- If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

- This handout is for reference only. Non-essential images have been removed for your convenience. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.

CONTINUED

Technical issues with the Recording?

- Clear browser cache using these instructions
- Switch to another browser
- Use a hardwired Internet connection
- Restart your computer/device

Still having issues?

- Call 800-753-2160 (M-F, 8 AM-8 PM ET)
- Email customerservice@AudiologyOnline.com

The Perception of Emotional Prosody by Listeners with Hearing Loss and Cochlear Implants

Monita Chatterjee, PhD

Auditory Prostheses & Perception Lab
Center for Hearing Research
Boys Town National Research Hospital

Learning Outcomes

After this course, participants will be able to:

- Describe the acoustic cues for vocal emotions.
- Describe how children with CIs communicate vocal emotion in their speech, compared to their normally-hearing peers.
- Describe factors that play a role in the perception of vocal emotion by listeners with cochlear implants and with hearing loss.

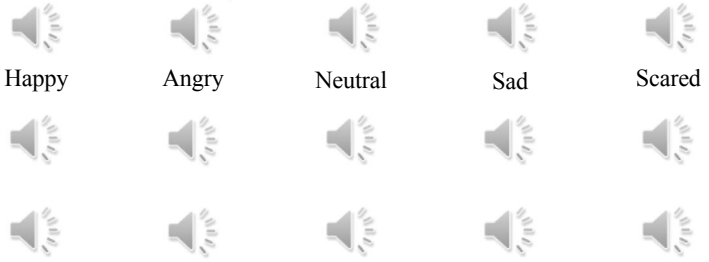
Motivation

- Present-day hearing prostheses are focused on speech recognition, not necessarily prosodic cues
- Full communication requires both
- Listeners with CIs have reasonable access to phonetic cues, but are severely limited in access to F0

Danielle Zion
UMD/ Walter Reed

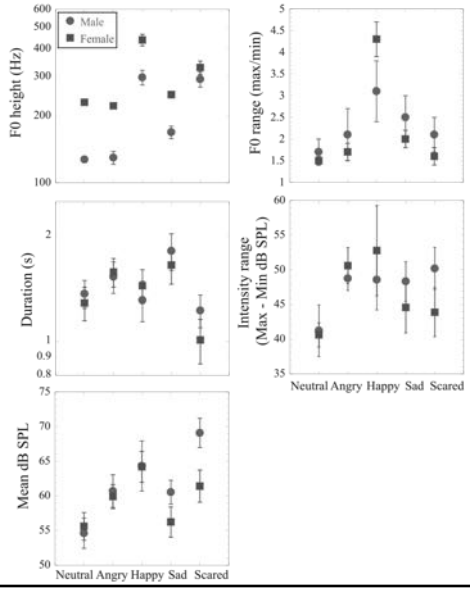
EMOTION: STIMULI

- 12 sentences, 5 emotion each: happy, angry, sad, neutral, scared (child-directed speech)
- 1 female and 1 male talker (selected from pilot with 4 talkers)

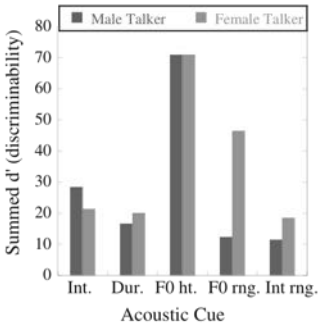


CONTINUED AMERICAN AUDITORY SOCIETY

M. Chatterjee et al. / Hearing Research 322 (2015) 151–162

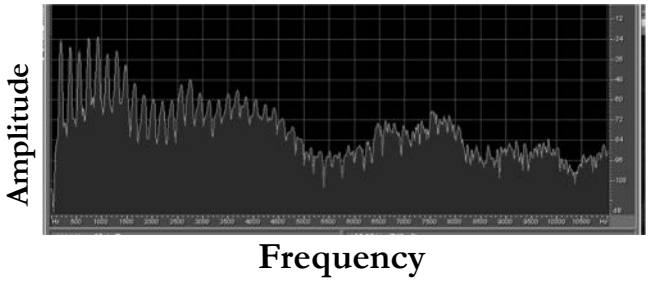


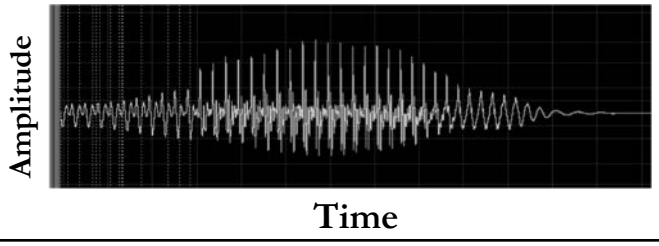
Acoustic Cues for Vocal Emotion



CONTINUED AMERICAN AUDITORY SOCIETY

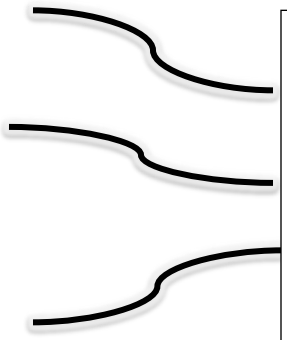
Complex Pitch Cues in NH and CIs





PRIMARY FOCUS: Cochlear Implants

- Perception of emotional prosody by listeners with CIs
- Production of emotion by listeners with CIs



- *Neural plasticity and adaptation in children – age, device experience, linguistic environment*
- *Cognitive and linguistic development*

A Growing Body of Literature Shows Deficits in Both Perception and Production of Emotions by CI Listeners

Deficits in vocal emotion recognition by adults and children with CIs:

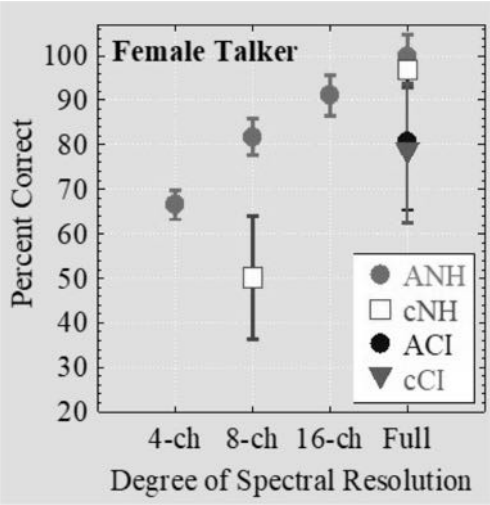
- *Luo et al., 2007; Hopyan-Misakyan et al., 2009; Schorr et al., 2005; Most & Aviner, 2009; Most & Michaelis, 2012; Chatterjee et al, 2015*

Facial emotion recognition/Emotion Understanding in children with CIs:

- *Hopyan-Misakyan et al, 2009; Wang et al., 2011; Wiefferink et al 2013; Fengler et al 2017*

Imitative production of happy and sad vocal emotions by children with CIs

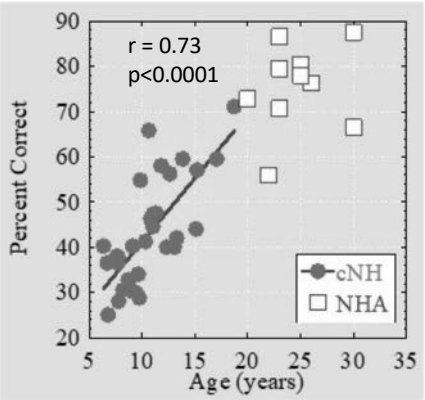
- *Nakata et al., 2012; Wang et al., 2013*



- 10 NH adults
- 9 CI adults
- 31 NH children (6.38 – 18.76 yrs., mean age 10.76 yrs.).
- 36 CI children (6.83 – 18.44 yrs., mean age 12. 15 yrs., mean dur. dev. 8.76 yrs.)

Chatterjee et al., 2015 (Hearing Res)

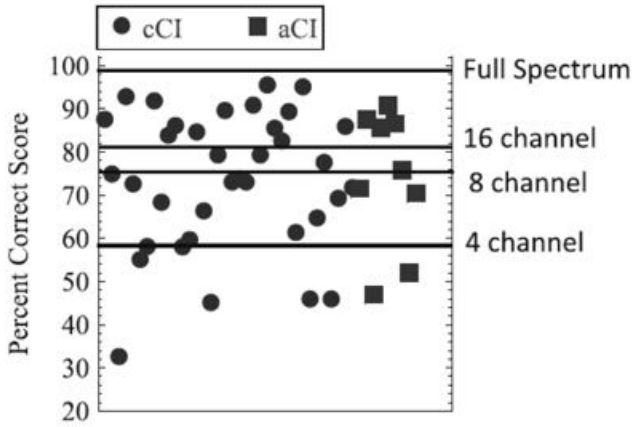
Developmental Effect in NH Children Listening to 8-channel NBV Speech



- Age effects in NH children and adults with 8-channel noise-vocoded speech.

Chatterjee et al., 2015 (Hearing Res)

A Closer Look at Individual Data



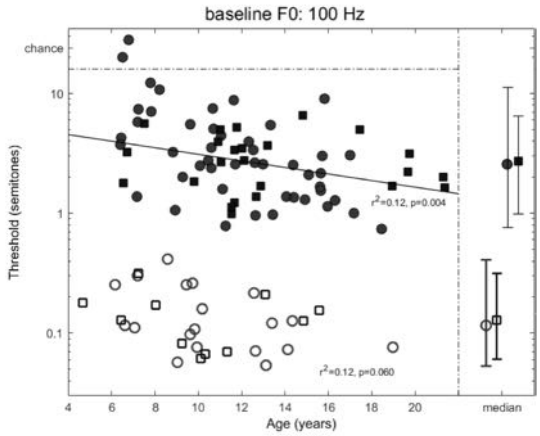
Chatterjee et al., 2015 (Hearing Res)

Predictors of Performance

1. Sensitivity to static and dynamic changes in F0
2. Age, age at implantation, duration of experience with device
3. Cognitive/linguistic factors
4. SES

Static-F0 Discrimination: Children with CIs have Large Deficits.

Mickael Deroche, PhD

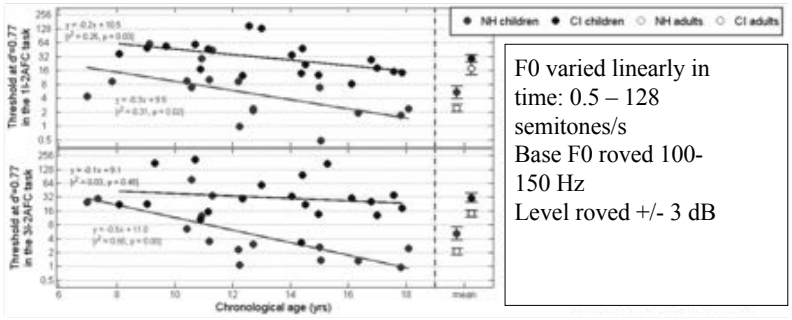


N=19 NH in the US
N=11 NH in Taiwan
N=47 CI in the US
N=24 CI in Taiwan

Deroche, M. L. D., Lu, H.-P., Limb, C. J., Lin, Y.-S., and Chatterjee, M. (2014). Frontiers in Neuroscience 8:282. doi: 10.3389/fnins.2014.00282.

Dynamic-F0 CUES: Deficits in CI Children and Adults

(labeling)

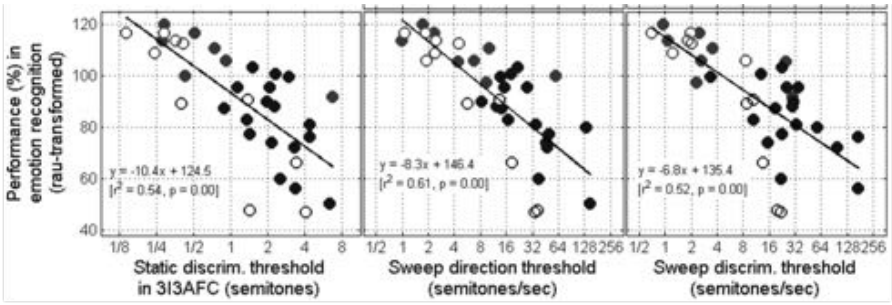


F0 varied linearly in time: 0.5 – 128 semitones/s
Base F0 roved 100-150 Hz
Level roved +/- 3 dB

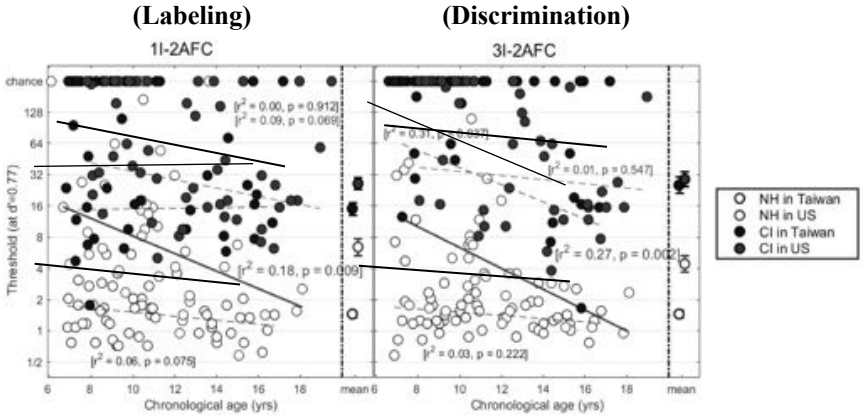
(discrimination)

Deroche, M. L. D. et al. (2016). Frontiers in Neuroscience doi: 10.3389/fnins.2016.00073

- Thresholds obtained in all F0 tasks are predictive of performance in emotion recognition tasks
- Even though acoustic cues for emotion are multi-dimensional, F0 remains an important cue for CI listeners



Newer Data: Benefit of Linguistic Background



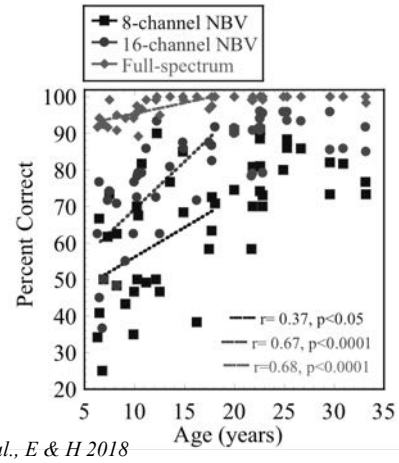
Deroche et al. Manuscript in Preparation

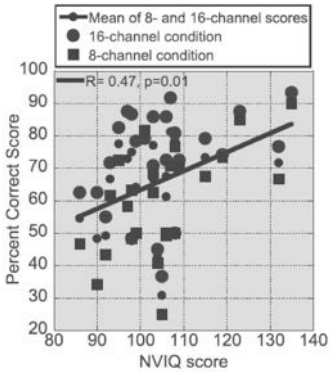
Age, Cognitive and Linguistic Factors

- NH children → CI-simulated speech
- CI children→ full spectrum speech

NH Children's Performance with Degraded Speech is Predicted by Age and by Non-verbal IQ

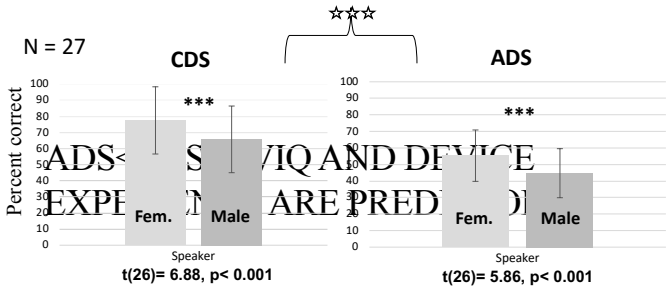
Anna Tinnemor





Tinnemore et al., E & H 2018

What about Children with CIs?



ADS< S VIQ AND DEVICE EXPER N ARE PRED D

Karen Chan Barrett

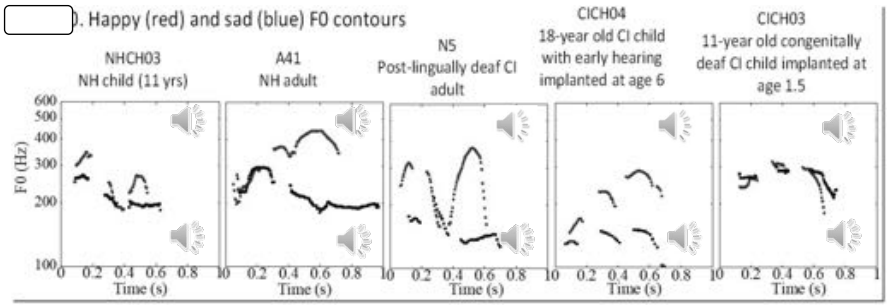
For CDS:

NVIQ was the only variable to have a significant contribution (β =0.47, p =0.02).

For ADS:
--years of experience using CI had a significant contribution (β =0.53, p = 0.01)
-- NVIQ had a marginal contribution (β =0.37, p = 0.059).

Vocal Emotion Productions by Children with CIs: Happy and Sad

EXAMPLES…AND INSIGHTS



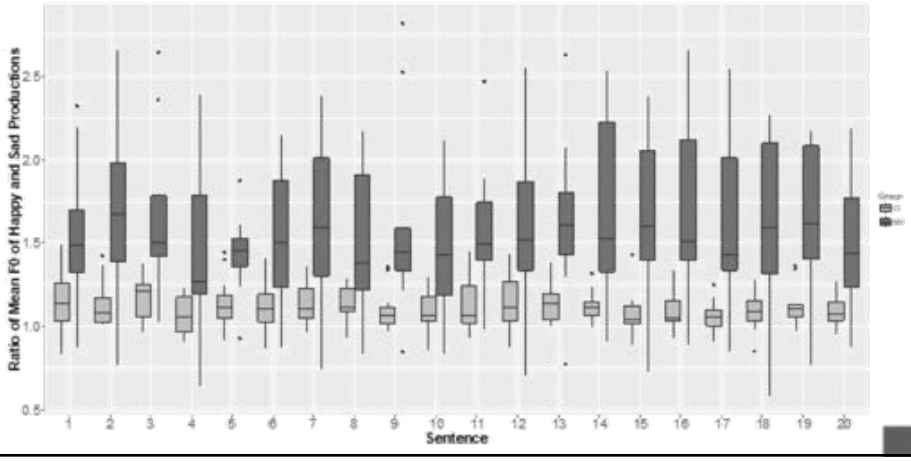
Vocal Emotion Productions by Children With CIs: Happy and Sad

Sara Damm
Jenni Sis
Aditya M Kulkarni
Julie Christensen

- 20 sentences:
  This is it
  She is here
  Time to go
  It's snowing again
  etc.
- Acoustic analyses
- Perceptual data
- 13 children with CIs
- 9 children with NH

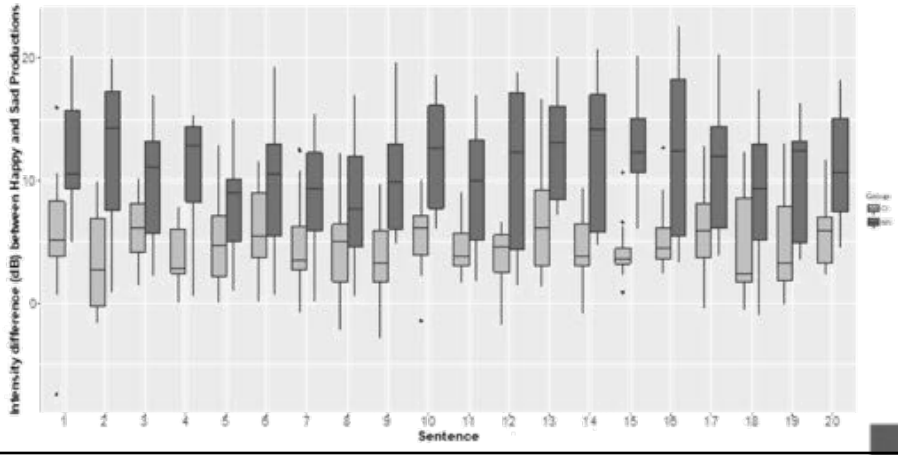
Vocal Emotion Productions by Children with CI Show Smaller Acoustic Contrasts than Children with NH

1. Mean F0 ratio [Happy/Sad]



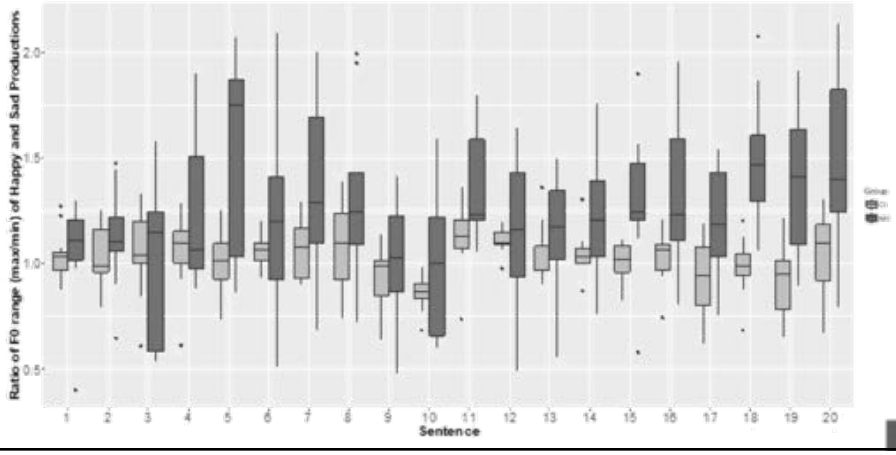
Vocal Emotion Productions by Children with CI Show Smaller Acoustic Contrasts than Children with NH

2. Intensity difference in dB [Happy - Sad]



Vocal Emotion Productions by Children with CI Show Smaller Acoustic Contrasts than Children with NH

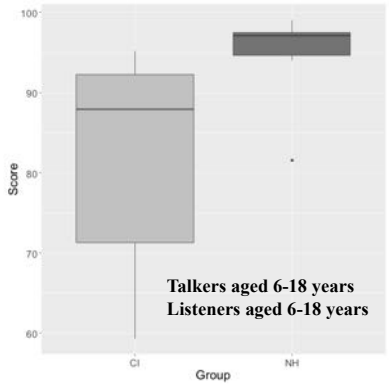
3. The range of F0 (max/min) [Happy/Sad]



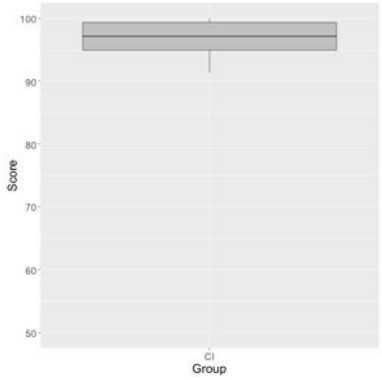
Vocal Emotion Productions By Children With CI are also Less Identifiable [Consistent with Smaller Acoustic Contrasts]

But Words in Sentences are Highly Intelligible

HAPPY/SAD IDENTIFICATION BY NH LISTENERS



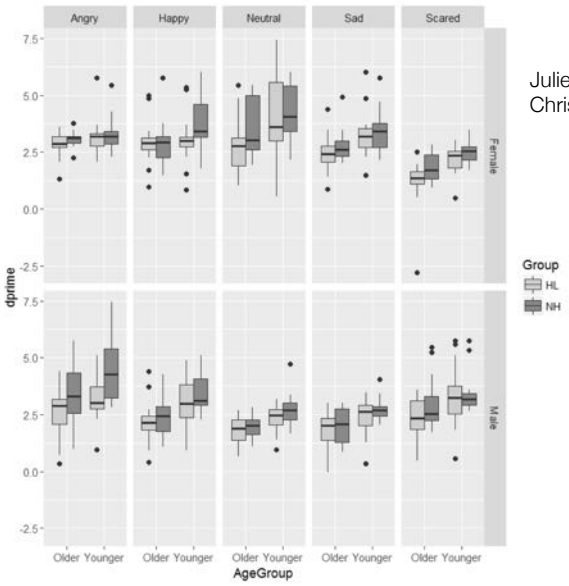
% WORDS CORRECTLY HEARD BY NH LISTENERS



Effects of Aging and Hearing Loss in Adults

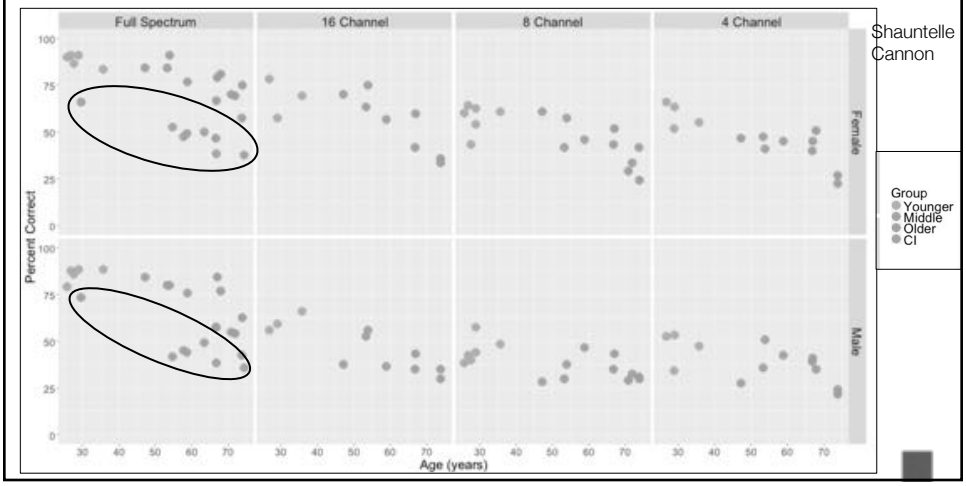
Participants

- 32 listeners with bilateral SNHL (ranging from mild to severe) with binaural hearing aids.
- 29 NH listeners.
- Participants ranged in age from 20 – 74 years



Julie Christensen

Post-lingually Deaf Adult CI Users, and Age-related Changes in Vocal Emotion Recognition



Shauntelle Cannon

SUMMARY

- Acoustic cues for voice emotion include voice pitch, intensity, timbre, duration
- Age and cognitive status predict children's emotion recognition when cues are degraded (both CI and NH)
- Sensitivity to F0 is predictive of voice emotion recognition in NH and CI groups, adults and children
- Productions of contrastive emotions (happy, sad) by children with CIs show smaller acoustic contrasts and deficits in recognition relative to their NH peers.
- NH listeners show age-related declines in emotion recognition; HL exacerbates the deficit.
- Middle-aged and older NH listeners show deficits in identifying emotions in CI-simulated speech. CI adults seem to show age-related deficits in emotion recognition as well.

Acknowledgements

- Charles Limb
- Karen Chan Barrett
- Danielle Zion
- Sophie Ambrose
- Mary Pat Moeller
- Julie Christensen
- Aditya Kulkarni
- Shauntelle Cannon
- Jenni Sis
- Mickael Deroche
- Yung-Song Lin
- Hui-Ping Lu
- Shu-Chen Peng

Thanks to research participants and families, BTNRH CI Clinic, Clinical Management Core of our P20 grant.
NIH grant nos. R01 DC004786-08S1, R21 DC011905, R01 DC014233, P30 DC004662, P20GM109023

THANK YOU!!!