# Wireless Technology……It keeps getting Better!

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## Disclaimer

Consultant for Phonak
- Training Seminars
- New Product evaluation

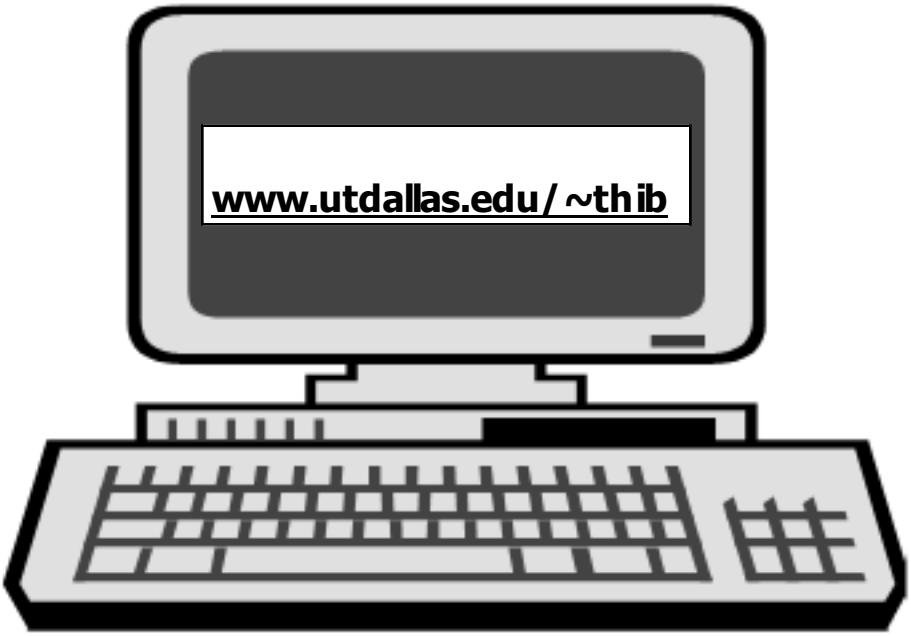
## University of Texas at Dallas

Callier Center for Communication Disorders

Advanced Hearing Research Center

Main Campus, Richardson, TX

Callier Center at Richardson



# Acknowledgements


- Phonak
- Oticon
- Frye Electronics
- Graduate Students: Jennifer Alford, Nancy McClellan, Amanda Lovelass, Sarah Wallace, Lauren Schaper

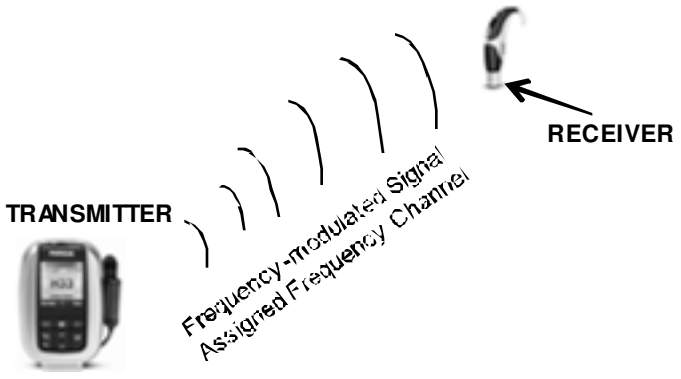

# ABSTRACT


Wireless technology can be used across the lifespan for persons with hearing loss and with normal Hearing. Benefits of wireless technology are evident in education, employment, leisure activities, and into senior living. Regardless of the age, there is a wireless configuration that can provide significant benefit. Recently the options for digital modulation (DM) wireless technology has expanded. Research has shown significant benefits of DM arrangements over the traditional FM devices. It is likely that with DM technology combined with speech-reading cues, listeners will be able to engage in communication in environments that would otherwise have not been possible.

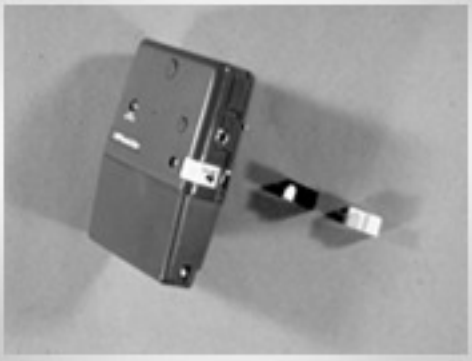
## LEARNING OBJECTIVES

1) Describe three situations that involve unique applications of wireless technology for students and for adults.
1) Decribe how wireless technology components vary for the young versus the elderly.
2) Describe benefits of DM over FM technology.

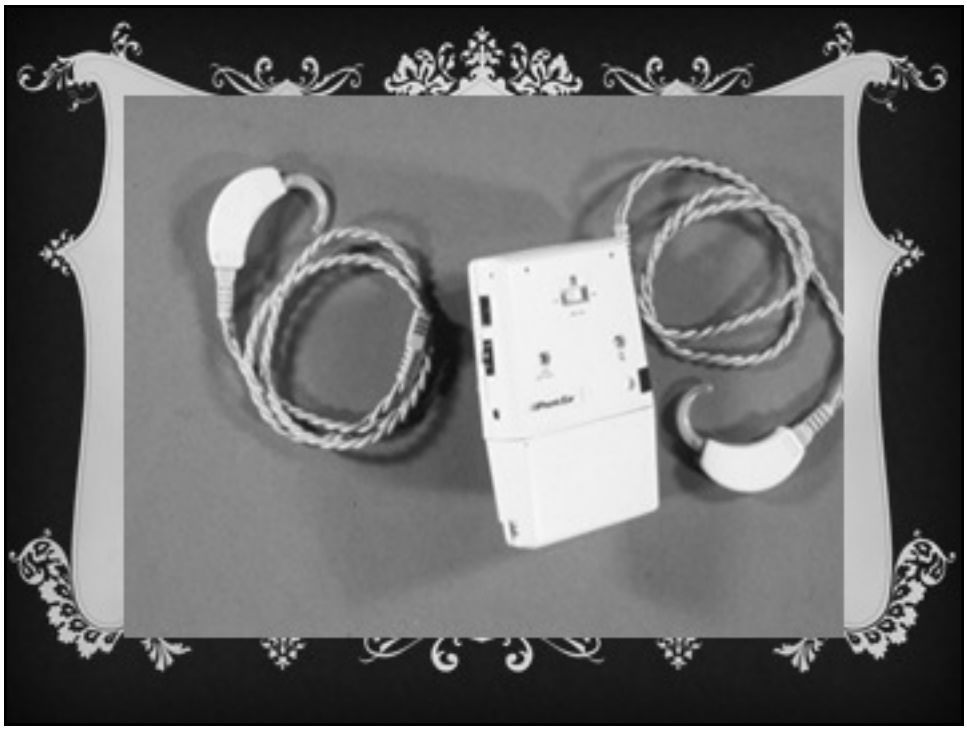
## FM Systems



# FM HISTORY



again
& again



FIRST BTE FM SYSTEMS

FM RECEIVERS

WIRELESS TECHNOLOGY
YOU MIGHT SEE TODAY!

**THE END**

## Wireless Connectivity

# Remote Microphones

# Connections to cell phones

# Connection to iPhone directly

Starkey and Resound

# Connections to your....

## Use of Wireless Technology Outside of the Traditional Classroom Setting!

## FM System Demonstration

- No FM
- FM+M
- FM Only

# Benefit of FM the Young

- **Video Recordings made**
  - **While parent spoke naturally during actual car ride**

without FM and with FM

## Update with Adaptive FM -

Same Family – about 1.5 years later

To illustrate advantage of the Adaptive FM, background noise increased by adding music from the radio

Comparison – NO FM
Smartlink (Traditional FM)
inspire (Adaptive FM)

## Update with Adaptive FM -

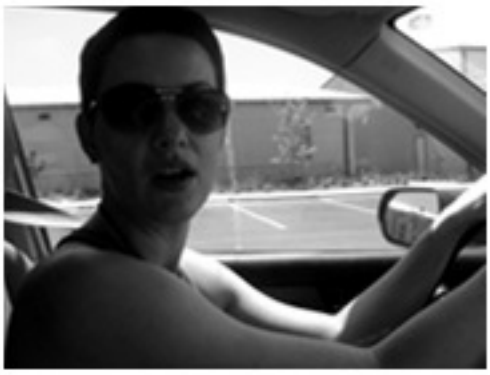
First.....riding in the car with
BACKGROUND MUSIC and NO FM

## Update with Adaptive FM

- Car Ride with RADIO MUSIC while using

SmartLink Uber Inspire

## Mother's Comment Regarding FM use in Noisy Situations



# RESTAURANTS

# SIARC

# SIARC

- Week Long Intensive Program
- Designed for Couples or Communication partners
- AuD Students paired with a couple
- Option to try NEW aids and SmartLink+ FM
- All students wear iLinks set for normal hearing

# SIARC-Sample Schedule

| | TUES | WED | THURS | FRI | SAT |
|---|---|---|---|---|---|
| 9:00 | Registration | | | | |
| 9:30 | Lecture-Welcome | Lecture-Guest | Lecture-Guest | Play Eval | |
| 10:00 | Class 1 | Class 1 | Class 1 | Class 1 | Class 3 |
| 10:45 | Break | Break | Break | Break | Break |
| | Class 2 | Class 2 | Class 2 | Class 2 | Class 4 |
| 12:00 | Lunch | Lunch | Lunch | Lunch | Group Evaluation |
| 1:00 | Research | Manufacturers | Lecture-Guest | | |
| 2:00 | Class 3 | Meyerson Tour | Class 3 | Class 3 | |
| 2:45 | Break | Break | Break | Break | |
| 3:00 | Class 4 | Lecture-Guest | Class 4 | Class 4 | |
| 4:00 | Lab Tour | Open | Open | Open | |
| 5:00 | Dinner | Dinner | Bus to Theatre | Dinner | |
| 6:00 | Closure Program | | Play-Musical | | |

# SIARC-Sample Schedule

**CLASSES**

| 1 AUDIO CLASS | 2 COMM STRATEGIES/ALD | 3 AUDIO VISUAL TRAINING | 4 COPING |
|---|---|---|---|
| Audiogram | COMM RULES | Seeing Hearing Speech | COSI |
| OAE | Audio/Sp Acoust/Simulate HL | CasperSent | Comm Breakdowns |
| Otoscopic | ALD's-Phone Tech/Stategies | LACE | Stress Effects |
| Tympanometry | ALD-TV/Alerting/Public | Tracking | Changing Behavior |
| HACK-Elec then Real Ear | ADA | | |
| New Technology | | | |
| HINT-No HA or W/persHA<br>HINT-New HA, FM | | | |

# AALTA
# Application of Advanced Listening Technology in Adults

(Thibodeau, 1997)

- Use a Scale to Identify Possible Situations where Assistive Technology could be beneficial

  (Thibodeau, 2004, 2007; 2008; Thibodeau & Alford, 2010)

- A series of questions to cover all the areas

  MARK ROSS has repeatedly told us to explore with EACH and EVERY patient

- Suggest as you routinely complete an Audiogram for persons who seek hearing assistance....also complete a.....

NAME _____ Date of Birth _____ Person completing Telegram _____

| | T | E | L | E | G | R | A | M | |
|---|---|---|---|---|---|---|---|---|---|
| | Telephone | Employ- | Legislation | Entertain- | Groups | Recreation | Alarms | Members | |
| RATING | | | | | | | | | |
| 1 No Difficulty | | | | | | | | | Live with Normal Hrg Adult |
| 2 | | | | | | | | | Live with Young Children |
| 3 Some Difficulty | | | | | | | | | Live with Teenagers |
| 4 | | | | | | | | | Live with Adult with Hrg Loss |
| 5 Great Difficulty | | | | | | | | | Live Alone |
| | C-Cell phone L-LandLine | J-Job S-School | P-Public Listening A-ADA | T-TV M-Movies | R-Religious P-Parties M-meetings | _____ _____ _____ | S-Smoke D-Doorbell C-Clock | Check all that Apply | |

Three Main Problems to Address

_____

_____

_____

**Recommendations:**

T_____ E_____ L_____ E_____ G_____ R_____ A_____ M_____

# Interview Format

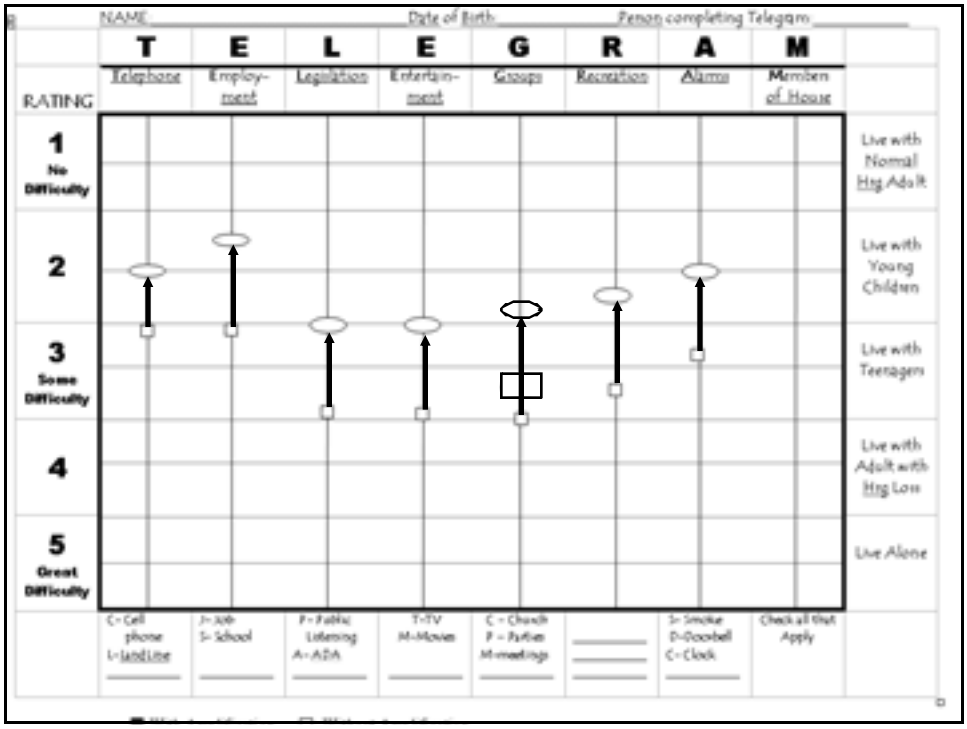
**ADULT TELEGRAM Rating Scale Key**

| Topic | Question | Rating |
|---|---|---|
| T | Are you having difficulty with communication over the **telephone**? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5= Can't use the phone<br>*Use "L" to designate LandLine and "C" to designate CellPhone* |
| E | Are you having any difficulty with communication in your **employment** or **educational** environment? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5=Stopped working |
| L | Do you know about **Legislation** that provides assistance for you to hear in public places or in hotels when you travel? | Knowledge<br>1=Vast, 2=Considerable, 3=Some, 4=Limited, 5=None |
| E | Are you having difficulty with hearing during **Entertainment** activities that you enjoy such as television, movies, or concerts? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5= Stopped Going |
| G | Are you having difficulty with communication in **Group** settings? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5= Can't hear at all in groups |
| R | Are you having difficulty with hearing during **Recreational** activities such as sports, hunting, or sailing? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5= Stopped the activity |
| A | Are you having difficulty hearing **Alarms** or **Alerting** signals such as the smoke alarm, alarm clock, or the doorbell? | Difficulty<br>1=None, 2=Occasional, 3=Often, 4=Always, 5= Can't hear alarm<br>*Use "S" for Smoke Alarm, "D" for Doorbell, and "A" for Alarm Clock* |
| M | Are you communicating with **Members** of your family? | 1=Live with Normal Hrg Adult,<br>2=Live with Young Children,<br>3=Live with Teenagers,<br>4=Live with Adult with Hrg Loss,<br>5=Live Alone<br>*Check all that apply* |

# TELEGRAM OUTCOMES

(Thibodeau, 2004, 2007; 2008; Thibodeau & Alford, 2010)

- All **AALTA** participants noted improvement in all 7 categories
- Some purchased other assistive devices prompted by the questions



# JOURNAL OUTCOMES

Wives more willing to wear mic after Group Dinner

Bluetooth very helpful for handsfree phone

Car and road noise less so could talk while on a trip

Used with ipad and worked great

New Listening Experiences-

Enjoyed separate listening options

eg. During dinner wife listened to TV, while husband listened to radio in truck in garage

# WORSHIP SERVICES

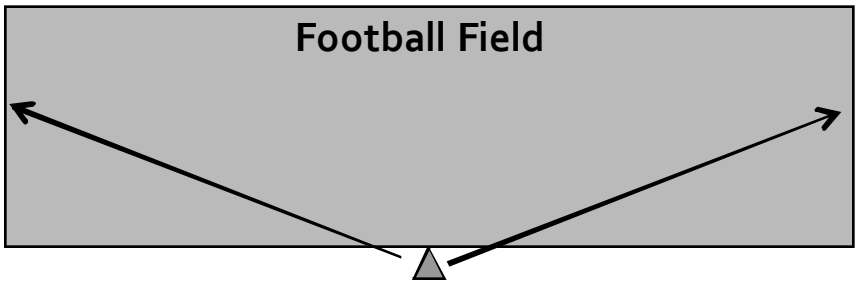
# Teen with CI trying FM in Church

EMAIL from Mother:

"We did use it at church for the first time yesterday!! Jordin wears the computer for the weekday mass on the projector, so I had him wear it because he is in the back of the church. There was good and bad because he was in the sound booth which has some problems left of the voice he said he heard. BUT, we were on the front pew next to my pastor, and I had quickly just put it around his neck and said, please wear this for Jordin. Boy did they said "Where is Jordin?" Jordin stood up in the sound booth and waved to him. They both got a kick out of it, did several teenage girls around me-:)"

## 700 Member Band Covers Entire Field !

- Battery Life also an issue with 7 am practice and performance at 8 pm that same night




Loudspeaker interfaced with wide area transmitter

## Camp CHAT

Communication Habilitation via Audition for Teens

# Theme of Camp CHAT

- Baseball!
  - Start with Pre-Game Warm-up
  - There are innings – each with a game or set of activities
  - Grad student mentors called "coaches"

## Horseback Riding

# ROCK CLIMBING

# Climbing with FM Systems

Receiver

Transmitter

## Climbing with FM Systems iSense and Smartlink

## Climbing with FM Systems

## Applications of Personal FM Systems

Noisy Environments

Recreational Activities

Sports

## Are FM Systems allowed in HS Sports?

- According to UIL regulations:
  - Practice— Local issue
  - Games— No, but….
- **Exceptions: players with a disability can request accommodations**

**Source: Dr. Mark Cousins** Director of Athletics—Texas UIL

# Team Sports

# Football

# Lessons from Derrick Coleman of the Seattle Seahawks

A Severe Bilateral Hearing Loss never STOPPED Derrick from his dreams!

[illegible]

# Cheerleading

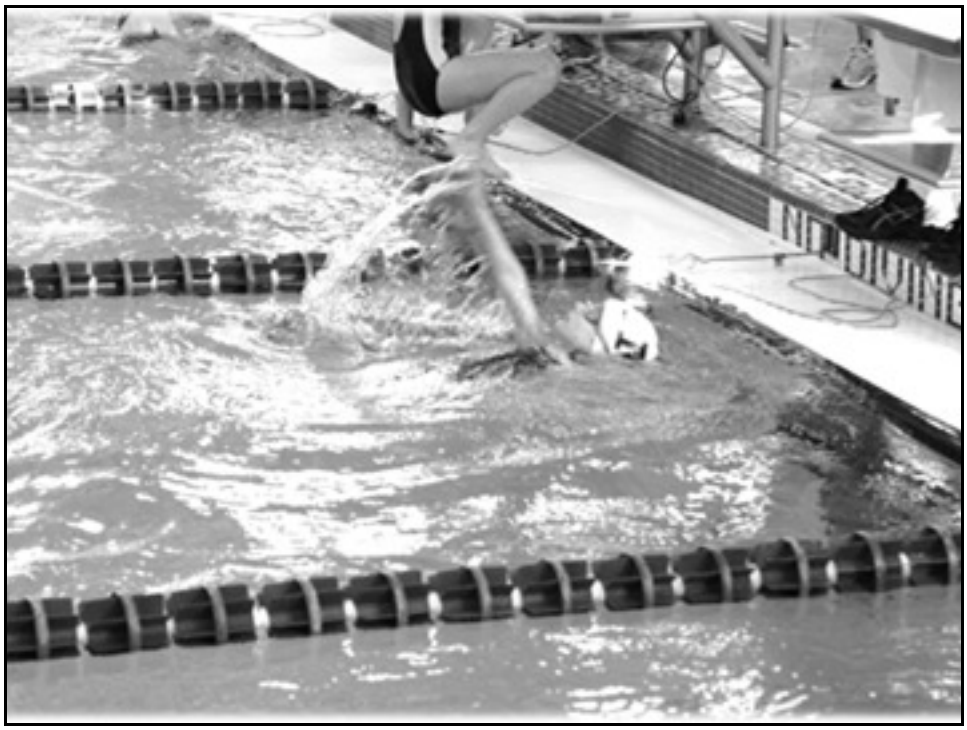
Cheer Coach wears the transmitter and watches from Press Box above the field. She'll tell Desi, who wears the receivers, what to say to the other girls to improve the routine!

## For Moisture Issues during Sports

- Wrap with saran wrap
- Use roll on deodorant on skin behind ear
- Use Neoprene cover to protect against moisture

http://www.gearforears.com/

## SWIMMING



Research with Roger Technology

# Wireless Technology Advances

- Single channel, body worn transmitters/receivers in the 80's
- Small, multi channel FM receivers integrated into behind the ear hearing aids in the 90's
- NOW…even Smaller Receivers and Clip-on Microphones which may lead to greater acceptance
- NOW…advent of digital transmission which impacts not only the signal quality but also channel management

# Review of Signal Processing Changes

- Traditional FM System
  - Level of FM signal is fixed above level of HA signal
  - Low signal-to-noise ratio (SNR)
- Adaptive FM System
  - SNR varies depending on ambient noise level
  - If noise exceeds 5 dB SNR…the FM Advantage is increased
- Adaptive Digital Modulation System
  - Digital processing is intended to provide even greater SNR at higher noise levels compared to traditional and Adaptive FM Systems.

# Benefits of Roger Technology

- This technology can be integrated into smaller components with wider bandwidth
- The signal quality can be theoretically superior because FM channel noise is most likely not present

# How much better is ROGER technology???

Based on design of 2010 study, with Traditional and Adaptive FM, the merits of Roger technology were evaluated in objective and subjective measures in adults and teens in clinical and real-world settings.

# Experimental Design

- Control for Bias in Examiners and Subjects
- Evaluate in a variety of settings with adults and children
- Obtain feedback from those with previous FM experience
- Use sensitive speech recognition materials

# SUBJECTS

- 9 adults and 6 teens with primarily moderate-to-severe hearing loss who wore binaural behind-the-ear hearing aids
- All experienced FM users and agreed to use the system over a one-week period

# METHODS

- Audiometric evaluation
- Electroacoustic analysis of hearing aids
- Connection via DAI to body-worn test unit
- Individual one group test session
- The sessions were conducted in a large classroom with four speakers placed at the corners to present classroom noise and one at the front to deliver the speech.

# Stimuli

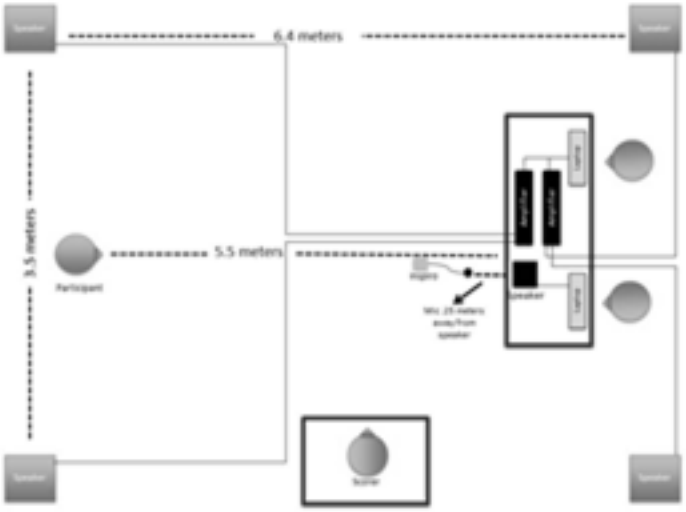
Clinical Testing

- HINT sentences presented in Quiet and 55 to 80 dBA noise
- Classroom Noise (Schafer & Thibodeau, 2006)

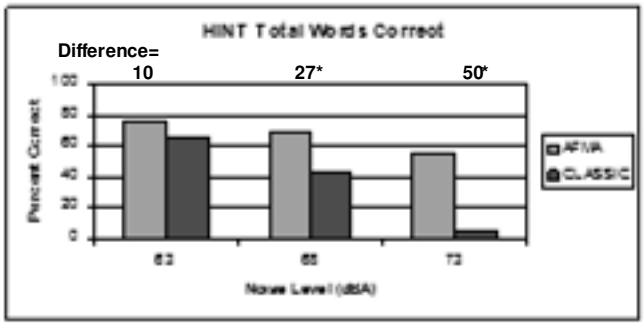
Real World Testing

Live Voice Presentation of "Lessons" about aquarium exhibits (eg waterfall, penguins, sloth)

Ambient Noise ranged from 65 to 85 dBA


6.4 meters
3.5 meters
5.5 meters
Participant
Amplifier
Amplifier
Camera
Camera
Speaker
Speaker
Speaker
Speaker
Speaker

# Traditional (classic) vs Adaptive (AFMA) Thibodeau (2010)




# Challenging Listening at the 80 dBA Level in the initial study

- 80 dBA – Not included in the statistical analysis because most listeners could not tolerate that listening condition!

# Subjective Results

## Adaptive FM Processing with Implants (Wolfe et al. 2009)

- Phonak Inspiro Transmitter and 2 different receivers: MLxi (Adaptive) and MLxs (Fixed)
- Listeners with Advanced Bionics and Cochlear Implants
- Repeated HINT sentences in 55, 65, 70, and 75 dBA of noise
- Found significant improvements in speech recognition for adaptive processing over fixed for both types of implant users

# Subjective Measures

- Four lessons were conducted in the Dallas World Aquarium
  - After listening to three to four sentences from each lesson, participants were instructed to change the setting on their test unit
  - After each session was completed, participants rated their difficulty listening in each setting.

# Double Blinded

- The participants had three settings available on their test unit and were blinded to the type of processing for each setting: Fixed FM, Adaptive FM, and Adaptive Digital
- During each activity, participants listened to each of the three settings by moving the dial on the test unit to setting 1, 2, or 3.
- The processing for each setting was unknown to listeners and examiners!

# Sample Rating Card

Name: _____ Dallas Aquarium World Location #_____ Box #_____

a) How easy was it to understand the speaker on Setting 1?

| very easy | easy | ok | hard | very hard |
|---|---|---|---|---|
| o | o | o | o | o |

Please Explain_____

b) How easy was it to understand the speaker on Setting 2?

| very easy | easy | ok | hard | very hard |
|---|---|---|---|---|
| o | o | o | o | o |

Please Explain_____

c) How easy was it to understand the speaker during on Setting 3?

| very easy | easy | ok | hard | very hard |
|---|---|---|---|---|
| o | o | o | o | o |

Please Explain_____

d) After listening to all three settings, what setting do you prefer?

Setting "1" o Setting "2" o Setting "3" o All the same o

Why?_____

_____

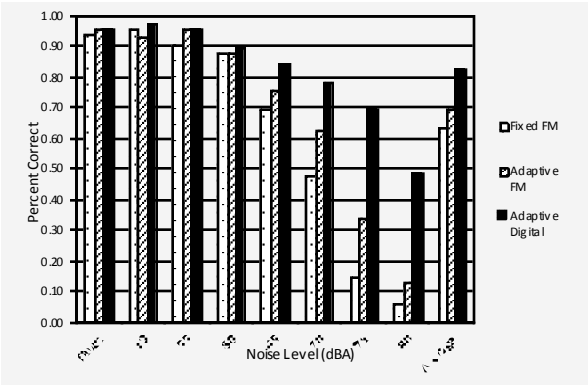
_____

# RESULTS

# Objective Measures

- Adaptive Digital technology resulted in significant improvements for 65, 70, 75, and 80 dBA noise levels over Fixed and Adaptive technology.
- The average improvement in speech recognition at the 80dBA level by
  - Adaptive Digital over the current Adaptive FM was 35%!
  - And Adaptive Digital over Fixed FM technology was 42%!

# HINT Results (N=10)



# INDIVIDUAL RESULTS

At the 80 dBA noise level……

9 scored 20% for Fixed FM

6 scored 20% for Adaptive FM,

1 scored 20% for the Adaptive Digital

The highest score at the 80 dBA noise was 80% (#2) for the Adaptive Digital technology!

# INDIVIDUAL RESULTS

- The results from one listener who had a profound loss were not included in the data analysis because of her extreme difficulty with speech recognition in noise.
- With the Fixed and Adaptive FM technology, she scored 20% for the Quiet and low noise-level conditions.
- However, with the Adaptive Digital technology, she was able to hear some words through the 75 dBA noise level and achieved her highest score (40%) at the 55 dBA noise level.
- Use of this Adaptive Digital technology with visual cues from the talker's face would most likely have resulted in much higher performance.

# SUBJECTIVE RESULTS

- The participants selected a preferred setting at the conclusion of each activity.
- Eight of the participants (73%) selected the Adaptive Digital Technology as the preferred setting at the four stations.
- One selected Adaptive FM (#4) and one selected both Adaptive Digital and Adaptive FM (#7) across the listening stations.
- One of the participants who participated in the previous study (Thibodeau, 2010) commented that this new system was a "dramatic improvement" over the best one she tried in the previous study.

# SUMMARY

- The Adaptive Digital processing resulted in significant improvements for participants in the four highest noise level conditions.
- The benefits of Adaptive Digital processing increased with increasing noise levels.
- Adaptive Digital processing was also the preferred technology for most of the listeners in the real-world setting.

- Newer Adaptive Digital Technology allows for greater communication across noise levels than was possible before!
- JUST IMAGINE……

Teens with hearing loss who use this technology may actually have to explain to their normal-hearing peers what the senior boys said at the pep rally!

How MUCH better can they hear with Roger compared to persons with normal hearing?

# Roger Followup Study

Purpose

To evaluate the speech recognition in noise for young adults with normal hearing in the same setup as was used for the Roger study with persons with impaired hearing.

# Reliability Check

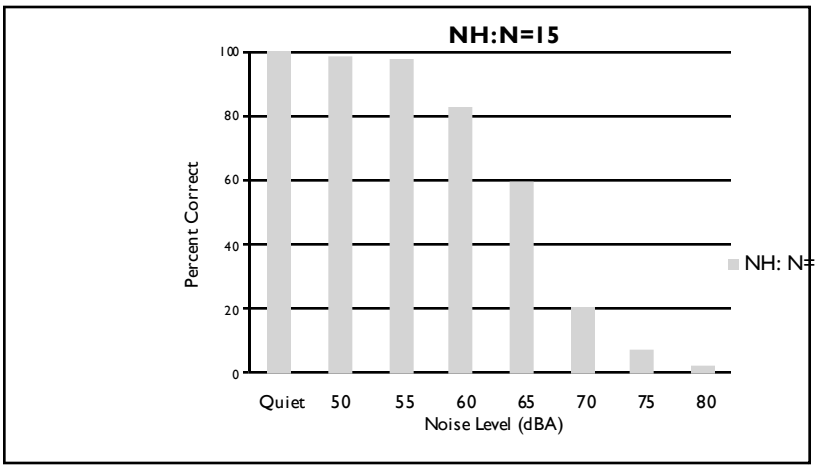
- One listener from Roger Study returned to listen in the current setup
- Severe to Profound Bilateral Hearing loss
- Sophisticated FM user!
- Had new Phonak Belero SPiro aids bilaterally
- Used CompilotX with MLxi and SmartLinks

# Procedure

- Same setup as with previous study
- HINT sentences
- Classroom noise in 5 dB steps
- Scored percent correct words
- Expect her scores to be lower than with Roger in previous study because we're only using SmartLinks this time

# Results for HI in Followup Roger compared to first Roger Study

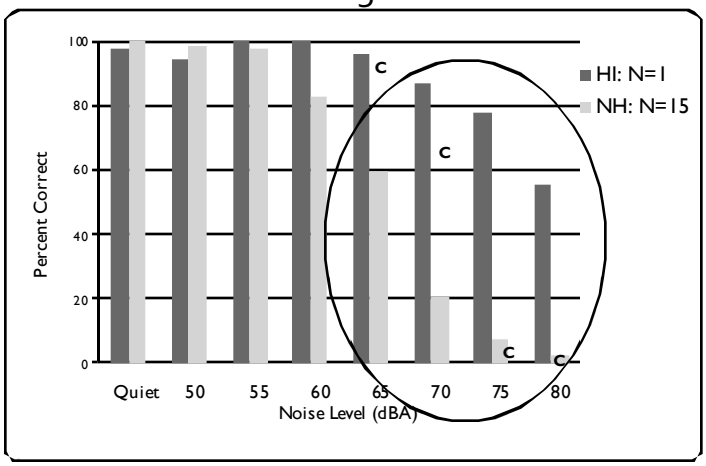
# Followup Results
# Young Adult Normals




# Followup Results

HI performed significantly better using her her Compilot/MLxi/Smartlink+ than the young adults with normal hearing

C= Scores with Fixed FM Adv



## Toolkit for those who work with wireless technology

Always need at your fingertips!!

- Simulation of hearing loss
- Background noise
- Demos of wireless technology

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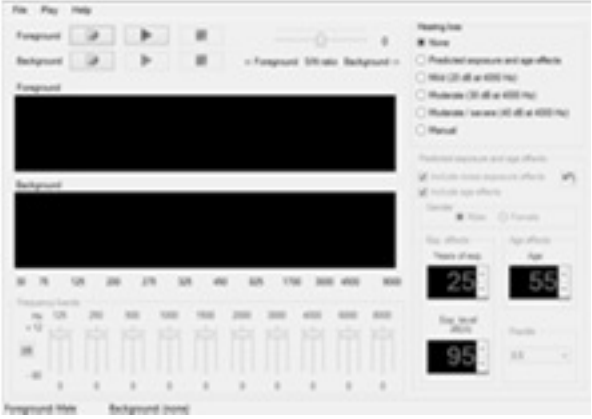
# Simulations of Hearing Loss

NIOSH Website

http://holmessafety.org/hlsim/




# Starkey Inspire Software

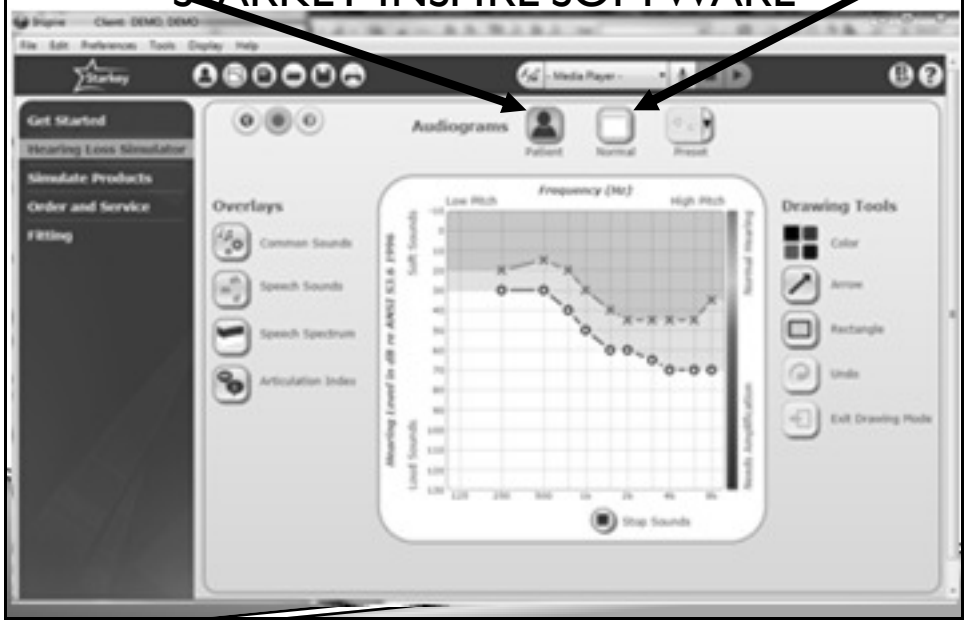
## Counseling Tools includes:

Hearing Loss Simulation,

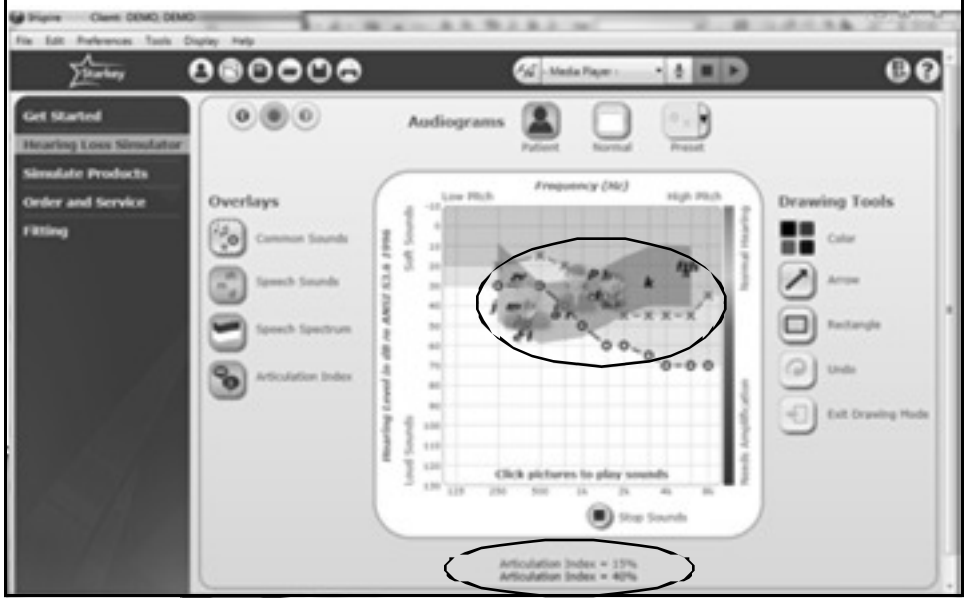
Speech Sounds Overlays

Articulation Index

# STARKEY INSPIRE SOFTWARE




# STARKEY INSPIRE SOFTWARE



# Educational Audiology Resource for Reducing Interference in Noisy Groups

**-ACCESS 2003-**

**Achieving Clear Communication Employing Sound Solutions**

**Edited by Linda M. Thibodeau**

**University of Texas at Dallas**

**Sponsored by Phonak Hearing Systems**

# This CD ROM contains three sets of Resources:

- Audio Demonstrations
- Assessment Inventories
- Implementation Tools
- CD Contributors

*Simply click on the one you want to explore.*

# SUMMARY

- Wireless technology can be used across the lifespan to enhance communication in social, educational, and athletic situations
- New Roger Systems provide significantly greater speech recognition in noise benefits than older technology in higher noise levels
- Adults with hearing loss and Roger Systems can perform BETTER than young adults with normal hearing at higher noise levels

# References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[illegible]

[illegible]

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# If Time Permits
# THIB-BITS

Battery Life extended up to 85% if opened 5 minutes before inserting into aid
http://www.kare11.com/story/news/education/2015/06/09/mn-8th-grader-makes-medical-discovery/28771777/

BDT –Battery Drop Test-Drop and Stop is GOOD!

Opening Programming Doors without tiny screwdrivers