Advanced Bionics Technologies for Understanding Speech in Noise

A Clinical Study

While most cochlear implant (CI) recipients can hear remarkably well in quiet, understanding speech in real-world situations with multiple sound sources can be a significant challenge. The Naída CI processor platform combines Advanced Bionics (AB) technologies (including T-Mic™ 2 microphone, AutoSound™ technology, and ClearVoice™ speech enhancement technology) with state-of-the-art, front-end, acoustic signal-processing features from Phonak (including UltraZoom, ZoomControl, and DuoPhone). The combination of these AB and Phonak technologies is designed to help AB implant recipients communicate more easily and effectively in noisy environments.

This clinical study assessed the benefits of UltraZoom, the T-Mic 2, and ClearVoice for understanding speech in noise. UltraZoom is an adaptive multi-channel dual-microphone beamformer that focuses on input originating from in front of the listener while attenuating sounds coming from the sides and back. Unique to AB, the T-Mic 2 is a microphone placed at the ear canal that takes advantage of head and pinna reflections to boost frequencies important for understanding speech. ClearVoice is a proprietary sound processing strategy that improves the overall signal-to-noise ratio (SNR) by estimating the signal and noise in each processing channel and minimizing stimulation in channels where the SNR is low.

Speech understanding was evaluated in quiet and in noise using the omnidirectional front processor microphone of the Naída CI Q70 processor (baseline). Performance then was tested in noise with UltraZoom, the T-Mic 2, and ClearVoice. Results were compared to assess the benefit provided by these technologies for hearing in noise.

STUDY METHODS

Subjects

Subjects were 20 experienced adult CII/HiRes™ 90K implant recipients, including 9 men and 11 women. They were tested only with the ear(s) implanted with a CII/HiRes 90K implant programmed with either the HiRes Fidelity 120™ or HiRes™ Optima sound processing strategy. Thus, 9 participants were tested bilaterally and 11 participants were tested unilaterally. Mean age was 52.85 years (range: 28-81 years) and mean duration of first CII/90K implant use was 6.05 years (range: 1-16 years).

Materials and Procedures

Speech perception in quiet, speech-shaped noise, and four-talker babble was evaluated using two methods.

1. An adaptive SNR task where Hearing in Noise Test (HINT) sentences were presented at 60 dBA and the noise level was varied until the listeners were able to understand 50% of the words. The SNR at which 50% of words were repeated correctly is denoted as the sentence reception threshold (SRT in dB). A more-negative SRT indicates an ability to understand speech in more noise.

2. A fixed SNR task where AzBio sentences were presented at 60 dBA. Subjects first were tested in quiet with the processor microphone. Then noise was added to determine an SNR for each subject that yielded an AzBio score 30-50% of their score in quiet. That custom SNR was used in all subsequent testing. Results are expressed as percent correct.

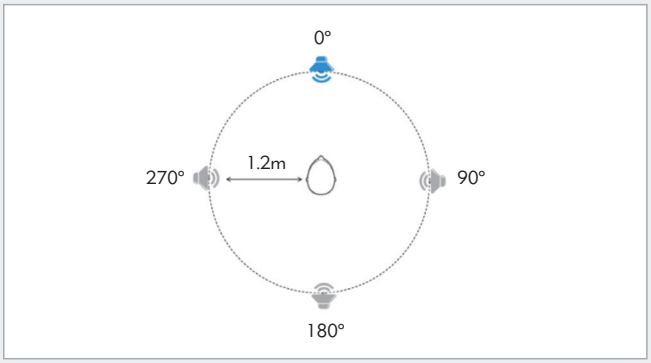
While undergoing the fixed SNR task, subjects rated the degree of listening difficulty for each test condition using a scale of 1-5 (1 = extremely difficult, 5 = extremely easy).

Data Analysis

Data for each method were analyzed using one-way ANOVAs. Pairwise post hoc comparisons were conducted using t-Tests with Bonferroni corrections.

Test Room Configuration

Subjects were tested in a double-walled sound booth. Speech was presented from a loudspeaker located at 0˚ azimuth and noise was presented from loudspeakers located at 90˚, 180˚, and 270˚ azimuth.



Test Conditions

Subjects were tested using five programs in random order.

- Program 1 (baseline): 100% processor microphone (omnidirectional) with no ClearVoice
- Program 2: 100% processor microphone plus ClearVoice (Medium)
- Program 3: 100% T-Mic 2 plus ClearVoice (Medium)
- Program 4: UltraZoom alone
- Program 5: UltraZoom plus ClearVoice (Medium)

Clinical Study Results

ADAPTIVE SNR TASK

Figures below show SRTs (the SNR at which 50% of words were repeated correctly) in speech-shaped noise and four-talker babble by test condition normalized to Program 1 (processor microphone only). A more-negative SRT indicates an ability to understand speech in more noise.

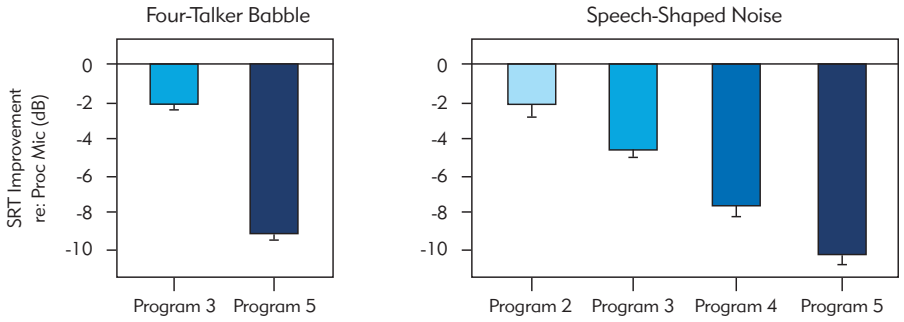
Program 1: Processor microphone

Program 2: Processor microphone plus ClearVoice

Program 3: T-Mic 2 plus ClearVoice

Program 4: UltraZoom

Program 5: UltraZoom plus ClearVoice



- **Speech understanding with noise reduction technologies was better** than baseline
  (Programs 2-5 compared to Program 1, p < .001)
- **The T-Mic 2 improved speech understanding** in speech-shaped noise *(Program 3 compared to Program 2, p < .001)*
- **UltraZoom improved speech understanding** in both types of noise *(Program 5 compared to Programs 2 and 3, p < .0001)*

FIXED SNR TASK

Figures below show AzBio sentence scores in speech-shaped noise and four-talker babble plotted by test condition. A higher score indicates better performance. Individual-subject test SNRs ranged from -4 to 13 dB for speech-shaped noise and from 0 to 17 dB for four-talker babble. For comparison, the right-most bar indicates speech perception in quiet with the processor microphone (baseline condition).

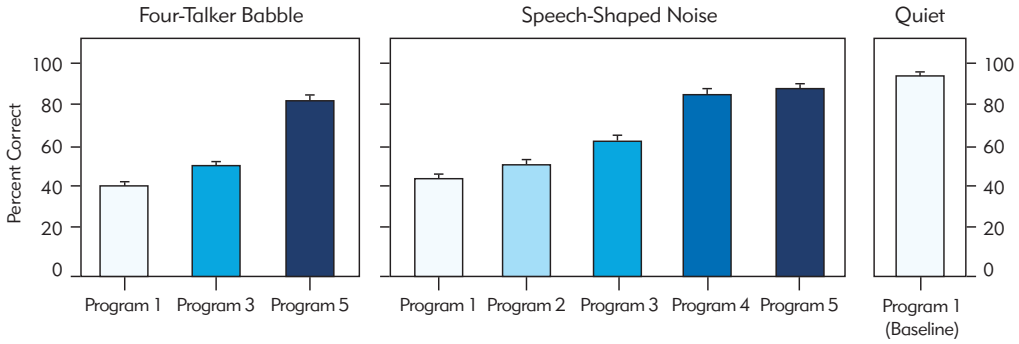
Program 1: Processor microphone

Program 2: Processor microphone plus ClearVoice

Program 3: T-Mic 2 plus ClearVoice

Program 4: UltraZoom

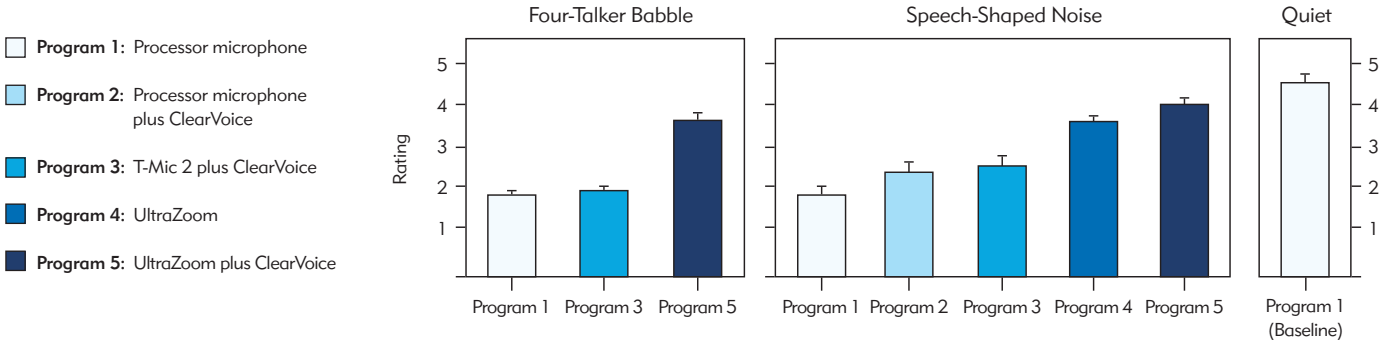
Program 5: UltraZoom plus ClearVoice



- **Speech understanding with noise reduction technologies was better** than baseline
  (Programs 2-5 compared to Program 1, p < .001)
- **ClearVoice improved speech understanding** in speech-shaped noise *(Program 2 compared to Program 1, p < .01)*
- **The T-Mic 2 improved speech understanding** in speech-shaped noise *(Program 3 compared to Program 2, p < .001)*
- **UltraZoom improved speech understanding** in both types of noise *(Program 5 compared to Programs 2 and 3, p < .0001)*
- **UltraZoom scores in noise approached scores obtained in quiet**
  (94% of quiet scores in speech-shaped noise and 92% in four-talker babble).

SUBJECTIVE RATINGS OF LISTENING DIFFICULTY

Figures below show listening difficulty ratings plotted by test condition (1 = extremely difficult, 5 = extremely easy). Individual-subject test SNRs ranged from -4 to 13 dB for speech-shaped noise and from 0 to 17 dB for four-talker babble.



- **Noise reduction technologies made listening in noise easier**
- **Ratings mirror the speech scores**

DISCUSSION

This study demonstrates that UltraZoom, the T-Mic™ 2 microphone, and ClearVoice™ speech enhancement technology can provide significant benefit for hearing in noise for AB implant recipients. The degree of benefit was independent of the baseline scores, indicating that recipients with varying levels of performance in quiet can benefit from these technologies.

ClearVoice allows AB implant users to hear better in noise regardless of microphone mode. In this study, processor microphone programs with ClearVoice provided significantly improved sentence understanding in speech-shaped noise when compared to programs without ClearVoice. These results corroborate the ClearVoice clinical trial data[1] and data from other investigators[2,3,4]. ClearVoice is the first and only sound processing strategy to receive a superiority claim from the U.S. Food and Drug Administration.

The T-Mic 2 microphone is unique to AB and provides listeners with natural pinna cues that improve sound quality and speech understanding in noise. Its concha-level location also allows for easy and natural use of the phone. In this study, the T-Mic 2 with ClearVoice provided significantly improved sentence understanding in noise over the processor microphone with ClearVoice. The results are consistent with independent published data[5,6]. The T-Mic 2 is available with the Naída CI, the classic T-Mic™ microphone is compatible with the Harmony™ processor, and Neptune™ processor recipients can use the T-Comm accessory, which provides the same natural microphone placement as the T-Mic.

UltraZoom is the result of over 20 years of research and development by Phonak and is used by hearing instrument wearers worldwide. Its real-time multichannel adaptive capability and continuous calibration of the dual microphones allows for optimal attenuation of noise in all environments. The effectiveness of UltraZoom with CI users is demonstrated clearly in this study, as well as in studies conducted by other investigators[7,8]. Given that many adult AB CI recipients use the T-Mic 2 and ClearVoice as their everyday default program, this study shows the additional benefit they can experience in difficult listening situations when Phonak beamforming technology is enabled.

CONCLUSIONS

UltraZoom, the T-Mic 2, and ClearVoice help AB implant recipients hear better and easier in noise. Clinicians should consider incorporating UltraZoom, the T-Mic 2, and ClearVoice into Naída CI programs. With appropriate counseling, these options will help AB implant recipients to improve communication in situations they encounter every day.

Note: *This study was conducted at Advanced Bionics facilities in Valencia, California, USA.*

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