



# Get in the Hearing Loop

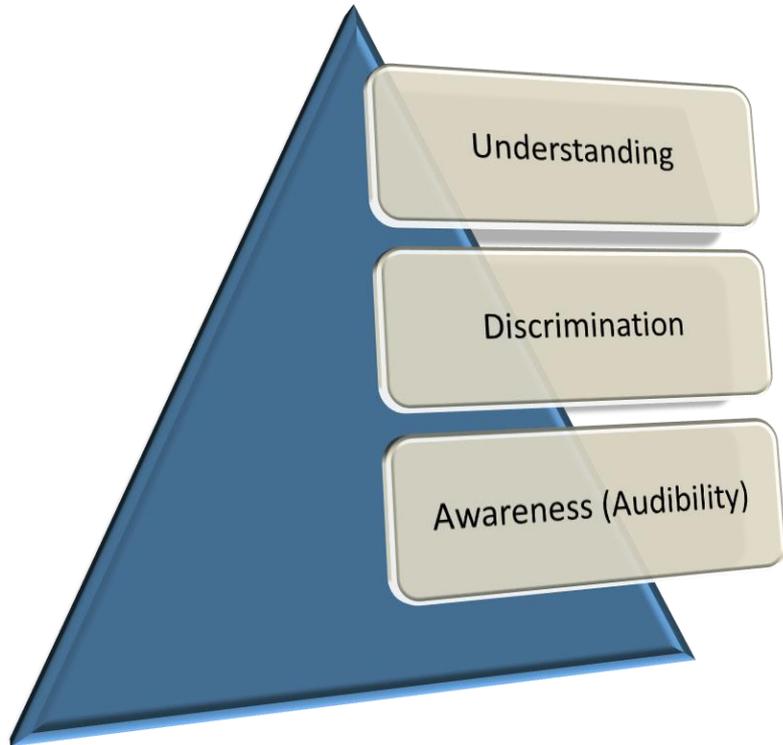
A program of the Hearing  
Loss Association of America

# Today's Topics

- Why listening in large rooms is difficult.
- Why large area assistive listening systems are needed.
- How they work.
- Coupling options.
- Why choose a room LOOP?

# Components of a successful hearing experience

## HEARING HIERARCHY



- To understand speech, it must be perceived – it must be audible.
- It also must be loud enough so that you can discriminate it from other sounds.
- And it must be even louder so you can understand it.
- How well you understand it depends upon:
  - Intensity level of the sound source (vocal effort, intensity of a recording)
  - Room acoustics
- This is true for people with normal hearing as well as for those with hearing loss.

# How much do hearing aids and implants help?

- Properly fitted, hearing aids and cochlear implants can provide audibility and understanding in quiet and in certain noisy situations if the listener is close enough to the talker.
- However, due to the nature of each person's hearing loss as well as room acoustics, additional technologies might be needed in order to hear as well as possible.



# Factors Affecting the Ability to Understand Speech in Rooms

1. Linguistic Complexity
2. Emotional Factors
3. Speech Level
4. Distance
5. Ambient Noise
6. Reverberation (echo)

ROOM  
ACOUSTICS

# 1. Linguistic Complexity

The more unfamiliar or difficult the topic, the more difficult it will be to understand it.



## 2. Emotional Factors

Boredom, fatigue, anxiety.



# 3. Speech Level

The intensity level of the speech is dependent upon the vocal effort of the talker, live or recorded.

Distance will influence the actual level of the signal received at the listener's ears.



"Hold on there! I think you misunderstood – I'm Al Tilley . . . The bum."

# 4. Distance

- As speech leaves the talker's mouth and crosses the room to the listener, it becomes softer and softer and might not be sufficiently audible at the listener's ears, even with hearing aids or cochlear implants.

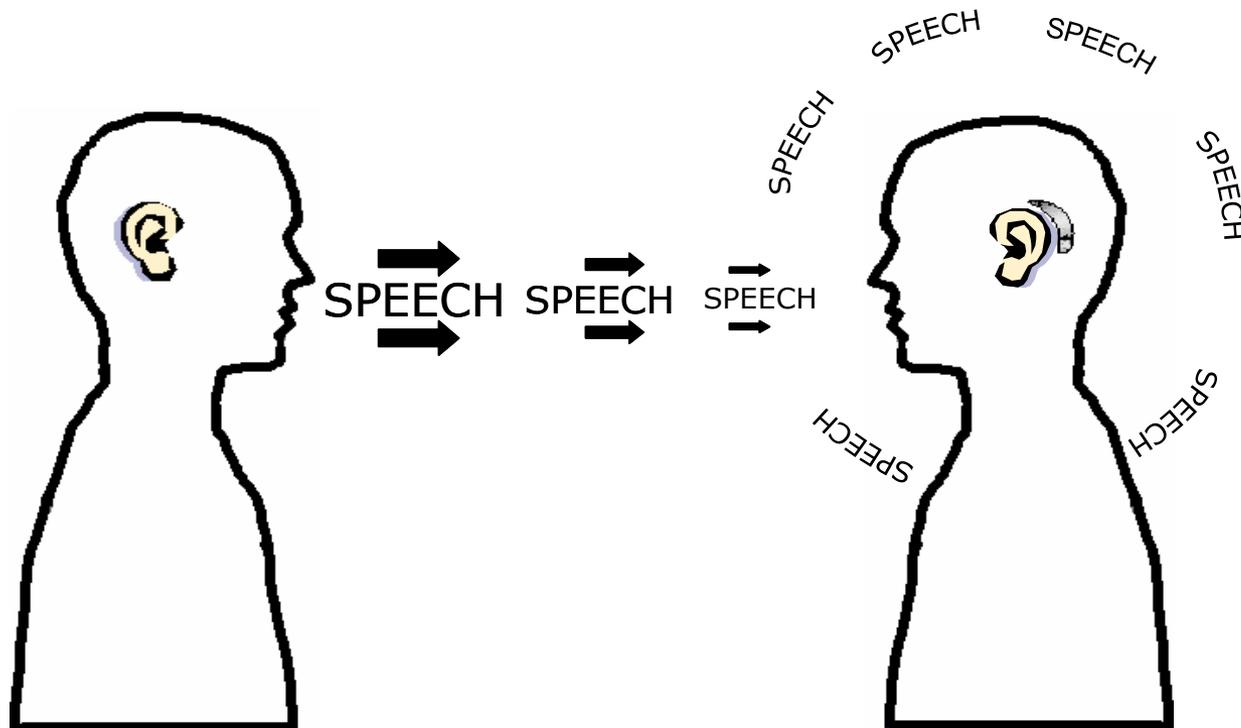


Illustration courtesy Cynthia  
Compton-Conley, Ph.D. © 2010

# 4. Distance

- Determines the sound pressure level (SPL) at the ears of the listener.
- Determines signal-to-noise ratio (SNR) – how loud the sound is in relation to the surrounding (ambient) noise.
- Determines relationship between the direct and reflected energy in the room.

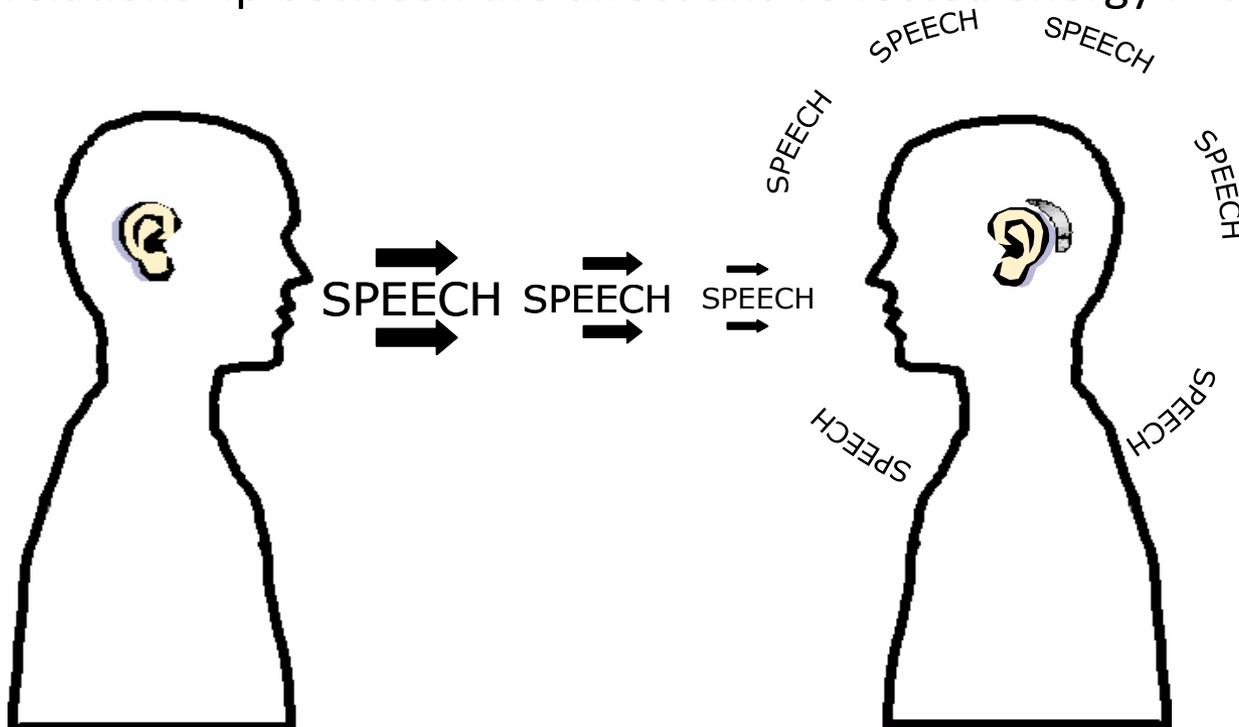
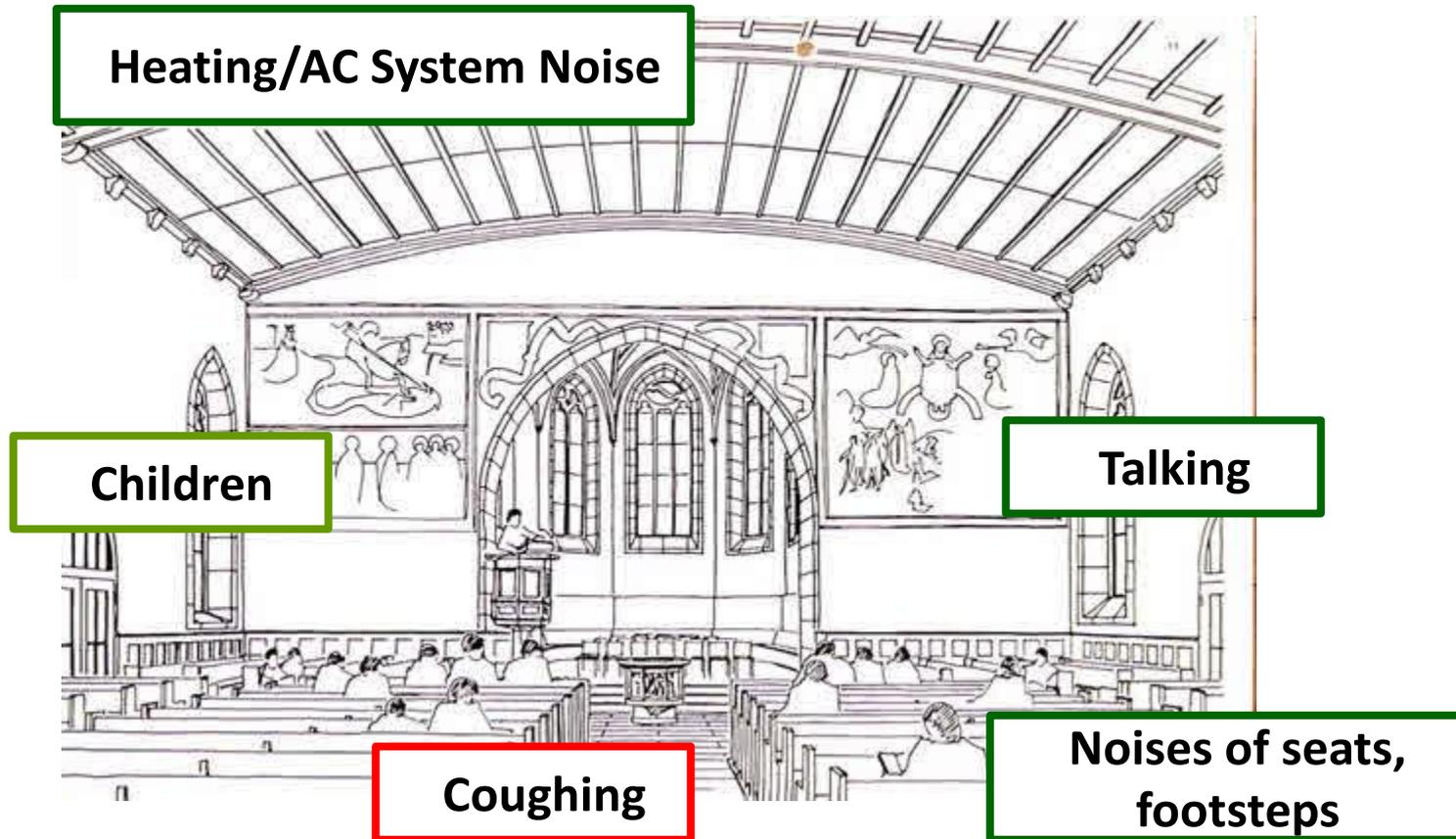


Illustration courtesy Cynthia  
Compton-Conley, Ph.D. © 2010

# 5. Ambient Noise

Ambient noise, also known as background noise, can be caused by a variety of sources.



# 5. Ambient Noise

- Here, the speech reaching the listener's ears appears the same font size to represent the same intensity level. However, the noise could be louder than the speech or softer than the speech.
- In other words, the speech-to-noise or signal-to-noise ratio can vary.

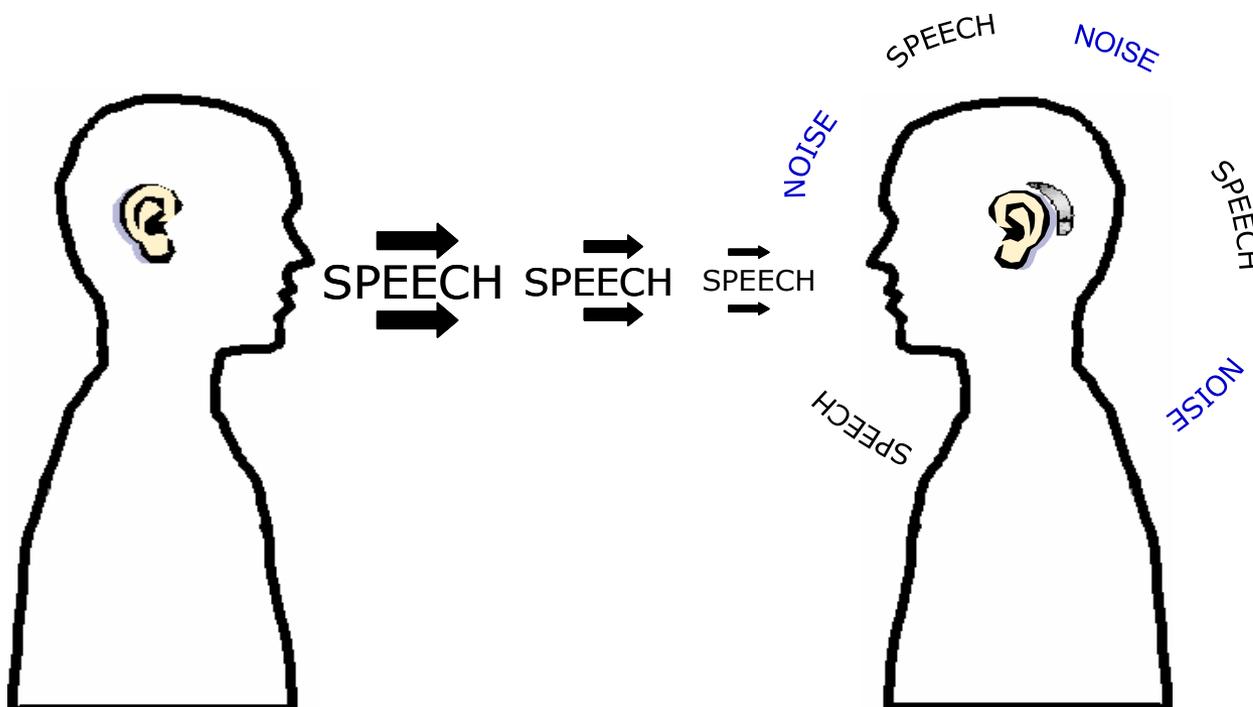


Illustration courtesy Cynthia Compton-Conley, Ph.D. © 2010

# 5. Ambient Noise

- The noise will mix with the desired speech signal, making it very difficult to understand.
- Understanding difficulty depends upon the relationship between the speech and noise. The louder the noise is, compared to the desired signal, the more difficult it will be to understand.

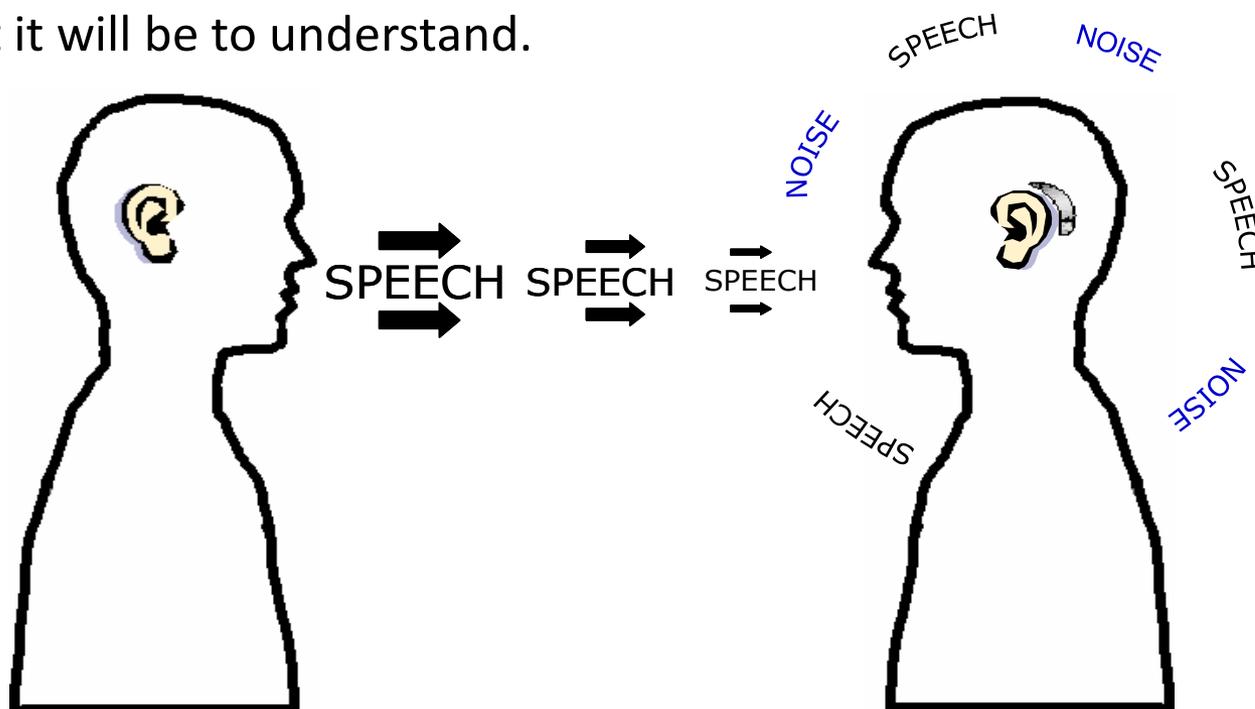
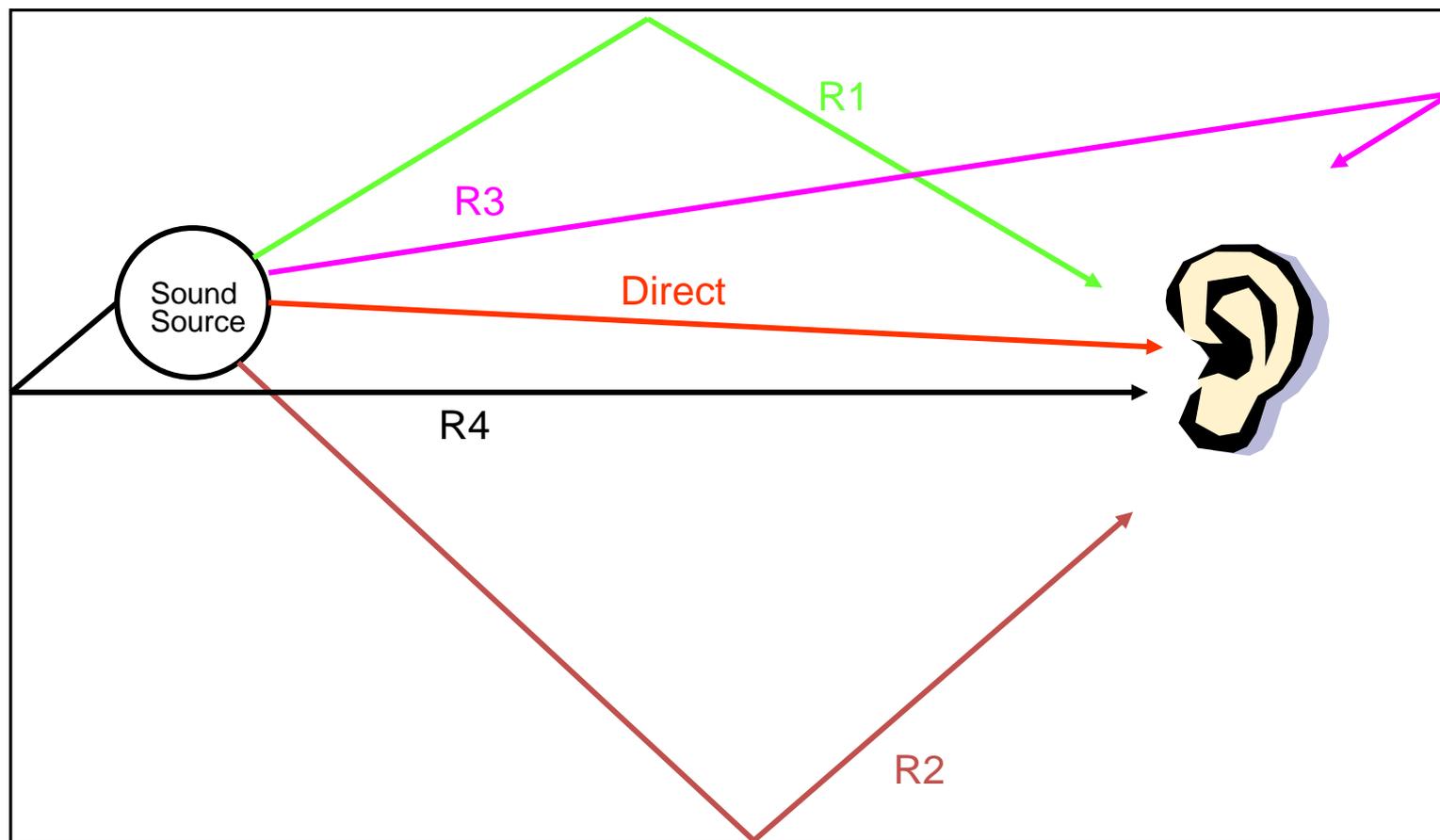


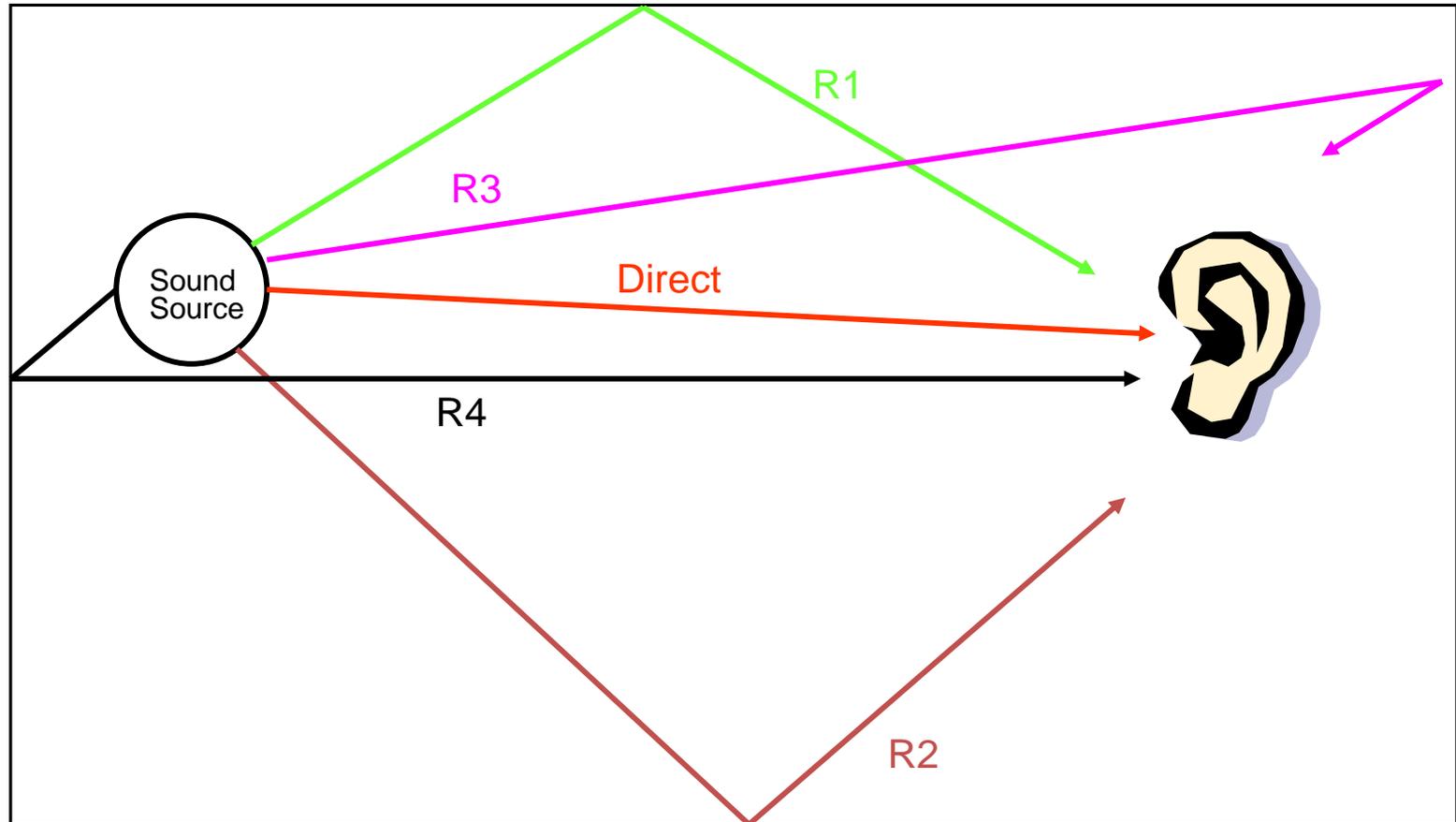
Illustration courtesy Cynthia Compton-Conley, Ph.D. © 2010

# 6. Reverberation

Reverberation is caused by sound bouncing off ceilings, floors, walls and other surfaces and objects in the room before it arrives at the listener's ears.



- The talker's voice takes more than one path to the listener's ears, traveling:
  1. Directly to the listener's ears (red arrow).
  2. Taking a longer route by bouncing (reflecting) off various surfaces of the room before finally reaching the listener's ears.



- These different arrival times at the ear cause the speech to smear, making it difficult to understand the speech, even if it is sufficiently loud.
- Here, speech becomes softer at the listener's ears, but is also smeared due to reverberation. Notice: This smearing can happen in the absence of ambient noise. In addition, the amount of smearing will increase with increased reverberation.

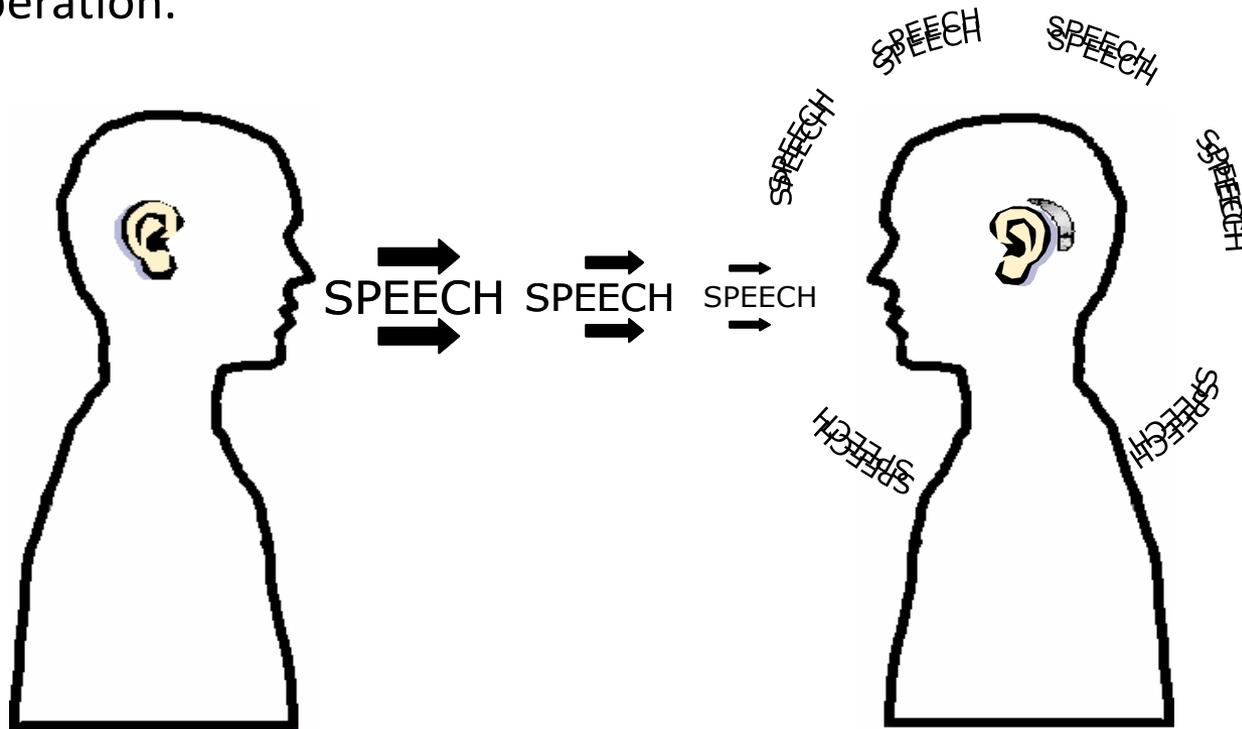


Illustration courtesy Cynthia  
Compton-Conley, Ph.D. © 2010

- This can happen even if a public address (PA) system is being used.
- Reverberation adversely affects speech understanding for people with normal hearing – and especially for people using hearing aids and/or cochlear implants.

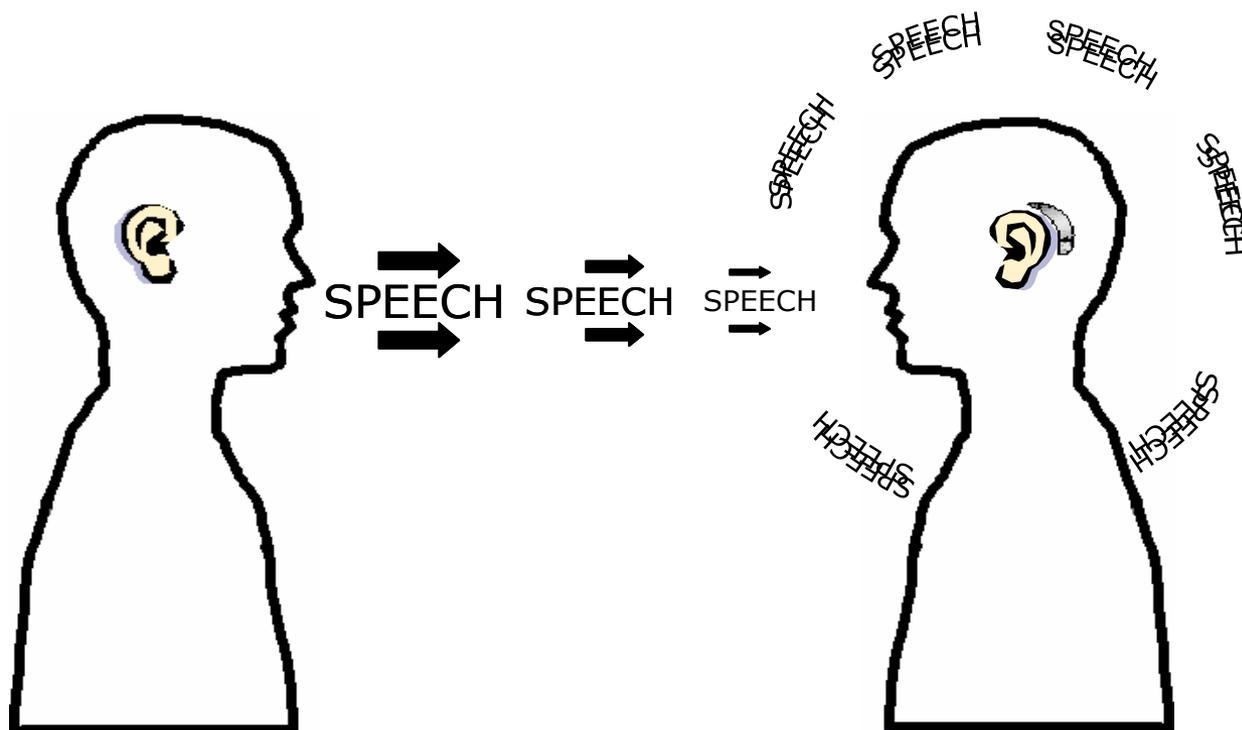


Illustration courtesy Cynthia  
Compton-Conley, Ph.D. © 2010

# The compounding effects of distance, noise and reverberation

- In rooms containing both noise and reverberation, both the speech and noise are smeared, making listening even more difficult.

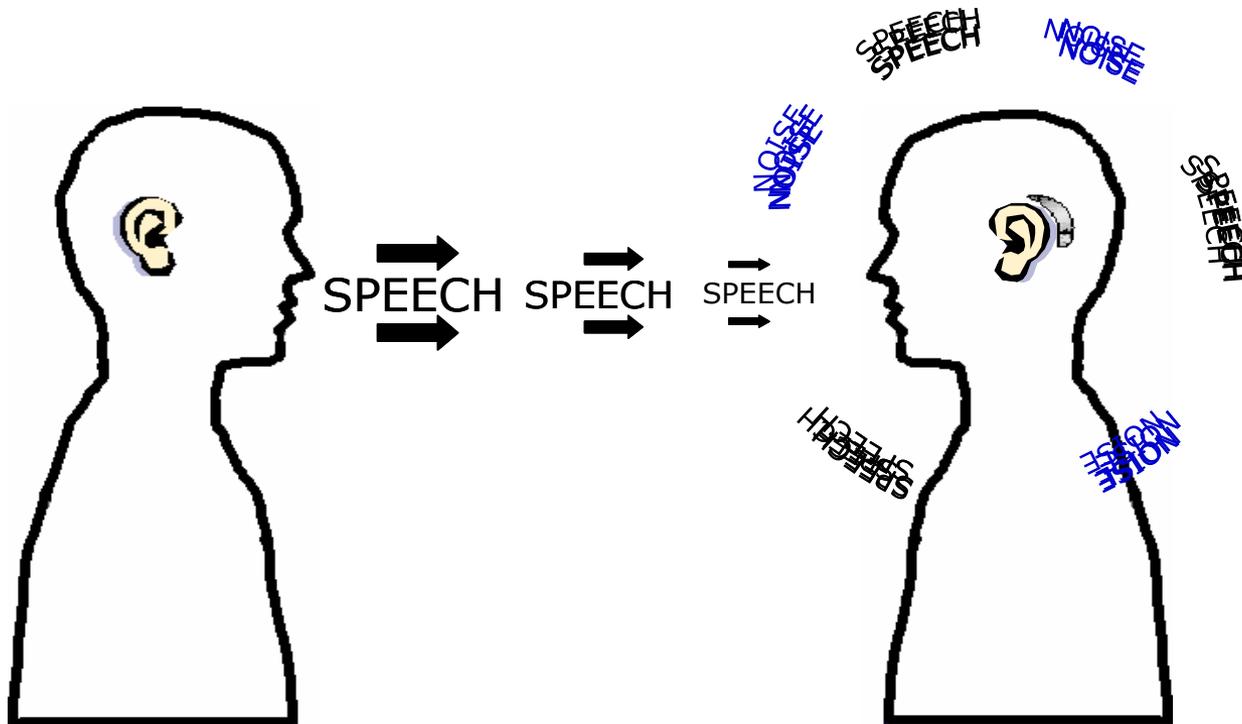


Illustration courtesy Cynthia Compton-Conley, Ph.D. © 2010

# The compounding effects of distance, noise and reverberation

- Here is a visual representation of how speech becomes softer at the listener's ears, mixed with ambient noise, and both the speech and noise are smeared, rendering understanding difficult to impossible.

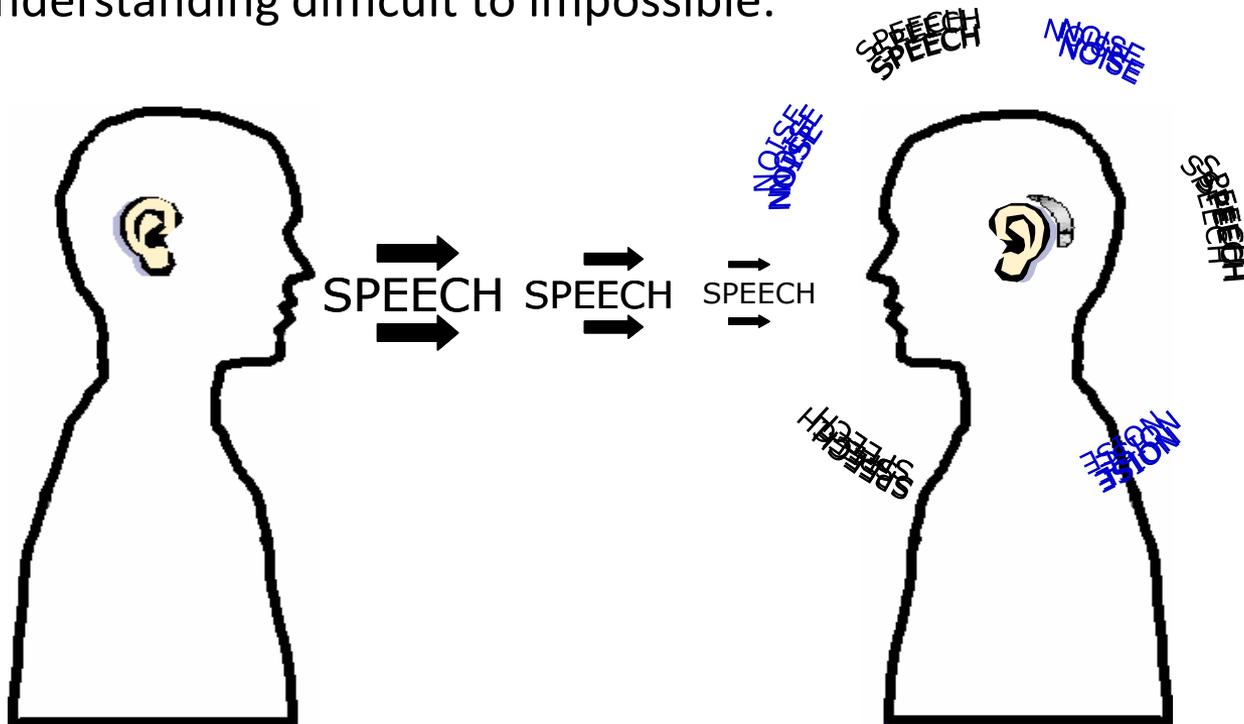
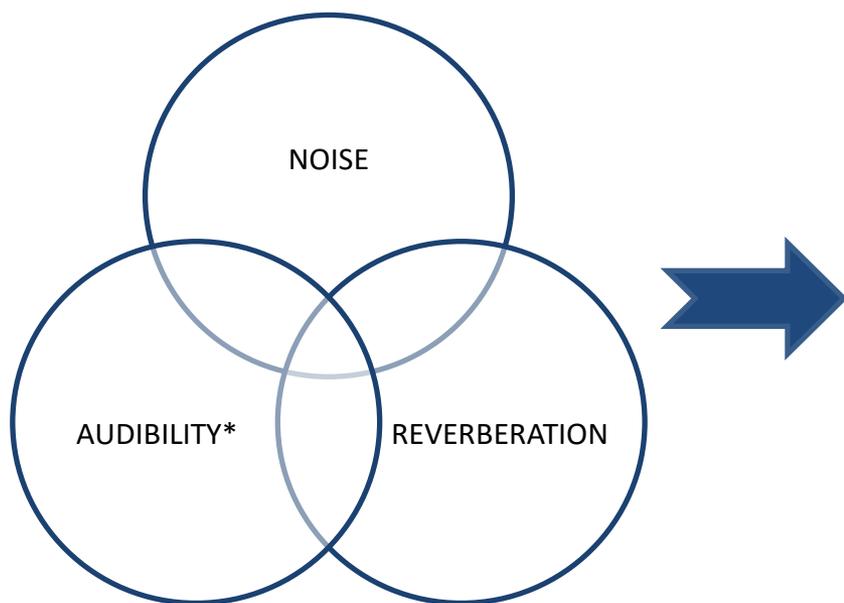


Illustration courtesy Cynthia  
Compton-Conley, Ph.D. © 2010

# Why hearing aids/cochlear implants might not be enough

Because the hearing instrument's microphone is worn on the head, speech understanding is negatively influenced by the synergistic effect of room acoustics and hearing loss. Even directional microphones cannot help from the back of a room.



## TARGET SIGNAL BECOMES:

- TOO SOFT
- MASKED BY THE NOISE
- SMEARED BY REVERBERATION
- ALL OF THE ABOVE

\*Audibility is determined by intensity of target signal, vocal effort of talker, distance, hearing loss

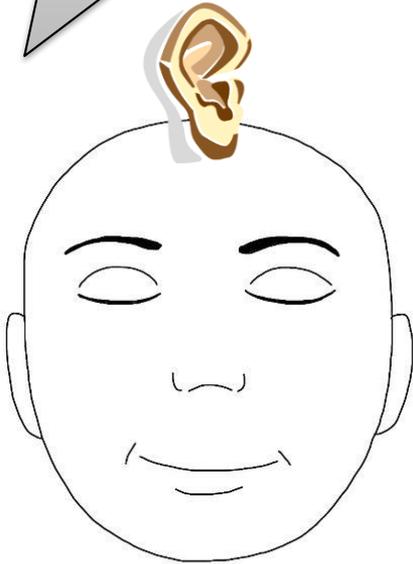
# Large Area Assistive Listening Systems to the Rescue!

- How do they help?
- 3 types of systems and how they work.
- How does the listener connect (couple) to the system?
- **Why choose a room LOOP?**

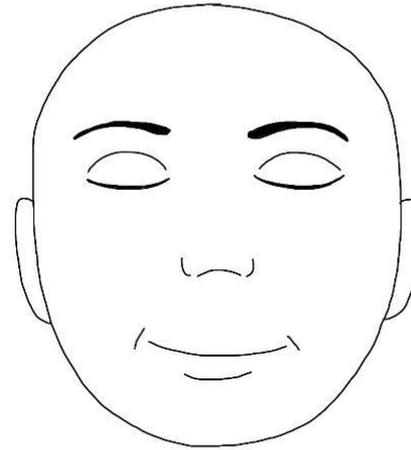
# How do they help?

- They overcome the negative effects of room acoustics (distance, noise and reverberation), allowing people with normal hearing as well as people with hearing loss to hear better in:
  - Houses of worship
  - Lecture and meeting halls
  - Government buildings
  - Movie theaters
  - The workplace (meetings)

Assistive Listening  
Systems are like  
having a “third ear.”



... that you can move  
across the room and  
place right next to the  
talker's mouth.



[http://www.audiologyonline.com/Articles/article\\_detail.asp?article\\_id=561](http://www.audiologyonline.com/Articles/article_detail.asp?article_id=561)

# The 3 Cs: The technology behind the magic.

CATCH

CARRY

COUPLE

- Placing a microphone (3<sup>rd</sup> ear) close to the sound source **catches** the desired speech before it travels across the room.
- Speech is then sent directly, or **carried**, to the listener's ears, resulting in no loss of loudness or distortion due to noise and/or reverberation.
- **Coupling** is how the sound is delivered to the ear once it reaches the listener.
- The communication link used to carry the sound from the sound source to the listener can be hardwired (tethered), as shown here or...



- The link can be wireless as in this example of a wireless personal assistive listening device (ALD) being used with a hearing aid.
- Speech is picked up by the microphone on the transmitter and broadcast through the air to the receiver and then sent to the hearing aid via a special cord. The word **SPEECH** shows how audibility and clarity are preserved, despite distance, noise and reverberation.

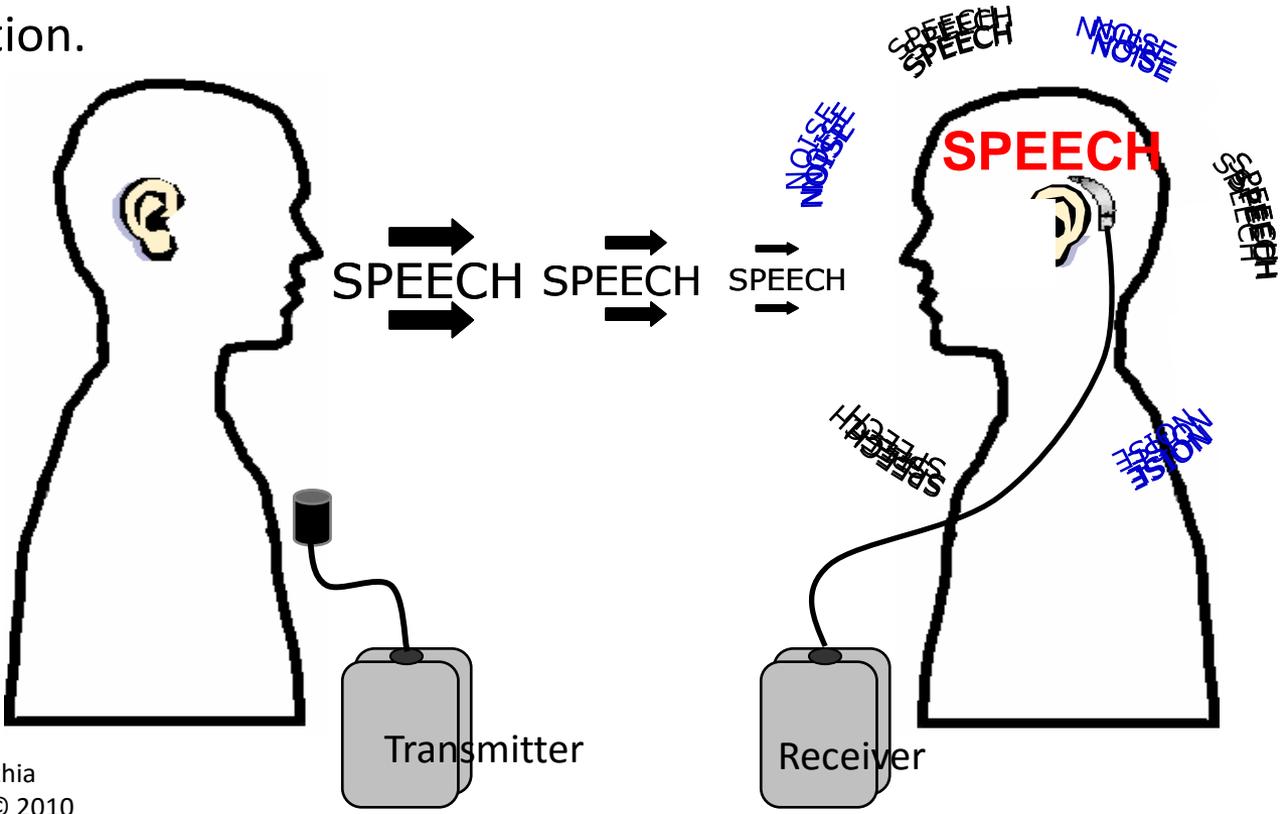


Illustration courtesy Cynthia Compton-Conley, Ph.D. © 2010

- As Cynthia Compton-Conley has said you can think of assistive listening devices as “[binoculars for the ears](#).” Just as binoculars magnify a distant image, bringing its details closer to your eyes so you can see it better, assistive listening devices catch the desired sound from a distance and sends it directly to your ears, preserving its loudness and quality despite poor room acoustics.

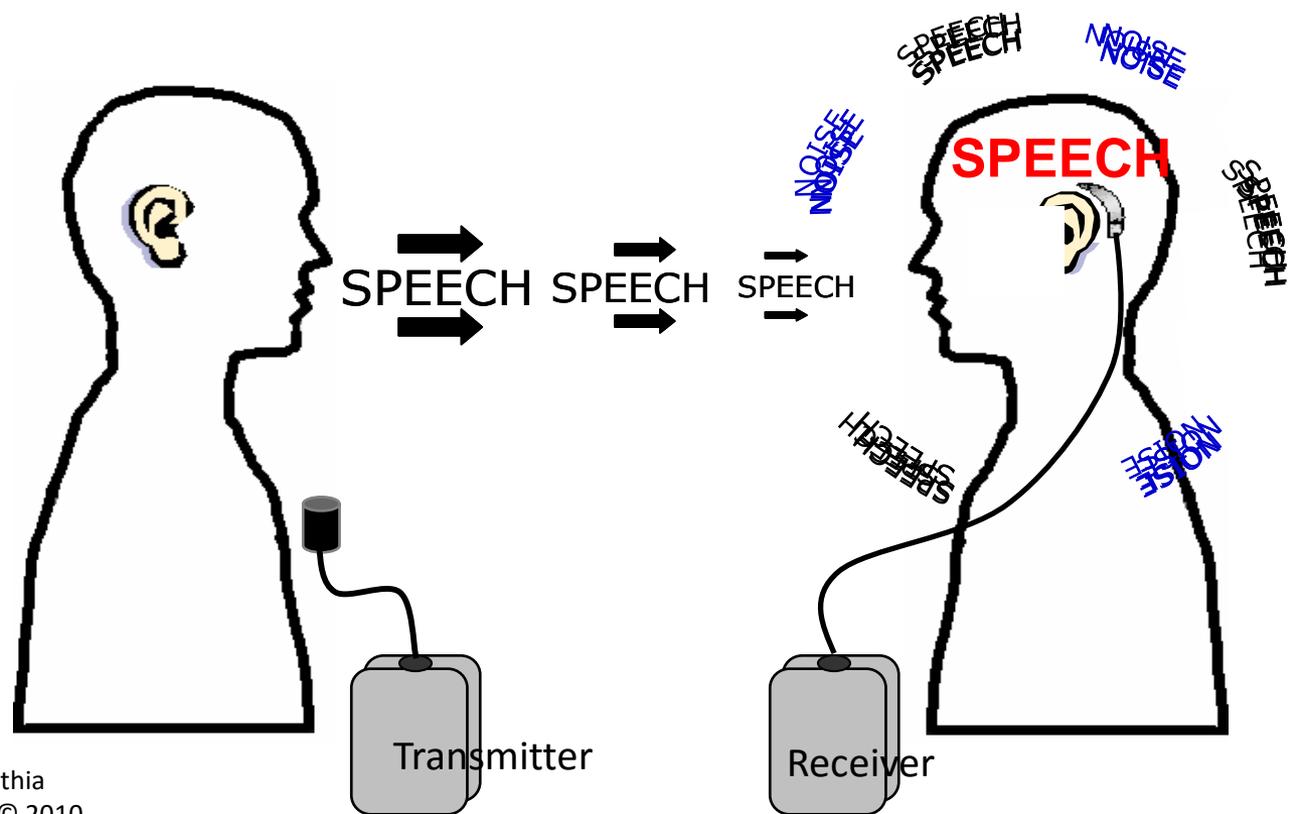
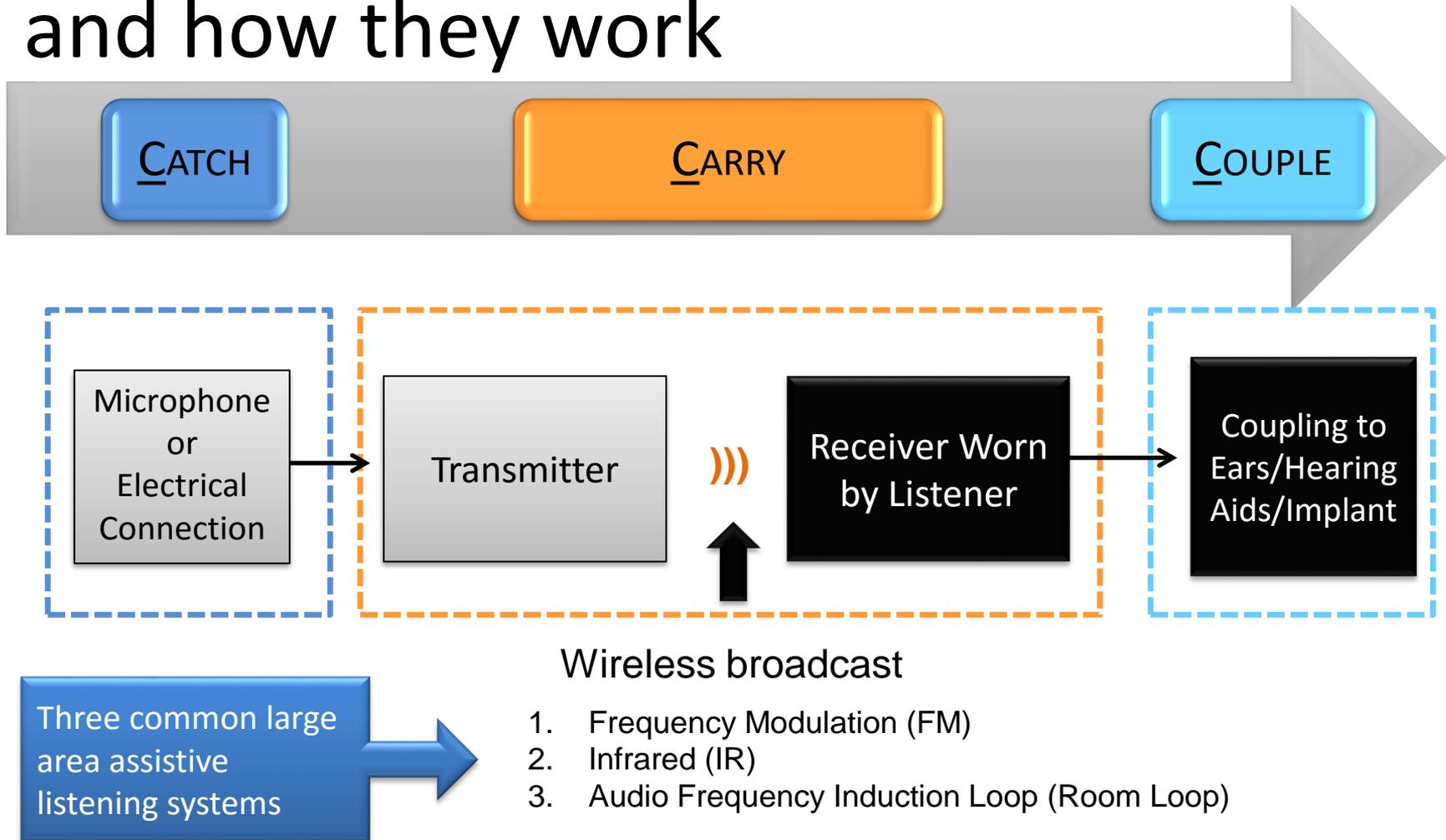


Illustration courtesy Cynthia Compton-Conley, Ph.D. © 2010

# Large area assistive listening systems and how they work



# Do these systems use radio waves?

- All three systems use radio-like waves, more precisely called **electromagnetic waves**. Technically, the transmission is called electromagnetic radiation, one of the elemental forces of the universe.
- FM, IR and Induction Loop technology “live” in different locations on what is called the **electromagnetic spectrum**.

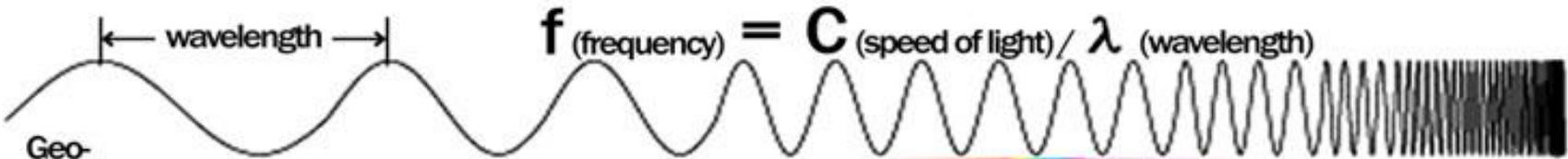
# THE ELECTROMAGNETIC SPECTRUM

Loop 100 – 5000Hz or ULF

FM

Infrared

SELF DC    ELF 3 Hz    VLF 30kHz    LF/MF/HF/VHF/UHF 3 GHz    SHF 300 GHz    EHF 430-750 THz    30PHz    3 EHz    300 EHz

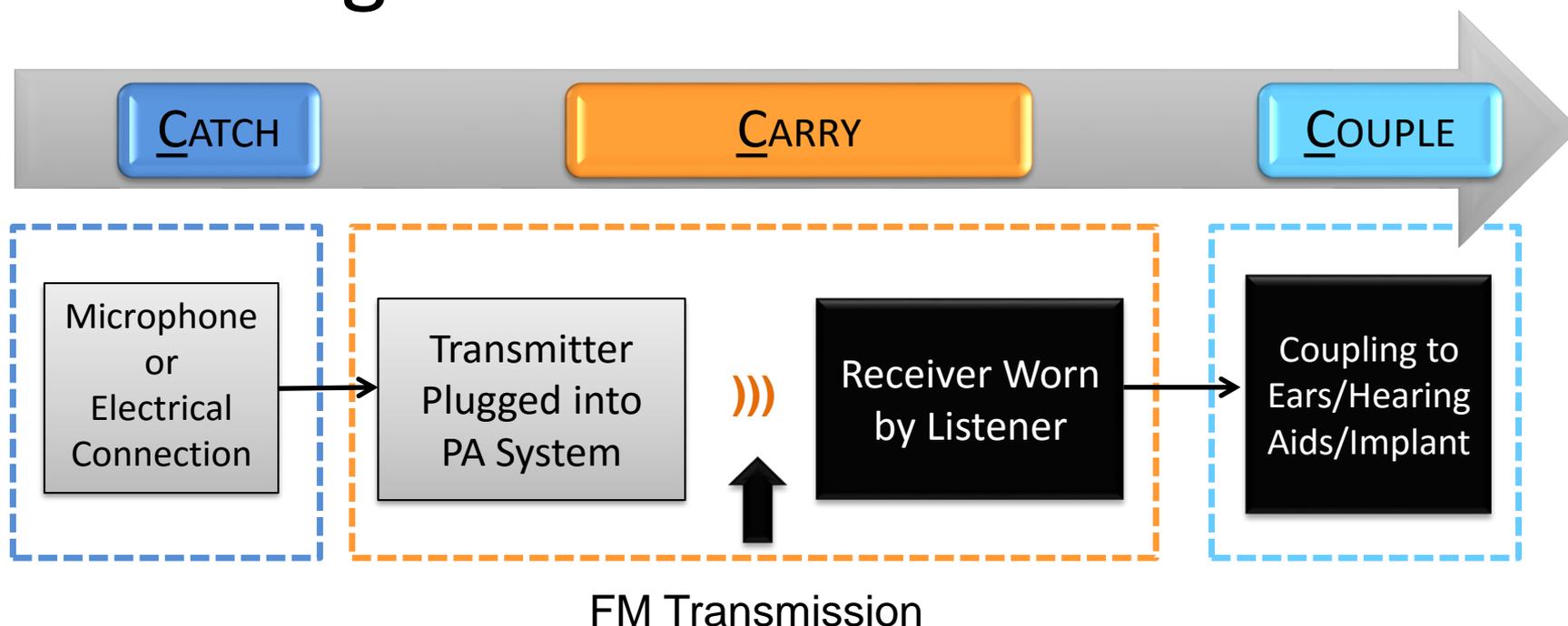


Geo-magnetic & sub ELF sources    Extremely Low Frequency    Very Low Frequency    Radio Frequency spectrum    microwaves    Infrared    Visible    Ultra violet    X-rays    Gamma Cosmic rays

EMF Sources

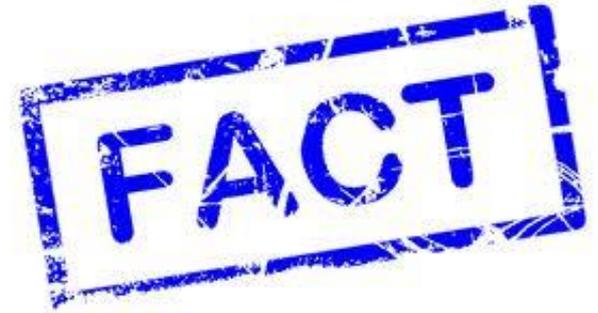
									
Earth & Subways	AC Power	Monitors	Mobile AM/FM	TV	Cell/PCS	Microwave & Satellite	Sunlight	Medical x-rays	Radioactive Sources

# How Large Area FM Works



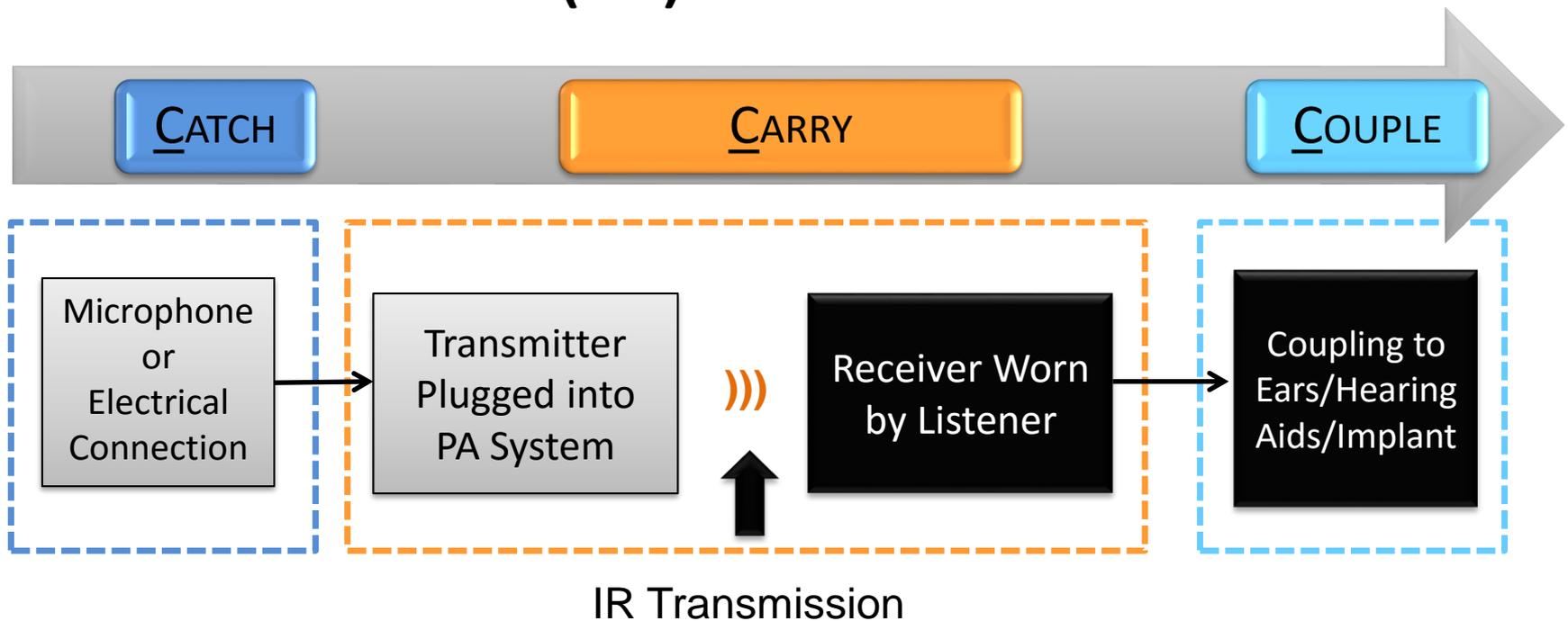
- FM transmitter connected to PA system sends sound, as an FM-modulated radio wave, directly to listeners using FM receivers tuned to same channel as transmitter.
- FM receivers change the FM signal to an electrical signal that is then sent to earphones or other coupling devices.
- Two types: 72-76 MHz band (wide or narrow band); 216-217 MHz band (more modern; narrow band only)

# FM Facts



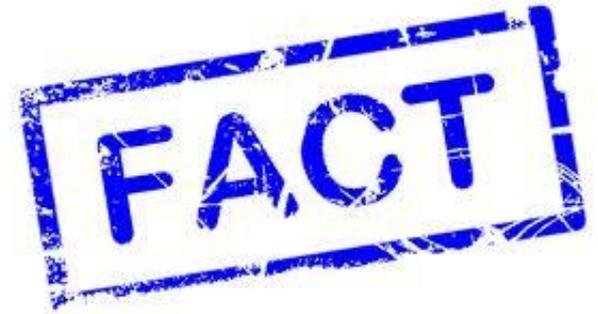
- The transmitter and receiver must be on the same channel in order for the listener to hear the broadcast.
- Ideal for multi-language translation.
- Listener must always borrow a receiver from the public venue unless the listener owns one that is operating on the same band (72- 76 MHz or 216-217 MHz) and (channel within that band) that is used in the venue.

# How Infrared (IR) Works



- IR transmitter connected to PA system sends sound, encoded as modulated invisible light, directly to listeners using IR receivers tuned to same channel as transmitter.
- IR receivers contain photosensitive cells to pick up the light and change it back to an electrical signal that can be sent to earphones or other coupling devices.
- Current channels being used: 95 MHz mono; 95/250 kHz stereo; 2.3/2.8 MHz stereo.

# IR Facts



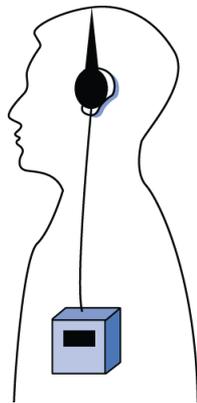
- Signal does not pass through solid surfaces; privacy preserved (must use window coverings).
- Must maintain line of sight between transmitter(s) and receivers.
- Careful installation required so transmission is not obstructed by posts, people's heads, etc. Accomplished via the use of multiple, strategically placed IR emitters.
- Listener must always borrow a receiver from the public venue unless the listener owns one that is on the same channel(s) as the transmitter installed in the venue.

# How to Couple to FM and IR Systems

- We will discuss the third large area system, the room loop, after we discuss how to couple (connect) to FM and IR systems.
- This is because one of the coupling methods for FM and IR systems works like a room loop, only it's around the listener's neck.

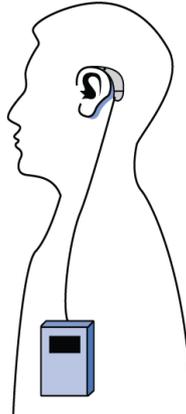
# Coupling to an FM System

FM Transmitter Connected to PA System Broadcasts to FM Receivers Worn by Listeners



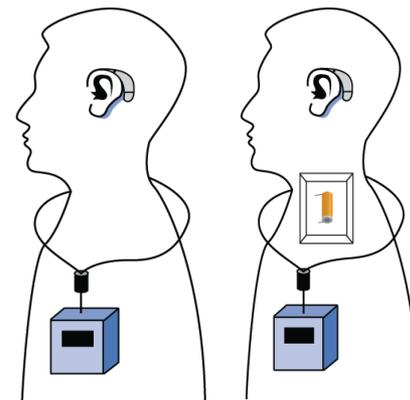
## 1. Acoustic Coupling

Listener **borrow**s receiver and uses **earphones** (no hearing aids) Called acoustic coupling because sound enters ear directly from earphone.



## 2. DAI (Direct Audio Input)

Listener **borrow**s receiver and plugs personally-owned **electrical** cable into hearing aid or implant (venue not required to have cables on hand).



## 3. Inductive Coupling

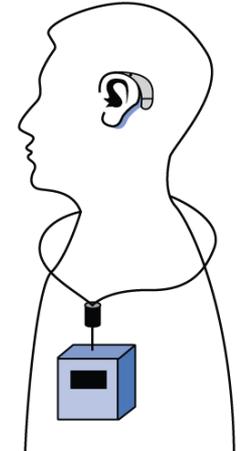
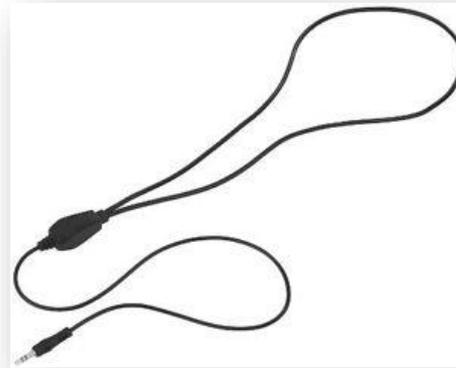
Left: Listener with telecoil-equipped hearing aids/implants borrow FM receiver with an **inductive** neckloop.

Right: Listener with no telecoils but with telecoil-equipped streamer **borrow**s FM receiver with neckloop.

# What is required for inductive coupling to an FM system?

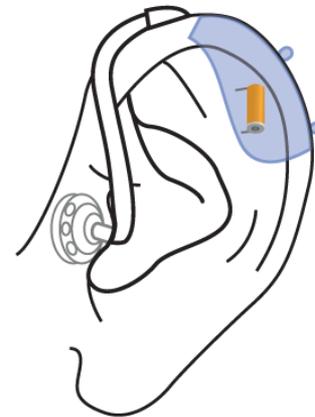
## 1. NECKLOOP

- Placed around neck and plugged into FM receiver.
- Picks up signal from FM receiver, and changes it to electromagnetic energy that is then sent to the telecoil.

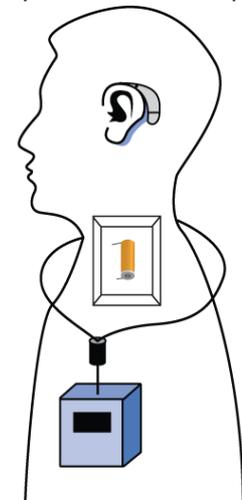


## 2. TELECOIL

- Located inside hearing aid or cochlear implant.
- Located inside hearing aid streamer.



Telecoil inside hearing aid

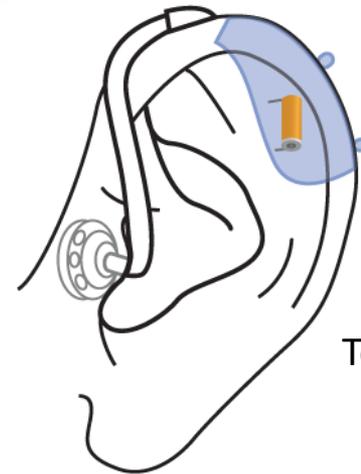
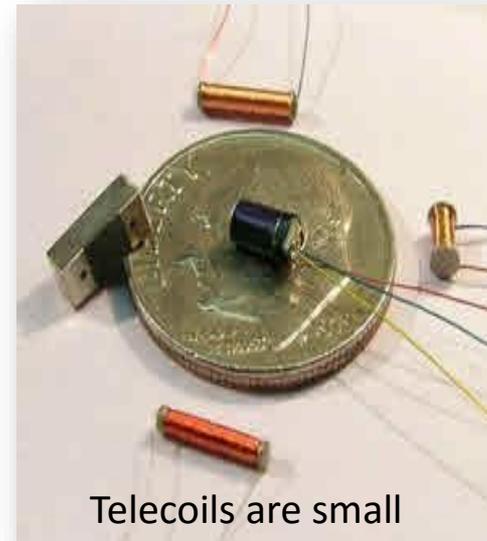


Telecoil inside streamer

Illustrations used with permission by Cynthia Compton-Conley, Ph.D., Sound Strategy.com, and Etymotic Research, Inc. © 2011

# What is a telecoil?

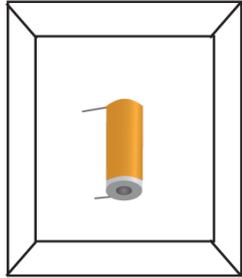
- Tiny metal rod surrounded by coils of copper wire.
- Designed to receive electromagnetic energy emitted by neckloops and room loops (to be discussed) and from hearing aid compatible telephones.
- It then converts it to electrical energy which is processed by the hearing aid or cochlear implant.



Illustrations used with permission by Cynthia Compton-Conley, Ph.D., Sound Strategy.com, and Etymotic Research, Inc. © 2011

# What is a streamer and why would it have a telecoil?

Illustration used with permission by Cynthia Compton-Conley, Ph.D., Sound Strategy.com, and Etymotic Research, Inc. © 2011



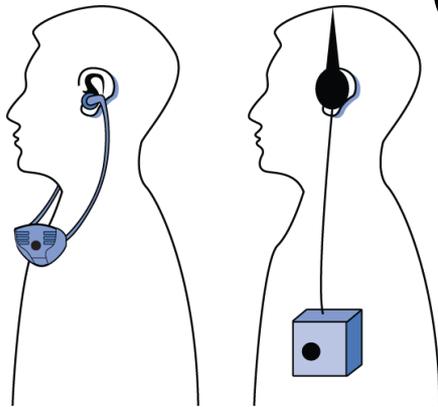
Generic illustration of a telecoil located inside of a streamer.

- Streamer: Body worn or handheld battery-powered device used to receive Bluetooth® signals from various devices.
- Some are equipped with telecoils, thus allowing a listener to use it to receive a signal from a neckloop used with a borrowed FM or IR receiver.
- Beneficial to wireless hearing aid users who do not have telecoils inside of the hearing aid itself.
- To listen to the neckloop, the wireless hearing aid user activates the streamer's telecoil and places it around the neck or clips it to a lapel inside the neckloop.

# Coupling to an IR System

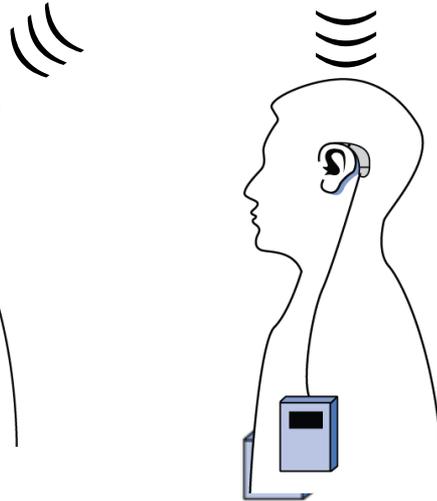
Illustrations used with permission  
by Cynthia Compton-Conley,  
Ph.D., SoundStrategy.com, and  
Etymotic Research, Inc. © 2011

IR Transmitter Connected to PA  
System Broadcasts to IR  
Receivers Worn by Listeners



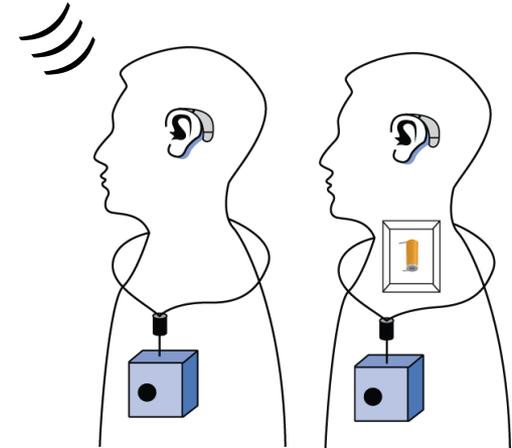
## 1. Acoustic Coupling

Listener **borrow**s receiver and uses **earphones** (no hearing aids). Called acoustic coupling because sound enters ear directly from earphone. Left: Under-chin version; Right: Body worn version.



## 2. DAI (Direct Audio Input)

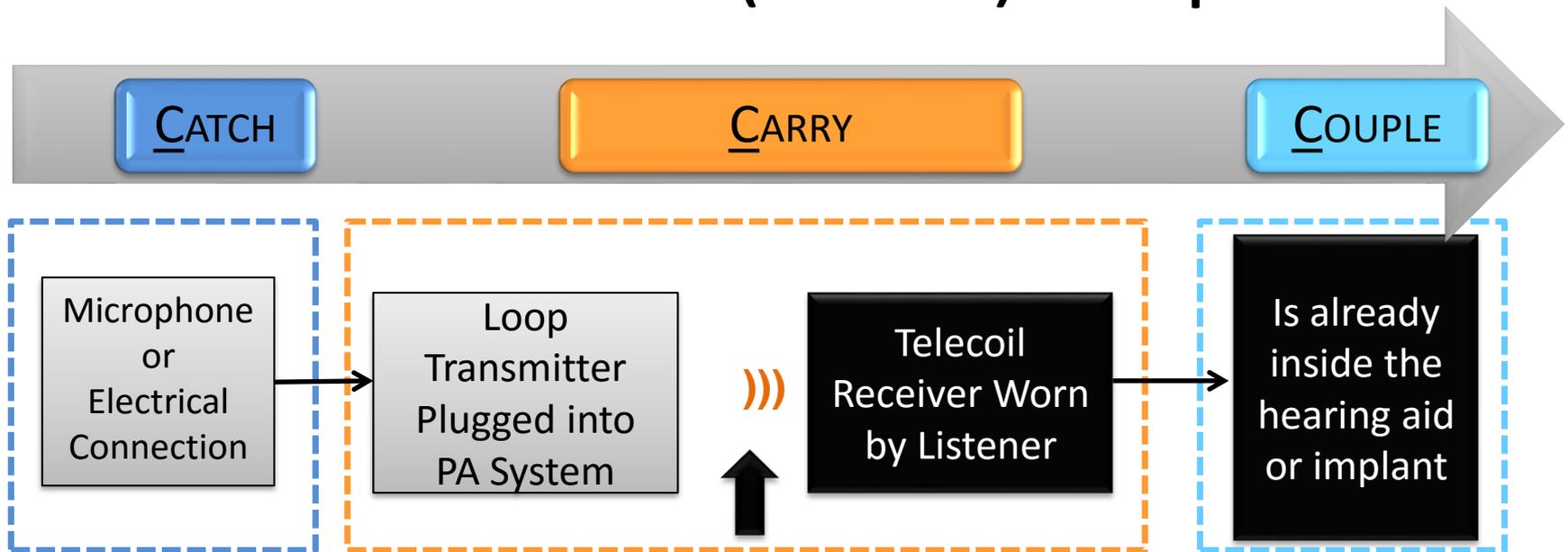
Listener **borrow**s receiver and plugs personally-owned **electrical** cable into hearing aid or implant (venue not required to have cables on hand).



## 3. Inductive Coupling

Left: Listener with telecoil-equipped hearing aids/implants borrow IR receiver with an **inductive** neckloop.  
Right: Listener with no telecoils but with telecoil-equipped streamer **borrow**s IR receiver with neckloop.

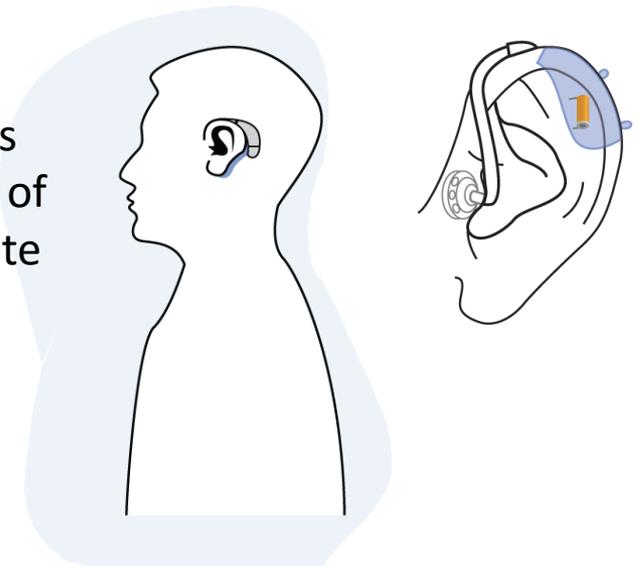
# How an Induction (Room) Loop Works

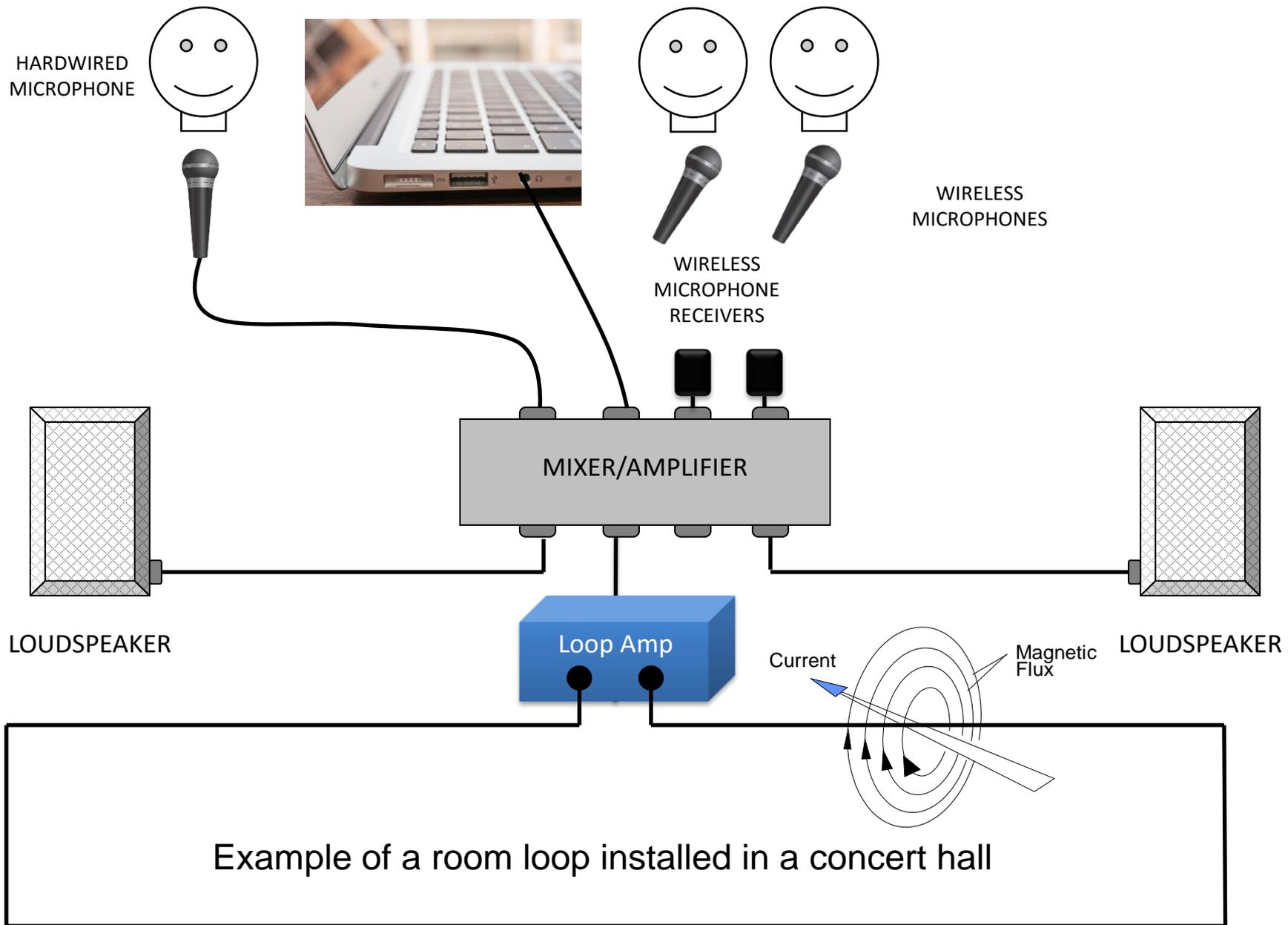


Inductive Loop Transmitter

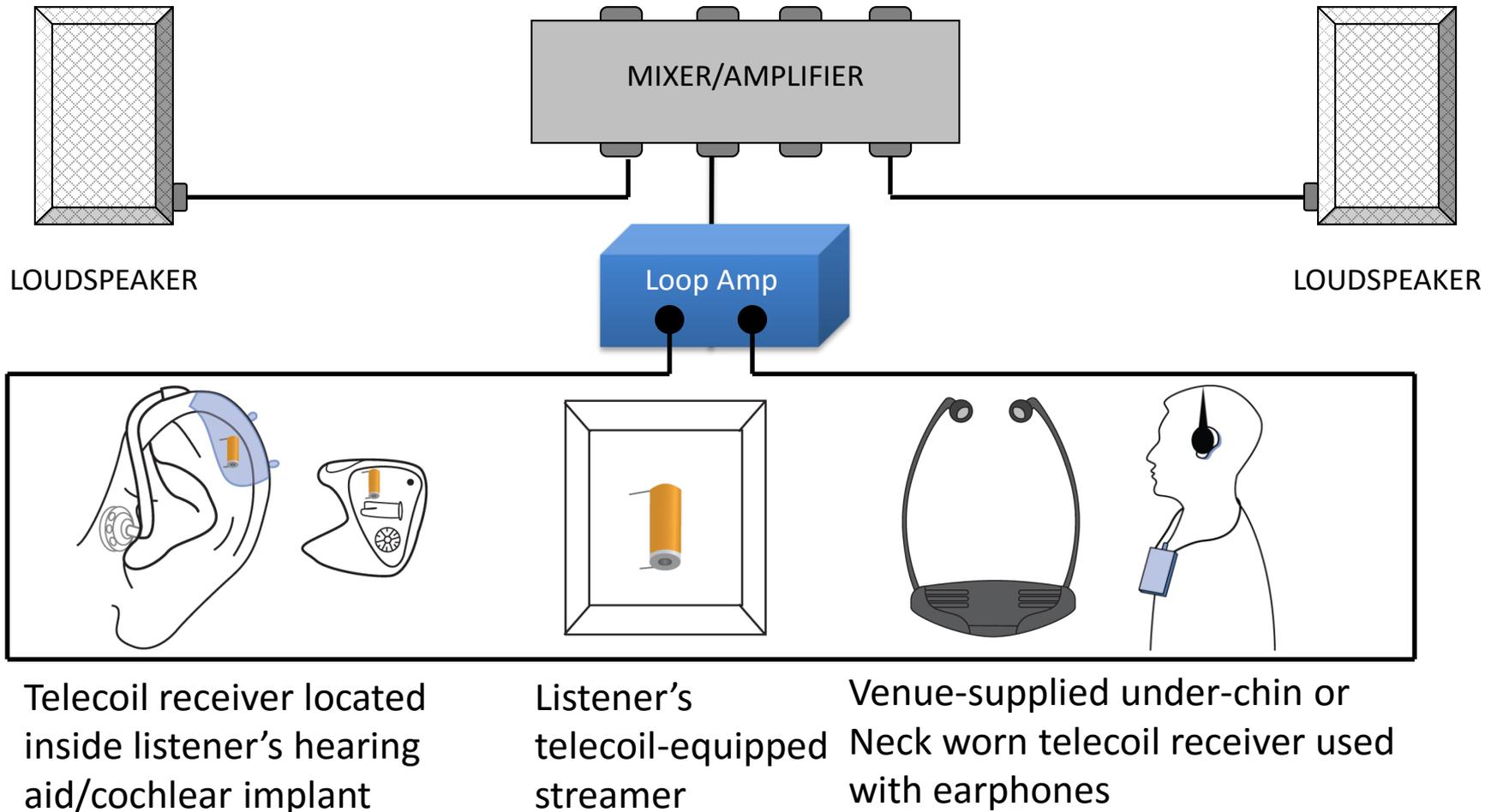
A room loop is like a giant neckloop. It seamlessly sends the desired signal directly to the telecoil receiver inside of your hearing aid or implant. You enter the room, activate your telecoil and – voila! – you hear.

**Nothing to borrow. It's convenient and discrete.**

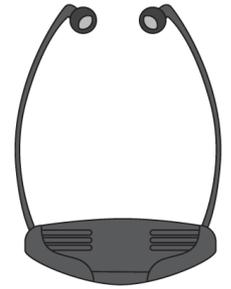




# Summary of Room Loop Coupling Methods



# Limitations of headsets

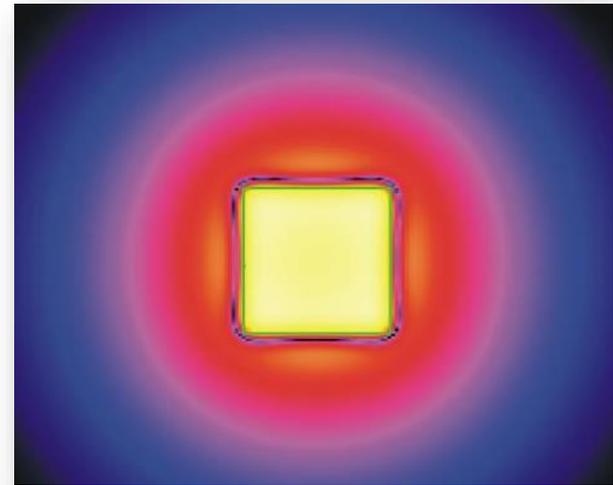


- Unlike hearing aids, headsets have a fixed frequency response and output that might or might not provide sufficient audibility for understanding.
- Hearing aids with telecoils attempt to provide sufficient audibility and understanding which should result in a better listening experience.

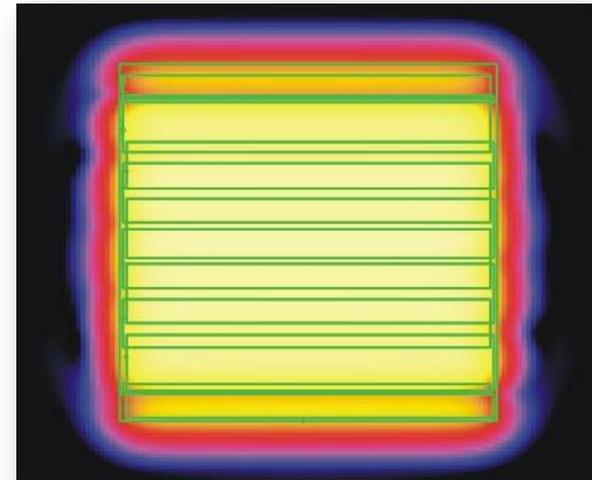
# Room Loop Facts

- Like FM, no line of sight needed.
- Like IR and FM systems, loops are subject to interference but this can be reduced or eliminated with careful pre-installation and installation methods.
- Two types of loops:
  1. Perimeter (single wire installed on floor around room).
  2. 3-D: Grid of wires with different phases and amplitudes.
- 3-D loop systems produce significantly less spillover, making it possible to loop adjacent rooms.

<http://www.ampetronic.com/info/keyissues.php#4>

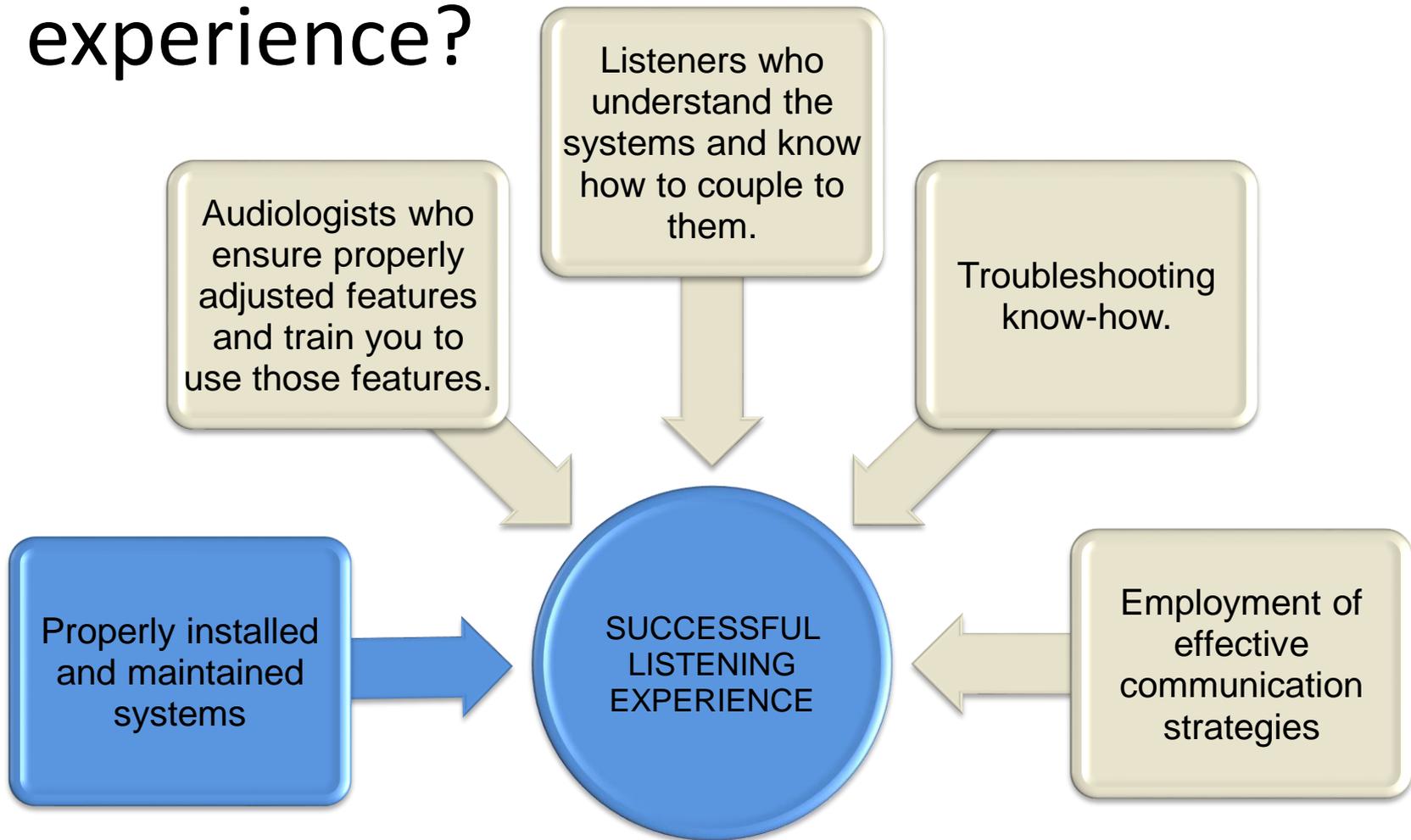


Spillover with perimeter Loop



Reduced spillover with 3-D Loop

# What makes for a successful listening experience?

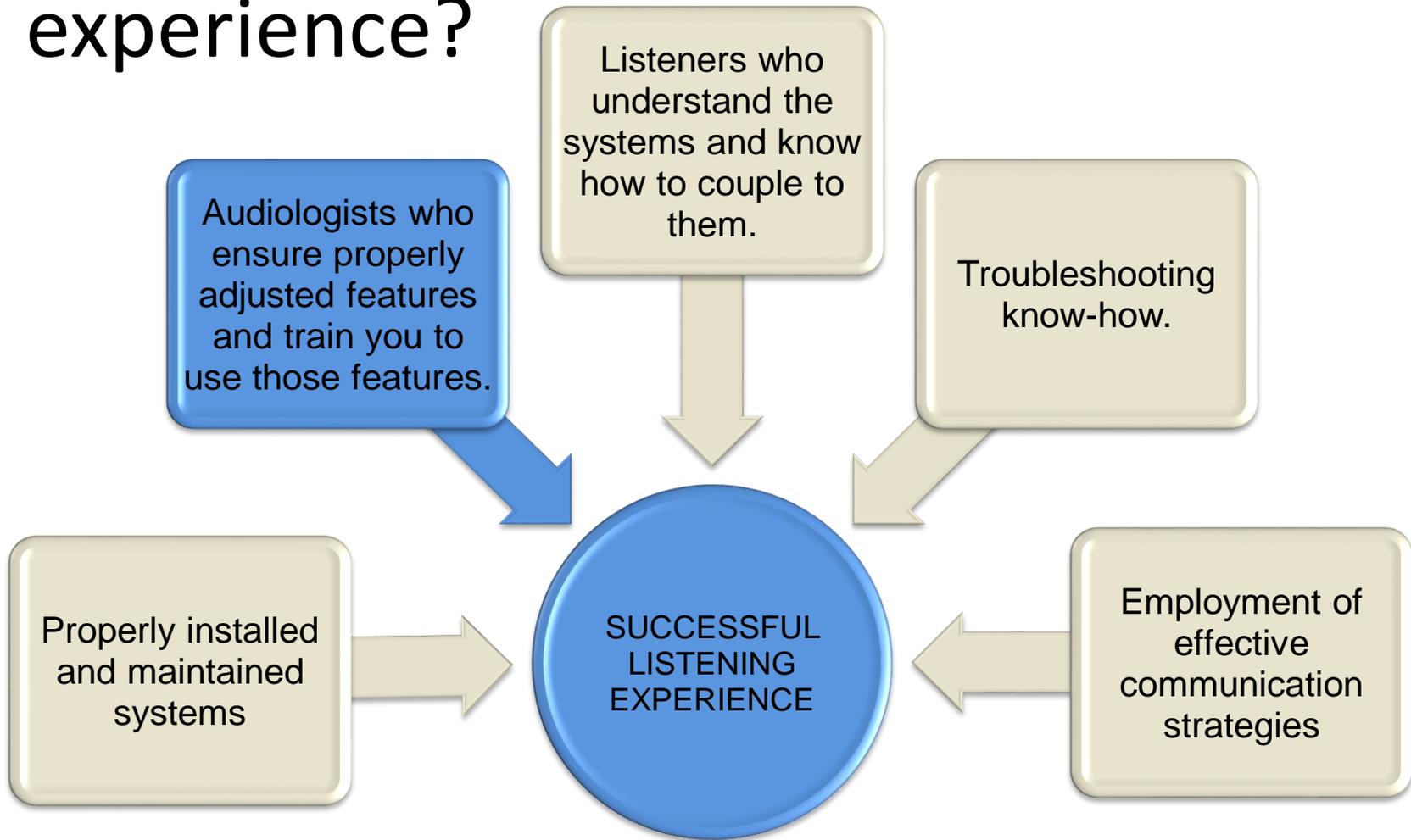


# Standards to ensure proper installation

- No national installation standards for large area ALS.
- International standard for the installation of loop systems: IEC60118-4.
  - Important for strong, even coverage.  
[http://en.wikipedia.org/wiki/Audio\\_induction\\_loop](http://en.wikipedia.org/wiki/Audio_induction_loop)

Potential installers should offer engineering expertise to meet this standard and can verify that they have done so.

# What makes for a successful listening experience?

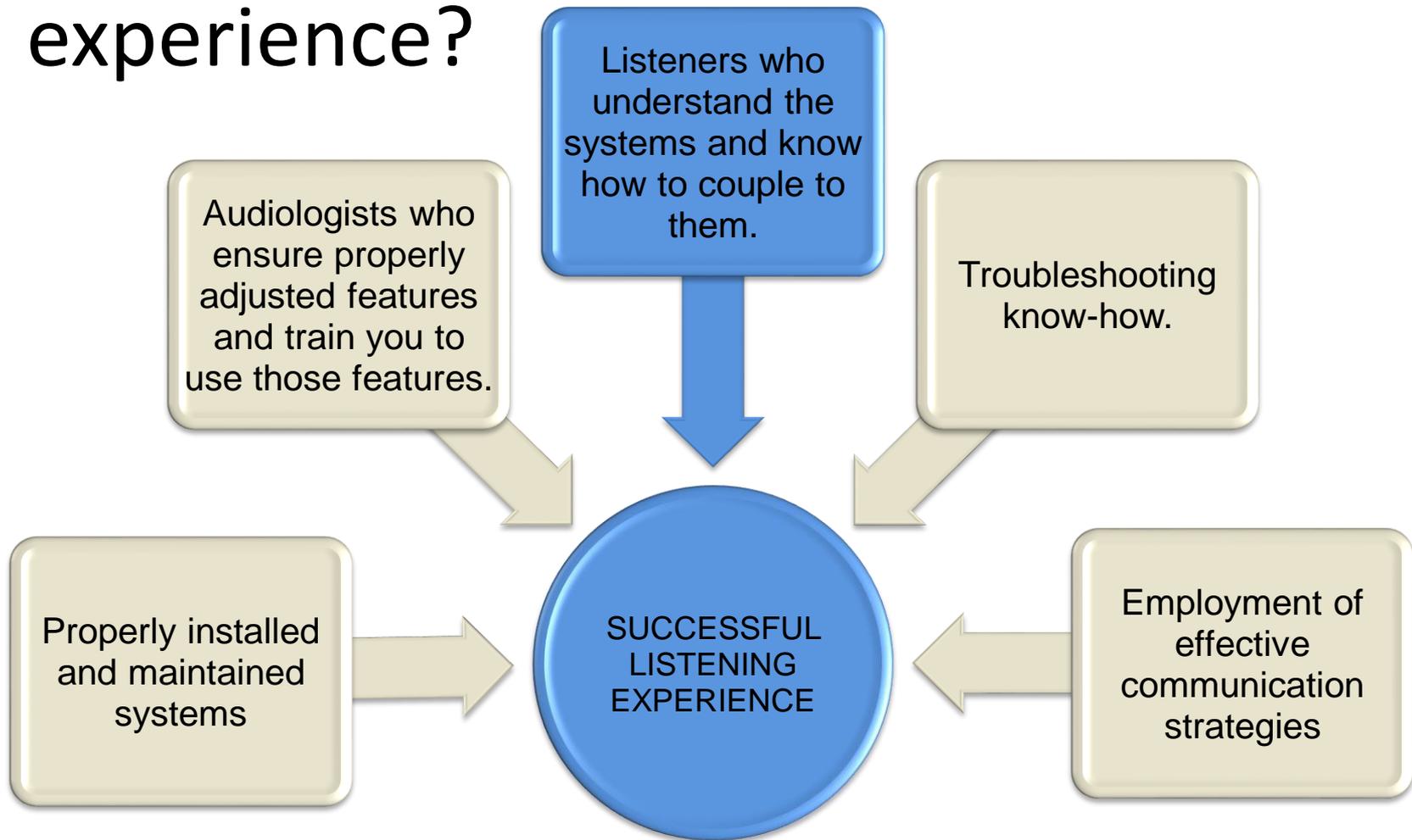


# Requirements for successful use of the telecoil

## **Audiologists and hearing aid specialists who:**

- ✓ Ensure that your hearing instruments have telecoils and are operating efficiently
- ✓ Ensure that the telecoils are properly oriented
- ✓ Properly program (adjust) the telecoils
- ✓ Train you to use the telecoil with various assistive listening devices

# What makes for a successful listening experience?



# Know Your Telecoils: Two Types

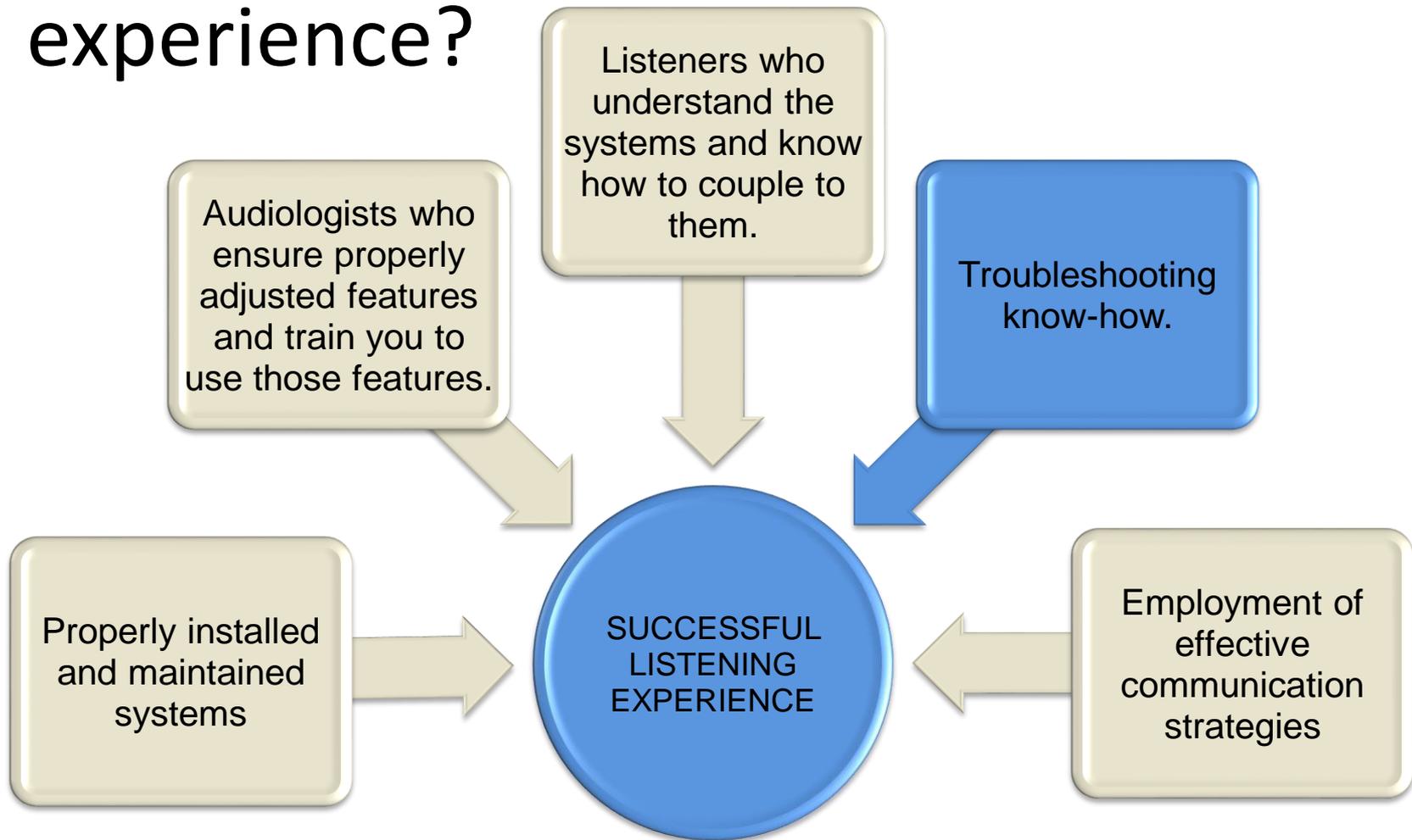
1. Manual – you turn it on via a switch or button.
2. Automatic – automatically activated when you place your hearing instrument near a hearing aid compatible phone.



# Know what type of telecoil and features you need – and when.

SETTING	WHAT IT MEANS	PROs	CONs
T Only	Telecoil on; microphone off	Allows you to hear through ALDs and nothing else; good in noisy settings	Cannot monitor your own voice
M + T	Microphone and Telecoil on	Allows you to hear through ALDs AND HAs; Allows you to monitor your own voice and to hear seatmate.	Might be distracting in noisy settings.
Auto-T	Automatic Telecoil	Allows you to hear on Hearing aid compatible phone	Will not work with loops, FM, IR without a manual override

# What makes for a successful listening experience?



# Questions for your hearing care provider:

- Do my hearing instruments have telecoils?
- Have they been activated?
- Have they been programmed (adjusted) for hearing loop use?
- Are they in good working order?
- How do I turn them on?
- Can my hearing instruments be retrofitted with telecoils?

# TROUBLESHOOTING

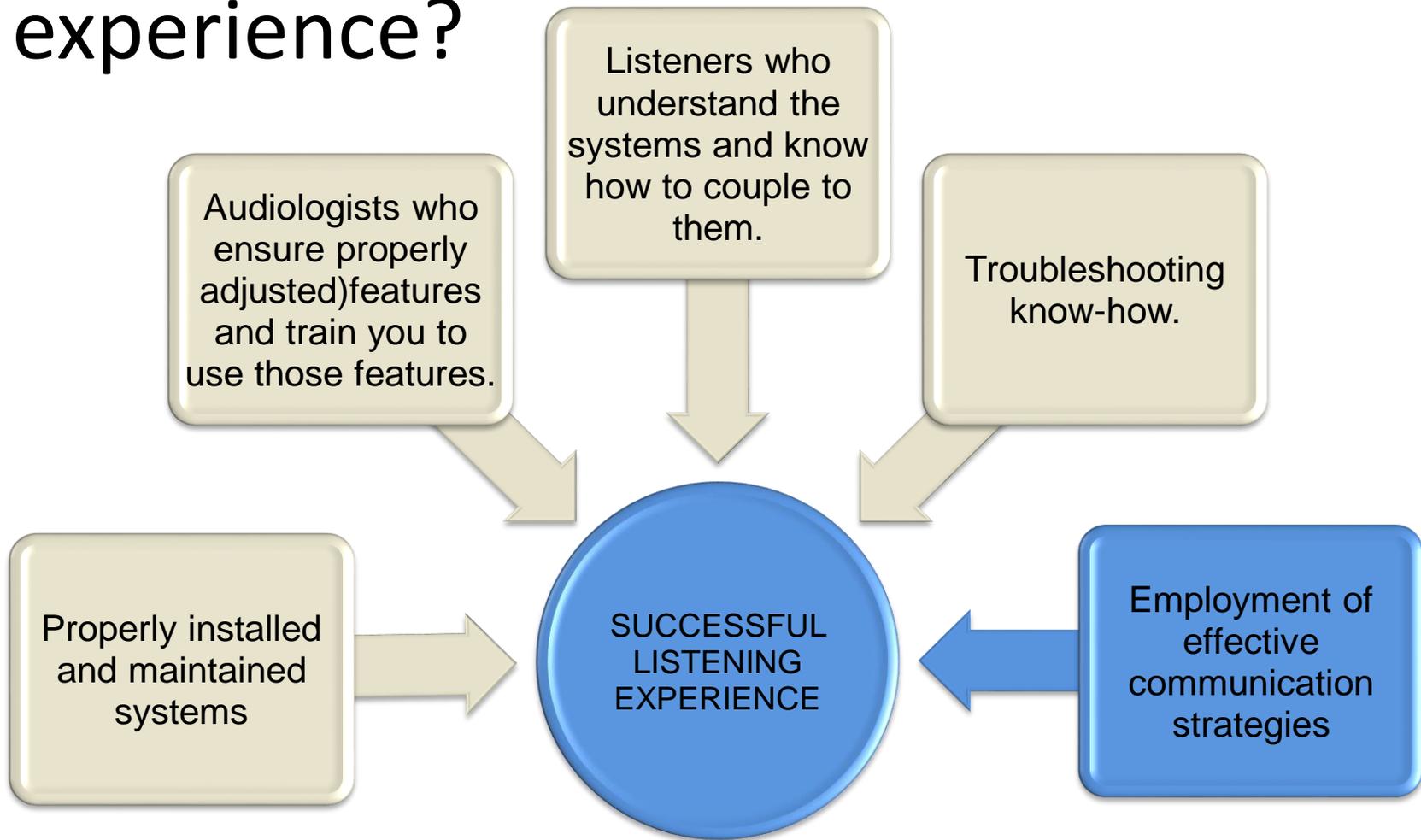
## TRANSMISSION

- Loop on?
- Microphone(s) on and being used properly?
- Recorded sound: Sound source turned on and connected properly

## RECEPTION

- Telecoil turned on and working properly?
- Fresh batteries in hearing aid/cochlear implant?

# What makes for a successful listening experience?



# EMPLOYMENT OF GOOD COMMUNICATION STRATEGIES

- SEATING
- MICROPHONE ETIQUETTE
- SPEAKER CLARITY
- TURN TAKING

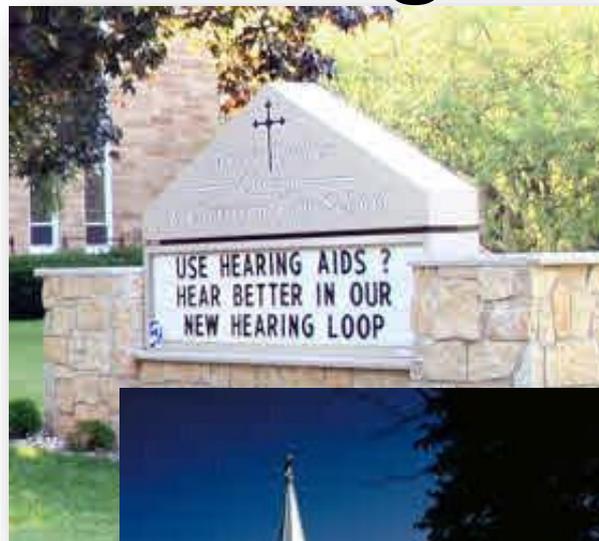
# Room Loop Signage

- Look for this symbol in any public venue. It indicates the presence of a hearing loop and prompts those with telecoils to turn them on.
- If listeners do not have telecoil-equipped hearing instruments, it alerts them to borrow a headset.
- Keep in mind that if a person's hearing loss is too severe, the headset will not provide sufficient audibility for understanding.



# Places you might find hearing loops

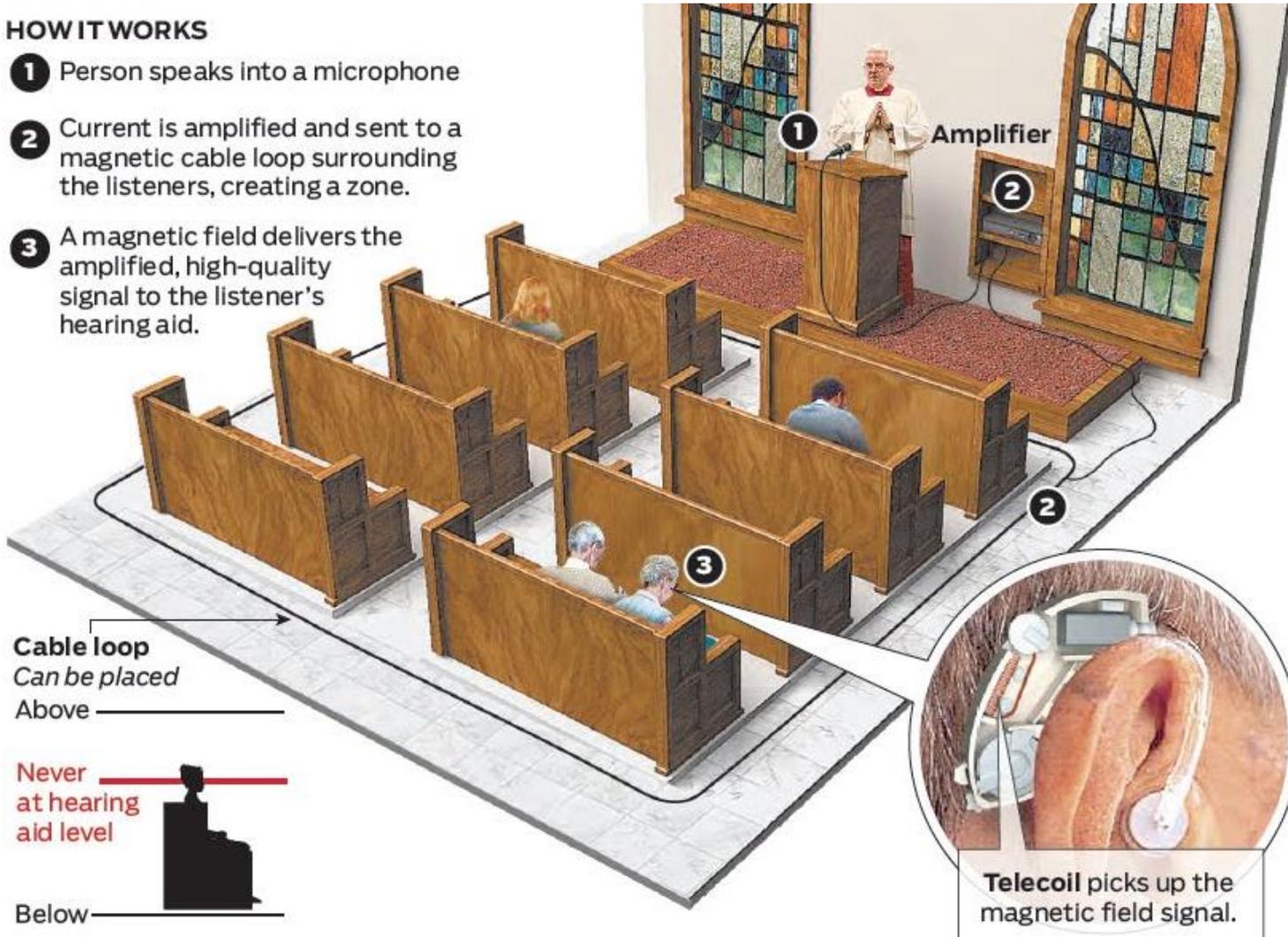
- As the looping movement has gained momentum, hearing loops are being installed throughout the U.S. in a variety of venues with installations.
- Houses of worship are heading the list.



# Example of a looped house of worship.

## HOW IT WORKS

- 1 Person speaks into a microphone
- 2 Current is amplified and sent to a magnetic cable loop surrounding the listeners, creating a zone.
- 3 A magnetic field delivers the amplified, high-quality signal to the listener's hearing aid.



**Cable loop**  
Can be placed  
Above

Never  
at hearing  
aid level

Below



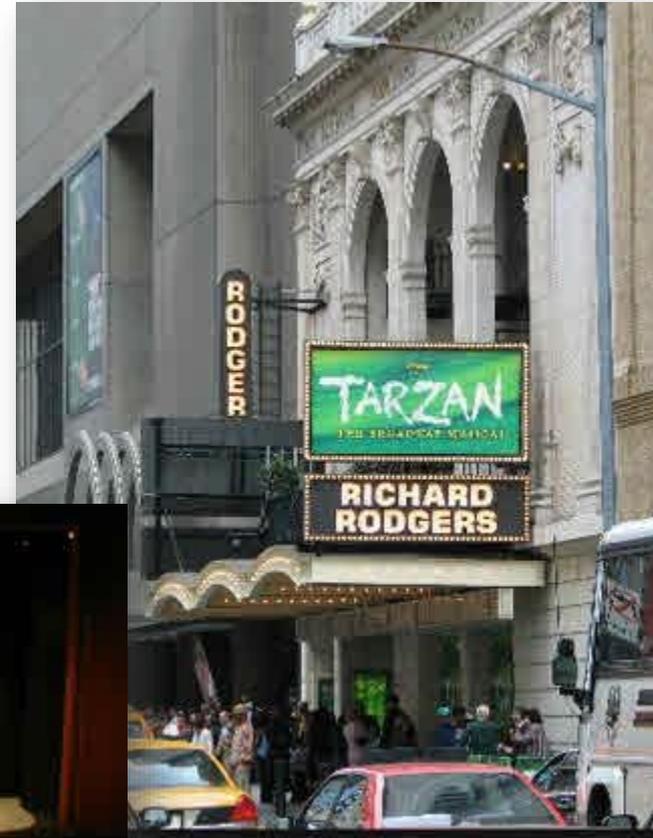
**Telecoil** picks up the  
magnetic field signal.

# Performance venues



Oshkosh Grand Opera House  
Wisconsin

Albuquerque Little Theater  
New Mexico



Richard Rodgers Theater  
New York City

# Transportation hubs



Penn Station  
New York City



Union Station  
Washington, DC



# Transportation hubs

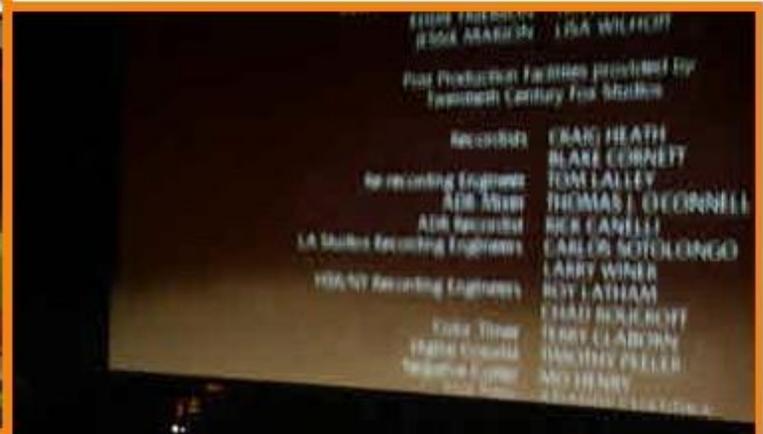
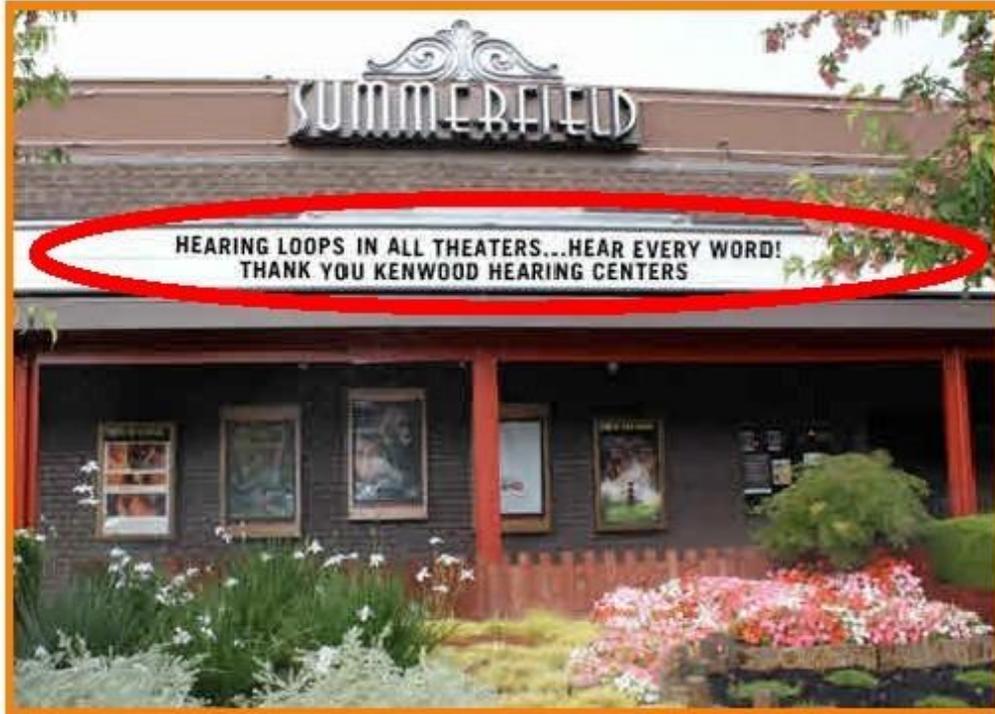


Gerald R. Ford International Airport  
Michigan

Milwaukee Intermodal Station



# Movie theaters



*The Nation's Voice for People with Hearing Loss*



# Amusement parks, museums, and other cultural venues



Disney World

Tour Bus at  
Bronx Botanical Gardens  
New York City



Metropolitan Museum  
New York City



# Banks and retail stores



# Offices and waiting rooms



# Loops can also be used at home in and the workplace

## The loop can be placed:

- Under wall-to-wall carpeting
- Under an area rug
- Under a baseboard
- On top of the baseboard and over door moldings
- Under the room in a crawl space or basement
- In an attic

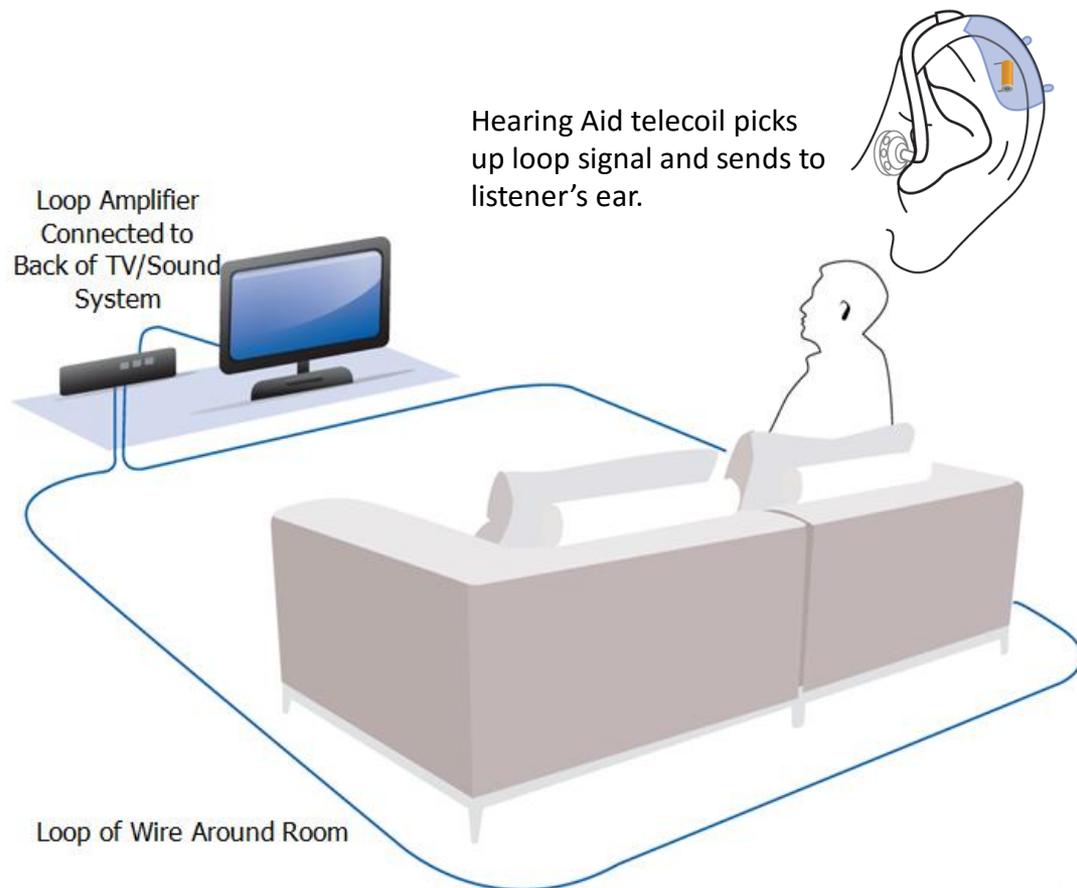
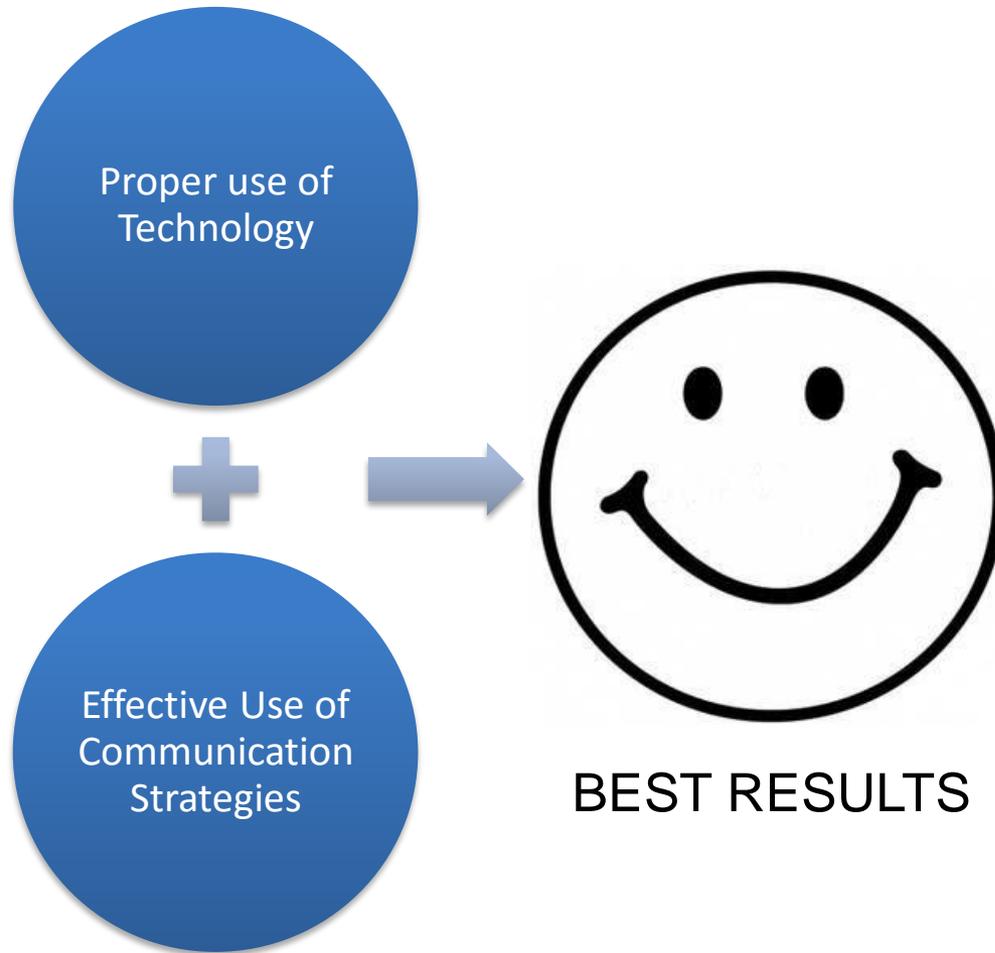


Illustration used with permission by Etymotic Research, Inc. © 2011: <http://soundstrategy.com/content/technology-enhancement-media>

# Why choose a **LOOP**?

- SEAMLESS
- DISCRETE
- EASY TO USE
- EASY TO MAINTAIN
- PROVIDES LISTENERS WITH BEST POTENTIAL TO MEET INDIVIDUAL HEARING LOSS NEEDS

# COMMUNICATION SUCCESS



To learn more about hearing loops and the **Get in the Hearing Loop** campaign, go to: <http://www.hearingloss.org/content/get-hearing-loop>

