Binaural VoiceStream Technology™

Improving Speech Understanding in Challenging Listening Environments

Binaural VoiceStream Technology™ from Phonak (Stäfa, Switzerland) allows two hearing devices to be linked wirelessly to stream full bandwidth audio signals from ear to ear in real time with short transmission delays and low power consumption. Using this technology, Phonak has introduced a variety of features that aim to improve speech understanding in challenging listening environments for users of conventional amplification devices.

Binaural VoiceStream Technology works by producing a third-order directional system via two-way communication between the dual-microphone systems on each of the two hearing instruments, thereby creating a four-microphone array. This communication allows for a variety of directional patterns. Robust directionality is maintained by precisely matching the dual microphones on each side for sensitivity during manufacturing and through an automatic in-situ calibration procedure that continually reduces sensitivity discrepancies.

Binaural VoiceStream Technology features like StereoZoom, ZoomControl, and DuoPhone have been available in Phonak hearing instruments for a number of years. In 2013, Binaural VoiceStream Technology was introduced into the Naída CI Q70 cochlear implant sound processor from Advanced Bionics (AB). For the implant system, the technology eliminates interference between the implant coil and the binaural communication transmission frequencies, and opens the door to program options that make use of the dual processor microphones on both devices (Latzel 2012). Currently, the Naída CI Q70 offers the ZoomControl (left/right) and DuoPhone binaural features. Future sound processors from AB will include additional binaural features like StereoZoom and ZoomControl (front/back).

StereoZoom

How does it work?

StereoZoom is a third-order directional beamforming system created by wirelessly connecting the four processor microphones across the two hearing devices. It produces a very narrow fixed target beam, allowing users to focus on a single speaker directly in front of them. StereoZoom has been used in Phonak hearing aids since 2010 and has been shown to be effective at improving speech perception with noise presented from loudspeakers positioned as close as ±45° either side of the speech signal (Nyffeler 2010).

When is it useful?

In order to work most effectively, a beamformer requires the speech signal to be spatially well separated from the noise signal. However, in some real life situations, the signal of interest is not well separated from the competing noise source, for example at a party. In these situations, StereoZoom improves listening by providing a narrower directional beam than is provided by a two-microphone first order beamformer such as UltraZoom (Figure 1).

Figure 1. Directional pattern of UltraZoom (left), which provides first order directionality. If the listener wishes to focus on just one speaker directly in front, StereoZoom produces a narrower directional beam (right). *Source: Phonak*

In a pilot experiment, StereoZoom was evaluated in ten experienced bilateral AB Harmony™ users by linking the StereoZoom feature of a modified Phonak Ambra hearing aid to a Harmony processor (Hehrmann et al. 2012, Büchner et al. 2014). Subjects listened to sentences (Oldenburg Sentence Test) in diffuse noise using an adaptive procedure to determine speech reception thresholds (SRT), i.e., the signal-to-noise ratio at which 50% correct word identification was attained. Figure 2 shows the test set-up and results from the experiment. StereoZoom provided a statistically significant improvement over omnidirectional microphones, as well as a smaller significant benefit over the adaptive UltraZoom setting.

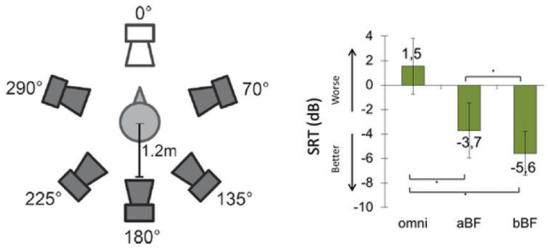

Figure 2. (adapted from Hehrmann et al. 2012). Left. Loud speaker arrangement used for testing. Oldenburg sentences were presented at varying levels from the front (0°) and speech-shaped noise (65 dB SPL) was presented from five loudspeakers placed at ±70°, ±135° and ±180°. Right. SRTs for three test conditions: bilateral omnidirectional microphones ("omni"), bilateral UltraZoom ("aBF") and StereoZoom ("bBF"). StereoZoom provided significant improvements over the two other conditions.

ZoomControl

How does it work?

ZoomControl allows the listener to select a preferred direction of focus. The user can choose to focus to the right, left, or back for situations where they cannot face the speaker. For focusing back, ZoomControl works by switching the point of maximum sensitivity to the back. For focusing left or right, audio signals

are transmitted from the selected side to the other side. On the receiving (contralateral) side, 75% of the direct microphone input is suppressed to accommodate the transmitted signal.

When is it useful?
ZoomControl (right/left), which is available with the Naída CI Q70 processor, improves speech understanding when the signal desired may not be in front of the listener, such as when driving a car. For children in noisy classrooms, ZoomControl (front/back) can help when the teacher or other pupils are speaking from behind. Someone using a wheelchair talking to a caregiver behind him/her would also benefit from ZoomControl. With the current Naída CI Q70 processor, the AB myPilot remote control as well as the processor program switch with DirectTouch allow bilateral recipients to have access to ZoomControl if they want to change the direction of focus from right to left.

DuoPhone

How does it work?
DuoPhone uses binaural streaming technology to improve the signal-to-noise ratio when using the phone. Similar to the ZoomControl left/right function, it uses wireless audio transmission between devices to deliver the signal picked up from the ear where the phone is located to the contralateral ear. On the contralateral side, the input is 50% transmission wireless signal and 50% local microphone.

When is it useful?
Because presenting the telephone signal to both ears rather than just one ear improves speech recognition (Picou and Ricketts 2011), enabling DuoPhone facilitates improved communication over the telephone. Although DuoPhone can transmit a telecoil signal for those users who prefer this as an option, it does not require a magnetic receiver and thus can be used with any handset or mobile phone. DuoPhone enhances the phone signal relative to the background noise, but ensures that the combined signal from both ears remains accessible to the user.

Preliminary data obtained from one AB implant recipient (Figure 3) indicate that DuoPhone can provide an advantage over using the phone in only one ear. For this adult bilateral Naída CI Q70 user, word recognition improved in both quiet and classroom-like noise (Schafer and Thibodeau 2006) when DuoPhone was enabled both for the T-Mic and for the telecoil.

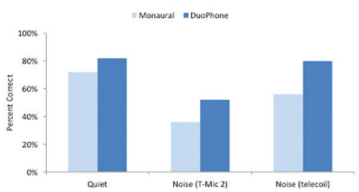

Figure 3. CNC word scores in quiet, in 60 dBA noise with T-Mic2, and in 60 dBA noise with the telecoil. Scores improved when DuoPhone was used compared to monaural listening (Wolfe 2013).

Summary

Unique Binaural VoiceStream Technology from Phonak enables a wireless network of multiple microphones distributed across two hearing instruments or two implant processors. This network allows bilateral hearing aid users and bilateral implant recipients to take advantage of enhanced directional capability and focused listening. In challenging listening situations such as restaurants, classrooms, or when making phone calls in noisy situations, Binaural VoiceStream Technology can and will provide bilateral listeners with a variety of solutions to improve communication. Future implementations of Binaural VoiceStream Technology will allow additional binaural communication between two AB sound processors, or between a Phonak hearing aid and an AB sound processor.

References

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