Poster Number: P076

Theme: Auditory Implants

CT-Based Mapping at Initial Activation: A Longitudinal Study of Music and Speech Perception

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Sound and Music Perception Lab

Introduction

- Music perception remains the most difficult listening endeavor for many cochlear implant (CI) recipients.
- There is significant frequency mismatch that between the electrode-neural interface and the frequencies allocated by the CI programming.
- Interpersonal and interaural variability exists in CI recipients due to individual differences in ear anatomy, electrode array length, and surgical insertion, but these differences are not typically accounted for by current CI programming techniques.
- Flat panel computed tomography (FPCT) technology has been used to visualize the location of the electrodes within the cochlea, with lower electrode artifact and higher resolution of cochlear structures than standard CT.
- We aim to improve pitch perception accuracy by using anatomy-based frequency allocation tables, beginning at CI initial activation, as compared to the clinical default map.

Methods

Map Usage Schedule (months post-activation):				
1	3	6	12	13
CT-Based				
				Clinical

Experimental Design:

- FPCT scans occurred ~2 weeks after CI surgery. An FPCT-based map was provided to their clinical audiologist for use during CI activation.
- Subjects used the CT-based map for 1 year and were then switched to a clinical default (LogFS) map for 1 month.
- Speech and music testing occurred at 1, 3, 6, 12 and 13 months.

Subjects:

- 14 CI recipients with a MED-EL Synchrony 2 completed 13-month study. Age: 56.3 years average ± 10.3 years std. dev.

FPCT Scan Analysis:

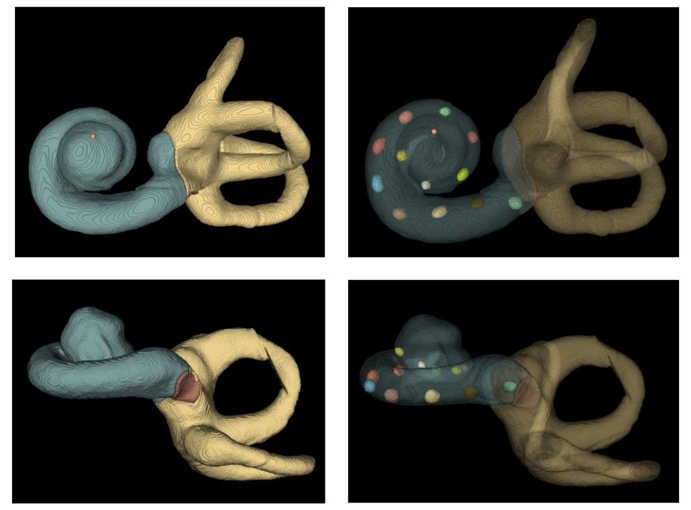

Figure 1. 3D inner ear models and electrode frequency calculations courtesy of Luke Helpard, PhD, Sumit Agrawal, MD, and Hanif Ladak, PhD, at University of Western Ontario, Canada.

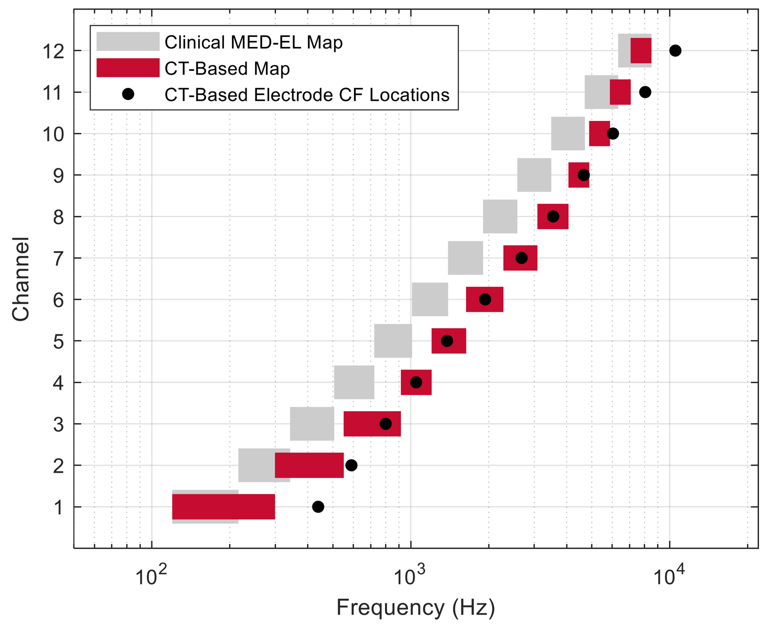

Figure 2. Freq. alloc. tables for Clinical Default Map (LogFS, gray bars) and CT-Based Map (red bars). The electrode contact locations were calculated by UWO (black circles). Figure courtesy of Josh Stohl, PhD, at MED-EL.

The CT-based map uses:

- Strict match: 950-4000Hz
- LogFS: <950Hz and >4000Hz
- Total bandwidth: 120-8500Hz

Results:

Figures 3, 4, 5, 7, and 8:

- Left column: CT map at 1 year post-activation
- Right column: Default map after 1 month of chronic use (13 months post-activation)
- Wilcoxon Matched-Paired Signed Rank Test (W statistic) for pairwise comparisons

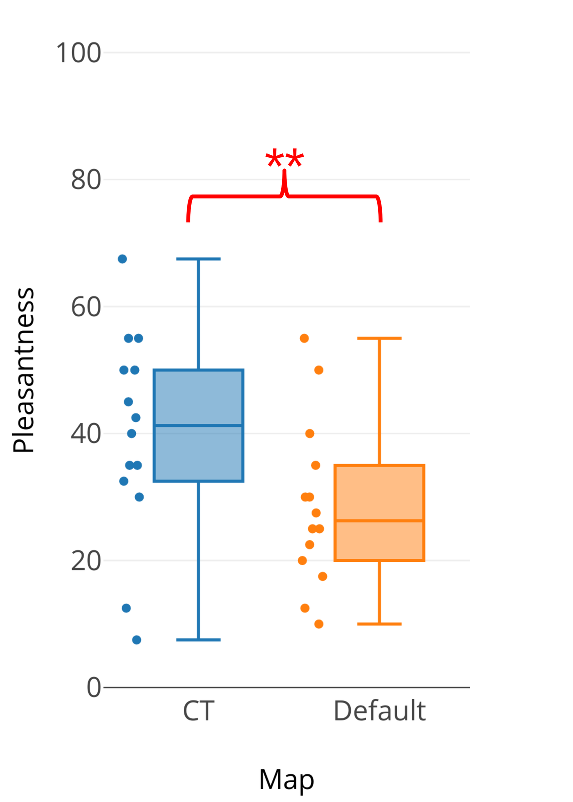

Figure 3. Music sound quality ratings for 10 music clips consisting of a synth. piano playing a melody and 3-note chord accompaniment. Music clips are part of a harmonic consonance-dissonance task.
** $p<0.01$

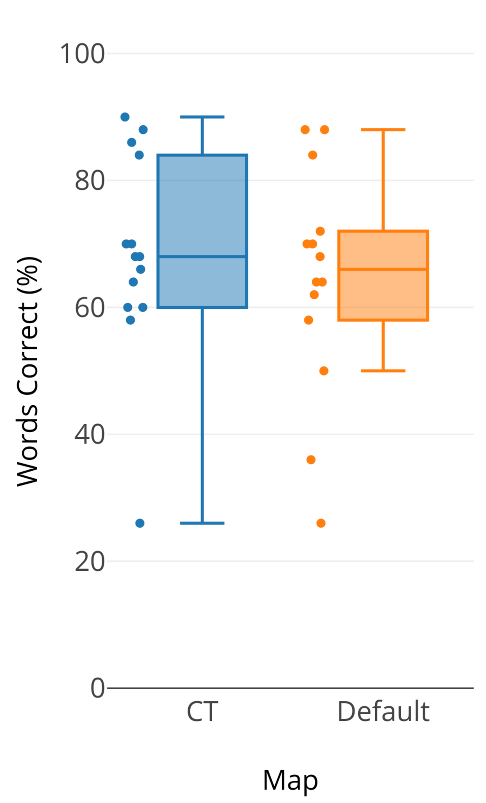

Figure 4. Word recognition on CNC monosyllabic 50-word lists.

- Improvement (≥10%) for 3 subjects with CT map over the Default map.
- Remaining 11 subjects showed <10% difference in scores.

Results:

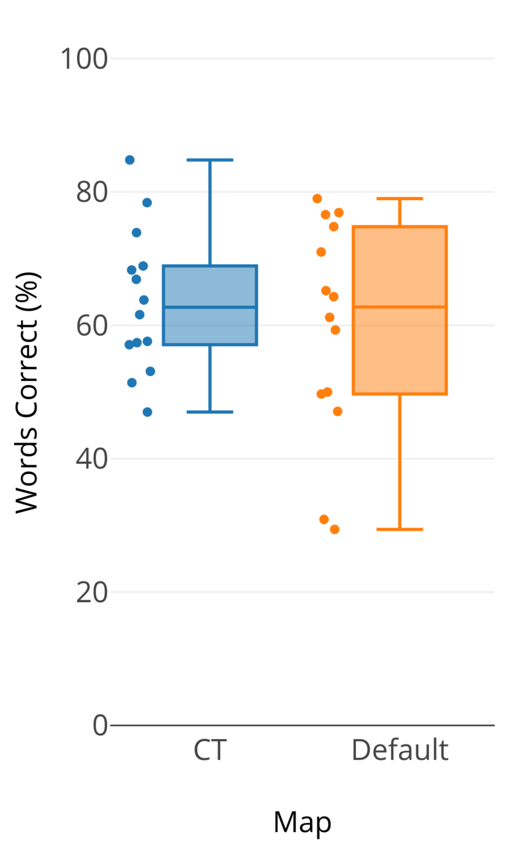

Figure 5. Word recognition scores on AzBio sentences in +10 dB SNR

- Improvement (≥10%) for 3 subjects with CT map over the Default map.
- Decrease (≥10%) for 1 subject and no significant change for 10 subjects.
- Group averages not different ($p>0.05$)

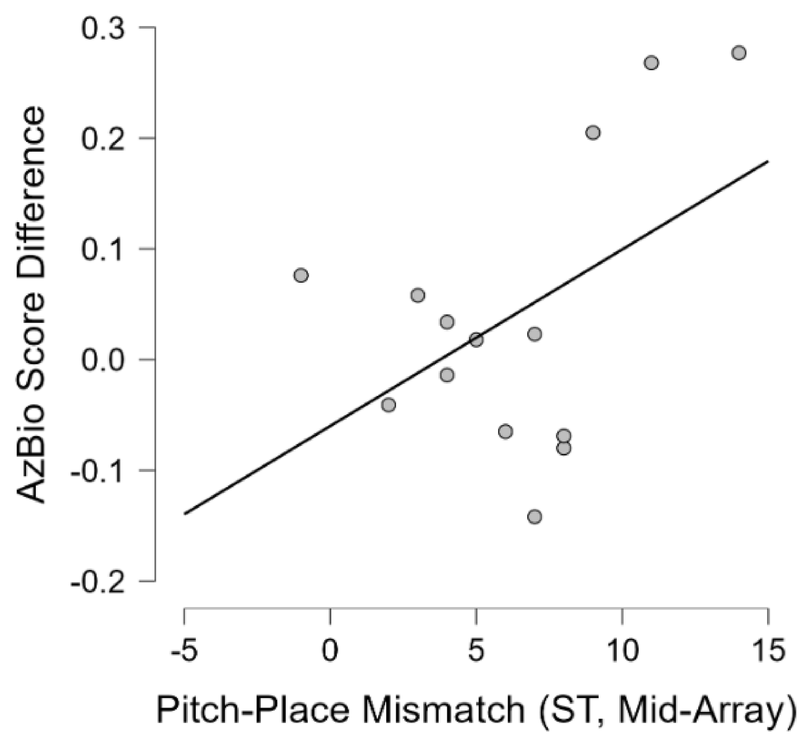

Figure 6. Linear correlation ($p<0.05$) between AzBio score differences and the pitch-place mismatch of the mid-array electrodes in semitones (ST).

Pearson's r = 0.47

Results:

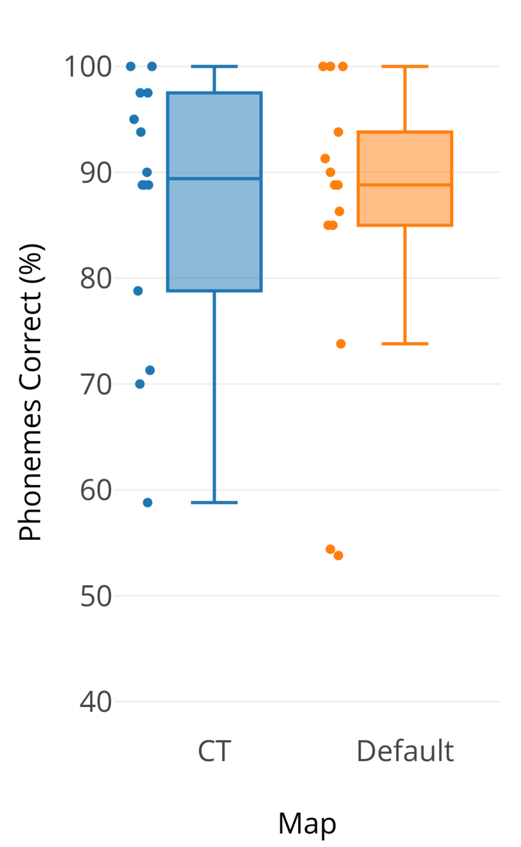

Figure 7. Phoneme scores for 8 synthetic vowel tokens in the form /hVd/ presented in a closed set.

- Group averages not different ($p>0.05$)

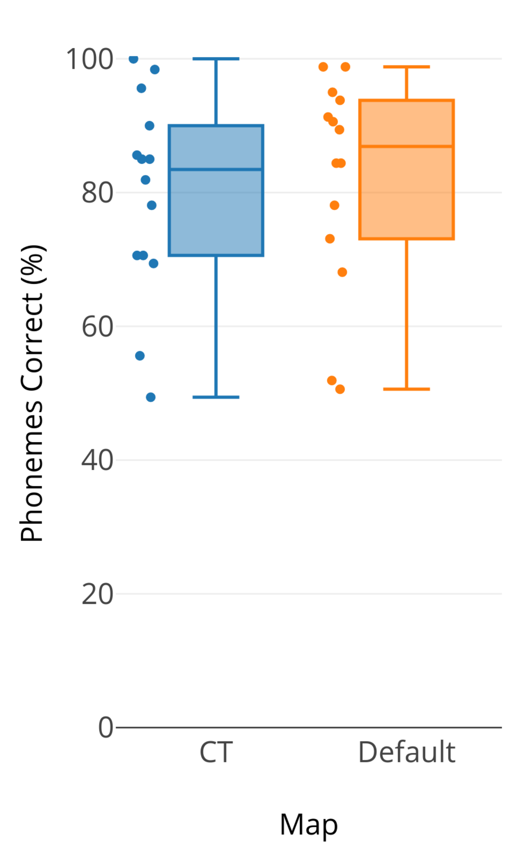

Figure 8. Phoneme scores for the 16 Iowa consonant tokens in the form /aCa/ presented in a closed set.

- Group averages not different ($p>0.05$)

Discussion

- Music: 10 of the 14 participants described a substantial benefit to music sound quality with the CT map as compared to the clinical Default map (Figure 3).
- Speech: No difference between group averages for speech in quiet or noise. However, a strong correlation was found in the most difficult listening condition (AzBio sentences in noise) between benefit from the CT map and degree of electrode array pitch-place mismatch.
- These results are consistent with prior studies from our lab showing that minimizing pitch-place mismatch can improve pitch perception in adult CI recipients (Jiam et al., 2019; Jiam et al., 2016).

Conclusions

- High-resolution CT imaging of cochlear anatomy and electrode array placement can be used to create custom pitch mapping (frequency allocation tables).
- CT map usage, beginning at initial activation, shows promise for improvement in both speech and music perception.

Acknowledgements

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References

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