TOWARDS PATIENT-CENTRIC SOUND FITTING FOR COCHLEAR IMPLANT USERS

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1. Introduction

- The placement of electrodes relative to the spiral ganglion determines the spatial specificity of neural excitation as well as the characteristic frequencies of neural clusters.
- Large variation in electrode insertion depths across recipients generally results in a unique frequency-place relationship for each CI user.
- Contemporary CI sound processors are usually programmed to assign a generic, pre-defined frequency allocation to the electrode contacts across all users.
- The degree of spectral mismatch and an individual's ability to accommodate to the distorted spectral representation of the perceived sound may at least be partially responsible for degraded performance or slower accommodation to electrically-evoked hearing with CIs.

2. Objective

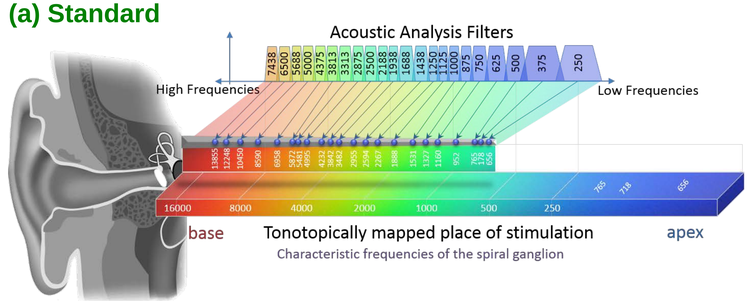
- Assess the effectiveness of an image-guided, patient-specific frequency allocation strategy that aims to tailor-fit sound processor frequency assignments based on the electro-neural characteristics of each individual.
- The proposed frequency fitting strategy aims to minimize frequency-place distortions by achieving a balance between frequency matching and frequency compression to provide a physiologically relevant representation of the sound signal.

3. Signal Processing

- Electrode placements were derived from patients' CT scans [1], which were used to create custom frequency-analysis tables for each individual [2].
- As shown in Fig, 1, this was achieved by maximizing the frequency match at lower frequencies (frequency range of first three formants), and introducing mild compression as needed to avoid over-truncation (e.g., due to shallow insertion). Mid and high frequency bands were assigned conventional logarithmic filter spacing

[1] Noble, J. H., *et al.*, "Image-guidance enables new methods for customizing cochlear implant stimulation strategies," IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 21, issue 5, pp. 820 - 829, 2013.
[2] Ali, H., *et al.*, "Image-guided customization of frequency-place mapping in cochlear implants," IEEE Int. Conf. on Acoustics, Speech and Signal Processing, ICASSP'15, Brisbane, Australia, April 19-24, 2015.

(a) Standard



(b) Proposed

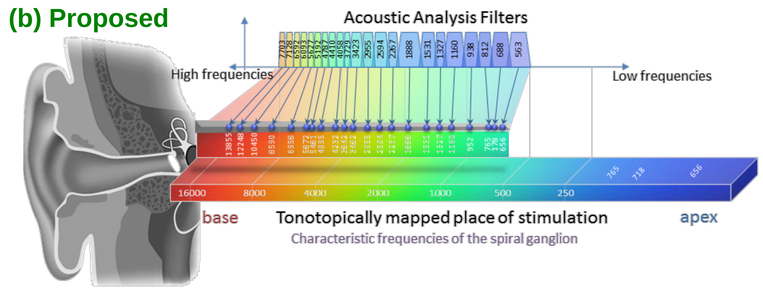


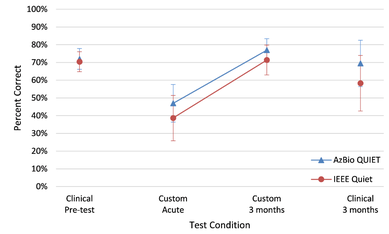
Fig. 1: An example of frequency-place mapping in (a) clinical processors, and (b) using proposed patient-centric mapping strategy.

4. Experimental Protocol

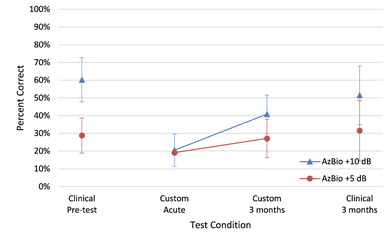
- Five adult post-lingually deafened CI users participated in a semi-chronic study that lasted three months.
- Patients were fitted with the experimental programs and then evaluated on various open-set and closed-set speech recognition tasks in an acute manner as well as following three months experience with the updated map.
- Speech assessment was also performed using patients' clinical maps at the start and the end of study.

5. Results

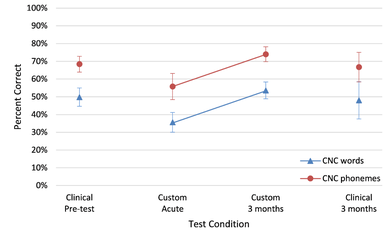
(a) Sentences in quiet (AzBio and IEEE)



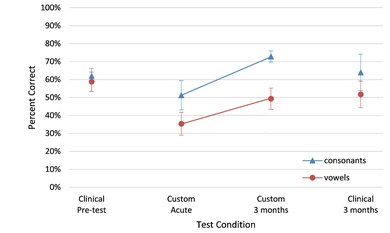
(b) Sentences in noise (10 dB, 5 dB SNR)



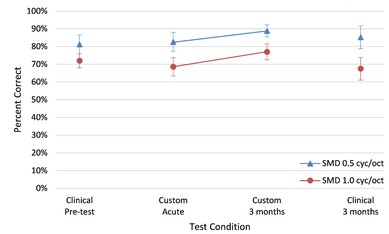
(c) CNC words and phonemes



(d) Consonants and vowels



(e) Spectral Modulation Detection (SMD)



(f) Individual mean performance levels on all speech recognition tasks

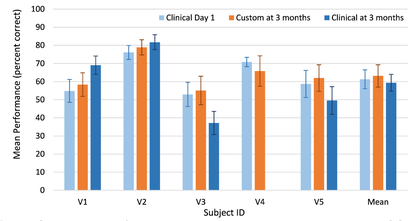


Fig. 2: Speech recognition scores with clinical and custom frequency maps. Assessment with experimental maps was carried out without training (acute) and after 3 months of continuous use.

6. Conclusion

The data from this study indicate that patient-centric optimization of frequency fitting may hold potential for improving implant outcomes, particularly for recipients with moderate to high degree of frequency-place mismatch.