Impact of Flat Panel CT-Based CI Fittings on Speech, Timbre, & Pitch Perception

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- Charles Limb: Advanced Bionics, MED-EL, Oticon, Spiral Therapeutics
Sound & Music Perception Lab
Principal Investigator: Charles Limb, MD

- Primary areas of research:
  - Cochlear implants & music perception
  - Creativity and the brain
- Website: ohns.ucsf.edu/limb-lab
FPCT-Based Fitting: Motivation
Cochlear Implants: Place-Pitch Mismatch

Default CI Program: 70 Hz – 8500 Hz total bandwidth

Jiam et al., 2018

Insertion Depth of E1 (Hz)

1 Octave

Default E1 Frequency
Goal: Restore accurate pitch & interval perception by minimizing place-pitch mismatch

- Obtain Flat Panel CT Scan
- Measure precise electrode location within each cochlea
- Use both speech AND music metrics to evaluate performance with CT-based fittings
Flat Panel CT Scans
UCSF Parnassus, Moffitt-Long Hospital, Q Suite

- Thanks to our co-PI, Daniel Cooke, MD, and the UCSF Neuro Interventional Radiology Department.
Flat Panel Computed Tomography (FPCT)

- High precision of electrode location and cochlear anatomy
- Low electrode artifact
- Lower radiation exposure than standard CT
Impact of FPCT-Based CI Fittings on Speech and Music Perception

(Unrolled) Cochlear Duct Length
Experimental Design

Clinical Baseline → CT-Based #1 → CT-Based #2 → CT-Based #3 → CI User’s Preferred Fitting

1 month → 1 month → 1 month
Timbre Discrimination

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Timbre is the “color” of sound

Clarinet

French Horn
Timbre Task Stimuli

Clarinet  +10db  +5db  0dB  -5dB  -10dB  French Horn
Timbre Discrimination Task

3I2AFC Paradigm

“You will hear 3 sounds; pick the one that’s DIFFERENT.”
Pitch Scaling
Pitch Scaling Task

6 pure tones, order randomized

→ ordered and scaled by pitch
Pitch Scaling Task

Clinical Fitting:

CT-based Fitting:

“problem area”

improvement in pitch separation
FPCT-Based Fitting: Results
FPCT Individual Data

CNC Change:
- 4 ears → improvement
- 10 ears → no change
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FPCT Group Data
FPCT Results – Music Tasks

Timbre 200 Hz
95%
90%
85%
80%
75%
70%
Clinical FPCT, Strict

Pitch Scaling
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
Clinical FPCT, Strict

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Future Directions
Future Directions

✓ Acute trial

ฏ (In progress) Chronic trial with multiple CT-based fitting schemes
ฎ (In progress) Optimization of CT-based fitting criteria

o Refine music tasks
o Activation of CI recipients using CT-based fittings
o Trials with pediatrics and special populations
Thank you!

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