Voice Emotion Recognition by Children and Adults with Cochlear Implants

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Present-day hearing prostheses are focused on speech recognition (what), not necessarily prosodic cues (how).

Full communication requires both voice pitch and its changes provide key information about vocal emotions.

Listeners with CIs have reasonable access to many phonetic cues, but are severely limited in access to voice pitch.
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
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)
- 10 NH adults
- 9 CI adults
- 31 NH children (6.38 – 18.76 years, mean age 10.76 years).
- 36 CI children (6.83 – 18.44 years, mean age 12.15 yrs, mean dur. dev. 8.76 yrs.)

Chatterjee et al., 2015 (Hearing Res)
A Closer Look At Individual Data

Chatterjee et al., 2015 (Hearing Res)
HYPOTHESESIZED PREDICTORS OF PERFORMANCE

1. Sensitivity to static and dynamic changes in voice pitch
2. Age, age at implantation, duration of experience with device
3. Cognitive/linguistic factors
4. Socio-economic factors
Sensitivity to pitch in a variety of pitch discrimination tasks is predictive of performance in emotion recognition.

-- Even though acoustic cues for emotion are multi-dimensional, voice pitch remains an important cue for CI listeners.
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

Tinnemore et al., E & H 2018

Anna Tinnemore
WHAT ABOUT CHILDREN WITH CIs?

For CDS:

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

For ADS:

-- years of experience using CI had a significant contribution ($\beta = 0.53$, $p = 0.01$)
-- NVIQ had a marginal contribution ($\beta = 0.37$, $p = 0.059$).
VOCAL EMOTION PRODUCTIONS BY CHILDREN WITH CIs

◆ 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
EXAMPLES...AND INSIGHTS

Happy (red) and sad (blue) F0 contours

- NHCH03: NH child (11 yrs)
- A41: NH adult
- N5: Post-lingually deaf CI adult
- CICH04: 18-year old CI child with early hearing implanted at age 6
- CICH03: 11-year old congenitally deaf CI child implanted at age 1.5
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 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
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 voice pitch changes 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.
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THANK YOU!!!
COMPLEX PITCH CUES IN NH AND CIs

- **Frequency**
- **Spectral detail**

- **Time**
- **Temporal detail**