SPAU338
Hearing Aids II

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Spring 2020

Assistive Listening Devices & Technologies

Why aren't hearing aids enough?

- Noise
- Distance
- Reverberation
- Let alone hearing environments with both, noise and reverberation!
- HA microphones can't always be close to sound source

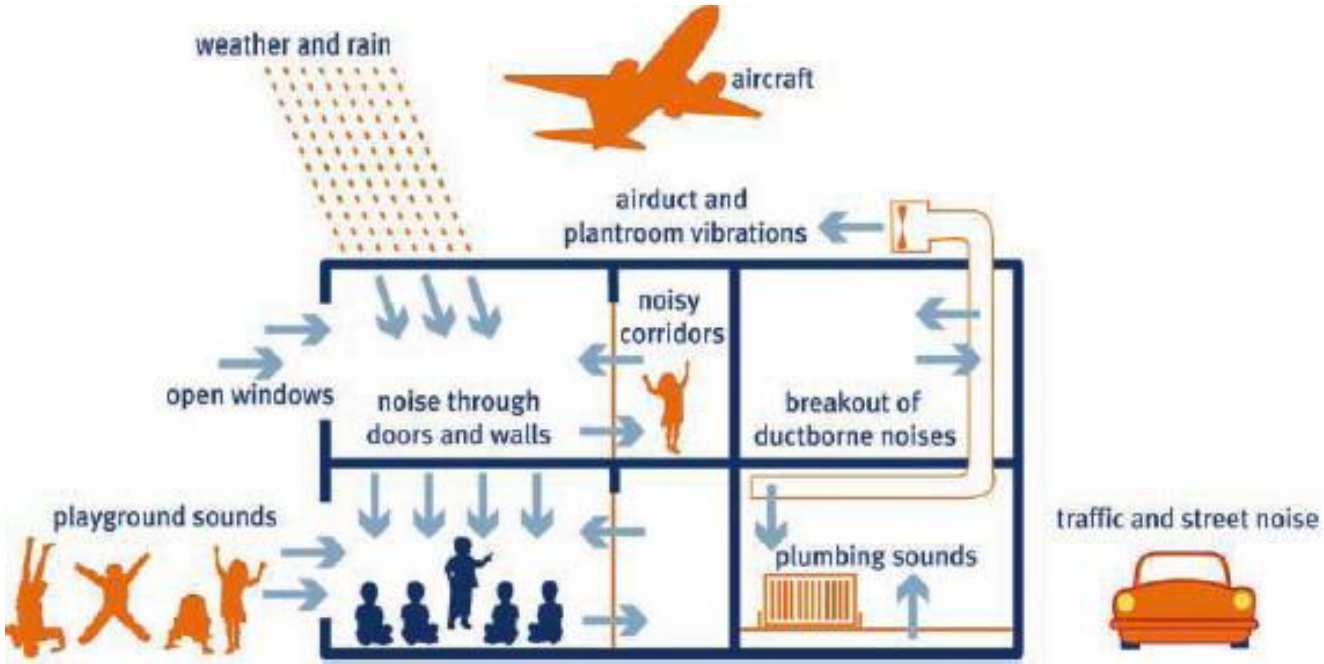
Effects of Noise

- Noise is present in most listening environments
- Hearing aids cannot selectively amplify only the speaker's voice
- Signal-to-noise ratio (SNR) - People with a HL require a greater signal-to-noise (SNR) ratio to understand speech
  - Normally-hearing adults need to have an SNR of +6 dB
  - Hearing-impaired adults need an increase of about 15 to 25 dB
  - NH children need +16 dB SNR
  - HI children need +20 to +30 dB SNR

Effects of Noise

- Sources of noise in a classroom
  - Classroom appliances: Heating systems, ventilation, and air Conditioning
  - External noises: Traffic noise, adjacent classrooms and corridors
  - Internal Factors: Conversation of fellow pupils

- In a typical classroom setting the teacher's voice is at a level of approximately 65 dB, and the background noise is approximately 60 dB
- SNR = 5 dB
- Clearly inadequate for deaf student
- Children with normal hearing also suffer when there is a poor SNR.

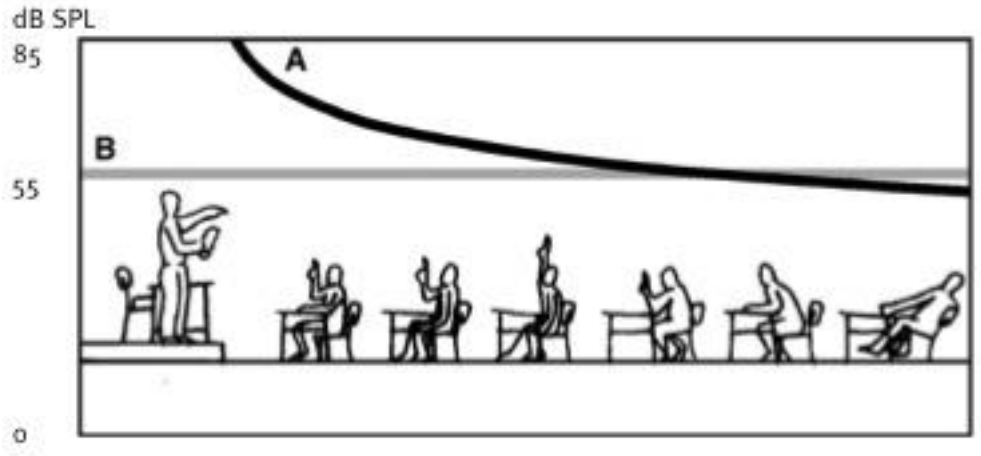


Effects of Distance

- Sound fades rapidly as distance increases
- Speech signal drops 6 dB for each doubling in distance
- If the speaker's voice starts at 85 dB it drops to 65 dB just one meter away

Effects of Distance

- Problem at school if not near teacher/speaker
- Distance can also be a challenge at home (many situations when children are far from speaker)



Increasing the distance between teacher and student reduces speech understanding.

A = Level of teacher's voice
B = Level of background noise

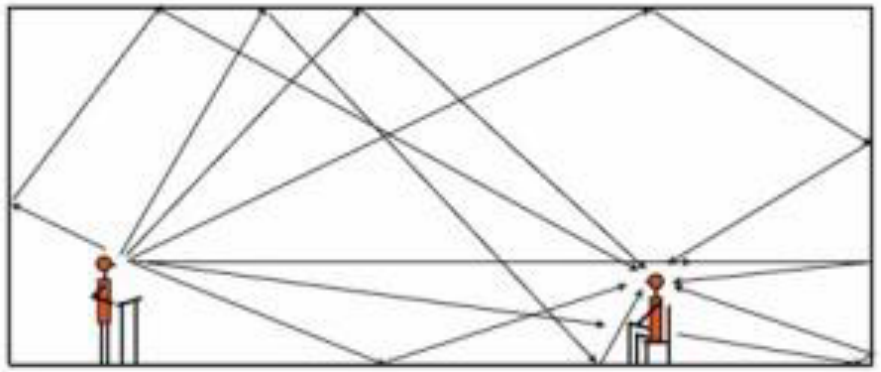
http://www.aussiedeafkids.org.au/all-about-fm-1.html

Effects of Reverberation

- Reverberation is the persistence of sound after the original sound is removed
- When sound is produced, a large number of echoes build up and then slowly decay as the sound is absorbed by the walls and air, creating reverberation
- RT60 is the time it takes for a sound to lose its intensity by 60 dB (e.g. from 60 to 0 dB)
- Result: Numerous sound reflections which are merged with original sound
- When so many reflections arrive at a listener it is difficult to distinguish them from each other, which results in disruption in speech intelligibility

Effects of Reverberation

- Should be no higher than 0.3 to 0.4 seconds for people with hearing loss
- The higher the reverberation time (greater than 0.6), the more difficult it becomes to understand speech
- Average reverberation time in classrooms? 0.8 seconds! (0.4 – 1.5s)
- High ceilings in old classrooms one of biggest problems



http://hearinghealthmatters.org/waynesworld/2016/echo-has-the-last-word-part-

Assistive Listening Devices (ALD's)

- Reduce effects of distance, background noise, and reverberation
- Microphone can be positioned close to sound source

Methods of Signal Transmission

- Direct audio input
- Electromagnetic energy
- Frequency modulated signal
- Infrared signal
- Bluetooth (usually with streamer)

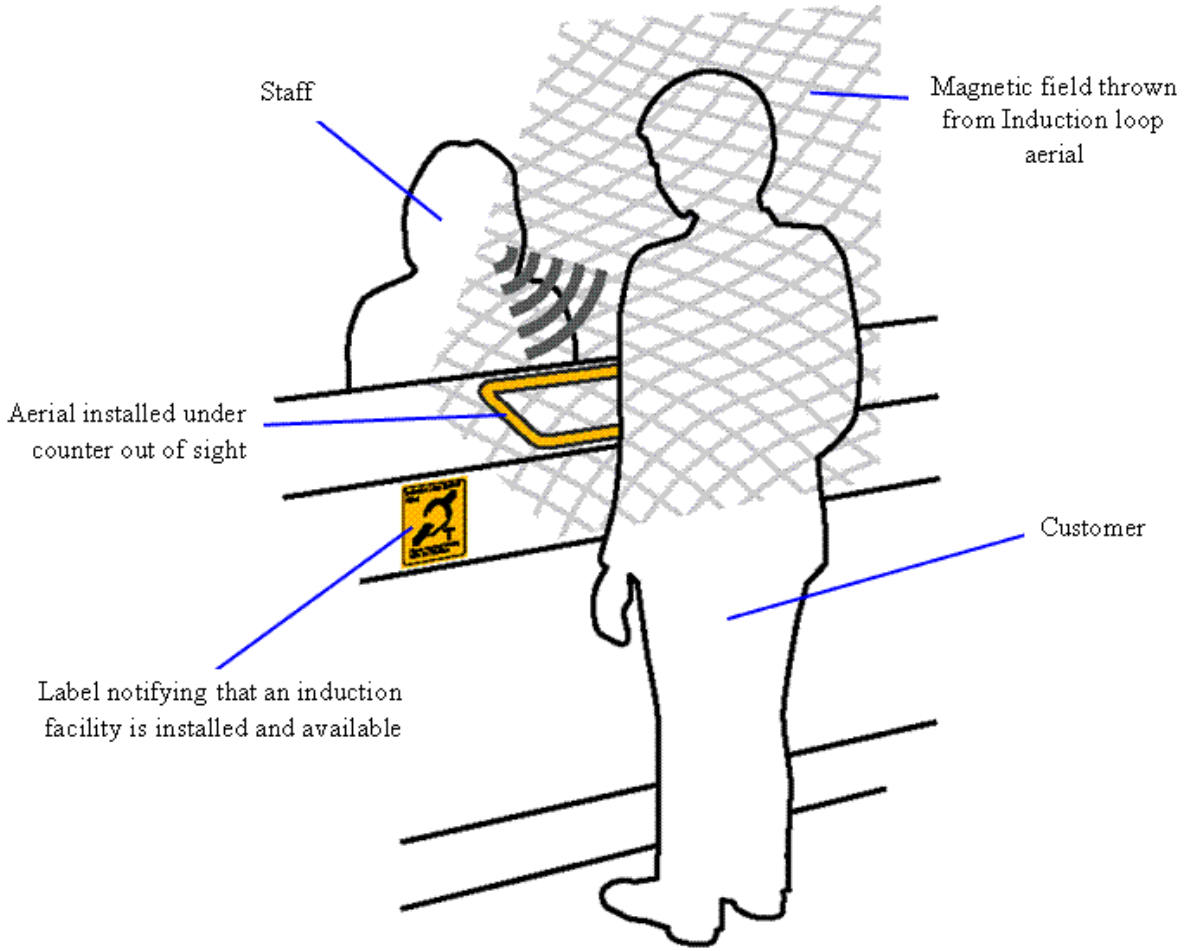
ALD’s

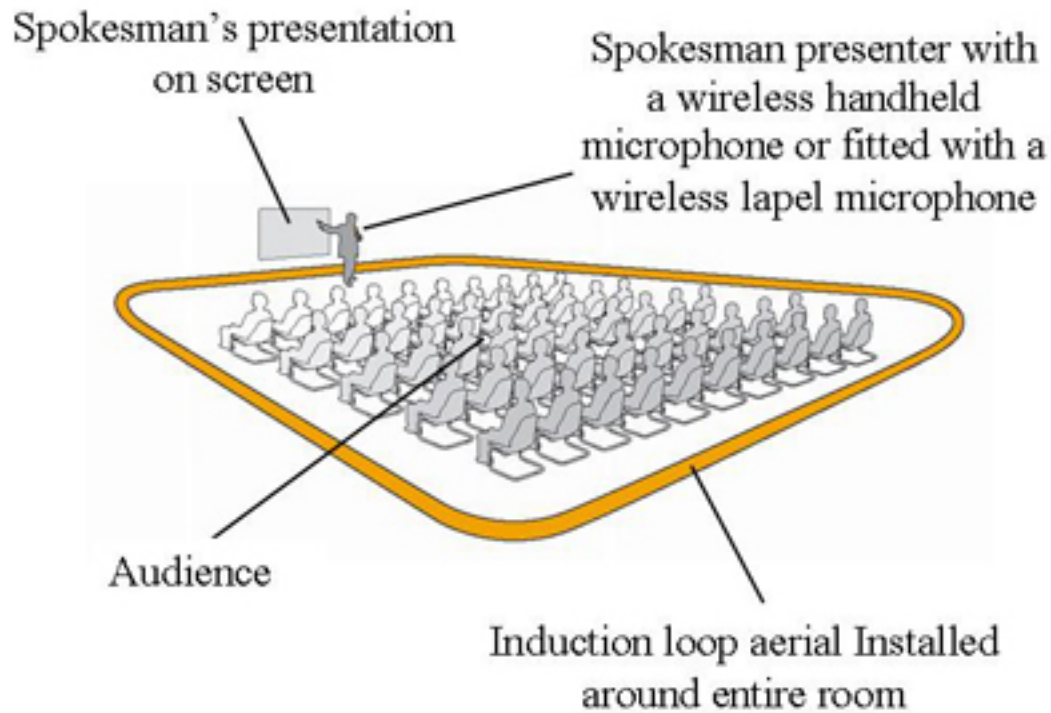
- Room loop systems (induction/telecoil)
- Radio Aids (i.e. FM systems)
- Personal amplifiers
- Telephone couplers & amplifiers
- Mobile phone adapters

Induction/Loop Systems

- Consist of a copper wire placed around a room, theater or counter which is connected via a special loop driver to a public address or sound system
- An electromagnetic field is created that connects to a telecoil in hearing aids, cochlear implants or telecoil receivers
- Simple, discrete and effective!

Induction/ Loop Systems





Radio Aids

Hearing aid or cochlear implant

Receiver

- Ear-level receiver unit, usually attached via a direct audio input shoe
- Integrated receiver, built into the hearing aid battery drawer
- Neck-loop receiver
- Body-worn receiver
- Ear-level receivers for children who do not use hearing aids

Transmitter

- FM
  - Transmitter and receiver must be on same radio frequency
  - May receive unwanted signals/ interference
- Digital
  - Frequency management much easier
  - Minimal chance of interference
  - Improved sound quality

Radio Aids:
Direct communication from teacher to pupil

- Noise
  - ✓Higher SNR
- Distance
  - ✓Sound is brought closer to listener without losing energy
  - ✓Child can sit wherever they want
- Reverberation
  - ✓Direct delivery of speech signal prevents masking

Main Benefits

- Easier for child to hear and concentrate
- Especially helpful when classroom has poor acoustics
- Can be used with or without hearing aids/cochlear implants

‘NDCS Quality Standards for the use of personal FM systems’

- Every child with a hearing loss is a candidate for a personal FM system

- Assess readiness for using an ALD:
  - Ability to manage equipment
  - Ability to report / show by behaviour problems with input (can the child report on what they can hear? instrument is not working?)
  - Be aware of over reliance / developing listening skills

Let’s watch

- https://www.youtube.com/watch?v=1mHHsHxb2xU
- https://www.youtube.com/watch?v=yf1n8Fs9JHs&feature=youtu.be
- https://www.youtube.com/watch?v=GiNFh665k7Q

Alerting Devices

Allow independent living

Give sense of control

Life & death!

Alerting Devices

- Alarm clocks
- Fire alarms
- Door bells
- Baby monitors
- Pagers

Hearing dogs for deaf people

- Trained to recognize alerting sounds (doorbell etc.)
- Lead owners to sound source
- Give warning in response to danger signal
- Owners report increased confidence
- https://www.youtube.com/watch?v=JrMMBUsKnNc

Obtaining Equipment (&dogs)

Social services	Employer & Education services	Private purchase	Charity
• Long-term loan • Self-referral or referral via Audiology • Limited range of equipment and long waiting times • Fire service may provide smoke alarm	• Equality Act 2010 – Employers/ educational institutions required to make “reasonable adjustments” • Includes changing telephone, installing loop in meeting room	• Specialist companies: Ex. Action on Hearing Loss • Some equipment sold by HA dispensers	• Hearing Dogs for Deaf people is a registered charity • Relies on public donations

Compton 2000: Advice (Alpiner & McCarthy book)

- Be flexible!
- Need for ALD's may not correlate with severity of hearing loss
- Consider: lifestyle, affordability, ease of use, versatility, other family members
- BTEs more compatible with most ALD than ITEs
- Demonstrate ALD's in a way relevant to patient
- Assertiveness training often helpful

ALD's as an alternative to HA's

- When only specific situations cause problems or concern (e.g. phone)
- When HA's are too difficult to manage (dexterity problems / dementia)
- For bed-bound patients (Feedback)

Contralateral Routing of Offside Signal (CROS) Aids

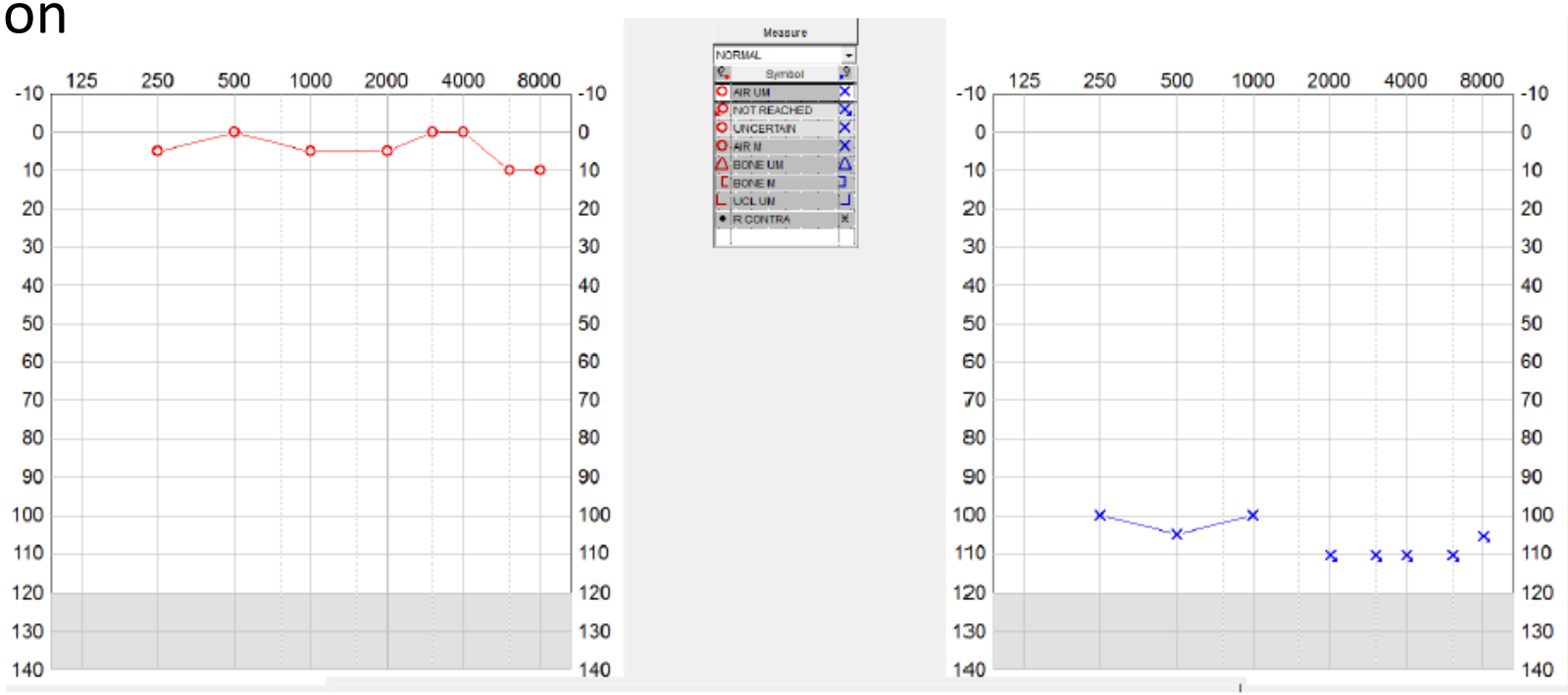
- Severe-profound unilateral hearing loss
- Unilateral poor speech discrimination
- Chronic infection
- Malformation

CROS Aids

- Fitting a power hearing aid on one ear and nothing on the good ear will:

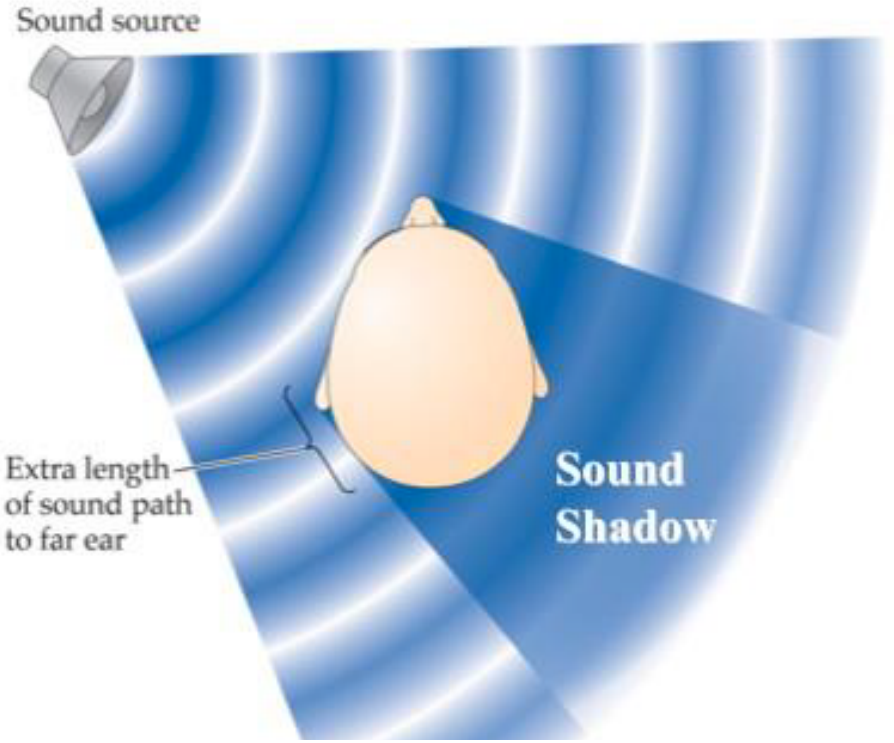
At worst: Cause distortion

At best: Do nothing



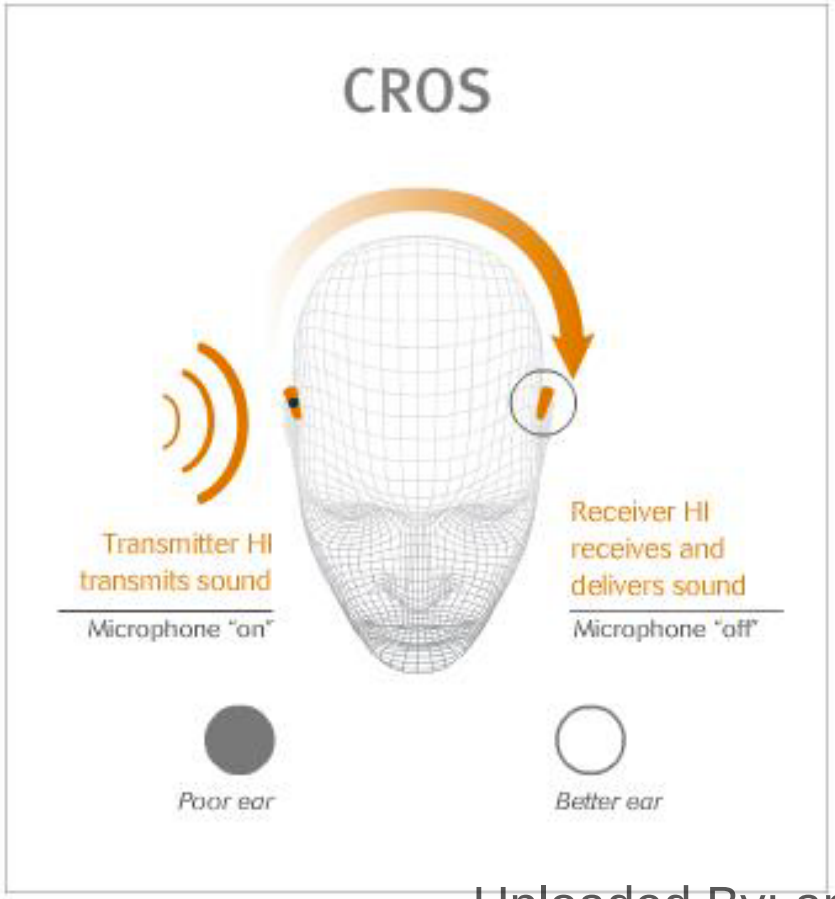
CROS Aids

- Head shadow can reduce speech recognition in specific listening situations
  - ➢ When sound of interest is directed towards poor ear



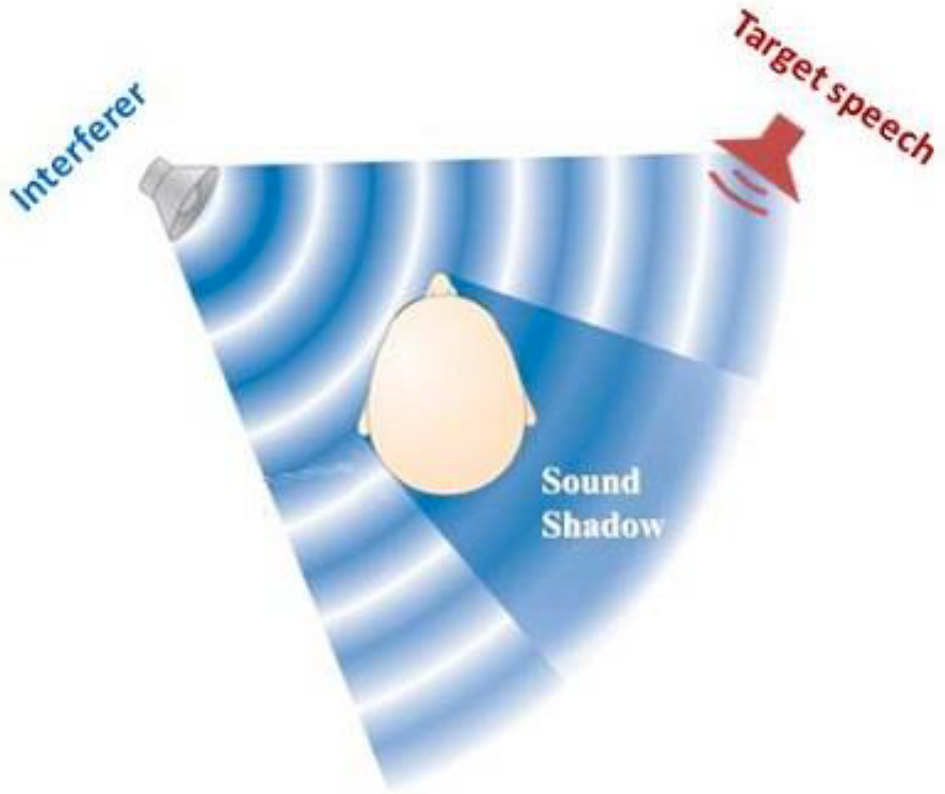
CROS Aids

- Microphone is worn on poor ear
- Amplifier and receiver worn on good ear
- Goal: Reduce head shadow effect
- Validation:
  - Apply 0 dB insertion gain
    (No gain, but also no loss)
  - REAR should equal REUR
    (Therefore REUR is the target)



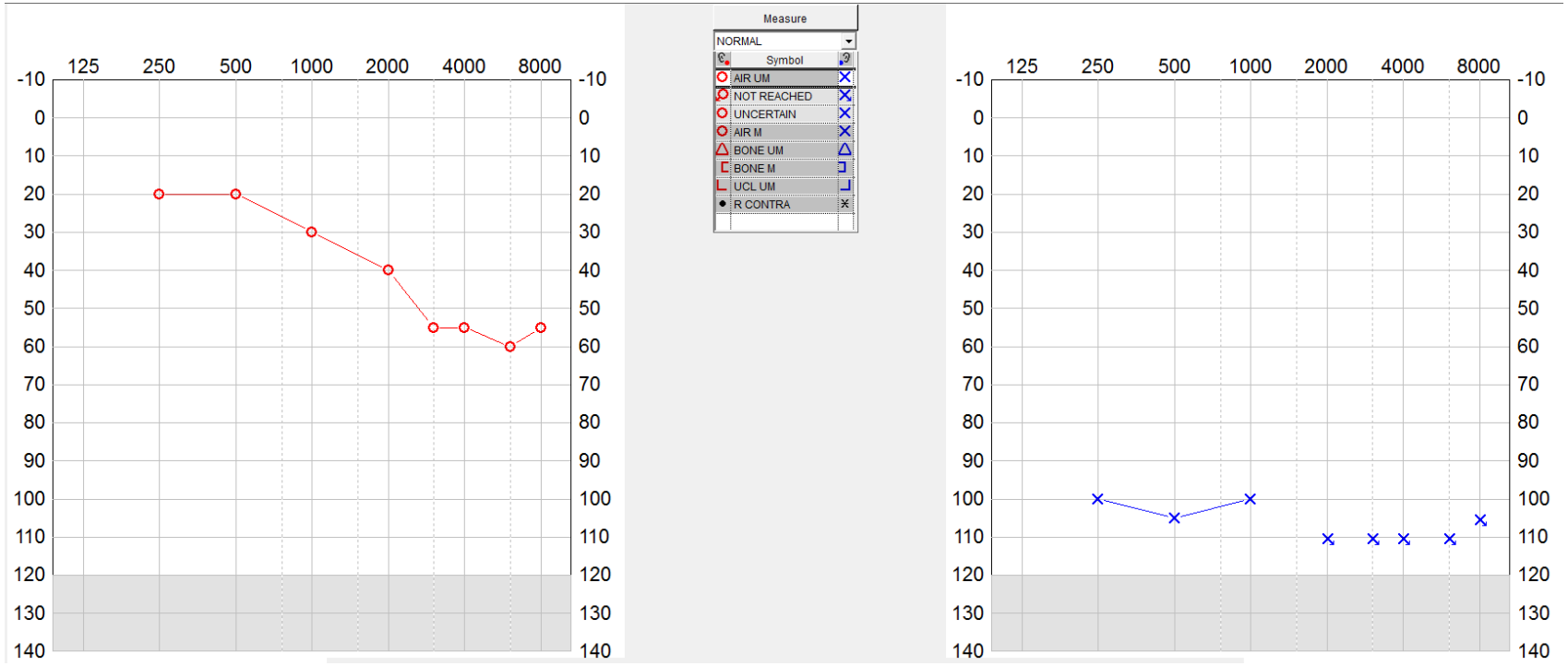
CROS Aids

- Possible problem:
  - Speech signal from good side
  - Noise from poor side



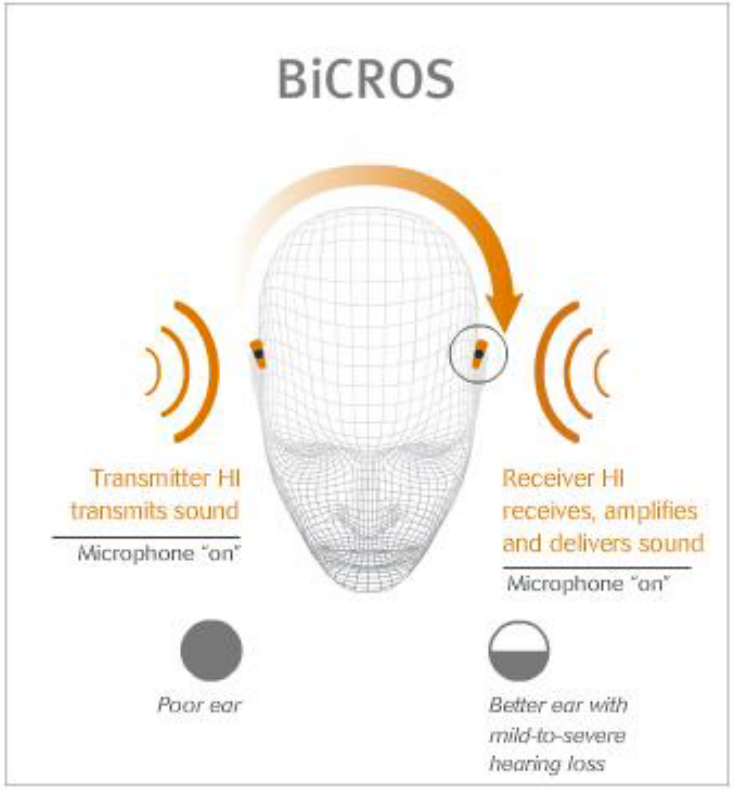
Bilateral CROS (BiCROS) Aids

- Both ears have hearing loss (Asymmetrical)



BiCROS Aids

- REAR targets for the better ear are also the targets for the signal directed from the poorer ear.



Let’s watch

- https://www.youtube.com/watch?v=16LC2FYu1-U