The American Academy of Audiology announced a new initiative to work with the Hearing Loss Association of America (HLAA) to advocate for improved accessibility for the 36 million Americans who have hearing loss. The goal is to increase consumer and audiologist awareness of telecoils and hearing loops - technology that enhances the listening ability of those who have telecoils in their hearing aids.

**Hearings aids improve hearing by:**

- **Amplification** – inaudible sounds become audible, soft sounds louder
- **Equalization** – improving the balance of high and low frequencies
- **Directionality** – reducing the noise level in back of the listener
- **Noise Reduction** – decreasing the effect of background noise

**The telecoil (or T-coil)**

Samuel Lybarger designed the first telecoil in 1947 so that a telephone could be used with “body” type hearing aids.
An Audiologist’s Guide to Induction Loops

Faraday’s Law of Induction

When you pass an electric current through a metal coil...

...it will generate a magnetic field.

Conversely, when you pass a magnetic field across a coil (such as a T-coil), you generate an electric current in the coil.

Telephones generate a magnetic field

The earpiece of a telephone had a wire coil that vibrated and moved a diaphragm. The side-effect of this was that it generated a small magnetic field.

If a small coil of wire is placed in the hearing aid, it picked up this varying magnetic field and generated a tiny electrical signal.

T-coils in hearing aids

The T-coil inside the hearing aid is placed in the “sweet spot” to pick up the magnetic field. The tiny electrical signal is amplified by the programming set-up in the hearing aid.

Hearing aids only work with telephones that emit a good magnetic field.

Infrared (IR) Systems

The PA system is connected to an infrared light transmitter, which disperses invisible light waves throughout the room. The signal is received by individual wireless receivers worn by each listener.

Advantages:
- IR light will not transmit through walls
- Immune to radio and electromagnetic interference
- Systems are compatible with each other

Disadvantages:
- Users have to wear headsets (which need to be checked out)
- Physical obstacles in the light path will cause drop outs
- Bright light in the room causes static and dropouts
- CFL bulbs can cause interference

FM Systems

The PA system is connected to an FM transmitter that broadcasts a radio wave. The signal is received by listeners wearing wireless receivers.

Advantages:
- Requires little set-up time
- Can be used in rooms adjacent to each other (when using different channels)
- Signal is not interrupted by physical obstacles in the room

Disadvantages:
- Users have to wear headsets (checked out, battery powered, maintained)
- Susceptible to radio frequency interference (cell phones, nearby towers)
- Signal transmits through walls (can compromise confidentiality)
- Hearing aid users must take off their hearing aids

Headsets Don’t Work!

St. Thomas of Villanova
Palatine, Illinois

Advantages of Headsets:
- User must seek out headsets
- Must keep batteries powered
- Must regularly check function
- Headphones are not sanitary
- Draws attention to user
- Can get “lost”
- Does not utilize a users investment in their hearing aid
Induction Loop Systems

The PA system is connected a driver with a wire that encircles a room. The signal running through this wire generates a magnetic field which is picked up by the T-coil in a hearing aid.

Advantages:
- No headsets to wear (does not call attention to hearing impairment)
- Sound is delivered directly to the hearing aid (HAs are not removed)
- Less expensive in the long term (no headsets to purchase and maintain)
- Unobtrusive (the loop wire can – and should – be hidden)

Disadvantages:
- Sometimes cannot be installed due to electromagnetic interference
- People without telecoils in their hearing aids need a pocket receiver

Room Acoustics and Hearing Induction Loops

Steve Thunder, BSE, COHC – Acoustical Engineer
Assistive Hearing Systems

Room Acoustics
Acoustic Barriers Affect Intelligibility and Ease of Listening

Hearing Induction Loops
Increases Intelligibility and Ease of Listening

Hearing Aids Have Trouble With:

- **Background Noise** – speech is masked by noise
- **Reverberation** – speech sounds get smeared together
- **Distance** – not enough direct sound
- **Poor Signal Quality** – speech is hard to understand with foreign accents, fast-paced speakers, or distorted PA systems

Background Noise

Speech
Peak
+12 dB
Average
-18 dB
Minimum
Speech/Noise Ratio

Reverberation – A Visual Analogy

Every good boy deserves a chance.

Reverberation “smears” the individual sounds of speech making words in sentences hard to understand.
Room Impulse Response

Sound source is modeled as omnidirectional ray emission. Only 4 of the paths that reach the detector are shown. The peaks represent different sounds that arrive at different times and with different energy.

Reverberation

Direct Field

Reverberant Field

Critical Distance

Sound Level vs. Distance

Tuning the Acoustics

- **Increase Direct Sound and Early Reflections** – decrease distance & add reflection panels
- **Decrease Background Noise** – reduce the level of any noise sources
- **Lower Reverberation** – add acoustically absorptive material

Optimum Reverberation

Music: High RT  Speech: Low RT

Places with music and speech have vastly different acoustical needs

How Induction Loops Can Help

- **Provides More Direct Sound** – decreases distance to a minimum
- **Reduces Background Noise and Reverberation** – achieves highest signal to noise ratio
- **Uses Hearing Aid’s Equalization** – best sound for the individual ear & can be routinely optimized by Audiologist
- **Improved Ease of Listening** – reduces impact of other communication barriers

Hearing Loops – Technical Basics

Presentation by Ken Hollands
Session 2: Technical Basics

How Hearing Loops Work

The standard
IEC 60118-4 and why it matters

Metal Loss
The effect of constructional metal

Loop Position
Signal strength and uniformity

Loops
6 basic loop types and when to use them

Applications
Where hearing loops should be used

How they work

International Standard EN 60118-4

1  Field strength
   400mA/m rms with 1kHz sine

2  Field strength variation
   ± 3dB across the listening area

3  Frequency response
   100Hz – 5kHz ± 3dB ref. Level @ 1kHz

4  Background noise
   -32dB from target a weighted

5  Subjective testing

Automatic gain control
  essential but not specified in the standard

Magnetic field

Vertical Displacement

Field Strength vs Displacement
Loop Displacement (front listening plane) as % of Loop Width

Metal Loss

The physics that make induction cooking possible causes signal loss in audio induction loop systems

Volume is reduced, sound is muffled and intelligibility lost
The frequency response needs to be flat for best performance
Over-spill loop

Perimeter Loop

Cancellation Loop

Figure 8 – Single array

Standard Phased Array

Ultra-Low Spill™ Design

Metal Loss Example 2
Applications – One-to-one communications

PORTABLE SYSTEMS

Portable systems are often purchased, but with omni-directional microphones they are no better than the hearing aid itself, even when they are positioned correctly.

Applications – Transport environments

Loops are installed in many public transport environments:
- Trains
- Buses
- Taxis
- Trams
- Subways
- Airports
- Stations
- Elevators

Applications – World wide

Loops can be installed in many public spaces:
- Universities
- Lecture halls
- Theatres
- Conference centers
- Cinemas
- Museums
- Sports Arenas
- Amusement Parks

Hearing Loops – Technical Basics

Presentation by Ken Hollands

TELECOIL VERIFICATION

Stephen A. Hallenbeck, Au.D.
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T-coil Background

- Fairly common component of a hearing aid
- Acts as an inductive transducer
- Sensitive not to pressure fluctuations but rather changes in an electromagnetic field
Verification of T-coils

- Hearing Aid verification is a must for all fitting instruments:
  - Why?
    - Differences between real ear output and software simulation
    - Demonstration of real world benefit
  - If verification of H.A. function is not common place, then T-coil verification is absolutely unheard of

Verification of T-coils

- Why should t-coils be verified?
  - Differences in ear canal characteristics can effect the device performance
  - If the devices are verified in a microphone mode, shouldn't they work in a t-coil setting?
  - Performance should be basically the same
    - T-coil verification becomes a question of quality control
    - Variation in T-coil placement may affect the functional capabilities of the device

Verification of T-coils

- Test box measures are most common
  - Graphs the output in the t-coil mode as a function of frequency
  - Other manufacturers provide a value for reference against the standard

Real Ear Verification

- Not a common practice
- Most verification devices do not support this feature
- Work around techniques to allow for real ear verification
T-coil Real Ear Verification

Summarize
- T-coil response can vary
- Test box measures can ensure standard performance
- Real ear verification will account for specific use variables
  - Requires special considerations for the professional dispensing the instrument

Questions?
- THANK YOU!
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Double Hearing Aid Functionality and Patient Satisfaction

By David G. Myers, PhD

A Synopsis by Steve Thunder, BSE, COHC – Assistive Hearing Systems

Social psychologist David G. Myers, PhD (davidmyers.org) is a professor at Hope College, Holland, MI, and author of 17 books (including A Quiet World: Living with Hearing Loss, Yale University Press) and creator of the nonprofit, public service Web site www.hearingloop.org

Dr. Myers, as a person with hearing loss, points out the difficulty the hearing impaired have using most assistive listening devices, “I can benefit from assistive listening only if I assert myself when entering a venue. I must locate and check out special equipment, remove my hearing aids, wear either ear buds that have been in others’ ears or a visible headset, struggle to hear generic sound not customized for my ears and, afterwards, return the unit and replace my hearing aids.” However, Scotland [like most of Europe] is a more supportive environment. A sign in the baggage claim area indicates that a hearing-aid-compatible hearing loop is available to broadcast any announcements via hearing aid telecoils, “effectively transforming [his] hearing aids into loudspeakers that deliver sound customized for [his] ears.” At worship, accents are sometimes a challenge; but the task is much easier when using the telecoils. At the post office, the clerk behind a glass window could be heard clearly because her voice was broadcast through his hearing aids. The U.K is similar where tourist information center counters, train station windows, pharmacy stations, and the back seats of all London taxis are looped. Virtually everywhere there is a PA system, an induction loop system could work.

After Dr. Myers’ first transformative experience in Scotland using his telecoils, he came home and in 2002 launched, with community support, an initiative to introduce hearing loops to his hometown of Holland, MI. Now much of western Michigan is looped and Dr. Myers affirms, “I love my hearing aids! In a variety of venues they serve me not only as sophisticated microphone amplifiers, but also as personalized wireless loudspeakers. Indeed, it’s a close call as to whether I love them more for their amplification of conversation or for their dual functionality as wireless, customized loudspeakers.”

Dr. Myers also explains the synergistic benefits for audiologists and their patients. Jerry Owens, AuD says, “Never in my audiology career has something so simple helped so many people at so little cost.” Audiologist Bill Diles’ survey of his patients showed that only “3% of those without a home loop system reported satisfaction with their hearing aids, compared to 53% of those with home loops. The end result, thanks to happy patients and word-of-mouth, has meant ‘tremendous growth’ for his practice.”

Looking to the future, “Sergei Kochkin, PhD, director of the Better Hearing Institute, argues that the way to increase adoption of hearing aids, and to reduce returns, is to increase their utility.” It will be difficult for a future technology to supplant telecoils and loops because of the current advantages they now have: low power, wide range, inconspicuous, miniaturized, cochlear-implant-compatible, and inexpensive.

Lastly, Dr. Myers says, “If we can double the utility of hearing aids, then surely we will also decrease the stigma of hearing loss and hearing aids, increase public support for insurance and Medicare/Medicaid reimbursement and ultimately double the proportion of Americans who benefit from hearing technology. And that will be a happy future for both people with hearing loss and those of you who serve us.”
**Start Here**

- **New Loop System Installed**
  - See an audiologist
  - Ask, do I have a T-coil?
  - Ask, will a retrofit work?
  - Use receiver until new hearing aids are purchased

**Yes**
- Have T-coil installed
  - Ask, is my T-coil programmed properly?
  - Verify frequency response
  - Learn how to activate the T-coil Program

**No**
- Reprogram
  - Functional Check Using Audiology Office Loop

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Telecoils: The Powerful Assistive Listening Device

by Mark Ross, PhD

A Synopsis by Tom Thunder, AuD, INCE – Assistive Hearing Systems, Chicago

Dr. Mark Ross is professor emeritus of audiology. But he has also been hearing impaired for several decades. So he appreciates and understands the difficulty faced by those wearing hearing aids. He makes the case that while telecoils have been useful in telephone applications, limiting their utility to phones ignores these devices’ greatest strengths.

During the era when behind-the-ear (BTE) hearing aids were the prominent style, most aids included telecoils. But as the size of hearing aids diminished with the introduction of in-the-ear (ITE) hearing aids, there was less room to fit a telecoil. This contributed to the decline of telecoils such that no more than 30%-40% of hearing aids in the US include telecoils. [Thunder’s note: This article was written in 2002. An article by Johnson in 2008 (Hear J 61(4):42-48) reports that t-coils increased from 37% in 2001 to more than 65% in 2007. Because mini-BTE hearing aids are on the rise, so too are t-coils.]

While the t-coil has historically been used to enhance telephone conversation, we are overlooking an equally important function for it: to serve as an assistive listening device. This was dramatically demonstrated by Michigan social psychologist David Myers, PhD, during his recent trip to Scotland. During this visit, he attended a religious service at an old church. Before the service began, while listening to the babble of 300 worshippers, he knew his experience was going to be what they ordinarily were in such situations—half-heard words and lots of stress and aggravation. At his wife’s suggestion, he switched on the t-coils of his hearing aids. When he did, his life was transformed. Suddenly, the surrounding babble fell away, replaced by the sound of music emanating from musicians across the Abbey. When the service began, the leader’s words came across clearly and distinctly.

Why FM and IR Systems Have Been Underutilized

While the Americans with Disabilities Act requires that assistive listening systems (ALS) be provided in all large-area listening venues attended by the public, the systems employed in the U.S. have in practice been limited to FM or infra-red (IR) systems, not induction loops (IL). So what’s the problem? For one, FM and IR assistive listening systems do not work with hearing aids. Secondly, there is little professional and consumer pressure to install IL systems or promote their benefits.

Then there are the facilities that have installed FM or IR systems to comply with the law. But after spending the money, they find that patrons rarely ask for a receiver. When a receiver is requested and one is located, patrons often complain that it does not work properly. Eventually, the receivers are relegated to a closet somewhere. Often, the newer employees are not even aware of the existence of an ALS.

Ross himself had experiences along this line. He helped two local synagogues acquire and install a system: one an FM system and the other an IR system. At first, somebody took responsibility for ensuring that the receivers were available at the door. But within 3-4 years, both places locked the receivers in a closet somewhere and seldom used them. Today, the ALS systems are still active, but their signals are not being “heard.” They benefit nobody. This happens all the time.
Even when FM or IR receivers are available and working properly, hard of hearing people are reluctant to request them. Most do not like to draw attention to themselves by wearing a visible device. Still others object to using uncomfortable or hygienically questionable earphones or ear buds. Others have experienced the frustration of the batteries going dead in the middle of a performance. Then there are the elderly who need help to use a receiver when these same people would be more willing and capable of simply switching their hearing aid to the “T” position.

**The Telecoil as an Assistive Listening Device**

Even with functional IR or FM receivers, users will never have an individually “tailored” signal made possible through their own hearing aid. When people who wear hearing aids attend a performance or lecture, their aids accompany them. If an IL system is installed, then all they must do is switch their t-coils on; no need to check out receivers and no worry about weak or dead batteries. And since the input signal from the t-coil simply substitutes for a microphone signal, the output is tailored to the specific individual (assuming that the t-coil has been properly programmed).

What happens to people who do not have a telecoil in their hearing aid? There are commercially available IL receivers that can be used to pick up the signal from the loop. However, the IL receiver should be viewed primarily as a transitional and occasionally needed device.

Installation of a large area IL system is likely to require more effort than the installation of either an FM or IR system. It takes skill to properly install large-area listening systems. If signal spillover is a concern, particularly when adjacent areas are to be looped and used simultaneously, then looping just a portion of an area is one solution. Incidentally, an excellent site for an IL system where spillover would not be a concern is a house of worship—a location not covered by the ADA.

In addition to spillover, there are concerns about ambient electromagnetic interference (EMI) from such sources as defective lighting, power transformers, or light dimmers. However, nine of 10 sites are sufficiently free of EMI to permit a satisfactory loop response. [Thunder’s note: Another issue is structures with a lot of metal. Since metal draws power from a loop’s magnetic field, special drivers are used to deliver a greater current to the loop and special loop configurations are used to enhance the strength and uniformity of the field.]

**Conclusion**

There will always be a need for the unique characteristics of FM and IR systems. All venues offer their own challenges. There is no substitute for the advice offered by knowledgeable installers. But the hearing care professional should not be a bystander in this effort. The hearing care field is long overdue in rethinking old ideas about recommending telecoils to their patients.

We seem to be in a “chicken or egg” situation. Because less than 50% of hearing care professionals mention the use of a t-coil, there are few IL systems out there. [Thunder’s note: Arizona recently passed legislation requiring hearing aid dispensers to education patients about the benefits of t-coils.]

And because there are few IL systems in the U.S., hearing care professionals are reluctant to mention t-coils. A combined approach is needed to extend the use of IL systems in our society. Hearing care professionals must strongly recommend the inclusion of telecoils in all of the hearing aids they dispense. At the same time, consumers and other interest groups must lobby strenuously for more IL installations. If this is done, then all hearing aid users can experience the same life-transforming auditory experience that David Meyers did during his trip to Scotland.