Cochlear implants

Carol De Filippo
Viet Nam Teacher Education Institute
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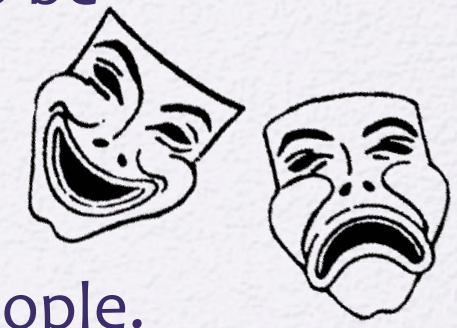
Controversy

- The CI is invasive and too risky.
- People get a CI because they deny their deafness.
- People get a CI because they believe that deaf people are inferior to deaf people.
- People who use a CI want to pretend to be hearing.
- The CI is a surgical way to fix people.
- The CI is a strategy to eliminate deaf people.



True or False ?

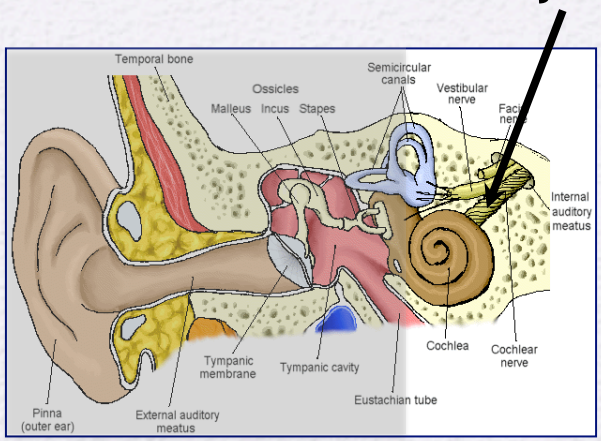
- The CI is a miracle cure.
- A person will experience the benefits of a CI immediately after the surgery.
- Listening with a CI is just like having normal hearing.
- The person with a CI never needs any training.
- The *potential* benefits of a CI are high if many success factors are present.

A cochlear implant is…

- **A device that *directly* stimulates the inner ear**
  - *Not* an amplifier – does not merely make sounds louder
  - Does not restore normal hearing
  - Provides coded information about sound
    - Environmental sounds
    - Speech sounds
      - Auditory awareness
      - Detection of environmental sounds
      - Improvement in speechreading abilities
      - Speech perception without visual cues
      - Conversations over the telephone

A cochlear implant is…

- **A device that is *implanted* in the head with surgery**
  - Bypasses the peripheral auditory system
    - Does not use the outer, middle, or inner ear structures
  - Directly stimulates the auditory nerve with electrical pulses



Candidacy

1. **"Substantial" hearing loss**

   Ages 1-to-2 years:

   Profound sensorineural loss

   Age 2+ years:

   Severe or profound sensorineural hearing loss

   Some indication that the cochlea is damaged, malformed, or missing

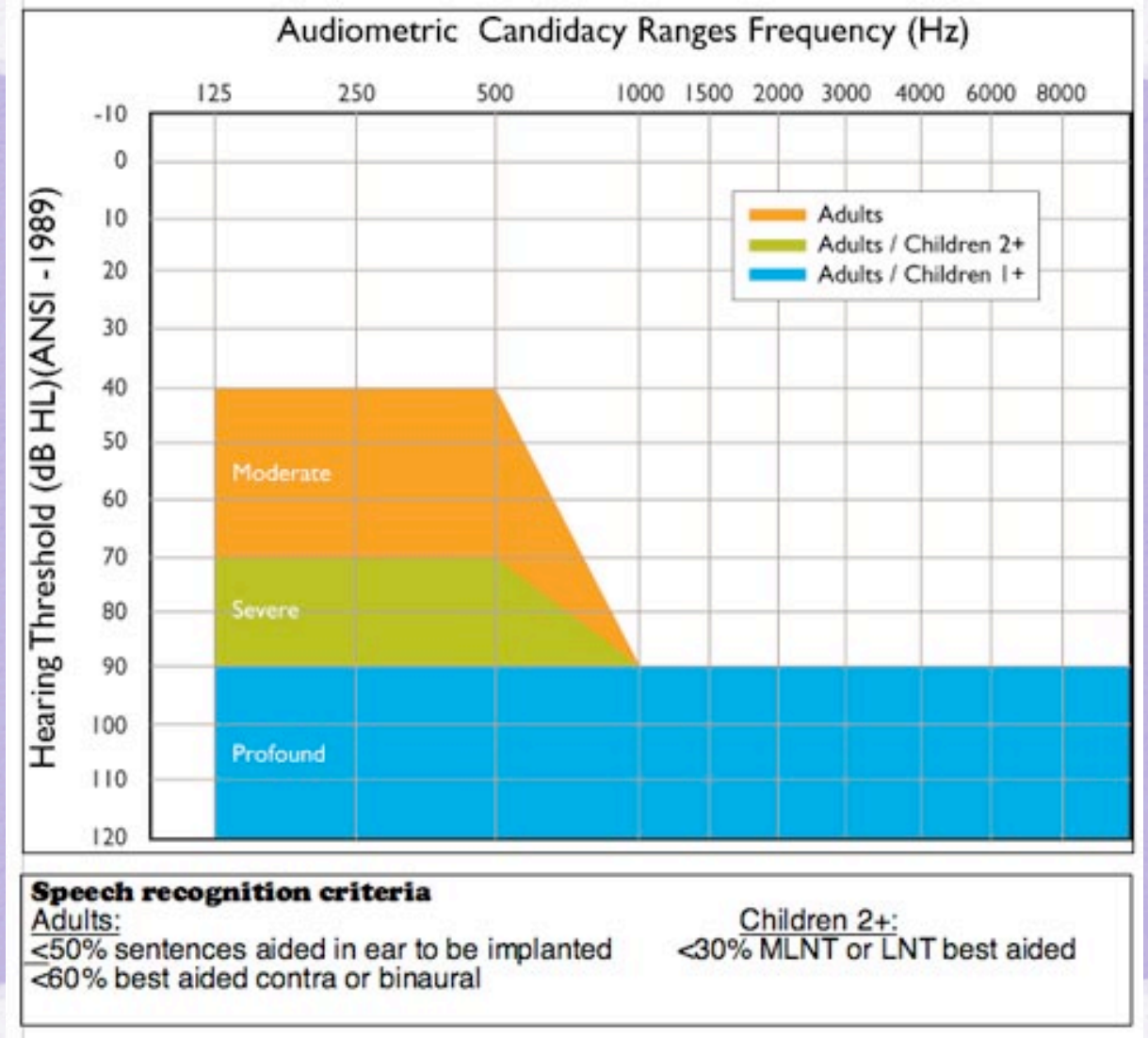
Candidacy

2. **Not successful with a hearing aid**

Adults: ≤ 50% auditory speech understanding

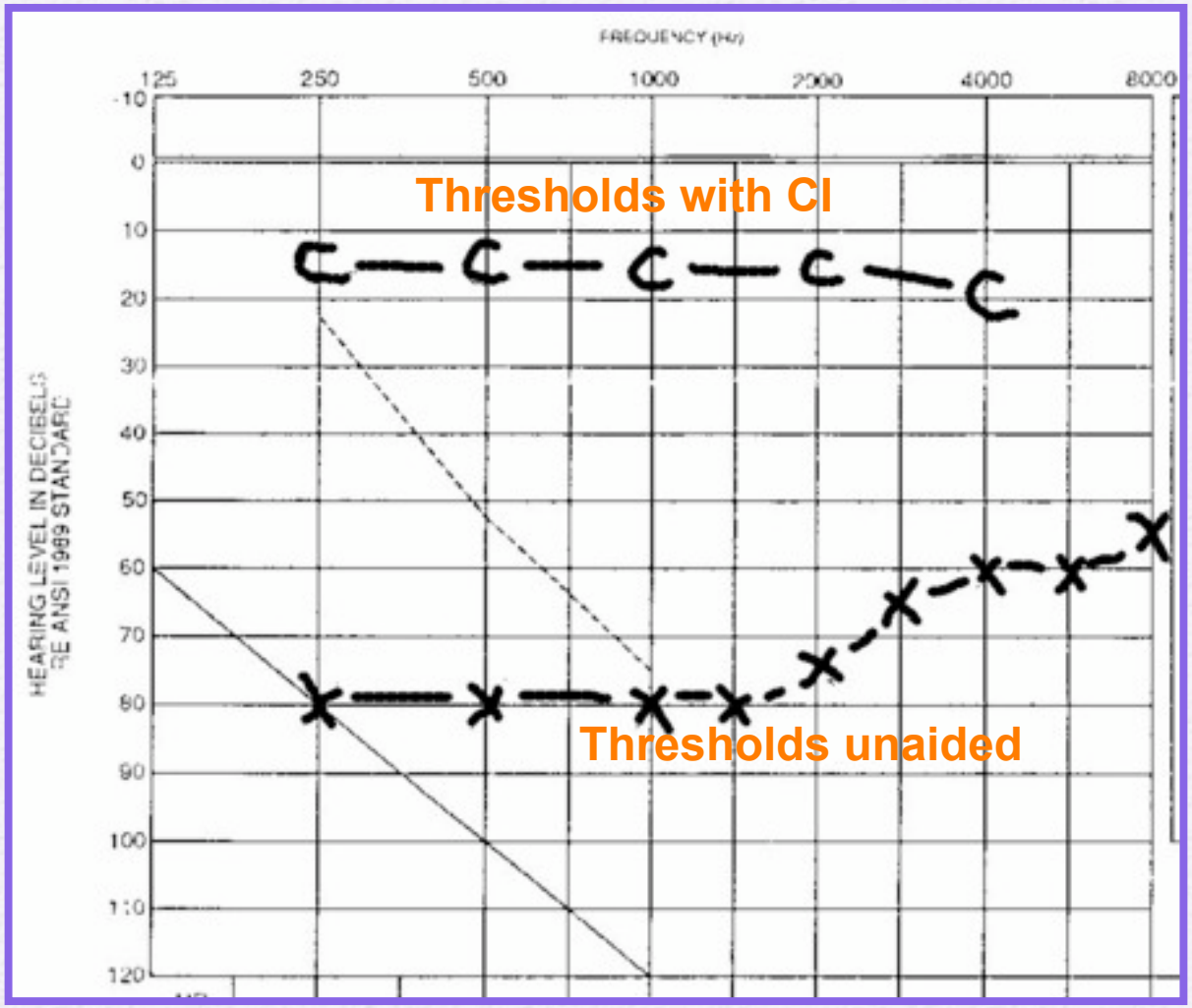
Children: ≤ 30% on a pediatric test; lack of progress with a well-fit hearing aid

Audiometric Criteria



http://www.audiologyonline.com/articles/pf_article_detail.asp?article_id=2272

Sample audiogram



http://www.whydomath.org/node/hearing/hearingLoss.html

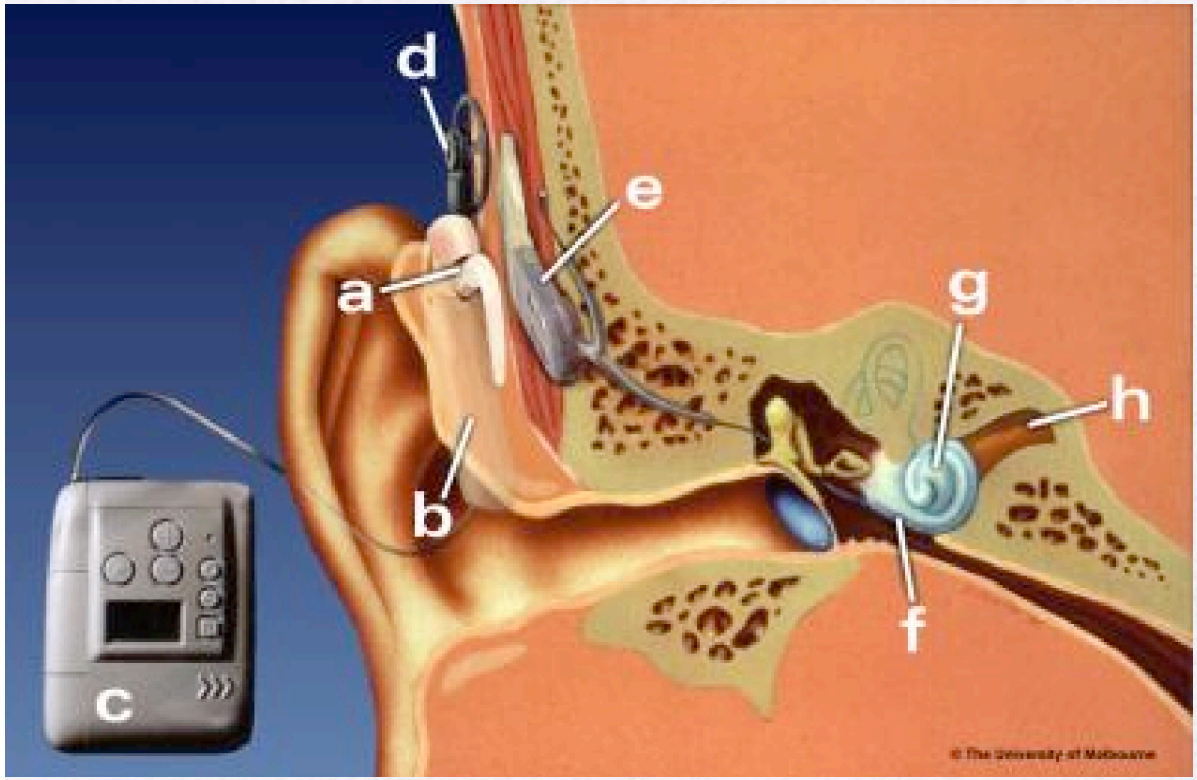
History of Development

1960s	Research began on electrical stimulation of the auditory nerve.
1972	First wearable CI. Single electrode device. For adults only. Improved speechreading and environmental sound awareness. Used in about 1000 people.
1980	House single-channel aid available for children > 2 yrs old.
1980s	First multi-electrode devices. Offered limited frequency cues. Some open-set speech understanding auditory-only.
1985	Nucleus 22-channel aid approved by FDA. For adults with postlingual profound deafness.
1990	Nucleus 22-channel aid approved for children > 2 yrs old.
2000	Approved for children > 1 yr old.
Present	Additional manufacturers. BTE style; additional features. > 188,000 CI users world-wide. > 25,500 children and > 41,500 adults in the US.

How does a CI work?

Movie:

http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/ImplantsandProsthetics/CochlearImplants/default.htm



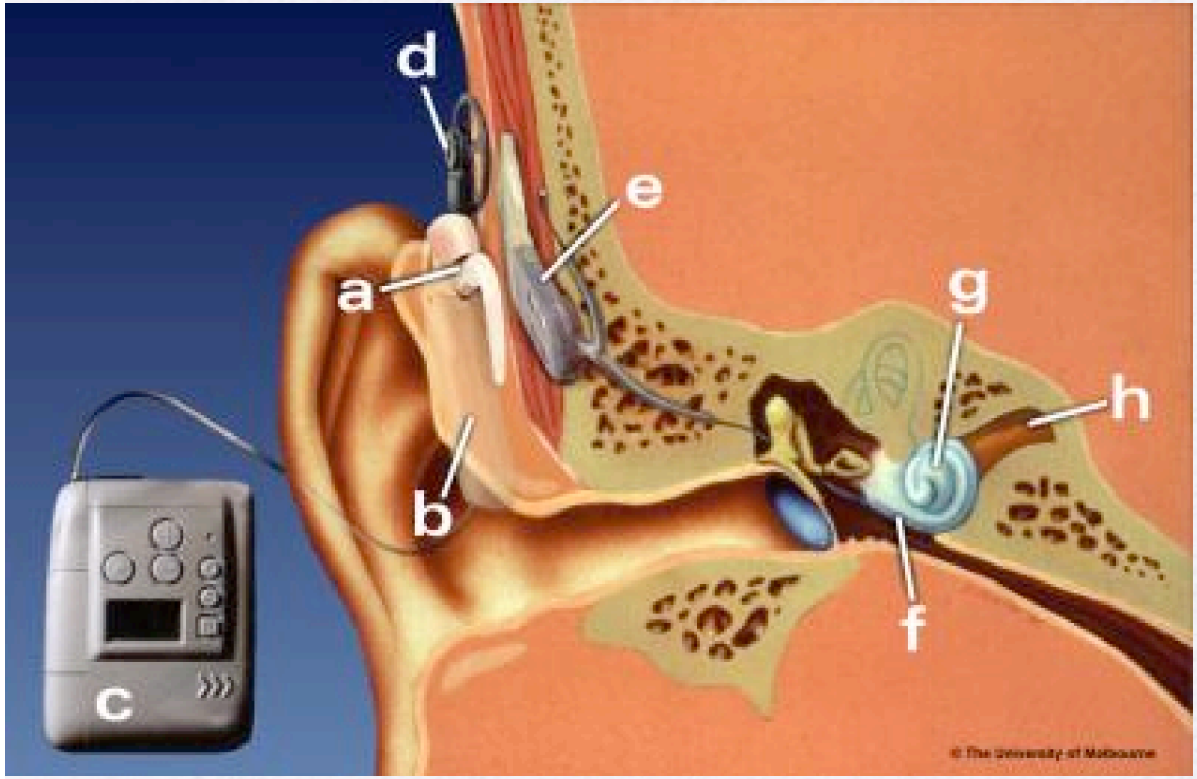
http://www.medoto.unimelb.edu.au/info/implant2.htm

a. Sound is picked by the microphone.

b. Information from the microphone is sent to the speech processor.

c. Speech processor analyzes the information and converts it into an electrical code.

d. A cable brings the coded signal to the transmitting coil on the head. Radio waves (or electromagnetic signal) from the transmitter coil carry the coded signal across the skin to the implant inside.



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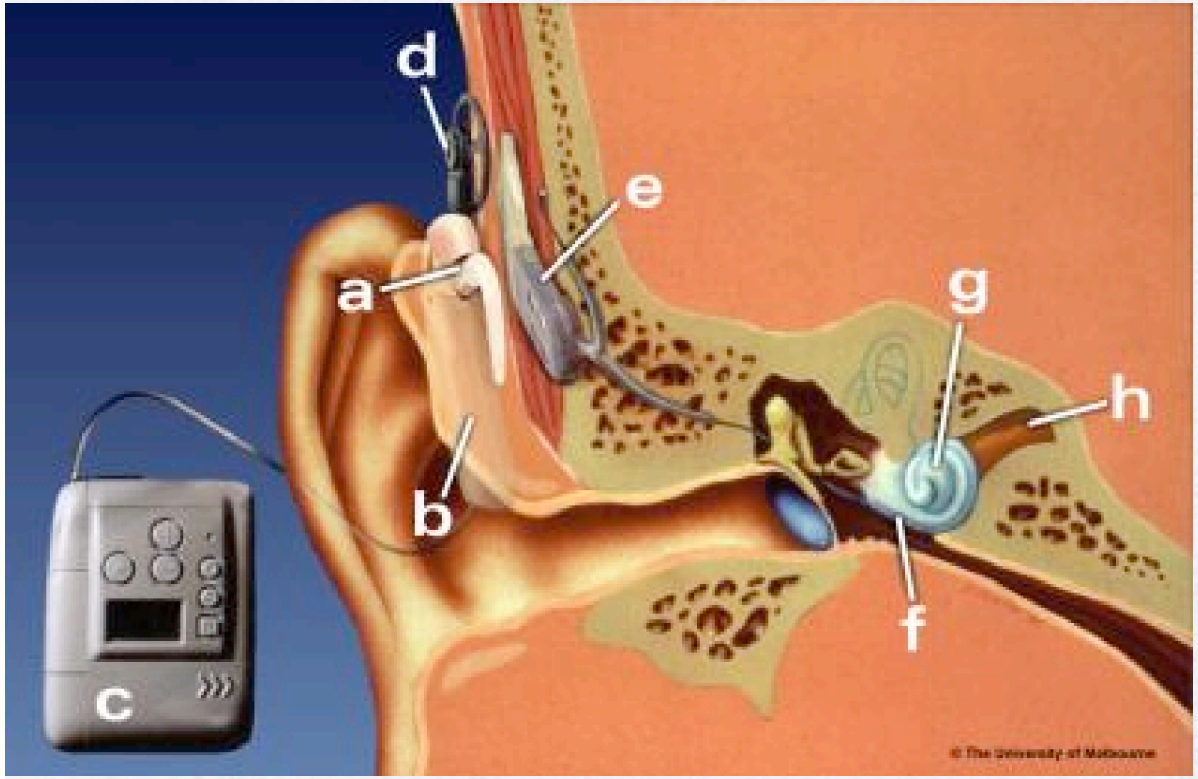
e. The implant uses the code to control the amount of electrical current to send to the electrode array.

f. Electrical current passes down the wires to the electrodes in the cochlea.

g. In the cochlea, the position of the stimulating electrode determines the *pitch* of the sensation.
The amount of electrical current determines the *loudness* of the sensation.



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h. The electrodes stimulate the nerve endings in the cochlea.

The message is sent to the brain along the hearing nerve.

The brain interprets the stimulation as a meaningful sound.

Components

1. **External Components**
    - Microphone
    - Speech processor
        - Program selectors
        - Volume control
        - Sensitivity control
        - Microphone monitoring system
    - Transmitter cable
    - External transmitter
        - Transmitting coil
        - Magnet & antenna

Easily replaced and upgraded as needed

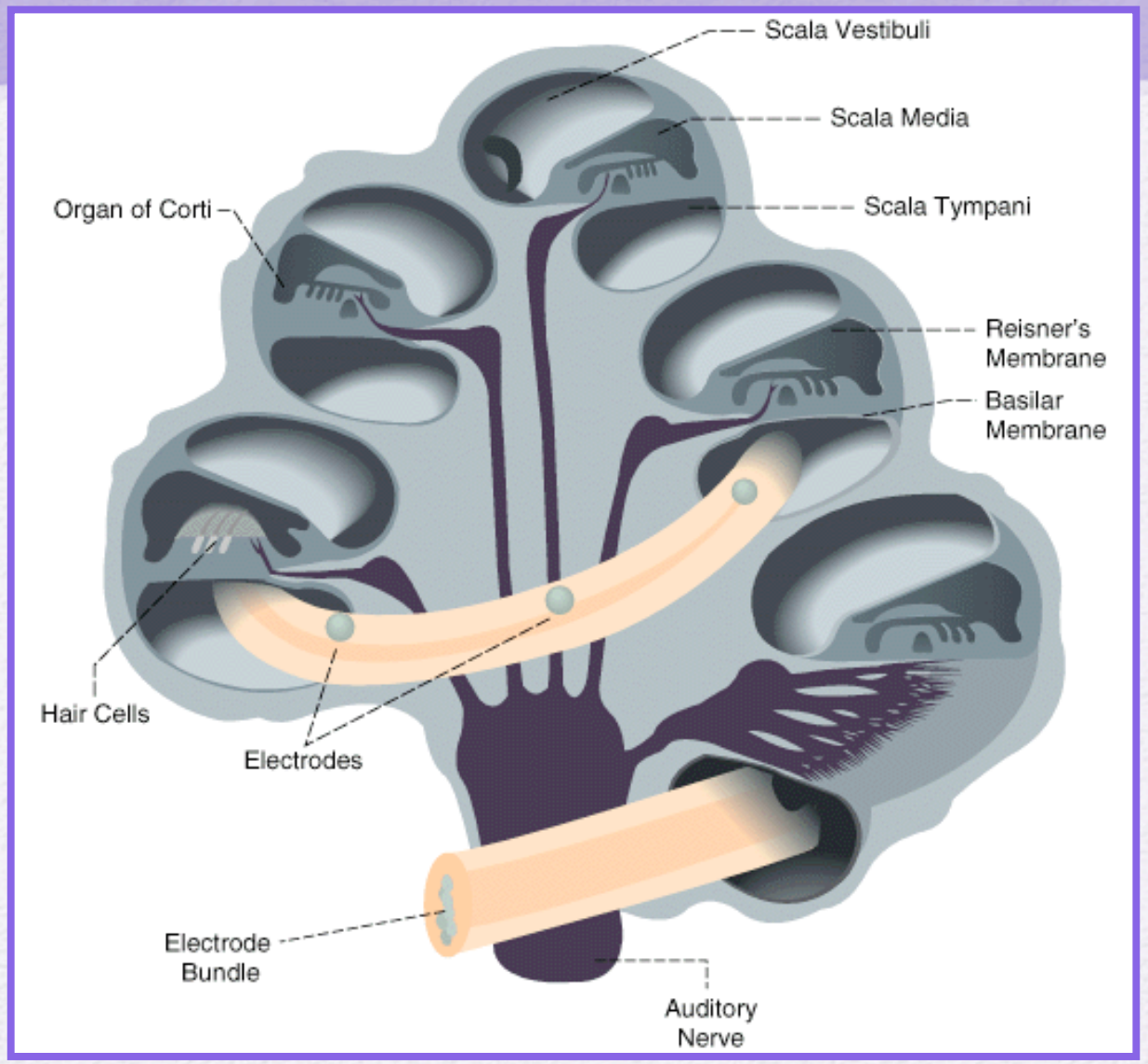
2. Internal Components

- Magnet
- Receiver-stimulator
- Electrode array

Surgically placed in the head
Can be changed only with surgery

Electrode array enters the cochlea

Electrode array in the cochlea



Surgery

- Common surgical approach (tympano-mastoidectomy) http://www.earsurgery.org/cochlear.html
- Risks
  - Usually resolve rapidly
    - Mild facial nerve weakness
    - Postoperative infection
    - Dizziness
    - Postoperative meningitis

      Vaccine is recommended prior to surgery.

Device Activation

- Provide external components 1-2 weeks after surgery
- Connect device to a specialized computer
- Create the first **"map"** -- Stimulate with tones and adjust electrical levels
  - Threshold
  - Comfort
- Counsel parents, child, and caregivers about maintenance and training

Repeated Mappings

1. Record the current levels for each electrode
   - T-level: lowest level of current needed to get an auditory response
   - C-level (or M-level): level of current that yields a sound that is comfortably loud
2. Store the information on a computer chip in the speech processor
3. Repeat monthly during the first year

What a CI sounds like

- Demonstration: *Only a simulation !!!*
- Uses digitized speech
- A hearing person cannot truly experience electrical stimulation like a deaf person

"Scientific American Frontiers with Alan Alda"

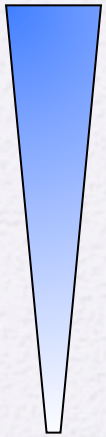
- http://www.pbs.org/saf/1205/features/Interactive/intro1.htm

Benefits

- No guarantee of a particular level of benefit
- Varies with the individual

Continuum of expected benefit:

All CI users



Some CI users

Greater awareness of environmental sounds

Helpful for individuals with Usher's syndrome

Sounds are louder, sharper

More sounds of speech can be heard

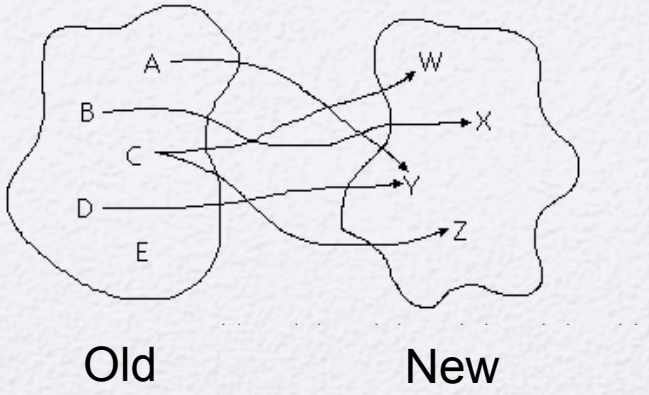
Easier lipreading

Improved speech development, voice control

Improved speech understanding *without* lipreading

How hearing develops

- For the **adventitiously** deafened
  - The listener's brain maps new sounds onto his memory of sounds
  - This is a process of ***re-***learning
  - Like building a new "sound dictionary"



How hearing develops

- For the **congenitally** deaf
  - If the listener had previous hearing aid experience

    May be like re-mapping

    May be like building a new sound dictionary

  - If listener had **no** previous exposure to sound

    The process is *unknown*

Ultimate benefit

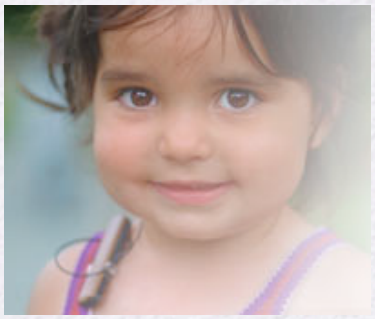
- **Decreases the "access barrier"**

Provides auditory information that facilitates acquisition of spoken language

- CI improves delivery of the sounds of language
- CI allows spoken language to be learned naturally, as an auditory/oral language

Implants for Toddlers/Infants?

- Universal Newborn Hearing Screening resulted in earlier identification of hearing loss
- Surgical techniques have been improved
  - Smaller incisions, less tissue damage
  - Little or no hospitalization
  - Lower risks
- Devices have been improved
  - Smaller internal & external components
  - Ease of use
  - Appearance
- Effectiveness has improved



http://www.medel.at/US/Information-for-Candidates/Solutions-for-Children/BabyBTE.php

Success Factors

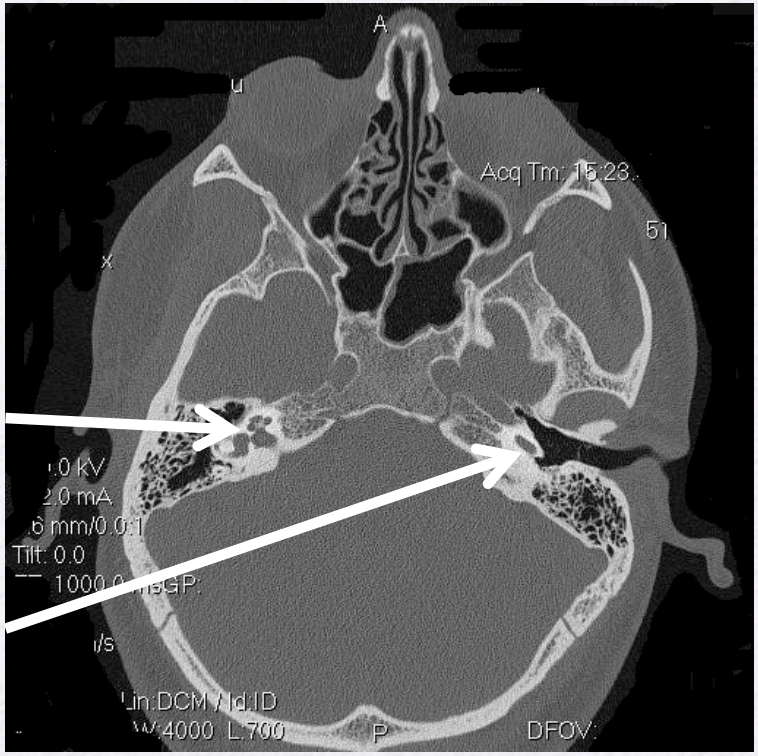
- Earlier age at time of implant
- Shorter duration of deafness
  - Shorter length of period of auditory deprivation
- No severe cognitive handicaps
  - Non-cognitive handicaps generally do not limit benefit
- Cochlea is present and not deformed

- Example: Cochlea not defined

  Mondini Deformities

  - Malformations of the cochlea
  - Fewer than 2-1/2 turns

    "Common cavity"



Success Factors

- Appropriate Level of Expectation
  - CI is not a "cure" for deafness
  - CI requires time, effort, training
- ***Suitable Educational Environment***
  - Numerous listening and speaking opportunities
  - The classroom environment *challenges* the student's listening and speaking abilities ***during instruction***

Summary

BETTER ODDS

- Congenitally deaf or pre-linguistically deafened and *implanted at a young age*
- Born with mild or moderate hearing loss, *progressing* to a profound level
- Became profoundly *deaf due to ototoxicity or head trauma* and implanted soon after losing hearing
- Auditory environment

LESSER ODDS

- Implanted when older
- Born with profound hearing loss
- Lengthy interval between time when deafened and time when implant is obtained
- Deafened due to a disease process
- No *need* to listen

U.S. Manufacturers

- All manufacturers provide adequate auditory information that can be processed meaningfully if properly fitted and supported

  - Advanced Bionics Corporation

    http://www.bionicear.com/

    Bionic Ear Harmony
  - Cochlear Corporation

    http://www.cochlearamericas.com/

    Nucleus 5
  - Med-El Corporation

    http://www.medel.at/US/MAESTRO-Cochlear-Implant-System/index.php

    Maestro

Current models

Cochlear
Cochlear Nucleus 5 System
CP810 Sound Processor
CI 512 Implant

Med-El
Maestro CI System
Opus 2 speech processor
Sonata TI^{100} & Pulsar CI^{100} implants

Advanced Bionics
Harmony HiRes BionicEar System
Harmony sound processor
HiRes 90K implant

Styles

- Body-worn
- Head word (behind the ear)
- Baby BTE *Example:*
  - http://www.medel.at/US/Information-for-Candidates/Solutions-for-Children/BabyBTE

Sports Participation

- Yes, most sports are OK with a CI
- Use a helmet when it makes sense

  Wrestling, football, lacrosse

- Remove device for swimming

Electrostatic Discharge

- Identify sources of static electricity
  - Carpet
  - Clothing
  - Mats
  - Plastic play equipment
  - Computer & TV screen
- Run humidifiers
- Discharge static before touching CI
- Put CI cables under clothing
- Use anti-static materials
  - Fabric softener sheets
  - Anti-static shield over monitors; mat on floor
  - Anti-static wristband for child

Resources for schools

- HOPE ("Habilitation Outreach for Professionals in Education", Cochlear)

  http://www.cochlearamericas.com/Support/291.asp

- Tools for Schools (Advanced Bionics)

  http://www.bionicear.com/Support_Center/Educational_Support/Tools_for_Schools.cfm?langid=1

- A G Bell e-Seminar Series

  http://www.agbell.org/DesktopDefault.aspx?p=Eseminars

More resources

- MedEl *Handbook for Educators*

  http://www.medel.com.ar/ENG/US/50_Resources/40_Educational_Resources/000_ed_resources.asp

- *Educators Guide to Cochlear Implants* (Cochlear)

  http://www.cochlearamericas.com/Support/2156.asp

- *Cochlear Implants International* (journal)

  http://www3.interscience.wiley.com/journal/112094302/home

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- The person with a CI never needs any training.
- The *potential* benefits of a CI are high if many success factors are present.

Controversy

- The CI is invasive and too risky.
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