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New?

- Product options/styles
  - Disposable
  - Implantable
  - “Open” fitting
- Processing schemes/features
  - Talking (music-playing) hearing aids
  - Trainable hearing aids
  - Features (DIR, DNR)
- Efforts
  - Focus on verification (yes!!)
  - Focus on training users
  - Focus on “ecological validity” of management scheme
1.a. Disposable

- (Been there, done that!)
- Earlier brand coming back as a BTE style
- New product placed deep into ear canal
  - Previously only MD
  - Now audiologist ("trained")
  - Costly (so is a Mercedes)

Disposable Hearing Aid

Photo courtesy of R. Sweetow, UC-SF
1.b. Implantable

- Short implant + hearing aid
- Clinical Trials (U of Iowa)
- Success...

Photos courtesy of U of Iowa and UT Southwestern Medical Center
Update ‘08: Hearing Aid Technology

Photo courtesy of UT Southwestern Medical Center
University of Iowa Data

1. c. “Open” fitting

- Micro-BTE
- RITE/RITA
- Open canal (OC)
- Open fit (OF)
- Open Ear (OE)
- Open (O)
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Popularity of “open” fitting

- Component size
- Feedback management
- Time for a new market!
- (and people love ‘em)
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Image provided courtesy of Siemens

Graphic provided courtesy of Siemens
Many to choose from...only a few covered today!

- Talking (music-playing) hearing aids
- Trainable hearing aids
- Features (DIR, DNR)
- Male/female (even Arnold Palmer)
- Multiple languages (one company has 22!)
- Alert to:
  - Memory
  - Low battery
  - “Time to schedule”
  - Zen musical patterns
Hearing aids talking to each other...

- FM across the head
  - Symmetrical steering of features
  - Adjustment of VC on one impacts the other
  - European data support it
- Near-field magnetic induction
  - Creates a “wireless sphere” around user
  - “Stereophonic” sound
2.b. Hearing aids that learn...

- “data-learning”
- Bayesian probability theory
- “Self Learning!”
- “Life Learning”
- nFusion technology
- S.M.A.R.T.
### 2.c. Features

- Directional microphones
  - Automatic/adaptive
  - Multi-channel/channel-less
  - First order/higher order

#### Back design of the Omnidirectional microphone

The output of the omnidirectional microphone is shown.

The original movie is from Gennum.
Basic design of the Two-port directional microphone

Rear port

Front port

Screen

The original movie is from Gennurn

Basic design of the Dual directional microphone

Rear Mic

TIME DELAY

Front Mic

Output

The original movie is from Gennurn
Ron Miles, PI: NIH R01 DC009429-01: Low-Noise Directional Hearing Aid Microphone using Optical Sensing with Electronic Feedback
(A. Mason, with permission)
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75 dBSPL WN Jammer at 90 degree

75 dBSPL WN Jammer at 180 degree
New?

- Besides size?
- Measurement techniques for multiple “jammers” and reverberant environments
- Different polars for different frequencies
- Different reaction to unilateral noise, or
- Same reaction for unilateral noise
- No reduction (adaptive) for speech off-axis

2.c. cont. Features

- Digital Noise Reduction
  - Complex!
    - Modulation-based gain reduction
    - Wiener filtering
    - Wind Noise reduction
    - Mic Noise Reduction
    - Expansion
    - Directional Mics
  - Data still suggest most likely outcome is “easier listening”
  - THAT is a good outcome
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All images from J. Chalupper, with permission

ASHA 0814/4741
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3.a. Focus on Verification!

- Seems obvious
- Verification of
  - quality control
  - gain as expected and audibility
  - output not excessive
  - aid fits well
  - features work
- What if reimbursement was withheld?
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Speech is somewhat audible...

Speech is highly audible...

Images provided courtesy of Audioscan
3.b. Focus on Training...

- Sweetow data
  - LACE
  - Self-paced training
- Hawkins data
  - Returns decreased
  - Cost minimal to staff
- Chisholm et al data
  - Quality of life improved
  - Satisfaction/Handicap/Disability
3.c. Focus on Ecological Validity

- Do different lifestyles/personalities require different signal processing (an area of research begun by Stuart Gatehouse)?
- Does output verification require the use of environmental stimuli? (Kiessling, Keidser, Bentler)
- Why do old people reject directional mics? (Wu & Bentler)

From Yu-Hsiang Wu dissertation:
New...different...more fun!

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Questions?

Image Credits
Thank You!

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