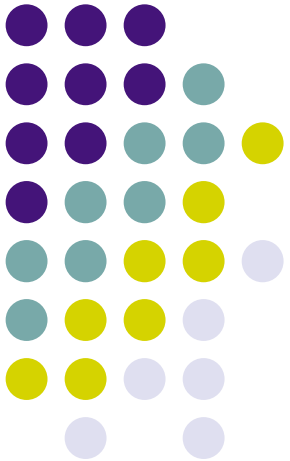
Hearing Aids

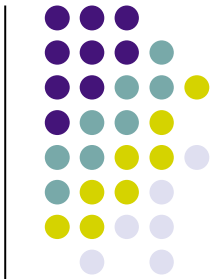
Carol De Filippo

Viet Nam Teacher Education Institute

June 2010

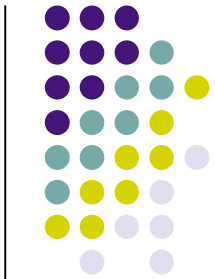


Topics: Hearing Aids

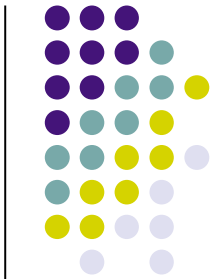


- Benefits
- Components
- Technologies
- Styles
- Fitting
- Care
- Classroom teacher tasks

Hearing Aids
… for *all* degrees of hearing loss



- **Mild Hearing Loss**
  - Very helpful for hearing high-frequency speech sounds (examples: p, t, k, f, s, sh)
  - Especially beneficial when hearing loss reaches 30-40 dB HL
- **Moderate to Severe Hearing Loss**
  - High motivation
  - High benefit



- **Profound Hearing Loss**
  - Great variation in benefit
    - May shift functional status to “hard-of-hearing”
    - May not be a choice for those who identify as culturally Deaf
  - Factors that influence benefit
    - Age when hearing loss was identified
    - Type of hearing loss and progression of loss
    - Age when hearing aid was first used (duration of deafness)
    - Exposure to spoken language
    - Consistency of listening experience
    - Family support
    - School support

Benefits of Hearing Aids

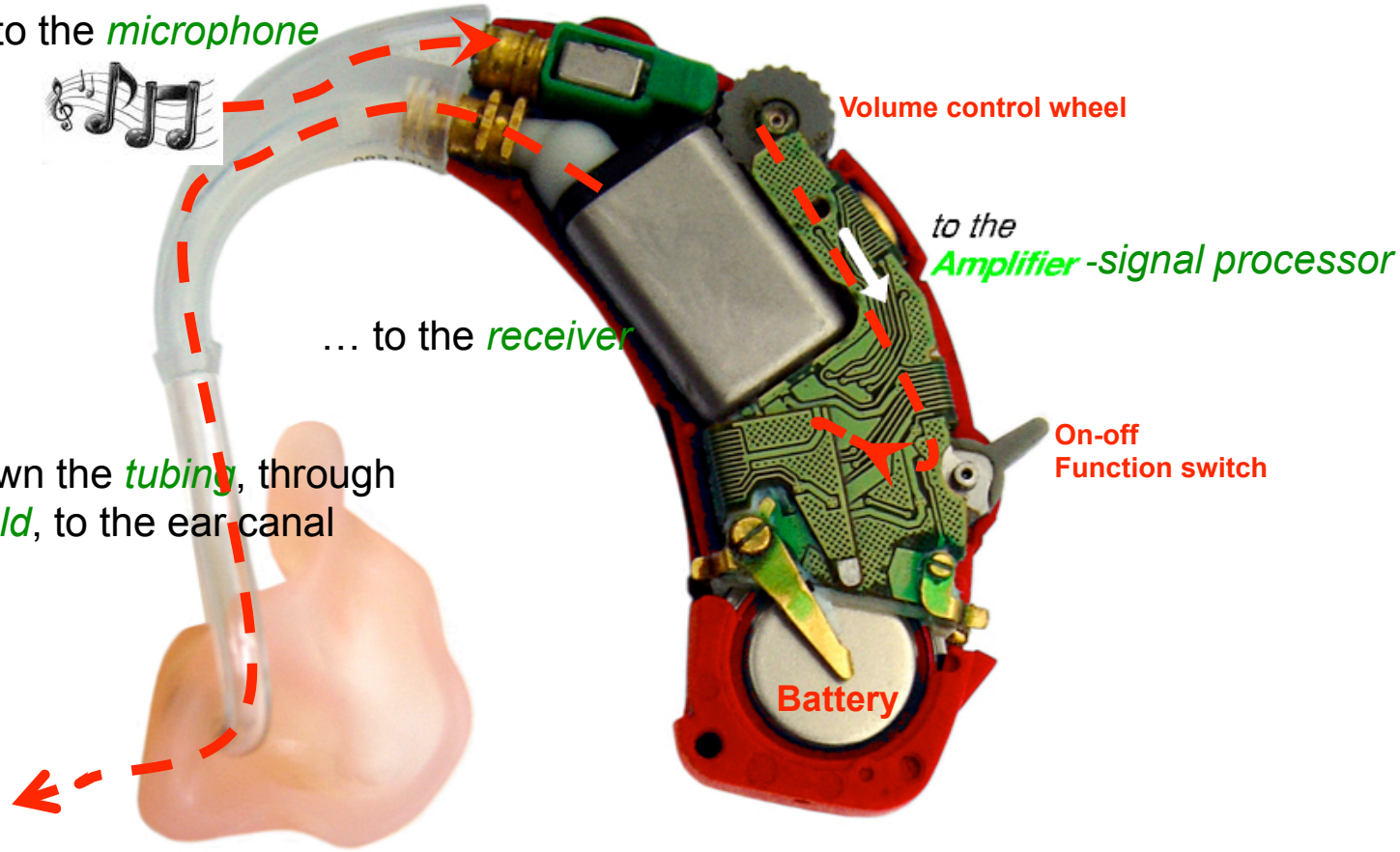
- Expanded **communication** options
  - Greater hearing aid use correlates with increased speech intelligibility
  - Greater hearing aid use correlates with more effective use of speechreading
- **Education** gains
  - Continued hearing aid use correlates with higher academic achievement
  - Duration of hearing aid use correlates with language skill level

http://www.time4speech.com.au/Page2-Speech-Sounds/Speech-Sounds.html

Reasons for nonuse in the U.S.

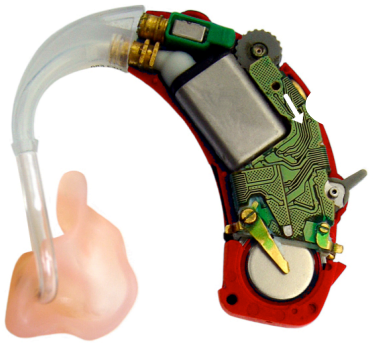
- Lack of encouragement
- Lack of models (successful adults in the environment with hearing aids)
- Lack of support
- Lack of auditory environment (no *need to listen*)
- Older children's concern that a hearing is very noticeable; peer pressure
- Poor hearing aid fit, which leads to poor benefit

Basic hearing aid components



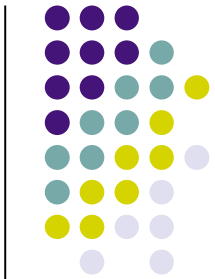
http://www.vanasch.school.nz/flash-window.php?flash_file=hearaid_animation.swf

- **Microphone**
  - Collects sound waves from the air
  - Convert waves to an electronic signal



- **Signal processor**
  - Increases amplitude of the signal
  - Modifies signal to ensure audibility, comfort, and protection from loud sound
- **Receiver**
  - Converts electronic signal back to acoustic sound waves
- **Battery**
  - Provides power

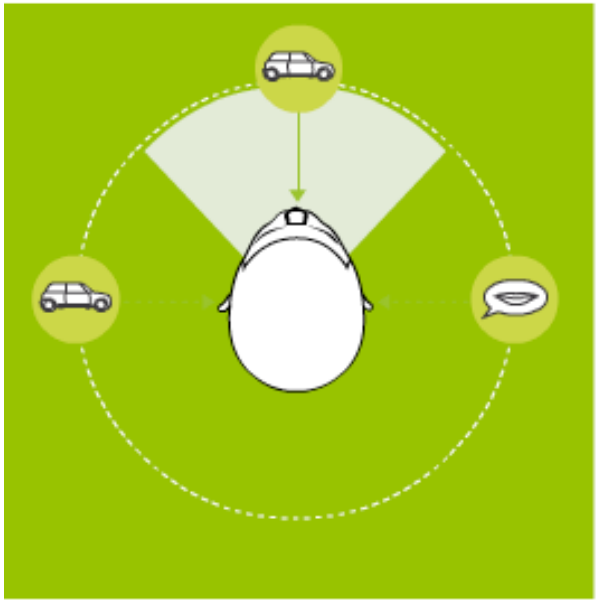
Hearing aid technology



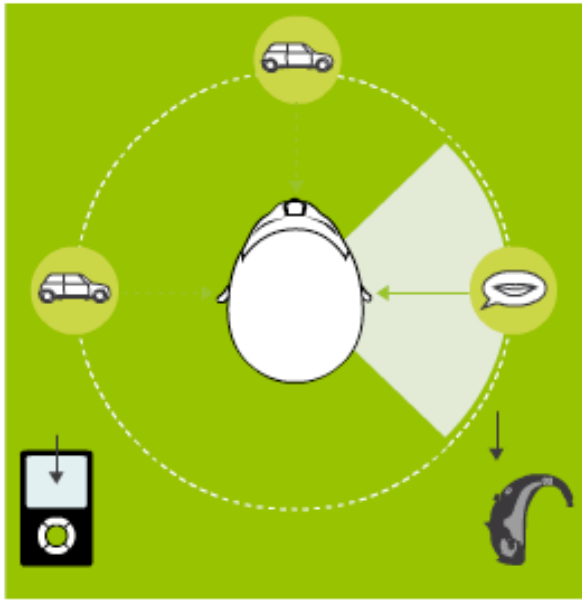
- **Digital signal processing**
  - Precise control of all fitting parameters
  - Takes up less space, so aid can be smaller
  - Analyzes incoming signals and then selects the appropriate processing strategy
    - Examples: automatic noise reduction, automatic speech compression
- **Multiple programs**
  - Hearing aid settings are stored for several different listening situations
  - Examples: one-to-one quiet conversation, large-group meeting, telephone
- **Bluetooth connectivity**
  - Wireless communication between a hearing aid and another device (examples: cell phone, music player, hearing aid on the other ear)
- **Remote control** to select programs and settings

Hearing aid technology

- **Microphones**
  - Omni-directional: Takes in sound from all directions
  - Directional: Takes in sound from all directions
  - Demonstration



Car noise interferes

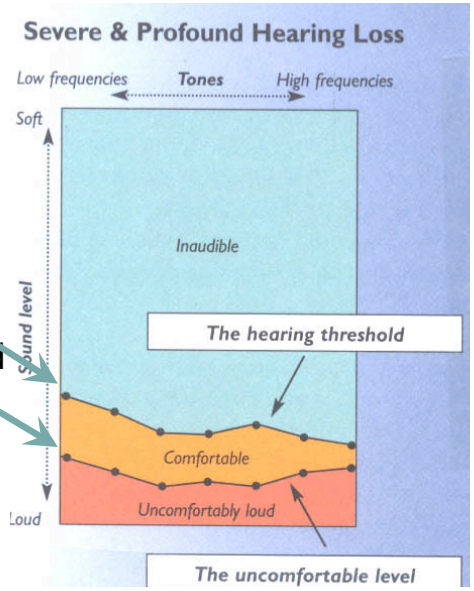


Hearing aid focuses on the person's speech

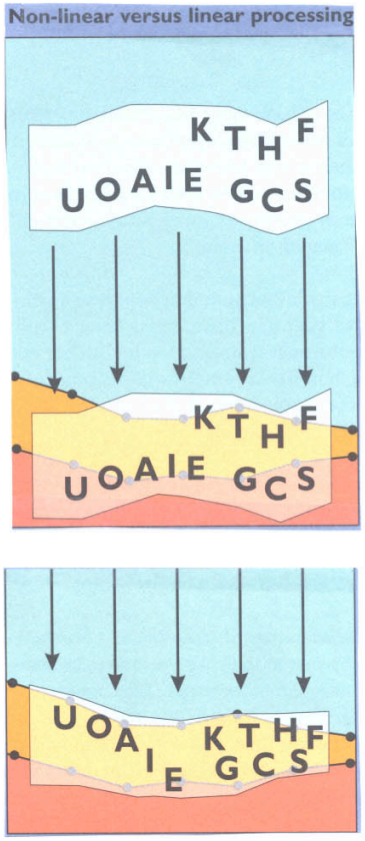
http://www.phonak.com/com/b2c/en/hearing/ways_to_better_hearing/what_modem_hearing_solutions_have_to_offer/how_a_hearing_aid_works.html

Hearing aid technology

- **Compression amplification**
  - The hearing aid automatically fits the speech signal into the listener's range of hearing
    - Above the threshold of detection
    - Below the threshold of discomfort
    - Without distorting the quality of the sound

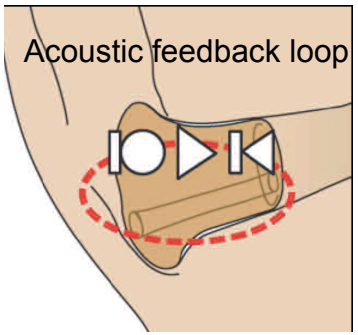


- Amount of amplification adapts to the level of the input
  - Weak inputs are amplified more
  - High-level inputs are amplified less



Hearing aid technology

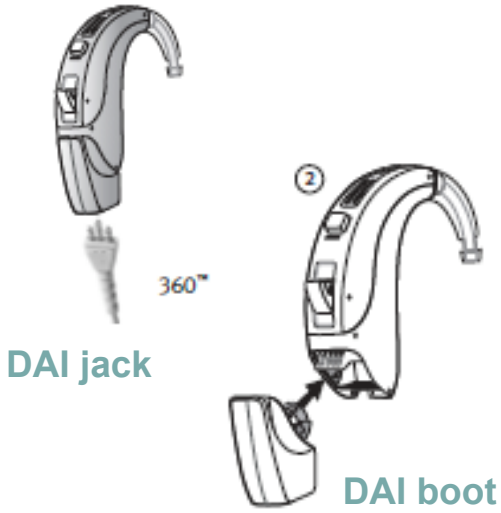
- **Feedback cancellation**
  - A squealing sound made by the hearing aid
  - Caused when the amplified sound is re-amplified
  - Can be controlled by digital sound processing



- **Telephone connection**
  - Telecoil
    - A special circuit that picks up and amplifies the electromagnetic signals that come out of a telephone handset (or any loop of wire)
    - Blocks out surrounding noise

Hearing aid technology

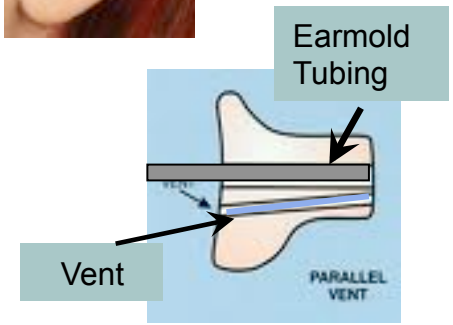
- **Direct audio input**
  - To connect to devices such as TV, telephone, computer, CD player
  - Hearing aid has an external connector or contacts
    - To insert a mini-plug to another device
    - To attach a “boot” and mini-plug that connects to another device
    - To attach a “boot” with a tiny FM radio receiver that picks up the signal from another device
  - Improves the signal because it bypasses the hearing aid microphone and eliminates background noise



www.unitron.com/es/360-direct-audio-input.pdf

Hearing aid technology

- **Earmold** materials and features
  - A good earmold reduces many hearing aid problems
  - Materials
    - Silicone
      - Softest
      - For sports; to control acoustic feedback (squeal)
    - Lucite
      - Hard; easily modified
      - More durable
      - NOT used with young children to avoid injury if struck on the side of the head
  - Earmold tubing
    - Shape and thickness can change the sound output
    - Will harden
      - Needs to be changed every 6-12 months
  - Earmold venting
    - Reduces occlusion effect (annoyance from talking, chewing)



Styles of Hearing Aids

- In-the-ear (ITE)
- Behind-the-ear (BTE)
- Body aid
- Bone-Anchored Hearing Aid (BAHA)
- Tactile aids

http://www.riversideonline.com/health_reference/Ear-Nose-Throat/HQ00812.cfm

In-the-Ear Hearing Aids

Advantages

- Small size
- Comfort (depends on the individual)
- Not very noticeable
- Sound quality
- Very little wind noise
- CIC & ITC can reduce occlusion effect

Up to 50 dB

Completely-in-the-canal (CIC)

Up to 50 dB

In-the-canal (ITC)

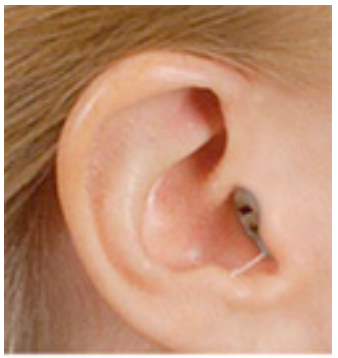
Up to 70 dB

In-the-ear (ITE)

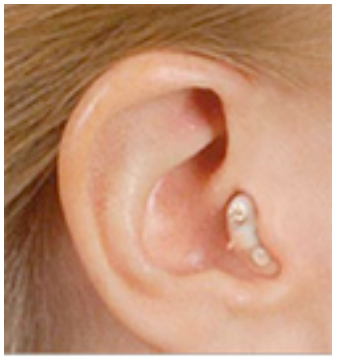
In-the-Ear Hearing Aids

Disadvantages

- Cannot fit severe or profound losses
- More expensive (custom fit housing)
- More difficult to manipulate
- May have fewer features (no telephone connection, directional microphone, venting)
- May need remote control device
- Prone to wax blockage
- May be uncomfortable
- Easier to lose
- Need loaner when out for repair



CIC



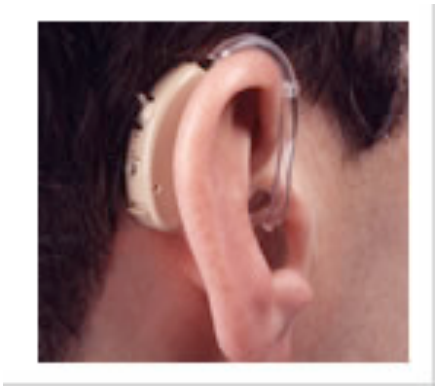
ITC

ITE

Behind-the-Ear Hearing Aids

Advantages

- High power for profound hearing loss
- Least expensive
- Most flexible to fit a wide range of needs
- User can wear a loaner aid with his own earmold when repairs are needed
- Multiple features
  - Direct audio input or FM input
  - Telephone connection (telecoil)
  - Program switch
  - Directional microphone
  - Durable
  - Easy to manipulate
  - Longest battery life
  - Full earmold venting possible



www.searshearing.ca/products/types.php

Disadvantages

- Less comfortable on the ear (depends on the individual)
- Wind noise (depends on location of the microphone)
- More noticeable

Advances in BTE design

- **Thin-tube, open-ear fit**
  - Avoids a fitted earmold and leaves the ear canal more open
  - The more open the mold, the more comfortable
  - Open system advantages:
    - Ventilation of the ear canal
    - Avoids overheating
    - Avoids accumulation of moisture
    - Creates more natural sounding voice
    - Potential for optimal amplification in the high frequencies
  - Works for mild & moderate losses

CONVENTIONAL OPEN-EAR FIT

Advances in BTE design

- **Receiver-in-the ear (RITE)**
  - Avoids acoustic resonance of earmold tubing
  - Places sound further down the ear canal
  - Can improve clarity of the signal
    - Can provide a smooth frequency response

www.oticonusa.com/.../HearingAidSelection.html

Closed dome for
greater hearing loss

1. Amplifier
2. Thin sound wire
3. Dome
4. Receiver
5. Ear grip

Body Aids

Advantages

- Highest gain (example: up to 130 dB)
- Controls are easy to manipulate (for small children; elderly people)
- Has many features with flexible fitting options

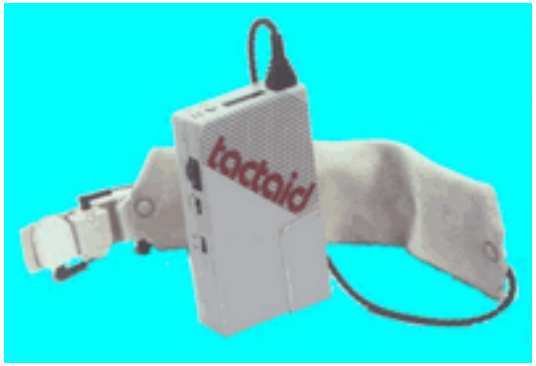
Disadvantages

- Cords can break
- Cord and “box” are very noticeable
- No directional microphone
- May not be programmable
- May not have a digital processor

Tactile Aids

Design

- Vibrators are used to deliver the acoustic signal to the skin (fingers, forearm, torso, or back)
- Example: Two vibrators might represent low frequencies (vowels) and high frequencies (consonants)



Advantages

- Provides access to the rhythmic pattern of speech
- Beneficial as a lipreading aid
- Helpful for speech training

Disadvantages

- Useful only in quiet settings
- Cannot obtain detailed frequency information

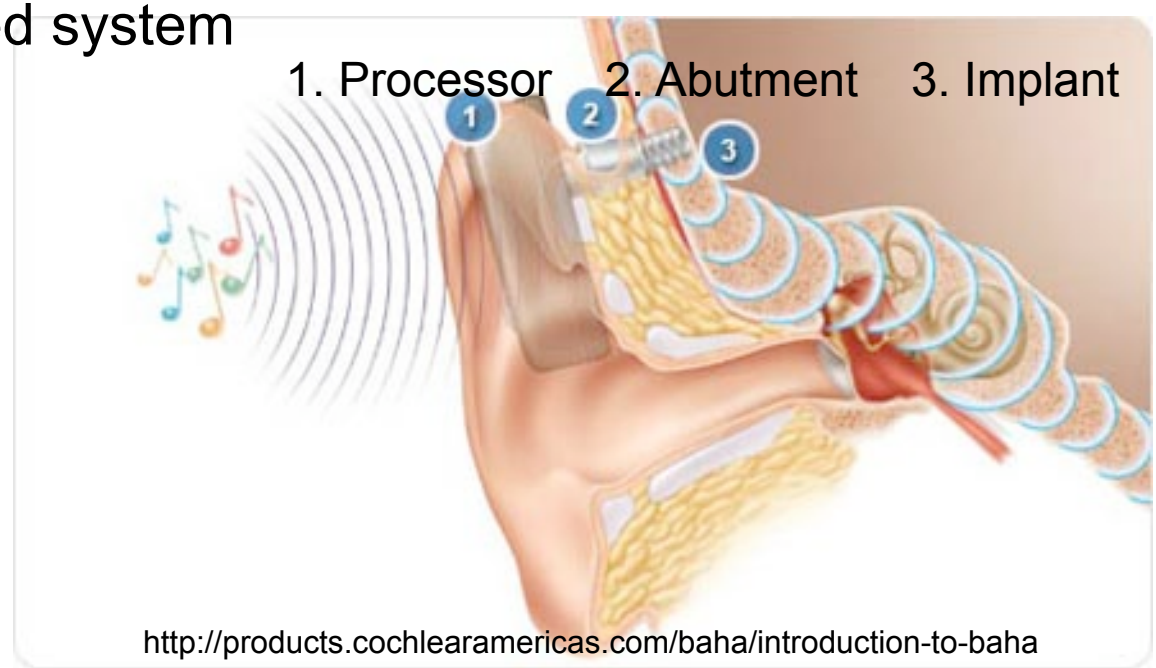
Bone-Anchored Hearing Aid
BAHA

- For persons with conductive or mixed hearing loss (outer or middle ear problems)
  - Chronic otitis media (middle ear infection)
  - Microtia or other malformations of the outer ear or middle ear (congenital or due to trauma or cancer)
- A surgically implanted system

Abutment

Processor

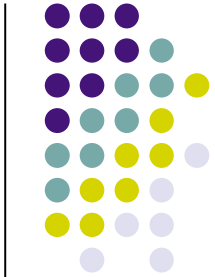
http://www.umm.edu/otolaryngology/baha.htm



http://products.cochlearamericas.com/baha/introduction-to-baha

Binaural hearing aids

- **The binaural advantage**
  - Eliminates head shadow
    - The listener can receive sound coming from either side at a comfortable level
  - Loudness summation
    - A listener with high thresholds can get a "boost" by using two aids
    - Less amplification is needed because a signal received by two ears is heard as "louder" than the same signal received by one ear
  - Binaural squelch
    - It is much easier to pick a signal out of the noise when the brain receives information from both ears
  - Localization
    - The brain can calculate the direction of the signal with information from two ears (localization is impossible with input from one ear only)
  - Convenience
    - If one hearing aid needs repair, the listener does not have to go without amplification

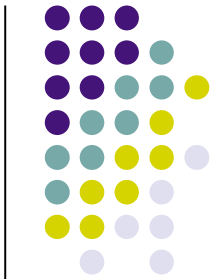


- **Disadvantages**
  - All costs are doubled
    - Purchase costs
    - Maintenance and repair costs
  - The combined signals may not blend
    - There may be a significant difference between ears in threshold or sound quality
    - The brain may require a lot of training to "pay attention" to the new input if one ear has not been stimulated in a long time
    - Neural capacity to use the input may have diminished

Hearing aid fitting

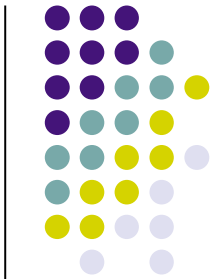
1. **Fitting** Stage
   - Select a hearing aid with the desired gain and other features
   - Use a computerized program to adjust the hearing aid to a "prescription" (rules for setting hearing aid levels)
     - Provide enough amplification so that soft sounds can be heard
     - Provide limits so that loud sounds are not uncomfortable
2. **Verification** Stage
   - Measure electroacoustic properties of the hearing aid
   - Perform "real-ear measurements"
     - Place small microphone in ear canal
     - Measure sound reception in open ear canal
     - Measure sound reception in ear canal with HA in place
     - Calculate difference with and without HA
     - Compare gain to amplification prescription
     - Adjust the HA as needed to match prescription

http://www.audiologyonline.com/articles/article_detail.asp?article_id=285



3. **Validation** stage
   - Measure benefit
     - Speech recognition tests
     - Parent report
     - Self report (questionnaires, inventories)

Hearing aid care



- **Cautions**
  - Do not place a hearing aid in direct heat or sunlight (example, hot car)
  - Avoid dropping the aid
  - Avoid getting the aid wet (no swimming or showering)
  - Keep aid away from pets and small children
- **Daily care** of the hearing aid
  - Wipe off any dirt or moisture with a soft, dry cloth
  - Remove earwax with special wire pick
  - Remove battery or open battery compartment overnight
  - Store overnight in a “dry-sac” (with a desiccant to absorb moisture)
  - Check battery voltage and replace battery when low
    - Remove dead batteries promptly
    - Turn aid off when not in use

Hearing aid care

- **BTE earmold and tubing**
  - Life expectancy of earmold/tubing is 1 year for an adult, 3 months for a child
  - Material shrinks over time, which will cause feedback
  - Clean every 1-7 days
    - Use *warm* water & soap
    - Remove all moisture by blowing air through the tubing

Classroom hearing aid checks

1. Visual Inspection

- Check earmold
  - Moisture
  - Wax
- Inspect the case
  - Cracks
  - Broken or missing parts
- Inspect hook and earmold tubing
  - Hard
  - Cracked, split, punctured
  - Twisted tubing
- Check battery and battery compartment
  - Match + to +
  - Measure voltage
  - Clean any corrosion with sandpaper or eraser
- Inspect cords for visible breaks

2. Listening Check #1

- Turn hearing aid volume full on
- Plug end of earmold
- Check for sound leakage

3. Listening Check #2

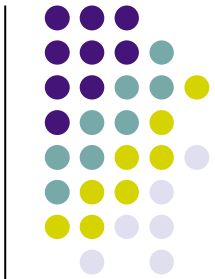
- Attach a stethoset
- Listen again
- Carefully increase and decrease volume
  - Listen for breaks, buzz, crackling noises

Classroom hearing aid checks

4. Check Student Function

- Use the Ling 7-sound test
  - **oo**, **ah**, **ee**, **sh**, **m**, **s, or** (example for English)
  - These sounds represent the variety of frequencies present in speech
- Set a baseline for each student
  - Use a functioning hearing aid with a good battery
  - Record which sounds the student can perceive from 3 feet away
  - Not all students will hear all 7 sounds
- Daily check
  - Student sits or stands about 3 feet away, wearing his/her hearing aid
  - Cover your mouth with a card
  - Individually present each of the 7 sounds
  - Have the student raise a hand, drop a block into a container, or say "yes," if the sound is heard

Review: Hearing Aids



- Benefits
- Components
- Technologies
- Styles
- Fitting
- Care
- Classroom teacher tasks