Auditory Training and Challenges Associated with Participation and Compliance

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Everything we do as audiologists is aural or audiologic rehabilitation (AR): counseling, hearing aids, ALDs, communication strategies, auditory training)...

BUT......

• less than 20% of new users (and less than 10% of experienced users) receive any form of audiologic rehabilitation (beyond hearing aids)
• only 2 - 5% are provided with formal retraining opportunities

– Kochkin, MarkeTrak VIII, 2009

Why do patients seek our help?

Elements of Communication
(Kiessling, et al, 2003; Sweetow and Henderson-Sabes, 2004)
Potential impediments to achieving mastery of these elements

• Hearing loss
• Neural plasticity and progressive neurodegeneration
• Global cognitive decline
• Maladaptive compensatory behaviors
• Loss of confidence

The biggest mistake we currently make may be....

• Making hearing aids the focus of our attention, when the focus should be....
• Enhancing communication

Are we really testing communication?

Current speech perception tests....

• Don’t take the contextual nature of conversation into account
• Don’t take the interactive nature of conversation into account
• Don’t allow access to conversational repair strategies that occur in real life

Flynn, 2003
Relevant domains for assessment

- Communication expectations and needs
- Sentence recognition in noise
- Tolerance of noise
- Ability to handle rapid speech
- Binaural integration (interference)
- Cognitive skills (working memory, speed of processing, executive function)
- Auditory scene analysis
- Perceived handicap
- Confidence / self-efficacy
- Dexterity
- Vision

Communication Needs Assessment

Measures beyond the audiogram that can be used to define residual auditory function.

Objective procedures
- QuickSIN
- BKB-SIN
- Hearing in Noise Test (HINT)
- Listening in Spatialized Noise Sentences (LiSN-S)
- Acceptable Noise Levels (ANL)
- Binaural interference
- Dichotic testing
- Listening span (Letter Number Sequencing)
- TEN
- Rapid (compressed) speech test
- Speechreading
- Dual-tasking

Subjective measures
- Hearing Handicap Inventory for the Elderly – Screening HHIE-S
- Communication Scale for Older Adults (CSOA)
- Communication Confidence Profile (CCP) or Listening Self Efficacy Questionnaire
- Self Assessment and Communication partner subjective scales (SAC and SOAC)

Combined (objective and subjective) methods
- Performance Perceptual Test (PPT)

Communication Confidence Profile

Please circle the number that corresponds most closely with your response for each answer.

If you wear hearing aids, please answer the way that you hear WITH your hearing aids.

1. Are you confident you can understand conversations when you are talking with one or two people in your own home?
2. Are you confident in your ability to understand when you are conversing with friends in a noisy environment, like a restaurant?
3. In order to hear better, how likely are you to do things like moving closer to the person speaking to you, changing positions, moving to a quieter area, finding better lighting, etc?
4. If you are having trouble understanding, how likely are you to ask a person you are speaking with to alter his or her speech by slowing down, repeating, or rephrasing?
5. How sure are you that you are able to tell where sounds are coming from (for example, if more than one person is talking, can you identify the location of the person speaking?)
6. Are you confident that you are able to follow quickly-paced conversational material?
7. Are you confident that you can focus on a conversation when other distractions are present?
8. Are you confident that you can understand a person speaking in large rooms like an auditorium or house of worship?
9. In a quiet room, are you secure in your ability to understand people with whom you are not familiar?
10. In a noisy environment, are you confident in your ability to understand people speaking with whom you are not familiar?
11. Are you confident that you can switch your attention back and forth between different talkers or sounds?
12. If you are having difficulty understanding a person talking, how likely are you to continue to stay engaged in the conversation?

CCP interpretation

• 50+ = Confident
• 40-50 = Cautiously certain
• 30-39 = Tentative
• Below 29 = Insecure

Some facts related to aging

• 2/3 of people age 70 and older have hearing loss
• Older adults with hearing loss have a 24% higher risk of cognitive impairment
• A 25 dB hearing loss equals the reduction in cognitive performance associated with a 6.8 year age difference
• Could be related to common cause hypothesis (shared neural pathways), extra resource expenditure; isolation from hearing loss

Lin (2011, 2013)
• Imaging studies of word identification in unfavorable signal-to-noise ratios have revealed greater activation of memory and attention brain regions in older adults compared with younger adults (Neuropsychologia 2009;47[3]:693-703). To compensate for reduced audibility or deficits in temporal processing (J Neurosci 2012;32[41]:14156-14164; J Acoust Soc Am 2006;119[4]:2455-2466), older adults appear to draw more on cognitive resources than younger adults do (Ear Hear 2010;31[4]:471-479).
• Despite this greater need to rely on cognitive resources, older adults often have a diminished cognitive reserve when trying to communicate in a complex listening environment (Trends Amplif 2006;10[1]:29-59).

• Older adults with hearing loss and poor working memory are more susceptible to hearing aid distortions from signal-processing algorithms, suggesting that cognitive skills should be taken into account in the hearing aid fitting.

Montreal Cognitive Assessment
• http://www.mocatest.org

So what’s the point?
• Like other diagnostic testing, any single measure (including speech in noise testing) may not provide enough additional information to justify the time or cost.
• However consideration of a combination of objective and subjective measures beyond the audiogram can supply important rehabilitation data.
Is this practical?????

Pilot study – what can busy clinical audiologists fit in?

• UCSF Request
  – Minimum of 2 objective and 2 subjective measures
  – Keep track of time
  – Keep track of how additional data impacted therapy plan

• Results
  – 80% received CCP and HHIE/A-S
  – 70% performed Quick SIN
  – 10% performed ANL, PPT-DIS, etc.

However.........

70% provided usable information above and beyond the “comp audio”

Why?????

• a) not enough time
• b) inconvenient
• c) don’t believe additional data will help
• d) all of the above
• e) don’t feel it is important to follow the instructions of the boss
**Expectations vs. Goals**

- Expectations have a product orientation
  - Patient assumes passive role
  - Whatever goes wrong is the professional’s fault
- Goals have a rehabilitation orientation
  - Patient assumes active role
  - Patient shares in the process

**Assessing Motivation and Readiness for AR**

- Source: internal vs. external
- Level: handicap perception
- Desire to rehabilitate
- Don’t fit an unmotivated patient

**Ida Institute tools**

- Circle of change
- Line
- Decisional Balance Box

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(Prochaska and DiClemente, 1984)
Outcome assessment should relate explicitly to the needs and goals determined.

Gatehouse 2003; Cox et al 2000

Benefit does NOT equal satisfaction!

- Cox (1997) estimated that satisfaction is comprised of:
  - 40% benefit (both psychosocial and acoustic);
  - 25% personal image;
  - 19% service and cost;
  - and 16% negative features.

How will your patient (and you) assess outcome?

- Hearing soft sounds
- Louder perception
- Understanding speech in noise
- Listening effort (elevators don’t make travel from floor 1 to floor 20 more effective, but they do make it easier) !!!!! [irv halter]
- End of day fatigue
- Use of new strategies
- Quality of life
- Benefit or satisfaction
- RFC

Client Oriented Scale of Improvement COSI

- Self-report questionnaire requiring patient to list 5 listening situations in which help with hearing is required. Post-rehab, the reduction in disability and the resulting ability to communicate in these situations is quantified.
- Takes less than 5 minutes of patient time, 2 minutes professional time for interpretation
Characteristics of Amplification Tool COAT

- 9-item measure of non-audiologic information to determine if technology is required.
- Takes 3 minutes of patient time, 2 minutes professional time for interpretation

Characteristics of Amplification Tool (COAT)
Newman and Sandridge

- Assesses
  - Motivation
  - Expectations
  - Preferences
  - Cosmetics
  - Cost considerations


"It doesn't sound normal"

- Normal to the hearing impaired patient may not be normal to the normal listener
- What do post-surgery patients report?
- Status quo is what the patient brings to the evaluation
- “If it sounds right, it’s probably wrong”
What do we do for a patient receiving an artificial limb?

What do we do for a cochlear implant patient?

What do we do for a patient with a balance disorder?

What do we do for a hearing impaired patient?

How can a person be trained to form whole perceptual units from auditory fragments?

Definition of an auditory processing disorder
Jerger and Musiek, 2000

- An auditory processing disorder is a deficit in the processing of information in the auditory modality. It may be related to difficulty in listening, speech understanding, and learning. These problems can be exacerbated in unfavorable acoustic environments.
- What does a peripheral disorder do?????
Does peripheral hearing loss lead to central auditory dysfunction

If so, can anything be done to compensate?

Why should AT be expected to produce benefit?

- Acuity and sensitivity are lower level functions
- Higher level functions (i.e. speech in noise) require more complex (hierarchical) processing (such as temporal analysis) that may utilize multiple channels of perceptual processing not governed by critical bands

Training-related physiological changes have been attributed to……

- 1) a greater number of neurons responding in the sensory field
- 2) improved neural synchrony (or temporal coherence)
- 3) may be a neural “decorrelative” processes in which training decorrelates activity between neurons, making each neuron as different as possible in its functional specificity relative to the other members of the population.
  - This process assumes that information common to two stimuli is disregarded, while responses to unique features of each stimulus are enhanced.

  Tremblay, 2006

Physiologic changes post training

- MRI shows increases in grey matter (Boyke, et al 2008)
- Cortical thickening in older adults (Engvig, et al, 2010)
- Changes in mismatched negativity response for adults trained on synthetic phoneme discrimination tasks (Kraus (1995); Recanzone (1995))
- Changes using auditory evoked magnetic fields - magnetoencephalography (Vasama and Makela (1995))
- Physiological changes occur quite rapidly, and precede changes in perception. (Tremblay, 1998)
Evidence based review of auditory rehabilitation and training in adults
(Sweetow and Palmer, 2005)

- Group
  - Beynon, Thornton and Poole, 1997
  - Chisolm, Abrams, and McArdle, 2005
- Individual
  - Kricos and Holmes, 1996
  - Montgomery, Walden, Schwartz, and Prosek, 1984
  - Rubenstein and Boothroyd, 1987
  - Kricos, Holmes and Doyle, 1992
  - Wright, B., Buonomano, Mahncke, and Merzenich, 1997
  - Bode and Oyer, 1970

AT Studies since 2000 meeting Evidenced Based criteria
(Sweetow and Palmer, 2005)
Henshaw and Ferguson, PLOS 2013; CBAT*

- Fu and Galvin, 2007
- Oba, Fu and Galvin, 2011
- Sweetow and Sabes, 2004
- Sweetow and Sabes, 2006
- Barcroft, Sommers, Tye-Murray et al., 2011
- Ingvalson, Lee, Fiebig and Wong, 2013
- Zhang, Dorman, Fu and Spahr, 2012
- Leavitt, Oden, Simon et al., 2011.

CONCLUSIONS

- 1) less than 5% of studies published on auditory training meet rigorous evidenced based criteria
- 2) auditory training resulted in improved performance for trained tasks in nearly all the articles that met evidenced-based criteria
- 3) although significant generalization of learning was shown to untrained measures of speech intelligibility, cognition, and/or self-reported hearing abilities, the improvements were variable, relatively small and not robust, though retention of learning was shown at post-training

Benefits of AR Programs

- Reduced return rate (13 vs 3%) of hearing aids (Martin, 2007); 9% - 3% (Northern and Beyert, 1999)
- Increased sale of assistive listening devices
- Fewer trouble-shooting visits
- Referrals from friends, co-workers, and family members
- Free advertising provided by satisfied hearing aid users
- Good community relations
Examples of good group rehab formats

- ACE (Active communication education program) (Hickson, 2007)
- Learning to Hear Again (Wayner and Abrahamson, 1996)
- Mayo Clinic (Hawkins, 2004)
- Krics
- Beynon, et al
- Northern and Meadows
- Abrams, Chisholm, et al

What happened to Aural Rehabilitation?

- declined because outcome measures concentrated on auditory training and speechreading and didn’t consider emotional and psychological by-products
- boring?
- too speech pathology like?
- too time consuming?
- lack of reimbursement

Training is not a new concept....

But now we have the means to do it effectively......via computer aided auditory rehabilitation....so that.....

- It can be performed in a private, non-threatening environment
- It can proceed at the individual’s optimal pace
- Progress assessment can be done automatically

What we can learn from learning theory?

1. Distribution of practice should be suitable for the task to be learned.
2. Active participation by the learner is superior to passive receptivity.
3. Practice material should be varied so that the learner can adapt to realistic variation and so that his motivation during drill is improved.
4. Accurate performance records need to be maintained in order to evaluate progress and effects of training.
5. The most useful single contribution of learning theory is the provision for immediate knowledge given to learners regarding their performance.

Wolfle (1951)
What we can learn from neuroscience...?

• **Appropriate feedback** (Holroyd et al. 2004, Birdsong studies)
• **Motivation** (Kligord and Merzenich, 1998)
• **Reward** (Benenger and Miller, 1998)
• **Training near threshold** (Blake et al., 2002)
• **Incremental training**: Go slow and steady (Linkenhoker and Knudsen, 2002)
• **Speed and spacing of the training** (Hairston and Knight, 2004, Marquet, 2001)

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Many available Computer-based Auditory Training Programs

- Baldi
- Computer-Assisted Speech Perception Testing and Training (CASPER)
- CogMed
- Computer Assisted Speech Training (CAST/TigerSpeech)
- Sound and WAY Beyond
- Seeing and Hearing Speech
- Sound Express
- eaRena
- FastForWord
- I Hear What You Mean
- IMPACT
- LACE (Listening And Communication Enhancement)
- Read My QUIPs
- SoundScape
- Speech Perception Assessment and Training System (SPATS)
- The Listening Room

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Music Training

- Kraus’ lab (Northwestern) has shown:
- Better understanding of speech in noise across age groups
- Shorter brainstem timing delays

![Graph](image)

Neurobio Aging 2012;33(7):1483

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OPERA

- **Overlap**: in the anatomy and physiology for speech and music
- **Precision**: more precision is required for music processing than speech
- **Emotions**: strong emotions evoked by music may induce plasticity via brain’s reward centers
- **Repetition**: extensive practice tunes the auditory system
- **Attention**: focused attention to details of sound is required when playing an instrument

Aniruddh D. Patel (Nat Rev Neurosci 2010;11(8):599)
LACE
(Listening and Communication Enhancement)

- Cognitive
  - Auditory Working Memory
  - Speed of Processing
- Degraded and competing speech
  - Background noise
  - Compressed speech
  - Competing speaker
- Context / Linguistics
- Interactive communication

All of the above are designed to enhance listening and communication skills and improve confidence levels

Sweetow and Henderson-Sabes, 2006

On average, normal hearing people require a +2 dB signal to noise ratio for 50% recognition of words in sentences while people with hearing loss require a 8 dB signal to noise ratio (Killion, 2002).

Even a 1 dB reduction in SNR has been estimated to be commensurate with a 6-8% improvement in percent correct scores for sentence recognition (Crandell, 1991; Wilson et al, 2007)

5 dB SNR loss = 20% quality estimation (Killion 2011)

Good news
- Higher benefit from training is significantly correlated with reduced listening effort (Olsen and Preminger, 2012)
- New hearing aid users in the training group experience the largest improvement (Preminger, 2011)
- Patients with more severe handicap show greater benefit (Henderson-Sabes and Sweetow, 2007; Kuk et al, 2009; Hickson et al, 2011)
- Patients with more severe handicap are more likely to comply with therapeutic recommendations (Sweetow and Sabes, 2007)
- Reduced return rate (13 vs. 3%) of hearing aids (Martin, 2007); 9% - 3% (Northern and Beyer, 1999)

Note: Even a 1 dB reduction in SNR has been equated with a 6-8% improvement in sentence recognition (Crandell, 1991). Wilson et al (2007)

Note: Henderson-Sabes (2012) separated the 3410 20-lesson finishers into groups according to their initial QuickSIN SNR loss tested at MCL
The biggest unresolved questions

- Will audiologists recommend it?
  - Impact on return for credit rate?
- Will patients do it?
  - Cost of effort
  - They do for physical therapy
    - Why?
      - MD recommendation
      - Immediate modeling of therapy after surgery

Why audiologists don’t recommend AR

- Belief that hearing aids alone are adequate
- Lack of belief in outcome measures
- Belief that additional resources (time, money) are required
- Lack of confidence regarding who needs AT
- Lack of reimbursement
- Reluctance to ask patients to spend more time or money
- Inertia
- Laziness

Something to consider

- Results from a counseling-based group AR program indicated that hearing aid users that participated in the program performed better on the Communication Profile of the Hearing Impaired than hearing aid users with no group AR experience at the conclusion of the program.
- However, there were no significant differences between the groups after one year.


- So what does this imply?
Compliance

• Clinical data from over 3,000 individuals reported that adherence (defined as completion of at least half of the recommended number of training sessions) was less than 30%. (Sweetow and Sabes, 2010)
• Similarly, in a study of home-based computerized AT for cochlear implant users, Stacey and Summerfield (2005) reported that about 1/3 of their users completed less than 1/3 of the recommended training.
• Non-compliance with prescribed medication regimens for hypotensive treatment ranges from 5% to 80% among glaucoma patients (Olthoff et al., 2005).
• Vincent (1971) reported that 43% of glaucoma patients refused to take the physician-ordered measures necessary to prevent blindness, even when that refusal had already led to impairment in one eye.

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Reasons

• Denial of the problem
• Cost (money, time, risk of failure) of the treatment
• Difficulty of the regimen
• Unpleasant outcomes or side-effects of the treatment
• Lack of trust
• Apathy
• Previous negative experience
• Failure to persuade that compliance is in their best interest
• Lack of “rewards” or recognition for effort

AT Studies from 2000 – 2012 meeting Evidenced Based criteria
(Sweetow and Palmer, 2005)
Henshaw and Ferguson, PLOS 2013; CBAT*
• – Fu and Galvin, 2007
• – Oba, Fu and Galvin, 2011
• – Miller, Watson, Kistler, Wightman and Preminger, 2008
• – Sweetow and Sabes, 2004
• – Sweetow and Sabes, 2006
• – Barcroft, Sommers, Tye-Murray et al., 2011
• – Ingvalson, Lee, Fiebig and Wong, 2013
• – Zhang, Dorman, Fu and Spahr, 2012
• – Levitt, Oden, Simon et al., 2011.
Six predictors of positive compliance

- Higher socioeconomic status
- Greater initial self-reported hearing disability
- Lower pre-contemplation stage (denial)
- Greater action stage of change
- Lower chance locus of control
- Greater hearing disability perceived by others and self

— Laplante-Levesque, Hickson, and Worrall (Ear & Hearing, 2012)

Suggestions

- Compliance generally increases if patients are given clear and understandable information about their condition and progress in a sincere and responsive way
- Do the first session face to face
- Simplify instructions and treatment regimen as much as possible.
- Have systems in place to generate treatment and appointment reminders

How should success be measured?

- On-task improvement
- Generalized speech recognition performance
- Quality of life
- Subjective communication confidence
- Individual vs group mean data
Attitude of the Professional

- Audiologists sell a process, not a product
- Patients will not regard listening programs to be important unless the clinician appears to believe it is important
- Radical changes in technology have immediate impact
- Changes in practice or procedures must overcome the hurdle of inertia

Summary

- Identify and manage patient’s emotional status
- Help the patient feel safe and free to express his/her feelings
- Manage emotional barriers
- Select appropriate amplification in accordance with the patient’s personality and needs
- Teach and orient the patient regarding adaptation and the use of the hearing aids
- Help the patient manage telephone use
- Help the patient attain realistic expectations
- Make the patient understand that hearing aid use is only one component of the hearing rehabilitation process
- Document your work
- Provide a rehabilitation plan

Challenges

- Convince MDs / audiologists / patients of importance
- Large scale studies on AR/AT
- Better diagnostic/prognostic assessments
- Establish optimal training parameters
- Raise acceptance to level of acceptance of “Brain games” (e.g. Lumosity, Brain HQ, Posit Science)
- More enjoyable AT (e.g. enhanced LACE with videos)
- More mobile apps (e.g. Hear Coach)
- More “fun” games (e.g. Read My Quips)
- Non-speech, i.e. music training (e.g. Kraus and Anderson)
- Incentives
- Determine appropriate outcome measures

Aural (auditory, audiologic) rehab......

Should NOT be considered an add-on!

Incorporate it at the very beginning

Above all.......... Do something!!!!!
Thanks for listening

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