Music and the Listener with a Cochlear Implant

Kate Gfeller, Ph.D.
Russell and Florence Day Distinguished Chair of Liberal Arts and Sciences
School of Music, Department of Communication Sciences and Disorders,
Iowa Cochlear Implant Clinical Research Center,
Department of Otolaryngology—Head and Neck Surgery,
The University of Iowa

I. Relevance of Music to CI Benefit
   A. Music perception as a stringent measure of CI benefit
   B. Music and speech perception: differences and areas of overlap
   C. Music and psychological wellbeing, social integration, quality of life

II. Music Perception as a Stringent Measure of CI Benefit
   A. Signal Processing and Perception
      1. Speech
         a. Requires as few as 4 bands of coarse spectral cues
         b. Adult CI users: Mean=80% word recognition in **quiet** with 3-6 months CI use.
      2. Music
         a. > 32 functional channels, better encoding of fine structure information required for transmitting melody and timbre
         b. Music Perception and Enjoyment
            i. Group data: CI recipients are significantly poorer than NH listeners in perception and/or appraisal of pitch, frequency difference limens, pitch ranking, melodic contour, melody recognition (simple, complex), harmonic change, timbre
            ii. CI users vary considerably in their perceptual accuracy and enjoyment of music
            iii. Music perception is not strongly predictive of music enjoyment: people with poor perception may still enjoy music listening and vice versa
      3. Music as a Stringent Measure: Measures of pitch and timbre require perception of spectrally complex acoustic features

III. Music and speech perception: differences and areas of overlap
   A. Musical aspects of speech
      1. Prosody, the melody of speech
a. affective speech prosody, prosody marking linguistic contrasts
b. sound quality: talker identification
c. lexical tones

B. Pitch perception correlated with
   1. Speech in background noise
   2. Recognition of prosody marking linguistic contrasts
   3. Tone discrimination in Mandarin Chinese
   4. Talker discrimination

IV. Music and quality of life
   A. Music plays a valuable role over the life span
      1. Lullabies present exaggerated pitch contours that soothe infants and promote joint attention
      2. Musical play in early childhood promotes heightened attention, predictable communicative patterns, lyrics presented at slower tempo than conversational speech, and with ample repetition.
      3. Music provides school-aged children with cultural enrichment, focused listening to complex sounds, communicative routines, social interaction.
      4. Adolescents use music for personal expression, emotional regulation, active engagement in music listening/production
      5. Music marks significant life events, and expresses cultural values.
      6. Music functions as an acoustic scrapbook of significant life events

V. Can CIs improve their musical perception?
   A. Technical upgrades? To date, no clearly superior signal processing scheme for music.
      1. Greater residual hearing supported by hearing aid use can improve music perception.
      2. Users of acoustic + electric devices that preserve residual hearing tend to show greater accuracy due to acoustic hearing
   
   B. Acclimatization: timbre and pitch do not improve as a result of incidental exposure, everyday listening

   C. Training?
1. Evidence from ‘star’ users for music suggests that music can improve with concerted effort, practice

2. Different Approaches to Training
   a. Analytic: Bottom up processing
      i. Increasingly difficult contrasts in isolated acoustic features
      ii. Increase efficiency in hearing small changes throughout auditory system
      iii. May generalize to similar listening tasks requiring similar processing capabilities
   b. Synthetic: Top down processing
      i. Naturalistic and connected stimuli
      ii. Promotes more efficient central processing
      iii. Enhance attention, contextual cues, priming
      iv. Assists listener in extracting usable information from complex signal

3. Research indicates that training can result in significant improvements in timbre recognition, sound quality ratings, recognition of familiar songs, and pitch pattern. Does not restore ‘normal’ perception.

VI. Practical suggestions for music training

A. Establish realistic expectations
   1. Don’t expect music to sound just like it used to
   2. Some kinds of music or specific songs will sound more pleasant
   3. Avoid comparisons with the ‘star’ users in the CI advertisements

B. Exploit the features best transmitted through the CI
   1. Pay attention to the rhythm
   2. Listen for the lyrics
   3. Listen to simpler forms of music

C. Improvement usually requires persistent practice over time
   1. Short and spaced rehearsal
   2. Listen in an optimal environment
   3. Listen when mentally sharp yet relaxed
   4. Lots of repetition!
   5. Trial and error
VII. Can music listening enhance speech perception.
   A. Conditions required to achieve speech benefit from music (Patel, 2011)
      1. Overlap in brain networks that process acoustic features in music and speech.
      2. Music requires greater precision of processing on shared networks
      3. Music activities associated with strong positive emotion, which enhances focused attention, motivation, persistence
      4. Musical activities involve considerable repetition, and thus repeated exposure, rehearsal
Bibliography

Resources on Music, Cochlear Implants, and Music-Based Training


