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Audiology Online
Music Training as Part of Aural Rehabilitation for Cochlear Implant Users, presented in partnership with ARA

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Learner Outcomes

• 1) Describe characteristics of cochlear implant recipients related to music that could be assessed as part of device candidacy and pre-implant counselling.

• 2) Describe practical accommodations to music choices, listening environments, and assistive devices that can help CI users to enjoy music.

• 3) Describe principles associated with application of music training to enhance music listening by cochlear implant recipients.
CIs and Music: A Complex Matter

Structural Features of Music

(Looi, Gfeller & Driscoll, 2012, Limb & Roy, 2014)
• CI users are similar to NH adults and children in perception of rhythm  (Gfeller & Lansing, 1992, 1992)
• CI users are less accurate than NH persons in perception of pitch and timbre (Gfeller, Woodworth et al., 1997, Gfeller Knutson et al., 1998, Gfeller, Witt et al., 2002a, b)

Perception of Salient Features of Music

• The good: rhythm (audio ex 1)
  lyrics
• The bad: timbre (audio ex 2)
• The ugly: pitch/melody (audio ex 3)

(Fujita & Ho, 1999; Gfeller, 2000; Gfeller & Lansing, 1991, 1992; Gfeller et al., 1997, 1998, 2002, 2004; Kong et al., 2004; Leal et al., 2003; Luisi et al., 2004; McDermott, 2004; McDermott & Luisi, 2004; Osias et al., 2005; Pijl, 1997; Vandelli et al., 2005; Vongpaisal et al., 2004)
Music Perception

• CI users perceive some aspects of music better than others.
  • Rhythm > Timbre > Pitch
    — Residual hearing especially helpful for pitch and timbre.

Helpful Listening Factors: Musical Elements
179 Adult CI Users

- familiar music
- knowing song title
- follow lyrics
- watch performer
- distinct rhythm
- simple melody/rhythm
- quality recording
- soft music

10/12/17
CI Users and Music: Clinical Considerations Pre Implant

- Music enjoyment high priority for the patient, family?
- Pitch perception important for tonal language, vocation?
  - Careful counseling to promote realistic expectations
  - Discuss options for training and accommodations post implant
- Good residual hearing in either ear? Benefits from hearing aids in low frequencies?
  - Consider device designs associated with preserved hearing
  - Encourage bimodal hearing device usage
• Adult CI users vary considerably in their perceptual accuracy and enjoyment of music
  (Gfeller, Gleason et al., 2008, 2010)

Video 1
• “Music sounds like a cage full of squawking parrots.”

• “I can hear music, but it doesn’t make sense to me.”
• “The organ at church sounds like a train coming through the sanctuary.”

• “I cannot recognize a violin vs. a flute or any other instrument. It sounds like a bunch of sounds kind of thrown together.”
• “I love good folk music. My husband and I are members of a close-knit folk community, and we meet in each other’s homes weekly.”

• “I try to listen to music daily. If I don’t, I miss it. It satisfies a deep hunger of mine. I now prefer Baroque music most of all.”
Video 2

Listening Habits: Adult CI Users

![Listening Habits Chart]

CONTINUED
Adolescent CI Users:
Importance of Music in Your Life?

Gfeller et al., 2012

- Better perceptual accuracy does not guarantee music enjoyment
  (Gfeller, Oleson et al., 2008, 2010; Wright & Lethanski, 2012; van Besouw et al., 2013).
  
  - CI users with above-average perception can still find music to sound disappointing
  - CI users with below-average perception can still enjoy listening to music
    - Realistic expectations, thoughtful use of accommodations
Accommodations and Expectations

- **Accommodations**
  - Listening environment, sound equipment
  - Judicious choice of musical stimuli
    - Focus on most available features (rhythm, lyrics)
    - Availability/use of non-auditory cues, context

- **Expectations**
  - Balancing optimism with realism
    - Start with more accessible musical sounds
    - Be open to different personal goals
    - Accurate information (re)habilitation
Diversity of Environments

• Accommodations may be essential for navigating complex real-world environments.

Hindrances: Noisy Rooms, Loud Music

<table>
<thead>
<tr>
<th>Hindrance</th>
<th>% Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noisy Room</td>
<td>92%</td>
</tr>
<tr>
<td>Echo in Room</td>
<td>90%</td>
</tr>
<tr>
<td>Loud Music</td>
<td>66%</td>
</tr>
</tbody>
</table>

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Better Listening Environment, Signal Input

Accommodations: Context and Visual Cues

Cues take into account hearing history (onset of loss, prior experiences), capabilities
Name that tune----with cues

Audio ex 1

Audio ex 2

Listening to Familiar Music

• “It does help . . if I know what it’s supposed to sound like. For example, the ‘Star Spangled Banner’ started to sound fairly normal about a week into the Olympics, but I think this is my brain filling in the missing pieces.”
Expectations

• “Initially it was very disappointing to listen to music with my CI. . . . . I have had to adapt. [After] accepting a ‘new sound' . . . . it can be extremely enjoyable to listen to music now. . it’s just different.”

Optimizing Music Enjoyment

• Realistic, individualized expectations
  – Taking advantage of residual hearing
  – Focusing on accessible features of music,
  – Taking control over environmental factors

• Compensate with visual, contextual cues
• Optimize through training/practice
CIs and Music: A Complex Matter

- Technical Features
- CI
- Training
- Individual Listener
- Meaningful Music?
- Accommodations
- Expectations Priorities

Video 3
Harnessing Human Capabilities to Enhance Technology

• Training
  – listening enjoyment
    • realistic expectations; strategic approaches to listening
  – accuracy in listening
    • use contextual cues (top down processing)
    • use multimodal input (e.g., visual cues)
    • learning auditory associations

CI Users and Music Training?

Clinical Considerations Post Implantation

• Is music enjoyment a high priority for the individual or their family? Is music listening worth some time and effort?

• What musical resources are available in the home, school, community, on line?

• Can the individual hear some differences in musical sounds?

• Are some aspects of music interesting or enjoyable to listen to/play?
Rationale for Music Training

• Overlap in brain networks that process acoustic features in music and speech

• Music training benefits cognitive and linguistic functioning in NH listeners
  – phonological processing, verbal memory, speech perception in background noise, language learning
  (e.g., Musacchia et al., 2007, 2008, Wong et al., 2007; Strait et al., 2009; Moreno et al., 2009; Parbery-Clark et al., 2009; Kraus & Skoe, 2009; Kraus, Skoe, Parbery-Clark, & Ashley, 2009; Kraus and Chandrasekaran, 2010)

Music promotes careful listening

• Music shares structural qualities of speech.
  – Pitch, tone quality, duration, intensity

• Music presents more complex listening tasks
  • wider frequency range
  • more varied spectral characteristics
  • often multiple instruments playing at once
  • wider dynamic range
  • requires more fine structure, spectral selectivity than speech
Research on Training:
CI Users

• Music training can improve timbre recognition, timbre appraisal, and pitch perception of adult listeners.
  • Simulations (Driscoll, et al., 2009; Loebach & Pisoni, 2008; Loebach, Pisoni, & Svendsy, 2009)
  • Adult CI users (Gfeller et al., 2000a, b; 2002; Fu and Galvin, 2007; Galvin, Fu & Nagaki, 2007; Galvin et al., 2009)

• Studies with pediatric CI users
  • Music instruction (Abdi, et al., 2001, Chen et al., 2010; Rocca, 2010; Yucel et al., 2009)
  • Acute laboratory training (Olszewski et al., 2005, 2006)

Results of Training
Behavioral Outcomes

Complex Song Recognition

![Graph showing the results of training for complex song recognition.]
• “I came home and found my husband enjoying a symphony concert on PBS for the first time in years. I have my husband back.”

• “For the first time in years, we went to a movie and my husband enjoyed the sound. We’re going to go to the movies again!”
• “I just returned from a Christmas concert last night. When they sang, ‘Do you hear what I hear?’ . . . I was overcome with emotion!”

• “After my dad’s funeral, I went home and all I could do was sit and stare at the walls. I put in a CD and listened to music for hours. Eventually, I found myself able to function again. I want to encourage you with your implant music project. The implant lets us hear music. Music opens up ways to enjoy and cope with life.”
Practical consideration in music training

• Focused listening paired with **many repetitions**
  • Analytic training: enhance underlying perceptual efficiency by practice with sound elements

• Synthetic training (more connected stimuli)
  – Using contextual cues
  – Improved selective attention


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Practical consideration in music training

• Practice in a ‘clean’ environment
• Focus on the music
• Distributed practice over time
• Judicious selection of musical materials
  – Start with accessible features of music; gradually increase difficulty
• Using contextual, non-auditory cues
• Experiment
• Perseverance and patience

Training Decisions

- Age of onset? Pre/post lingual?
  - Differences in auditory development
  - Differences in mental representation of musical sounds
  - Differences in available contextual cues

- Auditory periphery?
  - Synergistic benefit from hearing aids?

- Chronological Age?
  - Length of sessions, format, different forms of motivation, content

- Musical background?
  - Level of motivation
  - Existing skills in careful listening
  - Use of contextual cues
  - More specific selection of musical repertoire, stimuli
• **Motivation, attitude?**
  - Readiness for repetition, persistence
  - Linking training protocols to real-world meaningful experiences

• **Cultural lens?**
  - Family priorities
  - Cultural choices for meaningful music
  - Attitudes about re(habilitation)

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**Case Example**

• **Chronological Age:** 69

• **Auditory profile:** Postlingual, implanted age 65, uses hearing aid in contralateral ear

• **Socio-cultural factors:** no formal musical training but attended concerts prior to hearing loss; college education; basic computer skills

• **Motivation, attitude:** high on conscientiousness, openness, extraversion
Case Example

- **Chronological Age:** 4
- **Auditory profile:** Congenital loss, implanted age 2, limited residual hearing
- **Socio-cultural factors:** music is not a high priority in the family—enjoy sporting events
- **Motivation, Attitude:** short attention span for ‘quiet’ activities; enjoys activity

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One Approach

Fits All
In closing. . . .

• CIs do not convey spectrally complex information effectively.
  • Negative impact on musical features of pitch and timbre
  • Negative impact on prosody, speech in background noise, lexical tones
• CI users vary considerably in how well they perceive spectrally complex sounds
  • Experience with listening can improve CI benefit

• Training can enhance music perception in CI users; may also enhance speech perception
• Many forms of music-based training effective, depending upon desired outcomes.
• The characteristics of the CI user should be taken into account when considering the use of music-based interventions.

Thank you for your attention!

Questions?