Redefining the Unilateral Cochlear Implant Experience

Naída Link CROS Solution

Unilateral cochlear implant benefit can be enhanced by adding complementary microphones on the contralateral ear. In CI users, the ability to hear from both sides usually provides improved sound awareness and better speech perception in noise. However, many unilateral cochlear implant recipients do not have usable hearing in their other ear and are not able to pursue bilateral implantation due to medical or economic concerns. In these cases, contralateral routing of signal (CROS) technology can alleviate some of the challenges associated with single-sided hearing.

The new Naída Link CROS solution provides bilateral auditory input to unilateral implant recipients. The Phonak Naída™ Link CROS incorporates Phonak Binaural VoiceStream Technology™, which allows it to automatically create a wireless communication network with a Naida CI sound processor (Q70 or Q90) and stream full bandwidth audio signals from the non-implanted side in real time with low power consumption. By capturing sound on the non-implanted ear and transmitting it wirelessly to the sound processor on the implanted ear, the Naída Link CROS restores bilateral access to sound in unilateral CI users. The advanced directional microphone options UltraZoom™ and AutoUltraZoom™ are available with the Naída Link CROS. Additionally, the Naída Link CROS provides unilateral CI users access to the advanced binaural directional microphone StereoZoom™. The Naída Link CROS works as an out-of-the-box solution without the need for fitting, making it easy to use for professionals.

Unilateral AB users benefit from the Naída Link CROS solution, when listening to speech in quiet on the non-implanted side. Speech intelligibility tests show that using the CROS device in addition to a unilateral CI provides on average 5.5 ± 3.8 dB immediate benefit in speech recognition threshold. Lower speech levels are required for speech located on the non-implanted side to be intelligible. This benefit is maintained chronically after one month of use of the CROS device.

Eight out of ten unilateral CI subjects were able to perform the French matrix sentence test in quiet. Speech recognition thresholds (speech level at which 50% of the material is correctly repeated) were compared with and without the CROS device. Speech was presented to the non-implanted (CROS) side. The plot shows CROS benefits, i.e. how much lower the speech level could be set with the CROS device compared to without the CROS device to achieve 50% intelligibility.

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1. Available with Naida CI Q70 and Q90
2. Available with Naida CI Q90
Unilateral AB users benefit from the Naída Link CROS solution, when listening to speech on the non-implanted side in competing noise. In noisy listening environments, speech intelligibility tests show sizeable CROS benefits compared to listening with the CI alone. When noise is presented from one source on the implanted side, speech reception threshold benefits of $7.4 \pm 3.5$ dB and $7.8 \pm 2.4$ dB are shown. Similar to performance in quiet, benefit in noise is also maintained chronically after one month. When noise is presented from 12 loudspeakers (diffuse noise field), $4.0 \pm 0.6$ dB benefit in speech reception threshold can be shown. Using the Naída Link CROS device, higher noise levels still allow for speech on the non-implanted side to be intelligible.

### CROS Benefit in Noise — Effects of Head Shadow Notably Reduced

Seven out of ten unilateral CI subjects were able to perform the French matrix sentence test in noise. Speech reception thresholds (signal-to-noise ratio (SNR) at which 50% of the material is correctly repeated) were compared with and without the CROS device. Speech was presented to the nonimplanted (CROS) side and noise was presented to the implanted (CI) side. The plot shows CROS benefits, i.e. how much lower the SNR could be set with the CROS device compared to without the CROS device to achieve 50% intelligibility.

Seven unilateral CI subjects were tested using the German matrix sentence test (Oldenburger Satztest OLSA). Speech reception thresholds (signal-to-noise ratio (SNR) at which 50% of the material is correctly repeated) were compared with and without the CROS device. Speech was presented to the CROS side. Noise was presented either to the CI side ($S_{\text{CROS} \text{N}_{\text{CI}}}$) or from 12 loudspeakers ($S_{\text{CROS} \text{N}_{\text{All}}}$). The plot shows CROS benefits, i.e. how much lower the SNR could be set with the CROS device compared to without the CROS device to achieve 50% intelligibility for both speech-in-noise setups as indicated in the graph.
The availability of StereoZoom with the Naida Link CROS device provides further benefit for speech in front of the listener in a noisy environment. When speech is presented from the front in an approximately diffuse noise field, the addition of the Naida Link CROS device in omnidirectional microphone mode does not change speech intelligibility (0.3 ± 1.8 dB difference). Using the CI and CROS in StereoZoom mode results in a speech intelligibility benefit of 4.1 ± 1.3 dB. The advanced beamformer StereoZoom provides an improved signal-to-noise ratio.

Benefits provided by the Naida Link CROS device are perceived by unilateral CI users in their everyday listening environment. Questionnaire results show that benefits provided by the CROS device in addition to a unilateral CI cannot only be shown in controlled lab environments but are also experienced by listeners in everyday life. Several everyday listening situations were rated as ‘easier with the CROS’ and 6/10 subjects clearly preferred the CROS solution over a unilateral CI alone. Subjects consistently rated the device’s appearance and handling as (very) satisfactory.

### STUDY 2

Seven unilateral CI subjects were tested using the German matrix sentence test (Oldenburger Satztest OLSA). Speech reception thresholds (signal-to-noise ratio (SNR) at which 50% of the material is correctly repeated) were compared with and without the CROS device. Speech was presented from in front of the listener. Noise was presented from 11 loudspeakers located around the subject but not from the front \( \left( S_{\text{CROS},N_{0.330}} \right) \). The plot shows CROS benefits, i.e. how much lower the SNR could be set with the CROS device compared to without the CROS device to achieve 50% intelligibility. The Naida Link CROS solution was tested once in omnidirectional microphone mode and once in StereoZoom mode.

### STUDY 1

After one month, all ten subjects wore the Naida Link CROS consistently and only one found the need to mute the device under some noisy conditions. Six preferred using the CROS device to using the implant alone, 2 judged the CI plus CROS to be similar to using the implant alone, and 2 stated that they needed more time to accustom to the CROS device. All subjects were satisfied with the aesthetics and usability of the Naida Link CROS.

### STUDY 2

Out of the seven unilateral CI subjects, six filled in the Bern Benefit in Single Sided Deafness (BBSS) questionnaire, rating several everyday listening situations on a scale from -5 = much easier without the CROS to 5 = much easier with the CROS. On average, all situations were rated as easier with the CROS. Below, a subset of questions relating to overall hearing as well as speech intelligibility are presented along with the respective rating:

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating (Avg ± StDev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall hearing</td>
<td>2.50 ± 1.58</td>
</tr>
<tr>
<td>Hold a conversation with one person, quiet environment</td>
<td>2.17 ±1.72</td>
</tr>
<tr>
<td>Follow a conversation, background noise</td>
<td>1.83 ±1.66</td>
</tr>
<tr>
<td>Understand speech in a reverberant room</td>
<td>2.08 ±2.06</td>
</tr>
<tr>
<td>Hold a conversation while driving in a car</td>
<td>2.17 ±1.99</td>
</tr>
</tbody>
</table>
Summary

Although bilateral cochlear implantation remains the gold standard in the treatment of bilateral severe-to-profound hearing loss, the wireless Naida Link CROS device provides substantial benefits compared to a unilateral CI alone:

- Speech intelligibility in quiet for speech sources on the nonimplanted side is improved.
- Speech intelligibility is improved for speech sources on the nonimplanted side in directional as well as diffuse noise.
- Binaural VoiceStream Technology is made available to unilateral CI users, enabling the use of the advanced binaural directional microphone StereoZoom, which further enhances speech intelligibility in noise.

Additionally, everyday usability of the device and the perceived benefits in everyday life were rated very favorably. Taken together, these benefits combined with the discreet and wireless design and effortless fitting process, make the Naida Link CROS a beneficial addition to a unilateral CI in cases where bilateral implantation is not feasible.

References


Acknowledgments

Study 1 — Data were collected by Dr. Isabelle Mosnier, Ghizlene Lah lou, Jonathan Flam et al. at GHU La Pitié-Salpêtrière, Paris. The data included here were previously presented as Use of a Contralateral Routing of Signals (CROS) System in Bilaterally Deaf Recipients with Unilateral Cochlear Implant at the 13th European Symposium on Paediatric Cochlear Implantation, Lisbon, May 25th 2017.

Study 2 — Data were collected by Prof. Arneborg Ernst, Prof. Rolf-Dieter Battmer and Angie Diez at Unfallkrankenhaus Berlin. The data included here were previously presented as Evaluation of a Wireless CROS Device with the Naida Q90 Sound Processor at the 13th European Symposium on Paediatric Cochlear Implantation, Lisbon, May 25th 2017.

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