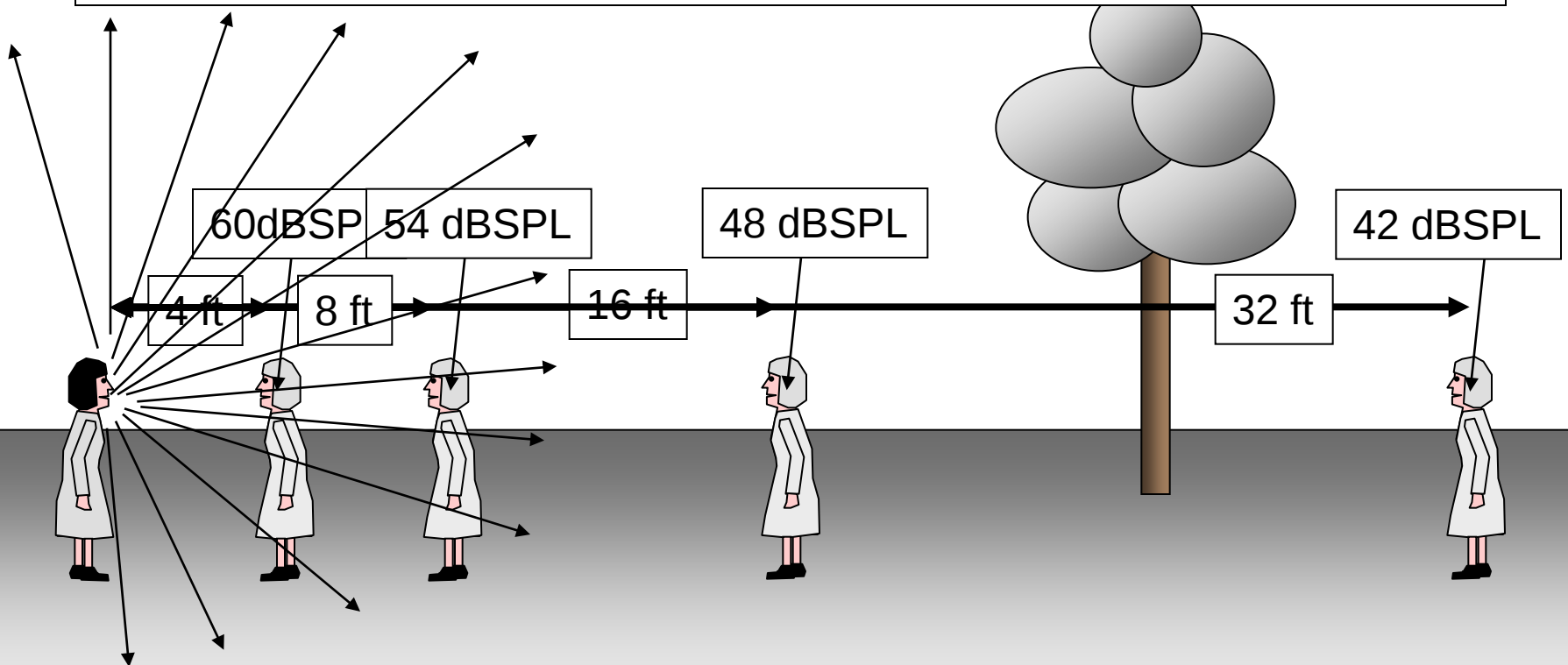
- **Visual Analogy**

The following is a list of Farmer's markets to be held in the surrounding areas

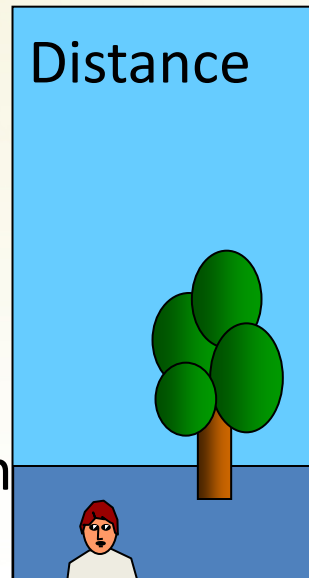
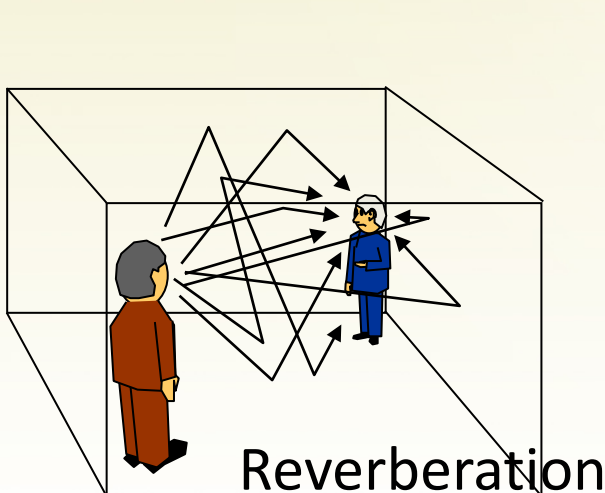
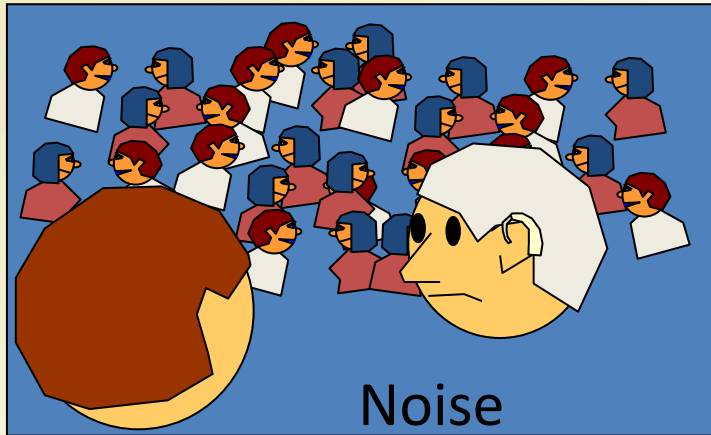
DISTANCE

between listener and talker

- The level of the direct speech signal falls by 6 dB for every doubling of distance



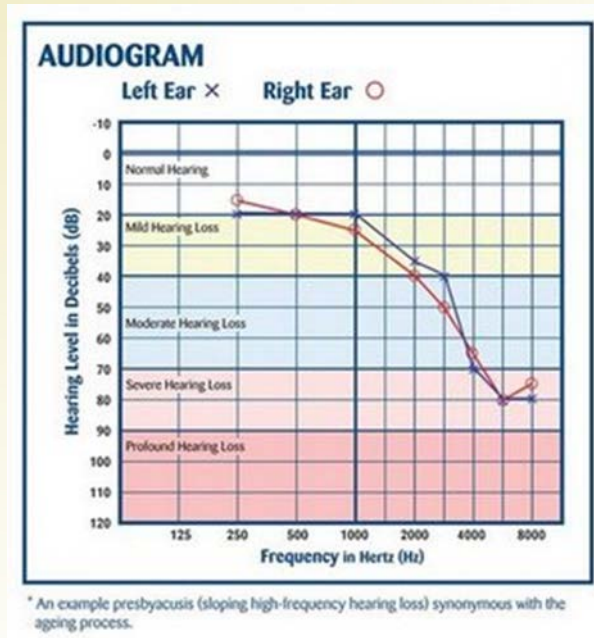
Combined Negative Effects



- Make listening & communicating difficult for all
- Exacerbated by effects of:
 - Hearing Loss
 - Aging-related processing declines

Managing Hearing Loss for Healthy Aging

Degree of Impairment



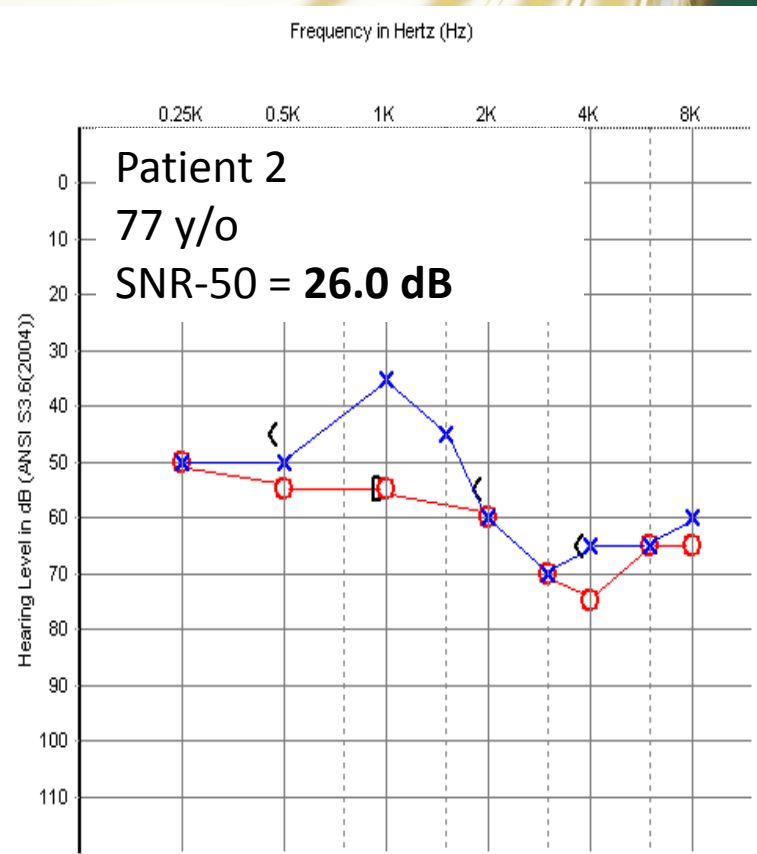
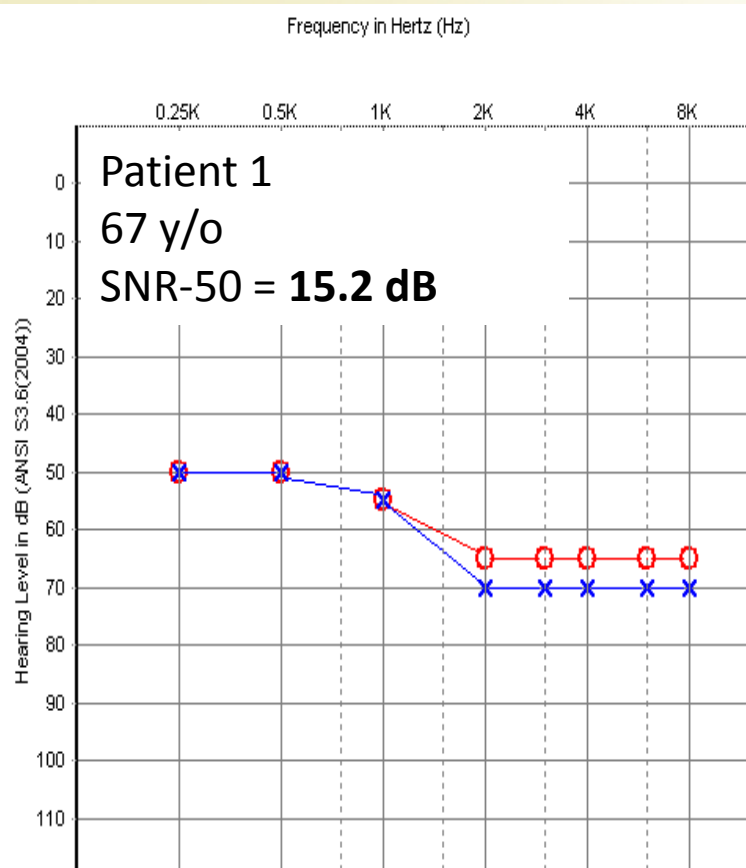
Speech Understanding in Noise

- Objective measure of Speech understanding in noise (e.g., QuickSIN, HINT, WIN)
- Signal-to-noise ratio needed to recognize 50% of the message

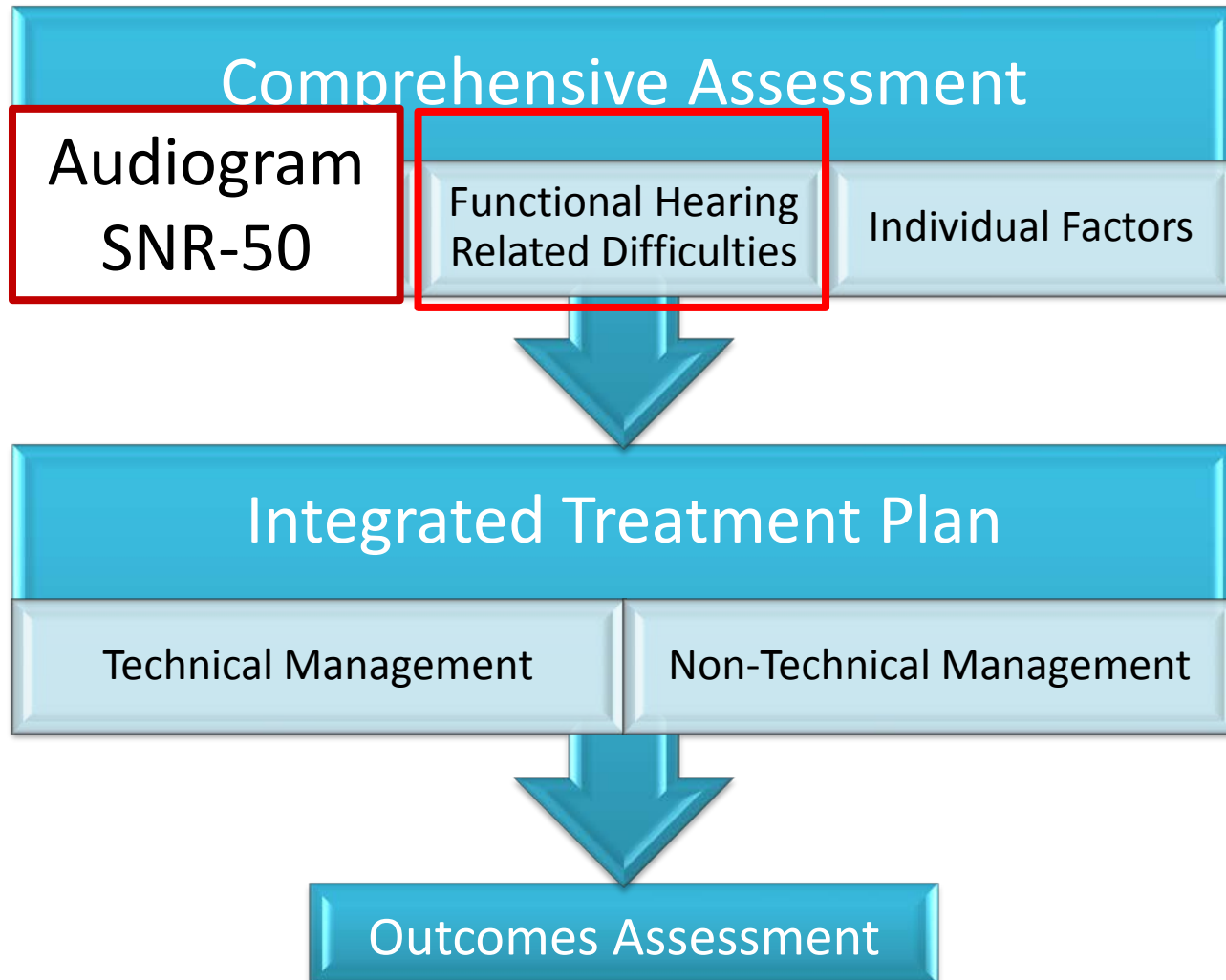
- Normal hearing person needs speech to be 2 dB > noise for 50% correct recognition
 - **SNR-50 = +2 dB**
- Person with hearing loss might need the speech to be 12 dB > than the noise for 50% correct recognition
 - **SNR-50 = +12dB**



SNR-50 cannot be predicted by the audiogram!



Managing Hearing Loss for Healthy Aging

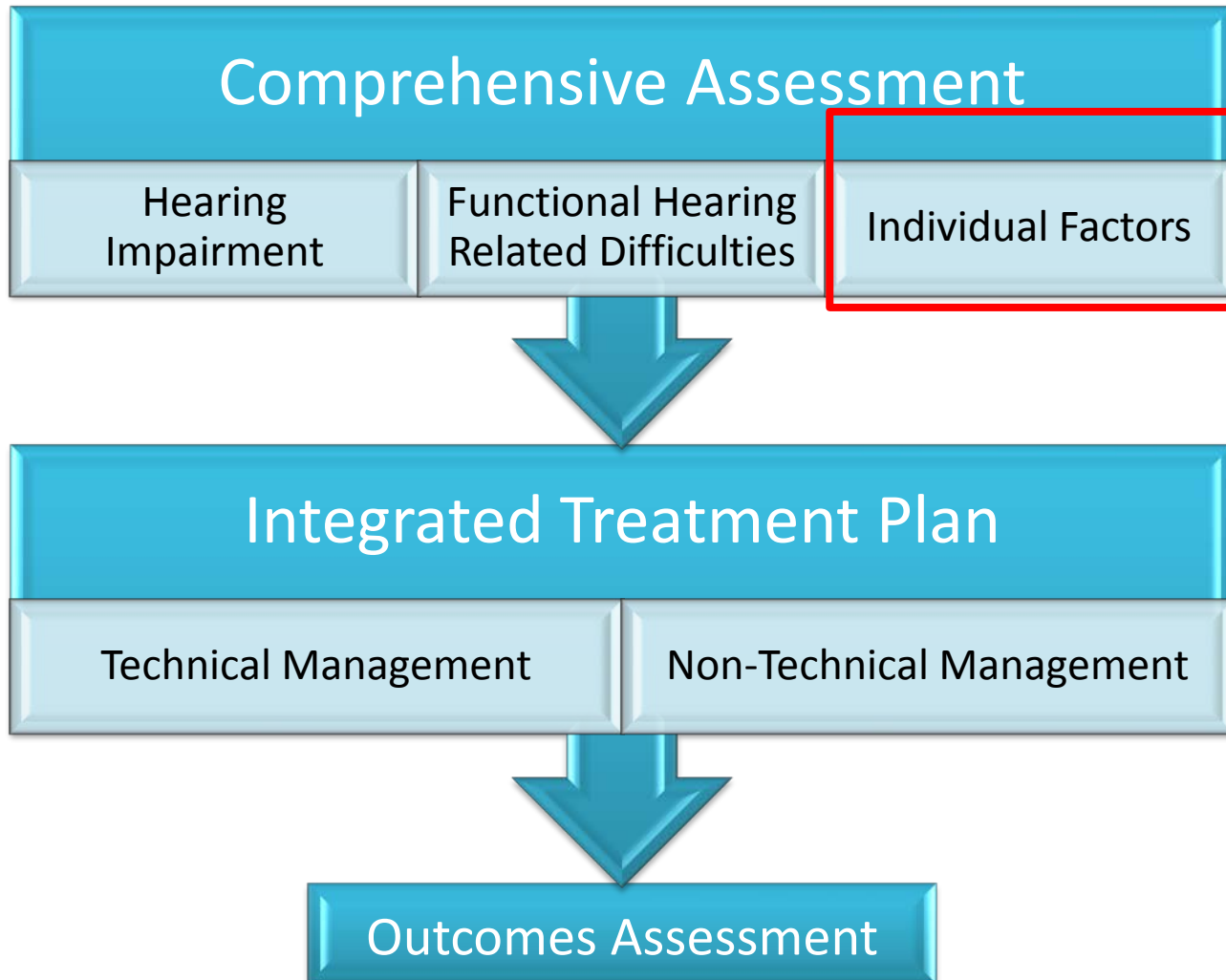


Activity Limitations and Participation Restrictions

- Detailed Case History
- Medical vs. Social-Emotional and Activities of Daily Living
- Psychometrically Valid Self-Report Measures
 - Hearing Handicap Inventory for the Elderly (HHIE) (Ventry and Weinstein, 1982).



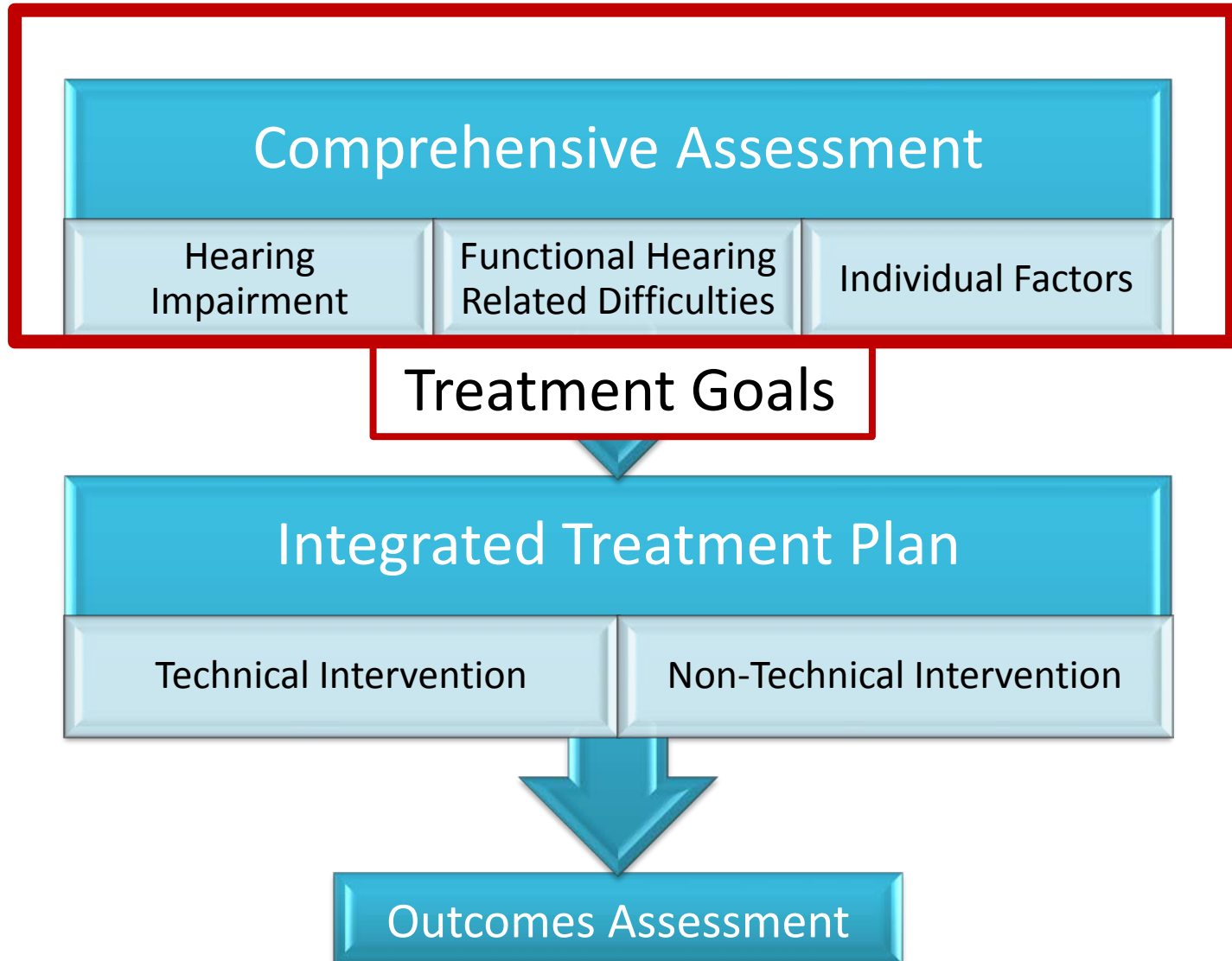
Managing Hearing Loss for Healthy Aging



Individual Factors

- Cognition
- Expectations
- Motivation
- Willingness to take risks
- Assertiveness
- Manual Dexterity
- Visual Acuity
- Visual Acuity
- General Health
- Tinnitus
- Occupational Demands
- Presence of support systems

Managing Hearing Loss for Healthy Aging



Client Oriented Scale Of Improvement

Name : _____
 Audiologist : _____
 Date : 1. Needs Established _____
 2. Outcome Assessed _____

SPECIFIC NEEDS

Category New _____
 Return _____

Indicate Order of Significance

☐ Being able to hear my son on the telephone

☐ Hearing Dr. Lin during dinner

☐ Understanding the talks at the IOM meeting

☐ _____

☐ _____

Degree of Change

Final Ability

Person can hear

10% 25% 50% 75% 95%

Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY	Hardly Ever	Occasionally	Half the Time	Most of the Time	Almost Always



NATIONAL ACOUSTIC LABORATORIES

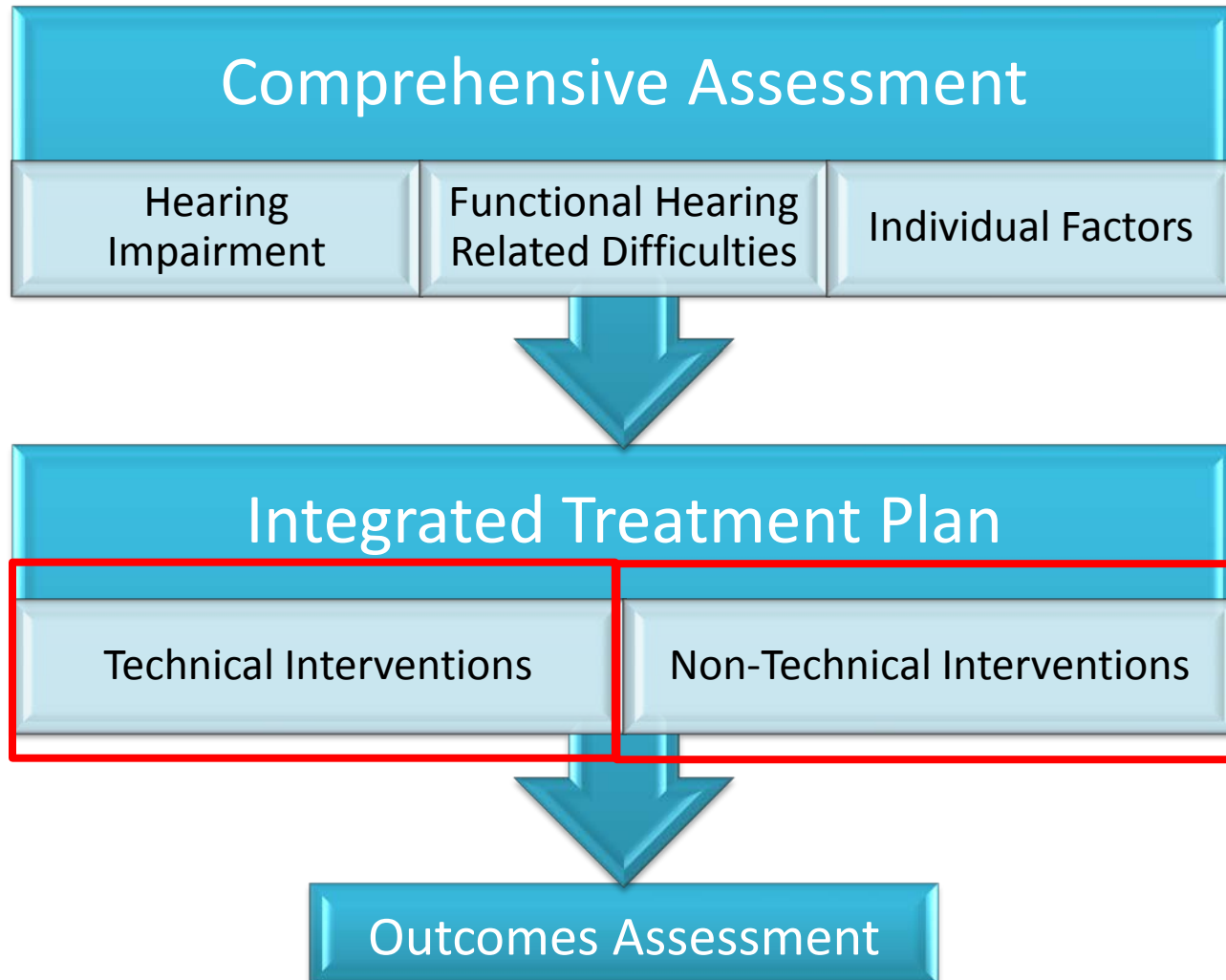
H. Dillon (NAL) et al

- Categories
- | | |
|---|----------------------------------|
| 1. Conversation with 1 or 2 in quiet | 9. Hear front door bell or knock |
| 2. Conversation with 1 or 2 in noise | 10. Hear traffic |
| 3. Conversation with group in quiet | 11. Increased social contact |
| 4. Conversation with group in noise | 12. Feel Embarrassed or stupid |
| 5. Television/Radio @ normal volume | 13. Feeling left out |
| 6. Familiar speaker in phone | 14. Feeling upset or angry |
| 7. Unfamiliar speaker on phone | 15. Church or meeting |
| 8. Hearing phone ring from another room | 16. Other |

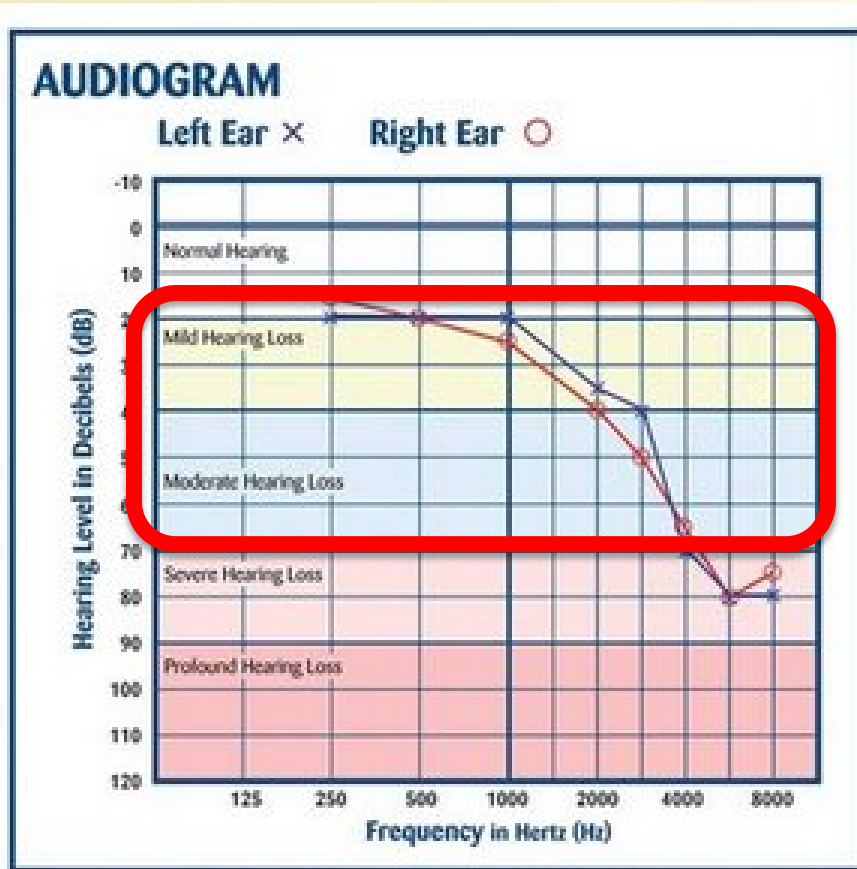
H. Dillon (NAL) et al



Managing Hearing Loss for Healthy Aging



Technical Interventions

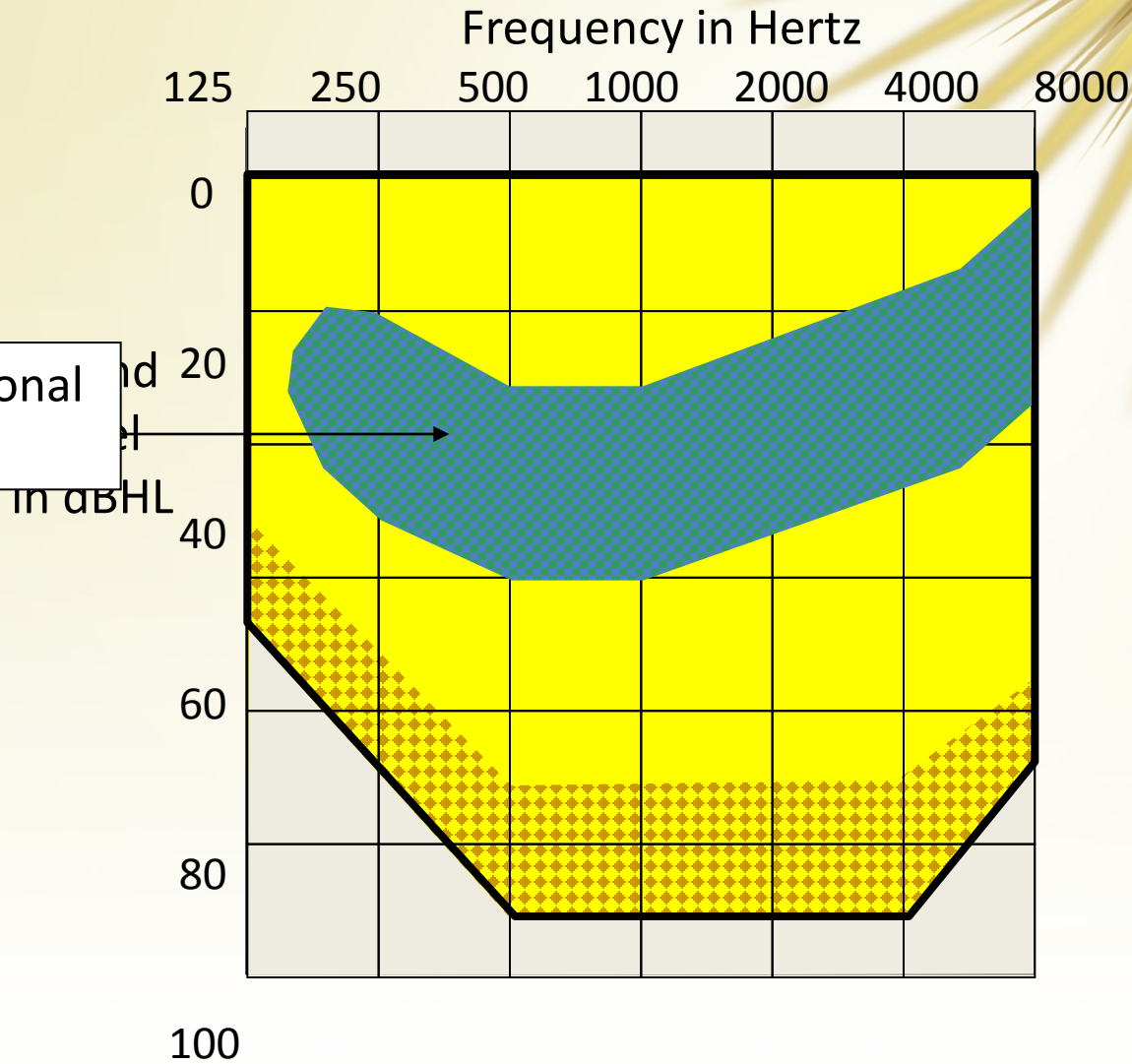


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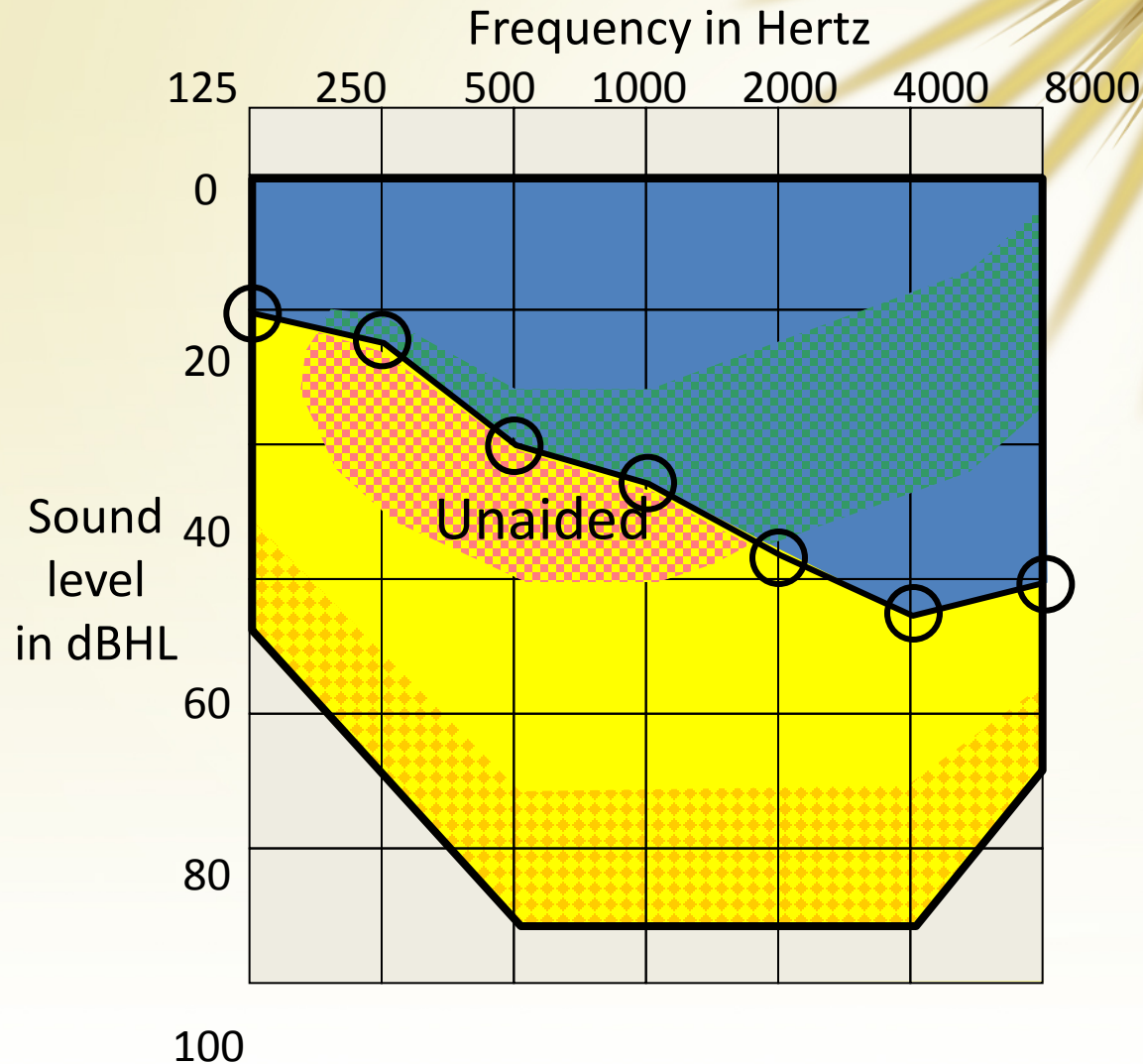
- Hearing Aids



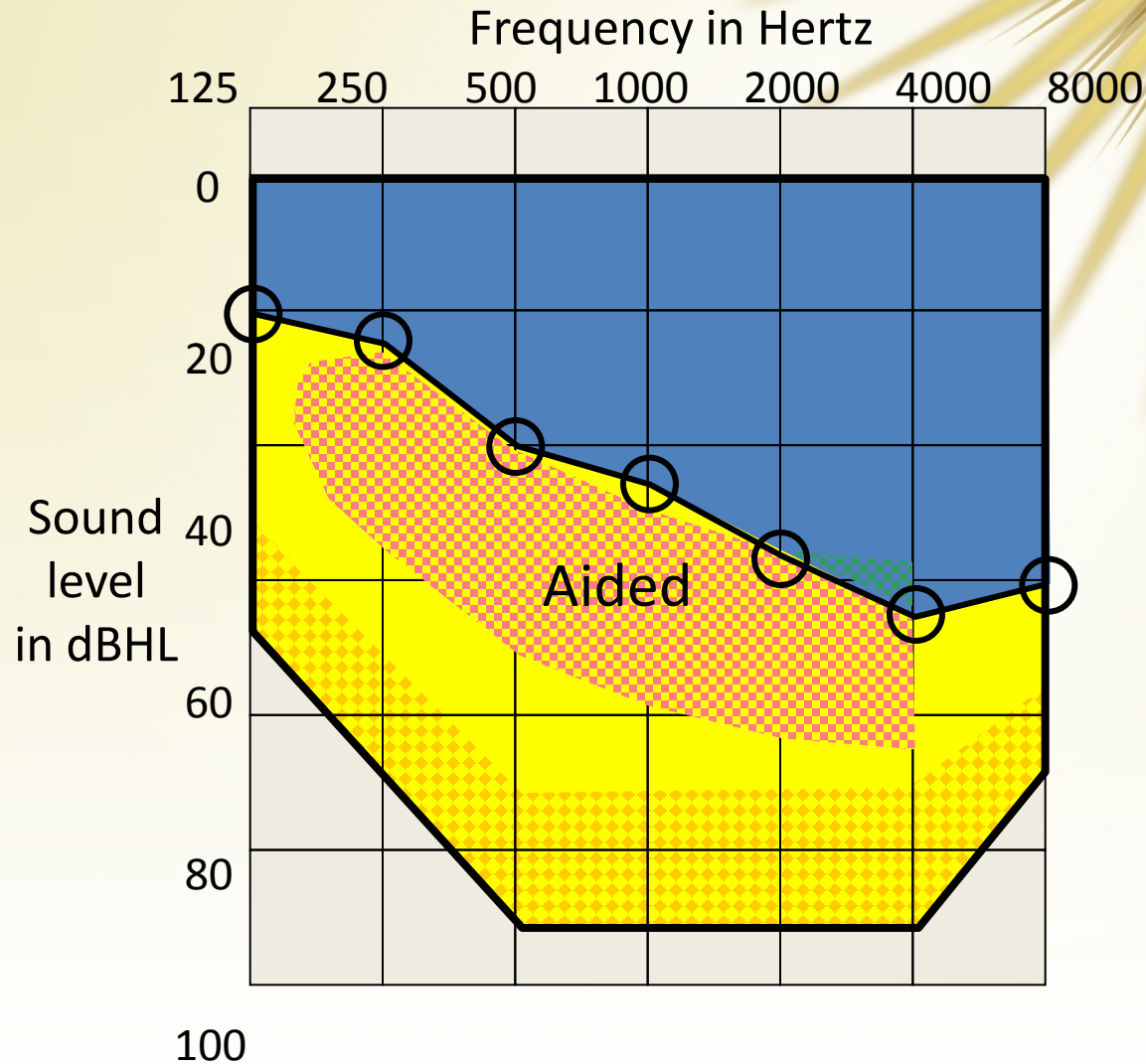
Conversational
Speech



Moderate Hearing Loss (30-60 dB)



Moderate Hearing Loss (30-60 dB)



Optimal Fitting of Hearing Aids

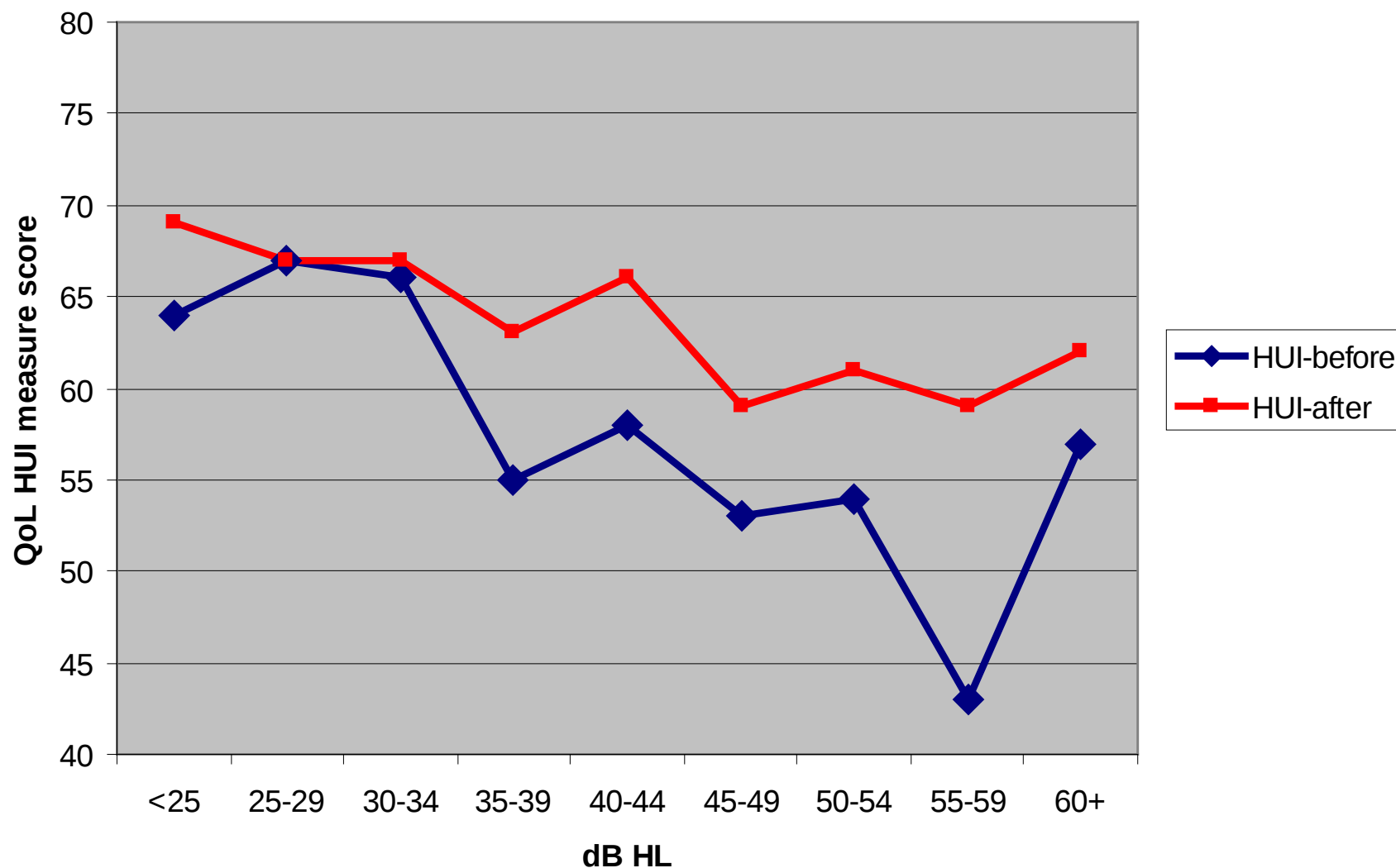
- Numerous evidence based decisions
 - Style
 - Features
 - Signal processing, etc
- Verification
 - Physical fit & comfort
 - Signal processing “Real ear testing”



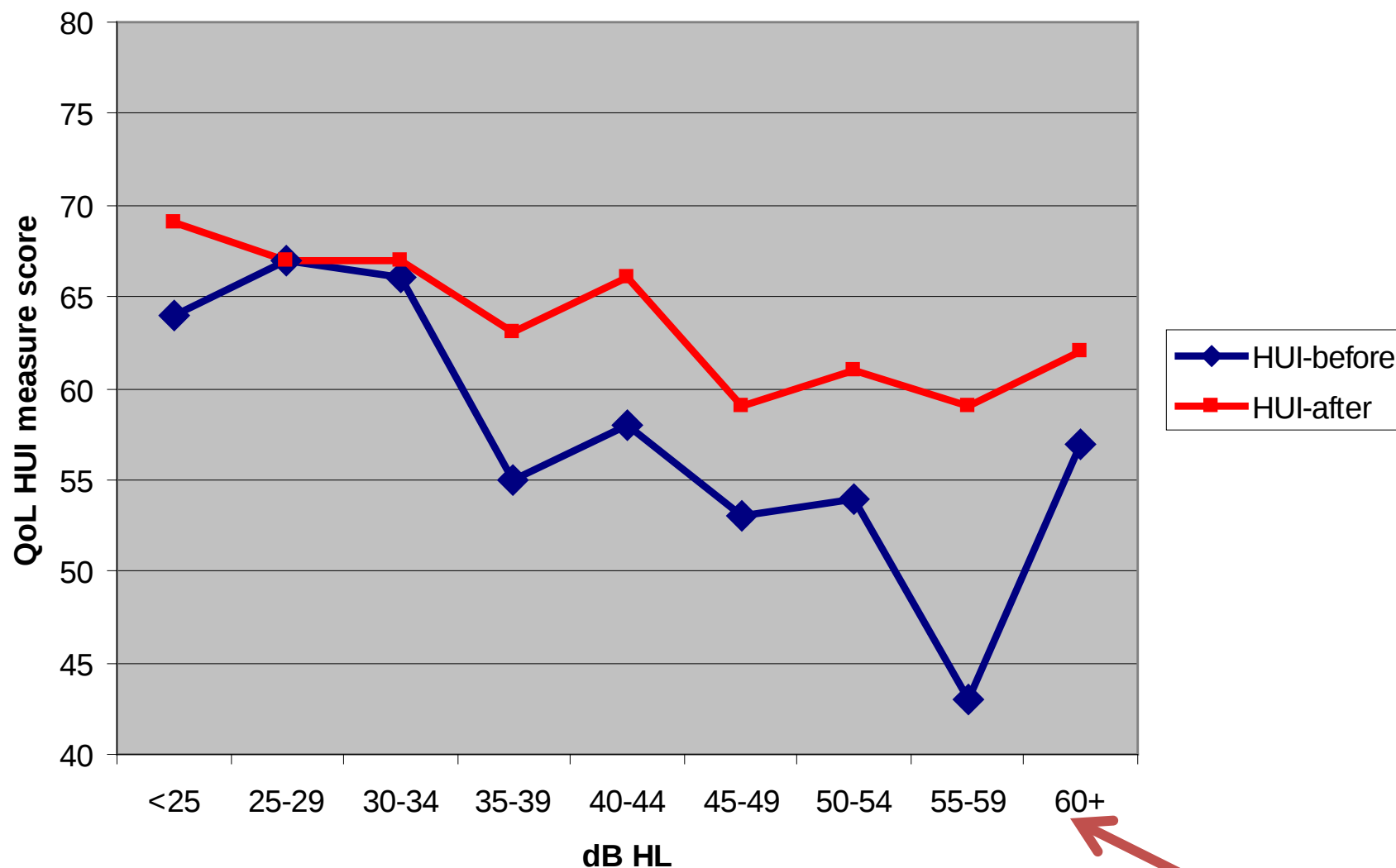
Efficacy of Hearing Aid Intervention

- Randomized Controlled Trial
 - Mulrow et al., 1990
- Improvements
 - Emotional function
 - Social function
 - Communication function
 - Cognitive function
- Lessening of depression
- Sustained for up to 1 year of hearing aid use

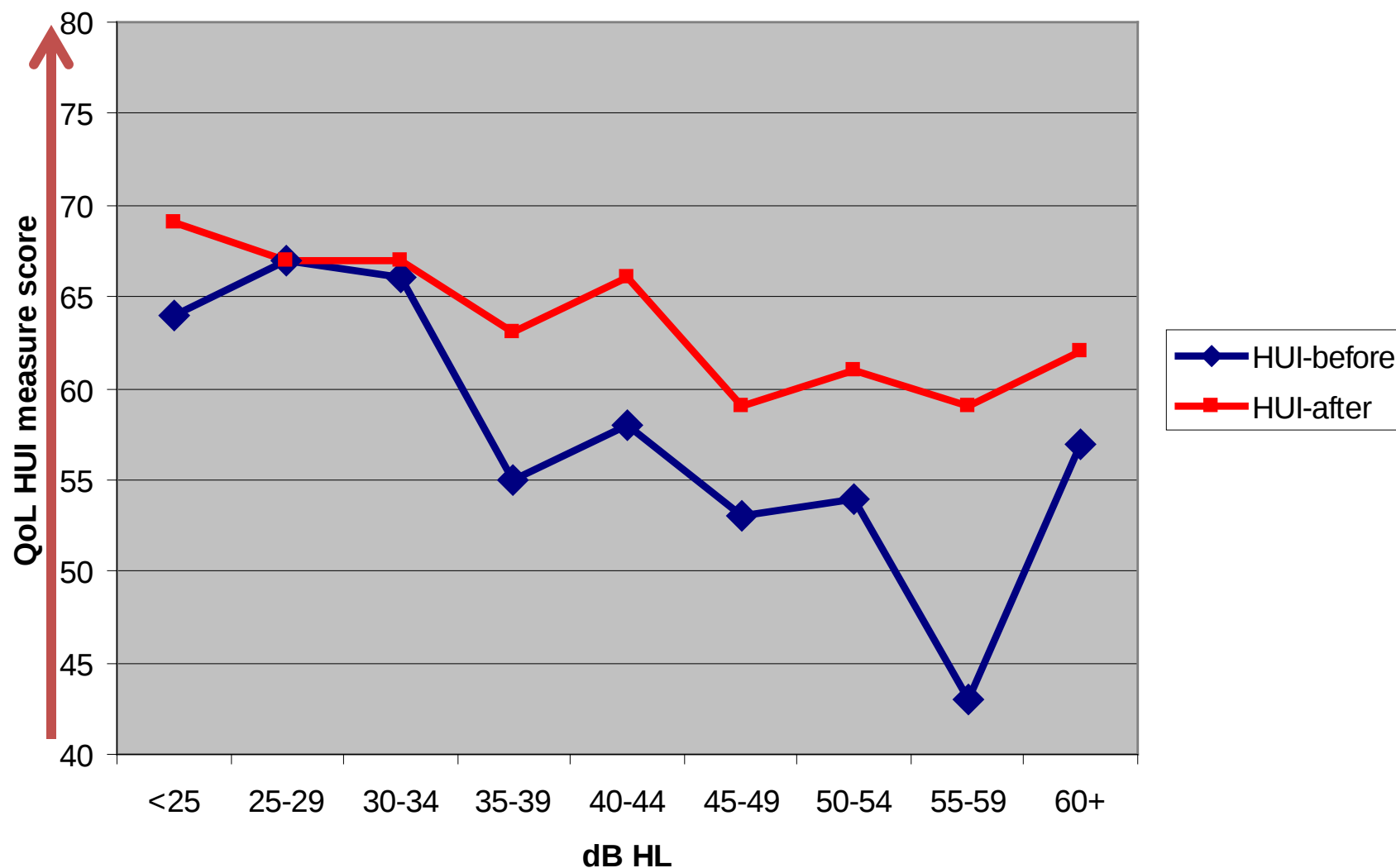
HUI QoL measure as a function of hearing level in new referrals before and after (3m) hearing aid fitting MHAS N= 589



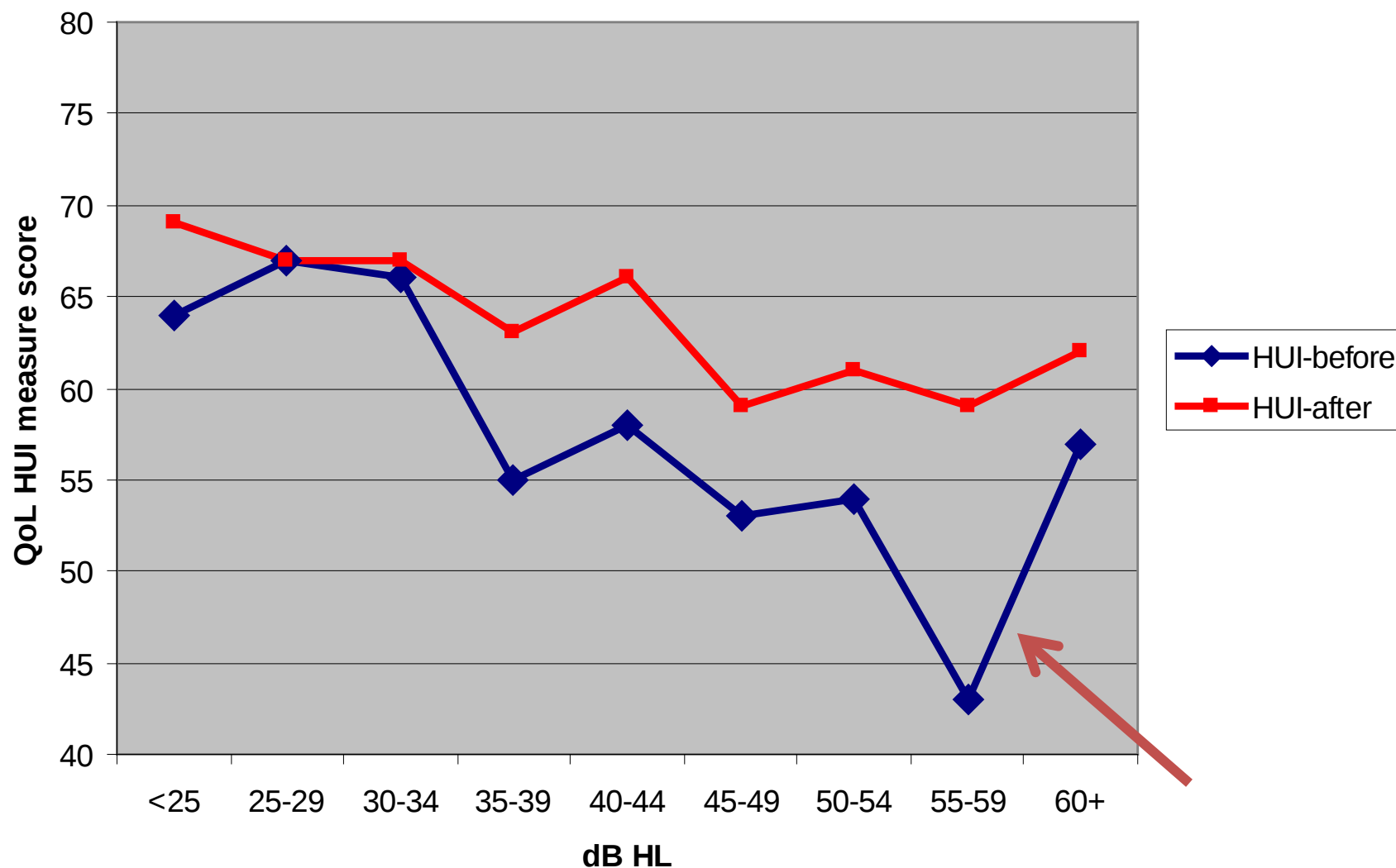
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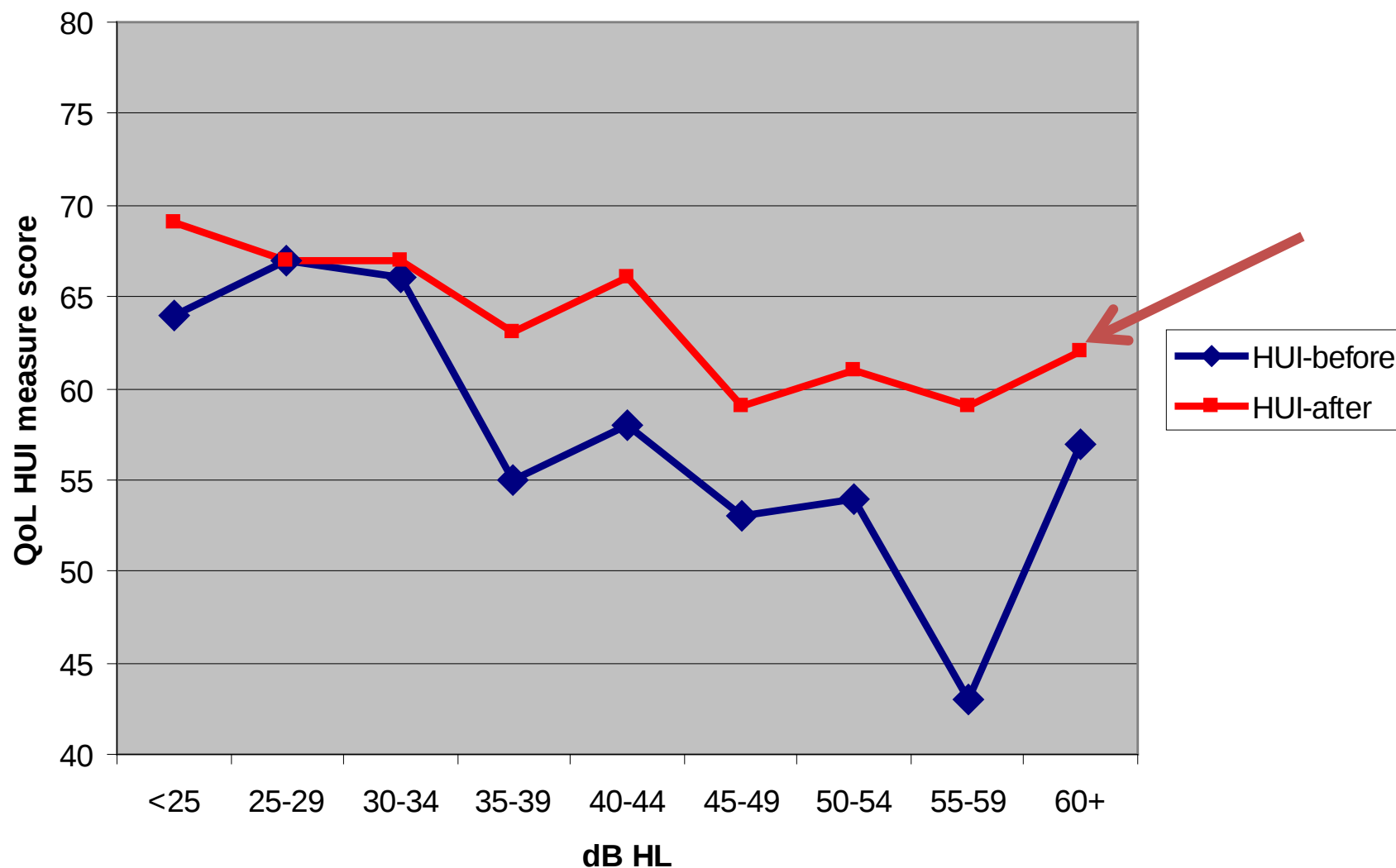
HUI QoL measure as a function of hearing level in new referrals before and after (3m) hearing aid fitting MHAS N= 589



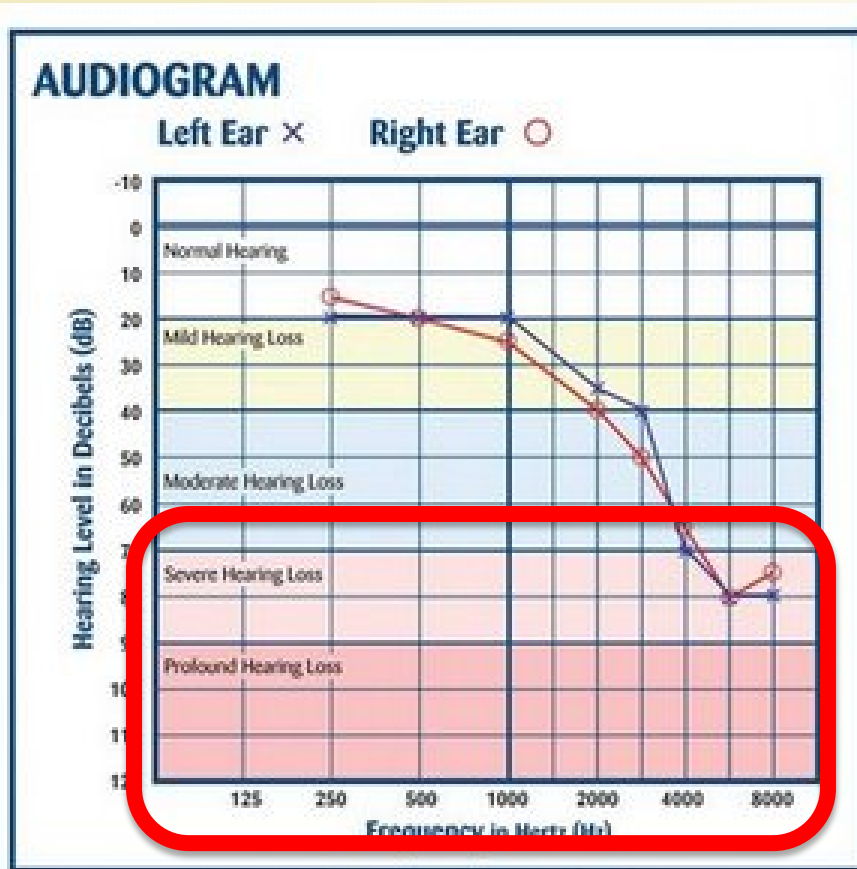
HUI QoL measure as a function of hearing level in new referrals before and after (3m) hearing aid fitting MHAS N= 589



HUI QoL measure as a function of hearing level in new referrals before and after (3m) hearing aid fitting MHAS N= 589



Technical Intervention



* An example presbycusis (sloping high-frequency hearing loss) synonymous with the ageing process.

- Cochlear Implants



Lin et al 2013

Cochlear Implants

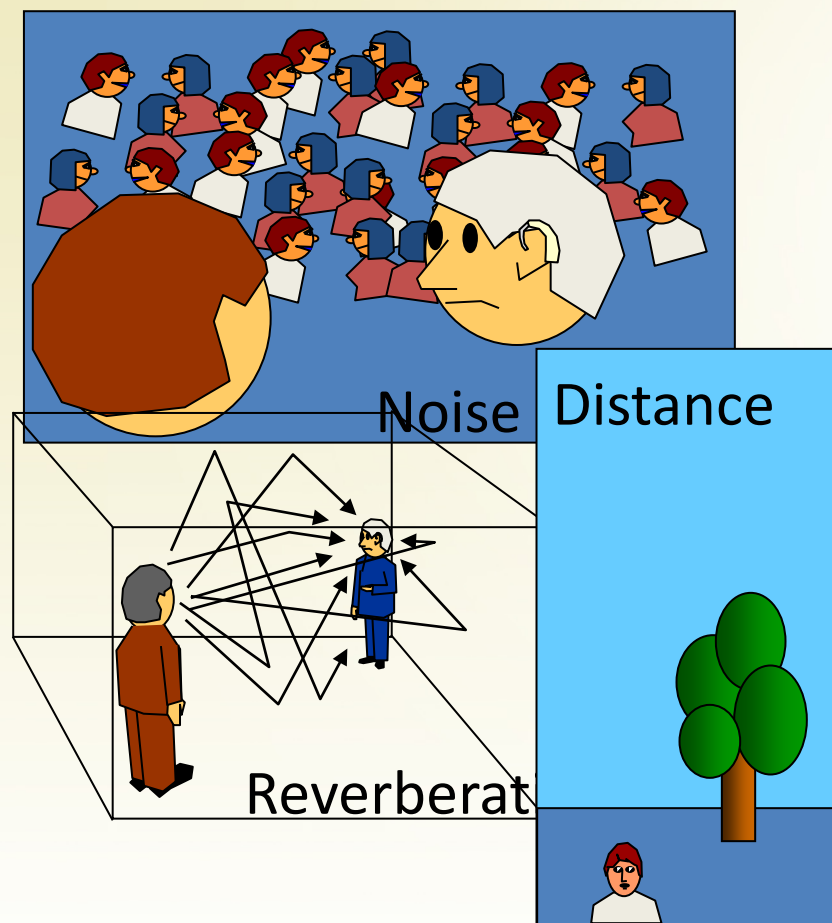
- Medically and surgically appropriate candidate
- Selection of devices
 - Internal surgically implanted electrode arrays
 - External signal processors
- Surgery
- Mapping (adjusting the T- and C-levels) for optimal comfort and understanding

- Improvements
 - Speech perception
 - QoL



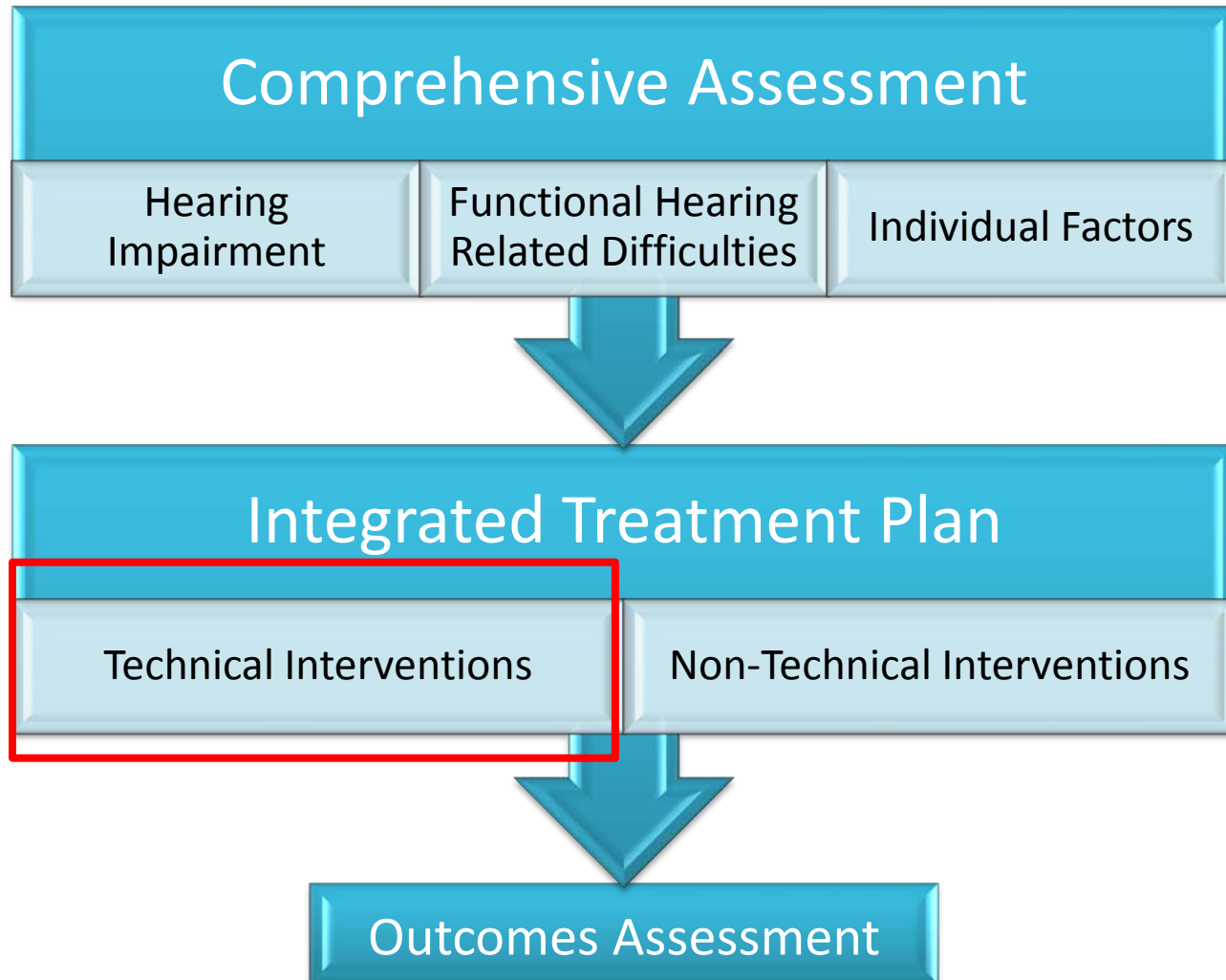
- *e.g., Klop et al 2007 Laryngoscope*

Even with the best hearing aids or cochlear implants, however...



- Challenges in listening and communicating
 - Hearing Loss
 - Cognitive Aging

Managing Hearing Loss for Healthy Aging



Hearing Assistive Technologies



- Assistive Listening Devices (ALDs)
 - Used alone or combined with hearing aids and/or cochlear implants
 - To supplement performance in difficult listening conditions.

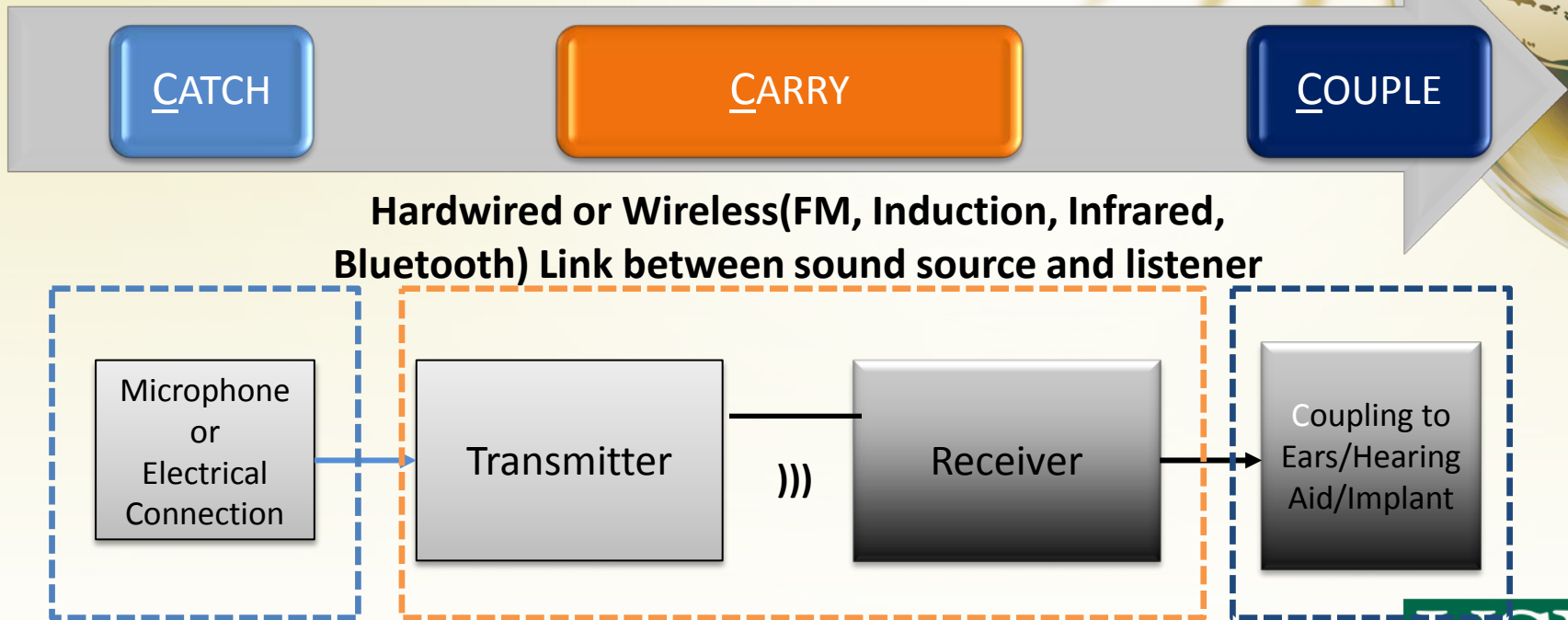
Face to Face

Large Groups

Broadcast or
other Electronic
Media

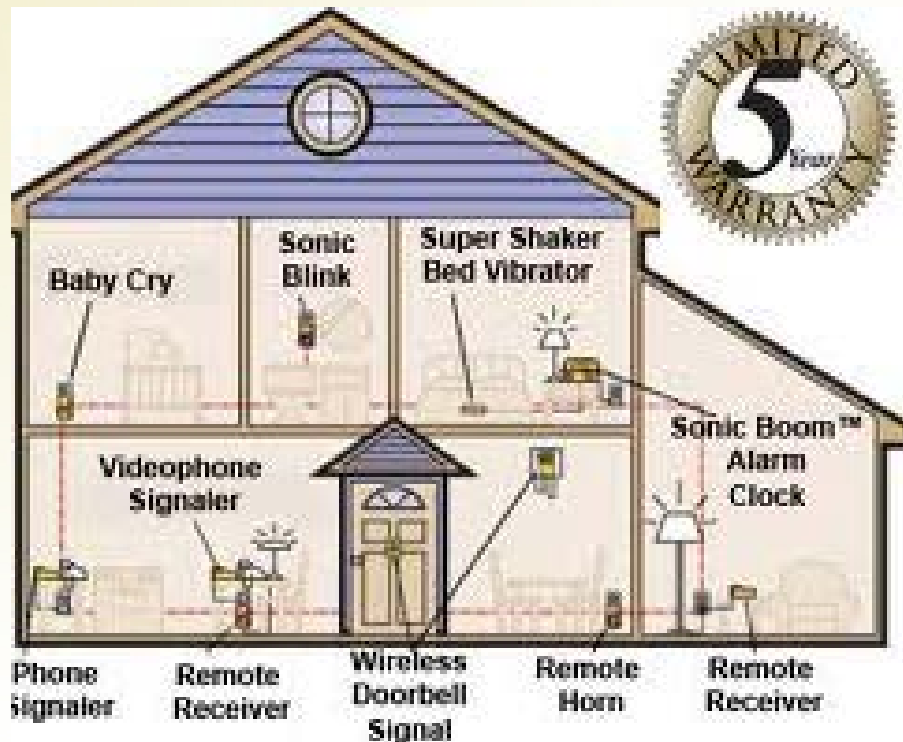
Telephones

Sound is picked up and transmitted directly to the listener, thus overcoming deterioration due to noise, reverberation and distance.



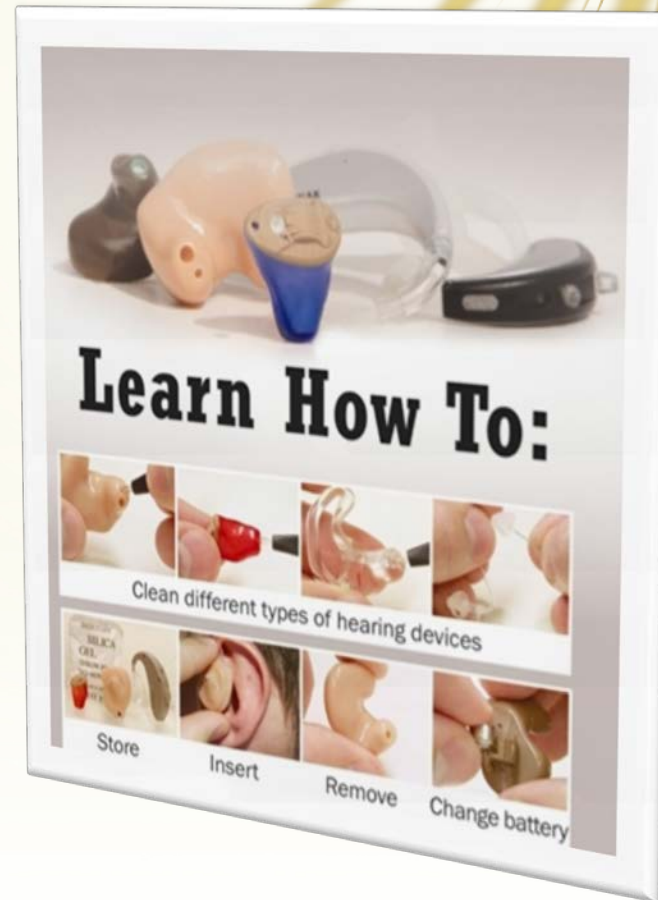
Hearing Assistive Technologies

- Alerting Devices
 - Visual or Tactile

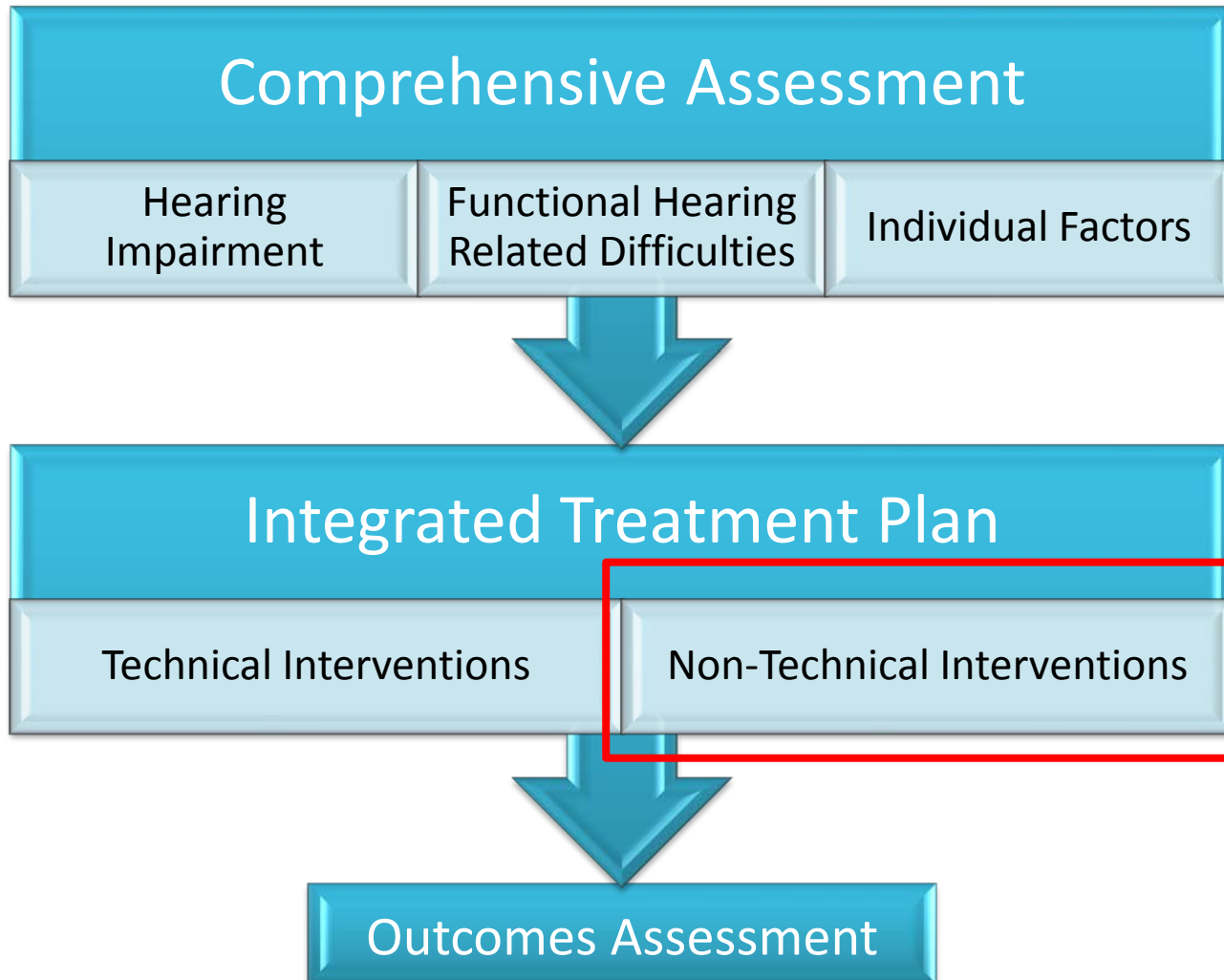


Systematic Device Orientation & Instruction

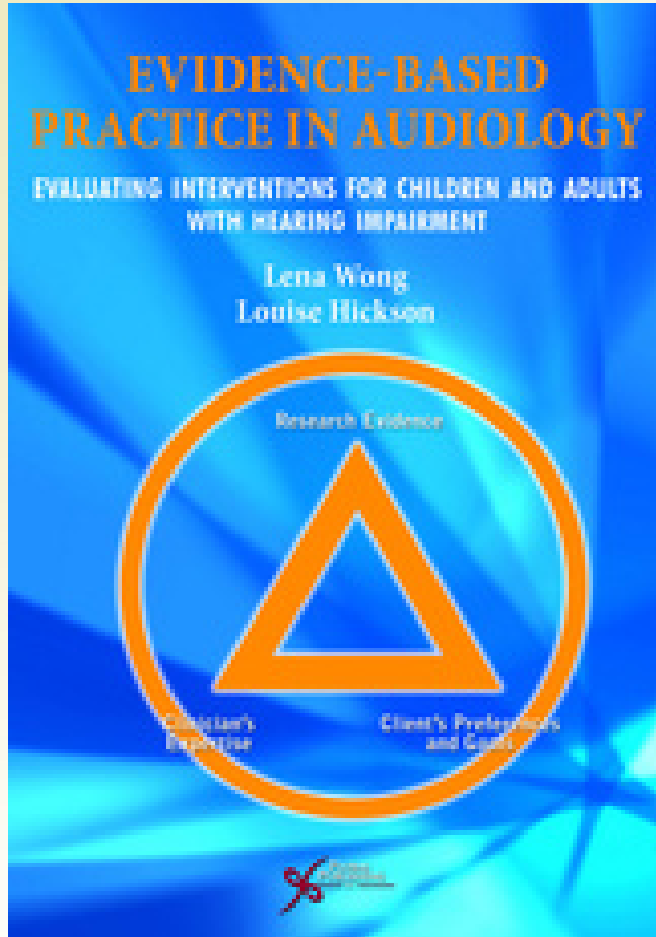
- Device use and care
- Individually or in Groups
- At least one, but sometimes several sessions
- Only about 50% of medical information in general, and HAO information too! (Reese & Chisolm, 2004)



Managing Hearing Loss for Healthy Aging



Aural (Audiological) Rehabilitation



- Chisolm & Arnold (2012)
 - *Evidence About the Effectiveness of Aural Rehabilitation Programs for Adults*

Hawkins, 2005

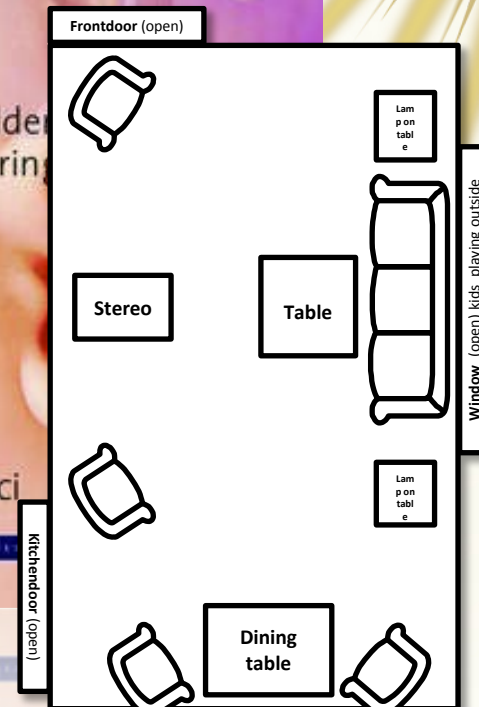
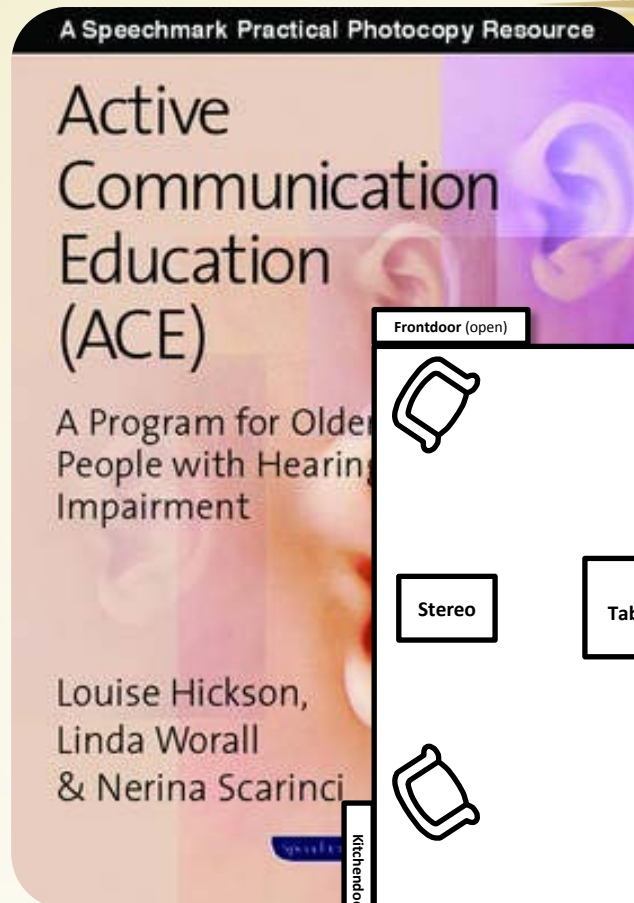
Group Aural Rehabilitation

Table 1. Summary of Studies on Adult AR Groups That Met the Inclusion Criteria

Reference	Design	Intervention	Outcomes	Results	Comments and Study Rating
Abrams et al (1992) <i>Ear Hear</i>	RCT N = 31 total, 3 groups (HA, HA + AR, nothing)	Treatment AR group 3 sessions	HHIE	AR reduced self-perception of hearing handicap (emotional subscale)	Good and no change in Rating
Abrams et al (2002) <i>J Res Rehab Devel</i>	RCT N = 105 total, 52 HA only, 53 HA + AR	Treatment AR group 4 sessions (8 hours)	SF-36V, mental and physical components of quality of life	HA + AR improved in mental domain more than HA, but not significant	Good and no change in Rating
Andersson et al (1995a) <i>Behav Res Ther</i>	RCT N = 24 total, 2 groups (HA, HA + AR)	Treatment AR group of 8 hours	Video observation, Hearing Coping Assessment (HCA)	AR improves relaxation and posture. No difference in HAs or handicap	Small nature phone Rating
Andersson et al (1995b) <i>Br J Audiol</i>	RCT N = 20 total (10 each from 1995a study, contacted 2 yrs. later)	Treatment AR group of 8 hours	HCA and communication strategies subscale of CPHI (posttest only)	HCA—no difference. On CPHI, AR subjects watched faces more and less pretending	Small equivalent HCA Low Rating
Benyon et al (1997) <i>Br J Audiol</i>	RCT N = 47 total, 26 HA only, 21 HA + AR	Treatment AR for 4 (# of hours unknown)	Quantified Denver Scale of Communication Function, scales for	AR group had larger reduction in handicap. Change was in	5 subjects on
Brickley et al (1996) <i>Br J Audiol</i>	Non-intervention cohort design. N = 92, 42 group AR, 50 individual AR	Treatment either group or individual	Hearing Performance Inventory (HPI), given at HAF and again after AR or 4 weeks after HAF if no AR	AR group had significant decrease in perception of hearing handicap. Knowledge of cognitive learning style had no effect	Small group on
Brewer (2001) <i>J Acad Rehab Audiol</i>	Non-intervention cohort design, no control group. N = 35	Treatment AR group 8–10 weeks (2 hrs./wk)			
Chisolm et al (2004) <i>Ear Hear</i>	RCT N = 106, 53 HA only, 53 HA + AR	Treatment AR group 4 sessions (8 hours)			
Hallberg and Barrenas (1994) <i>Br J Audiol</i>	RCT N = 38, 12 group AR, 26 no treatment	Treatment AR group 4 weeks (12 hours)			
Norman et al (1995) <i>Scand Audiol</i>	Non-intervention cohort design. N = 124	Treatment AR group 6 hours, 6 weeks p			
Freminger (2003) <i>J Am Acad Audiol</i>	Non-intervention cohort design. N = 25	Treatment AR group six 90-min sessions or without significant			
Smaldino and Smaldino (1988) <i>J Acad Rehab Audiol</i>	RCT N = 40, 10 in each of 4 groups: HA, HA + AR, HA + cognitive learning style, HA + AR + cognitive learning style	Treatment via AR group (total time not given) and/or disclosure of subject's cognitive style			

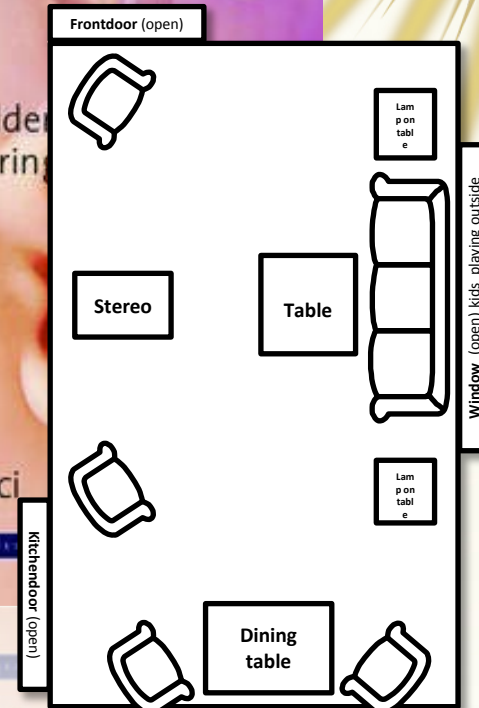
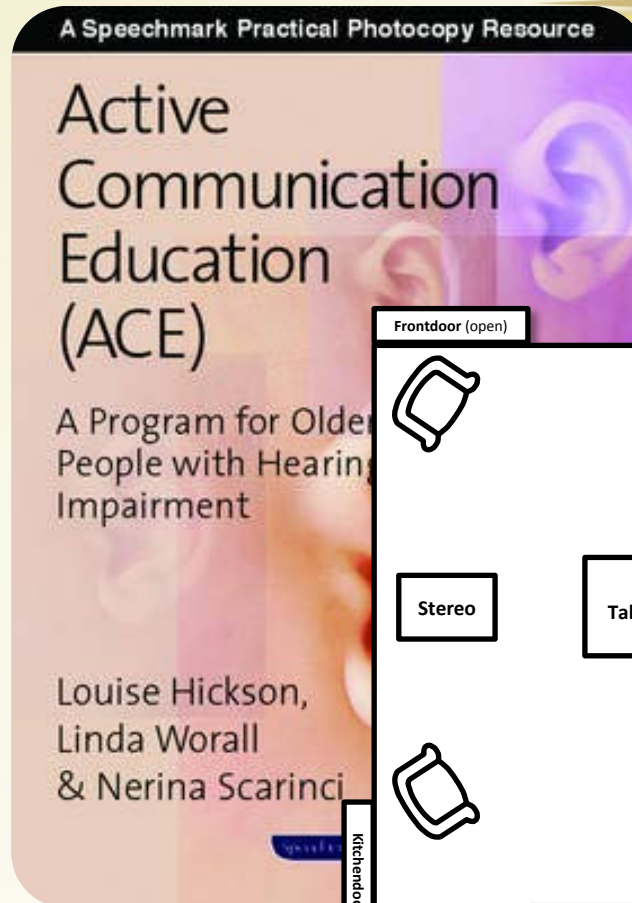
Weekly assignments

- Get to know
 - Communication strategies
 - Problem solving
 - Assistive listening devices
 - Information & advices to spouses
 - Applied relaxation

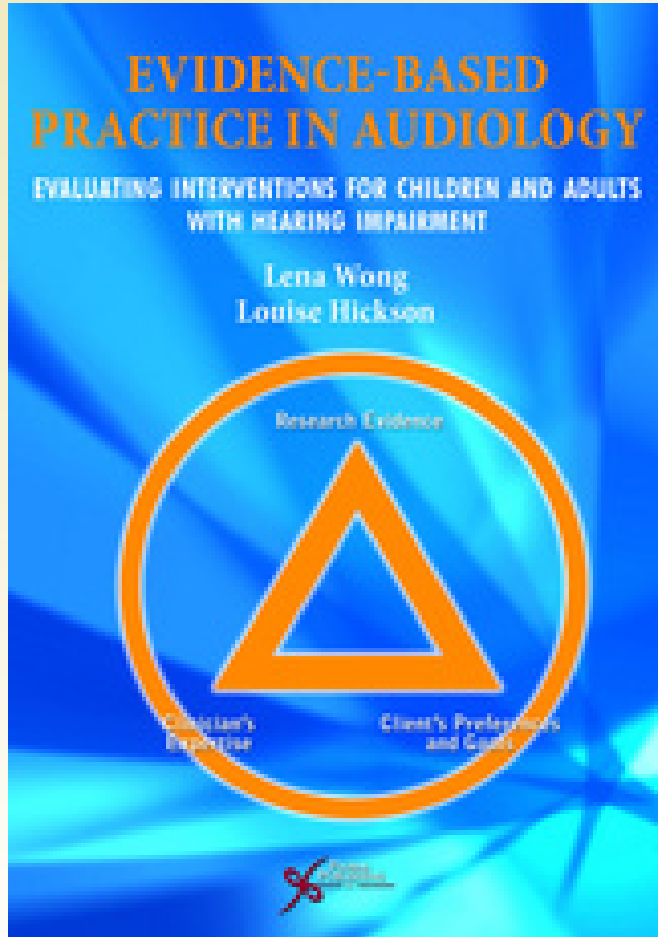


Weekly assignments

- Try out
 - Communication strategies
 - Problem solving
 - Assistive listening devices
 - Information & advices to spouses
 - Applied relaxation



Aural (Audiological) Rehabilitation



- Chisolm & Arnold (2012)
 - *Evidence About the Effectiveness of Aural Rehabilitation Programs for Adults*

Sweetow & Palmer, 2005

Auditory Training for Adult

Table 1. Review

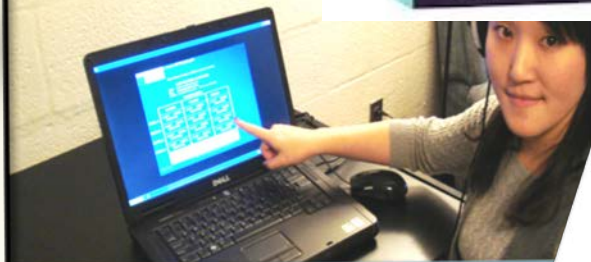
Reference	Design	Measure	Findings
Bode and Oyer (1970)	Before/After with control group	Auditory consonant recognition Visual consonant recognition A-V sentence recognition	All groups improved with training. AR + visual and AR + auditory groups improved more than the AR alone group
Walden et al (1981)	RCT	HHIE Speech recognition test at various SNRs (signal-to-noise ratios)	Significant reduction in self-perceived hearing handicap and improvement in speech recognition in all subjects (control and experimental)
Kricos et al (1992)	RCT with pre- and posttest outcome measures	A-V sentence test	Experimental group improved more on the audiovisual sentence task than
Montgomery et al (1984)	RCT with pre- and posttest outcome measures		
Rubenstein and Boothroyd (1987)	Before/After with no control group		
Kricos and Holmes (1996)	Before/After with control group		

Note: AR = aural rehabilitation; A-V = Communication Profile for the Hearing Impaired; HHIE = Hearing Handicap Inventory for the Elderly (Ventry, 1982); M-Rhyme Test (Resnick et al, 1975); RCT = randomized

Many Commercially Available Computer-Based Programs

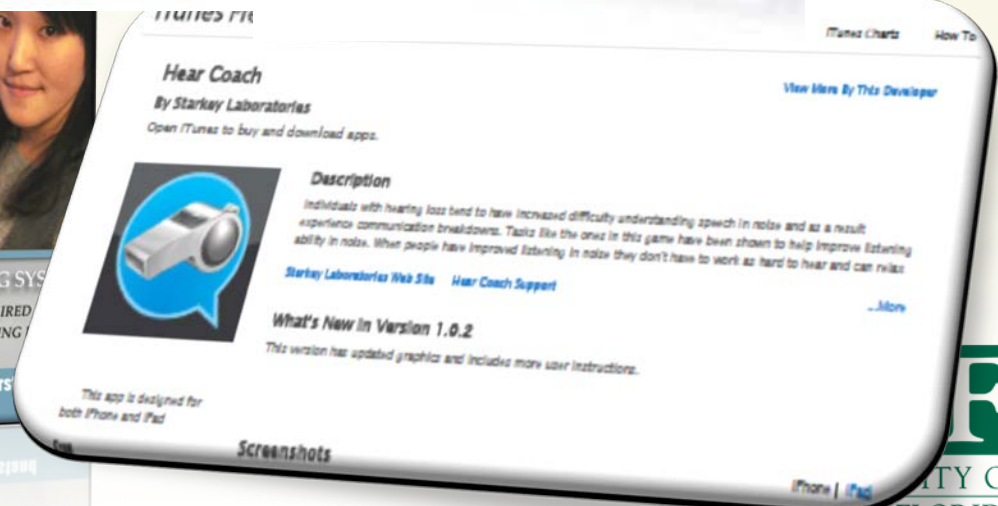
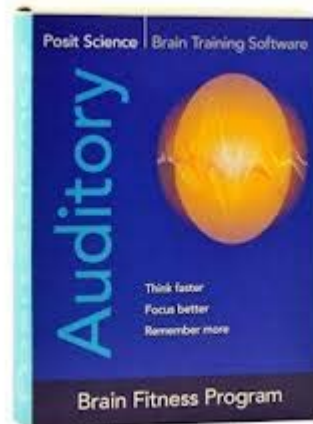


NEW! SPATS-ESL IS NOW FOR
QUALIFIED USERS (to learn more



SPATS PERCEPTION ASSESSMENT AND TRAINING SYSTEM
SPATS-HI: SPEECH RECOGNITION TRAINING FOR HEARING-IMPAIRED
SPATS-ESL: SPEECH RECOGNITION TRAINING FOR THOSE LEARNING
AS A SECOND LANGUAGE

Both systems have been shown to improve the ability to understand conversational English spoken at normal rates.



LACE Training

➤ Comprehension of Degraded Speech

- Speech-in-babble
- Time-compressed speech
- Competing speaker

➤ Enhancement of Cognitive Skills

- Auditory working memory
- Missing word identification using context

➤ Use of Communication Strategies

- Helpful hints



Systematic Review: Computer Based Auditory Training Systems for Adults with Hearing Loss (Henshaw & Ferguson, 2013)

- *“Our findings demonstrate that published evidence for the efficacy of individual computer-based auditory training for adults with hearing loss is not robust and therefore cannot be reliably used to guide intervention at this time.”*
- Further research is needed for optimizing auditory training for adults with hearing loss

Summary of Evidence for Group AR and Auditory Training (Chisolm & Arnold)

- Post-fitting Group AR can improve outcome
 - Reduced perceived handicap
 - Improved speech-in-noise performance
 - Improved quality of life
- Group AR can ‘accelerate’ hearing aid benefit
- Communication partners benefit
- Even without device use, for milder HL, Group AR can provide information and strategies to enhance communication (1st step)
- Listening (auditory) training can be effective for “some” people, further research needed.

Final Thoughts:

Hearing loss & healthy aging from a public health perspective

- Individuals recognize that they have the condition
- Society and individuals believe the condition is important & should be treated
- Making effective treatments readily accessible



Final Thoughts:

Hearing loss & healthy aging from a public health perspective

- Age-related hearing loss is not understood to be an important public health issue
 - Studies of cognitive, functional, and social-emotional effects
 - Studies examining Health Beliefs & Attitudes and Hearing Loss



Final Thoughts:

Hearing loss & healthy aging from a public health perspective

- Evidence-based interventions are available
 - Continued need to improve, based on new understandings of cognitive aging
 - Studies examining potential for hearing intervention to influence cognitive, functional, and social-emotional status



Final Thoughts:

Hearing loss & healthy aging from a public health perspective

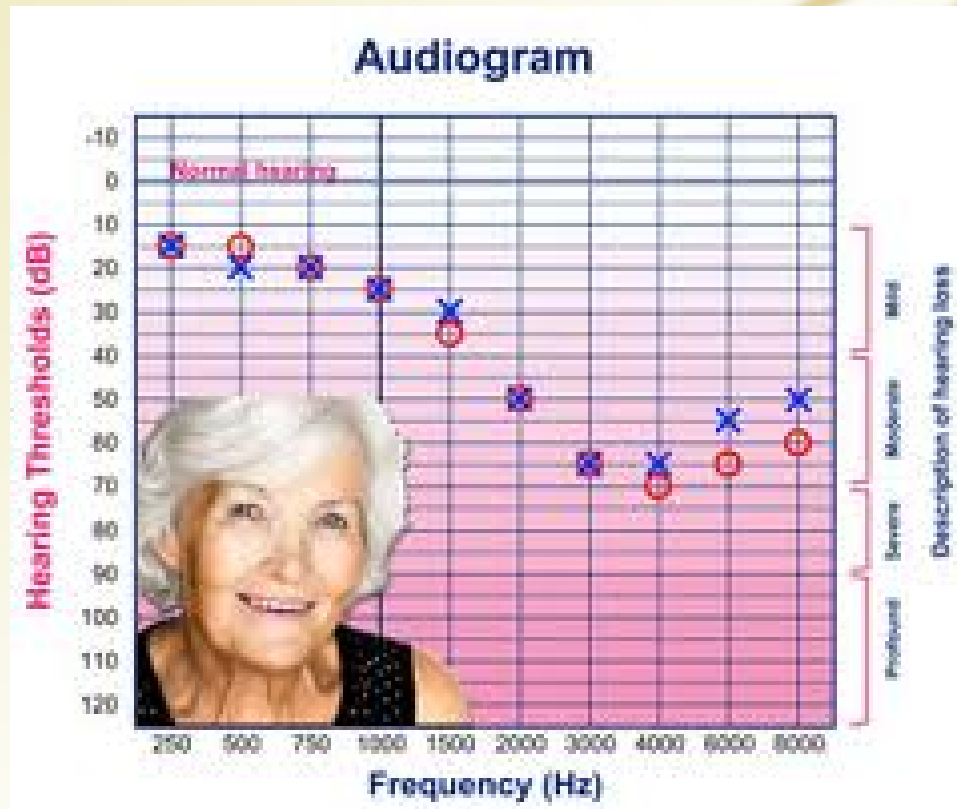
- Lack of insurance coverage for hearing rehabilitative devices and services
 - Cost of devices (PSPs?)
 - Value through well-controlled studies of both technical and non-technical interventions
- Over-emphasis on devices rather than comprehensive, integrated hearing rehabilitation.



CHANGE THE LANDSCAPE

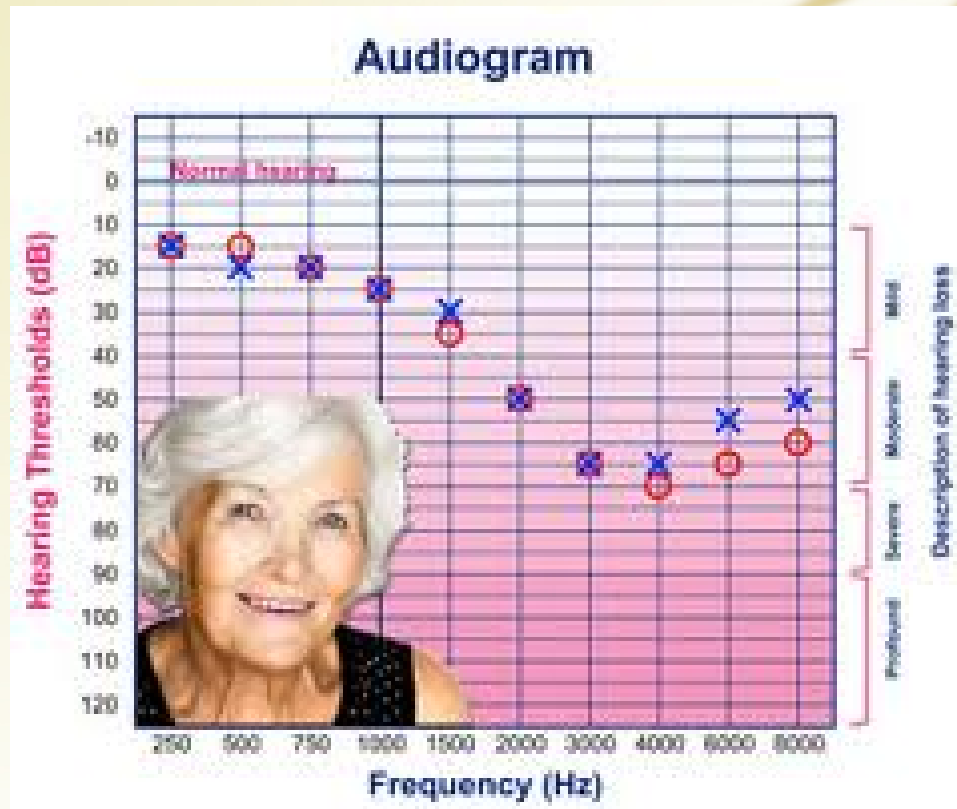


Spectrum of Hearing Impairment



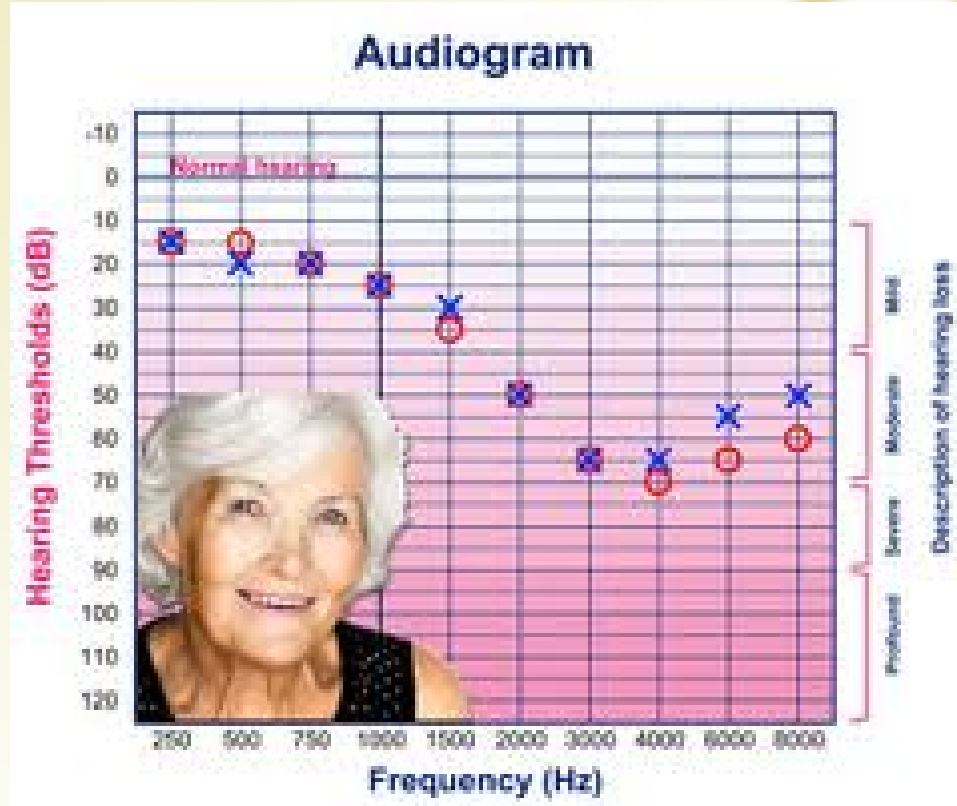
“Blindness separates us from things but deafness separates us from people.” Helen Keller

Provide interventions that mitigate the negative effects



“Blindness separates us from things but deafness separates us from people.” Helen Keller

Live well with Hearing Loss as a part of Healthy Aging



“Blindness separates us from things but deafness separates us from people.” Helen Keller