Clinical evidence with Cochlear™ Wireless Accessories

Cochlear™ Nucleus® 6 System

Hear now. And always

Cochlear®

Cochlear Wireless Accessories and their clinical evidence.

Cochlear Wireless Accessories empower recipients to further improve their hearing abilities in a variety of different listening scenarios such as when a target speaker enhancement is required. The Wireless Accessories pick up the sound of the target signal and transmit it directly to the sound processor with an energy saving 2.4 GHz wireless connection without any extra adapter or connector. Due to the direct transmission of the target signal to the Wireless Accessories, the signal to noise ratio is improved by design. Distinct counselling and adjustment of the mixing ratio allows the user to modify their audio inputs to further enhance the target signal or the surrounding depending on the situation and the listener's individual requirements. The long range (approx. 7 metres) gives freedom of movement to the user. The accessory automatically reconnects if/when the recipient returns into range within 5 minutes.

The **Mini Microphone** serves one-to-one or one-to-many personal communication. It can be used for effortless conversation in noisy environments and over distances. A power jack enables additional applications. An unlimited number of sound processors can be paired with a Mini Microphone.

The **Phone Clip** is for audio streaming of mobile phone calls or any other Bluetooth devices in stereo for bilateral/bimodal applications via simultaneous connection to two Bluetooth devices (or mono for unilateral application). Access to smart phone voice control functionality is retained.

The **TV Streamer** enables the users to listen to stereo (or mono for unilateral application) sound directly from a TV, stereo HiFi system or other audio devices such as laptop, computer or music/video players (MP3, MP4 etc). There is no limit as to the amount of sound processors that are paired with the TV Streamer.

Multiple applications as described above are best dealt with by having multiple Wireless Accessories. Each has been designed for ease of use when fulfilling its main purpose. A variety of different clinics and research centers across the globe evaluated the Wireless Accessories with their patients. This booklet contains outcomes of investigator initiated research and Cochlear's First Experience Program with a wealth of evidence about the real clinical benefits of Cochlear Wireless Accessories.

CONTENTS

Hearing in noise benefit using the Cochlear™ Wireless Mini Microphone with Nucleus® CP900 Series Sound Processors.

Marian Jones
Cochlear Limited, Sydney, Australia

STUDY AIM

Would the Cochlear™ Wireless Mini Microphone provide speech performance benefit in classroom noise when used with a Nucleus® CP900 Series Sound Processor and, optionally, a GN ReSound hearing aid contralaterally (bimodal configuration)?

SUBJECTS AND PROCEDURE

18 subjects who had at least three months experience with Nucleus CP900 Series Sound Processors were recruited. Speech performance testing in adaptive classroom noise was conducted comparing the Nucleus CP900 Series Sound Processor(s) and GN ReSound hearing aid (for three bimodal subjects) with and without the Mini Microphone. A fixed speech presentation level of 80 dB SPL at the speaker (65 dB SPL at the subject's ear) was presented with noise presented simultaneously from four speakers at 45, 135, 225 & 315 degrees from the subject. The sound processor SCAN programme was used during all testing with the subject's preferred volume and sensitivity settings. The default paediatric mixing ratio of 1:1 (accessory) was used to represent common FM settings in the classroom. The volume for the Mini Microphone was at the "out of the box" setting which was constant for all testing.

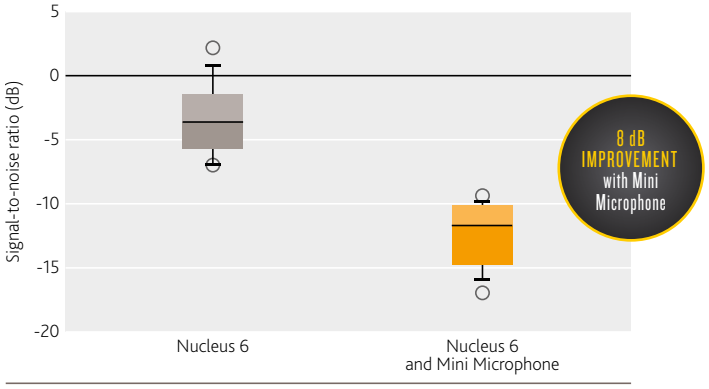

Figure 1 BKB sentence recognition (50% correct threshold)

CONCLUSION AND CLINICAL RECOMMENDATION

1. Mini Microphone provided over 8 dB improvement in hearing understanding in classroom noise.
2. Noise testing suggests that the Mini Microphone will perform well in a classroom environment, offering an effective alternative for those unable to access to a regular FM system.

The Cochlear™ Wireless Mini Microphone improves understanding in noise for school children.

Tuğçe Dikici[1], **Kadir Serkan Orhan**[1], **Beldan Polat**[1], **Selda Gökmen**[2], **Şengül Terlemez**[2] **and Yahya Güldiken**[2]
[1] Istanbul Medical School, Istanbul University, Istanbul, Turkey | [2] Cochlear Turkey, Istanbul, Turkey

STUDY AIM

The aim of the study was to evaluate subjective listening benefit with the Wireless Mini Microphone in classroom situations in experienced cochlear implant recipients.

SUBJECTS AND PROCEDURE

10 Nucleus® 6 recipients with ≥ 1 year cochlear implant experience and an average age of 9 years (min 7 years, max 14 years) were enrolled in the study. Subjects were asked to use the Mini Microphone at home and school for four weeks. The LIFE-UK IHP was used to subjectively evaluate teacher–child and child–child interactions in various listening and classroom situations with and without the Mini Microphone. Datalogs from recipients were also evaluated to calculate "time on air" with the accessory and sound processor.

KEY OUTCOMES

Subjects used their Mini Microphone for an average of 3 hours 11 minutes per day during the four week trial. The daily average "time on air" with the sound processor increased with use of the Mini Microphone by almost half an hour (p=0.0697). Each subject completed a LIFE-UK questionnaire at the beginning of the study and after four weeks of Mini Microphone use. All LIFE-UK categories of teacher–child and child–child interactions, in noise and in quiet, with and without lipreading, significantly improved in school situations with the Mini Microphone compared to listening abilities without the Mini Microphone.

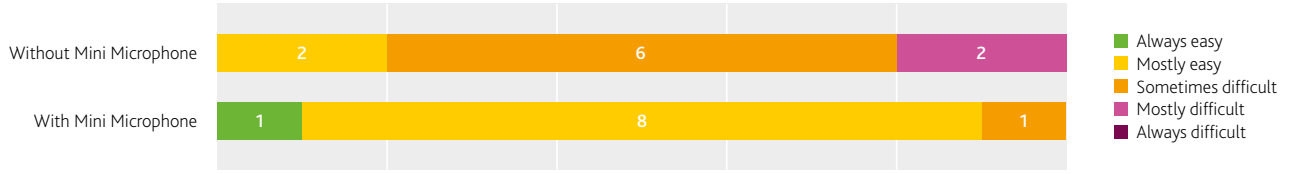

Figure 1 Child-child interaction – Noise – No lipreading (p<0.001)

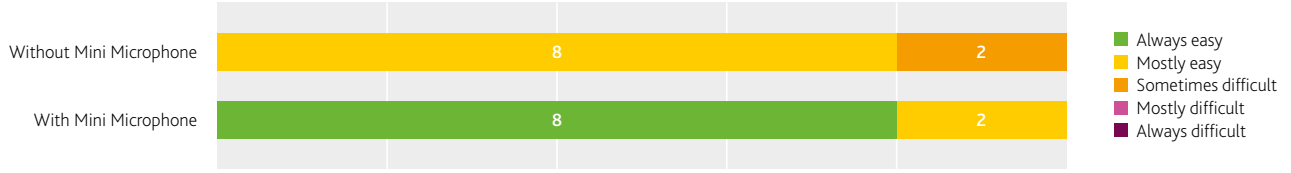

Figure 2 Teacher-child interaction – Noise – No lipreading (p<0.001)

CONCLUSION AND CLINICAL RECOMMENDATION

1. The increase in average "time on-air" could indicate reduced listening effort with the Mini Microphone.
2. Teacher–child and child–child interactions significantly improved in school situations with the use of the Mini Microphone.
3. The Mini Microphone is a great accessory for school children to further improve their listening and learning abilities.

Benefit of the Cochlear™ Wireless Mini Microphone in experienced adult cochlear implant recipients at work and during daily life.

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[1] Çukurova University Medical School, Adana, Turkey | [2] Gazi University Medical School, Ankara, Turkey

STUDY AIM

To evaluate the benefit of Cochlear™ Wireless Mini Microphone on experienced cochlear implant users.

SUBJECTS AND PROCEDURE

10 unilateral adult cochlear implant recipients with at least three years of experience participated in this study. Standardized international questionnaires (IOI-HA, SSQ) and take home diaries were administered to the subjects to measure their subjective evaluation of the Mini Microphone in combination with a cochlear implant.

KEY OUTCOMES

42% of the recipients were already able to hear well without the Mini Microphone; however, most recipients rated the use of the Mini Microphone as "extremely beneficial" for iPod/MP3 Players, Laptop/Computers, TV/HiFi, conversations in the car, and for single conversations over a distance (lecture/church). Most recipients found the Mini Microphone to be either "extremely or often beneficial" during multiple conversations in some noise and multiple or single conversations in loud noise. *(Figure 1)*

According to the IOI-HA questionnaire results, recipients reported the Mini Microphone significantly helped their listening abilities and significantly reduced their perceived difficulty of important listening situations. As a result of using the Mini Microphone other people felt less bothered by the recipient's hearing disability and the recipient's enjoyment of life increased significantly as indicated by the IOI-HA result. *(Figure 2)*

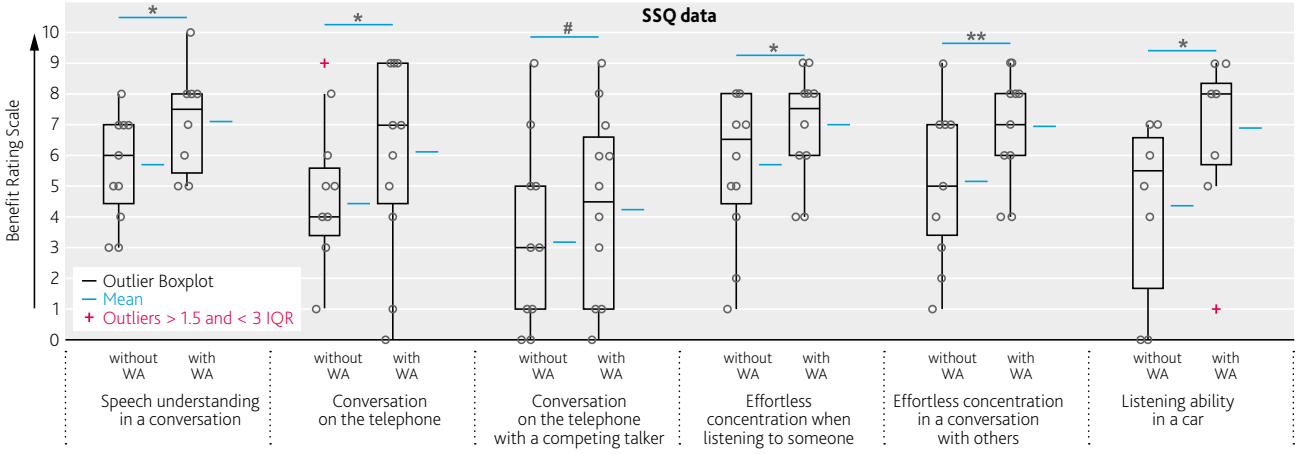
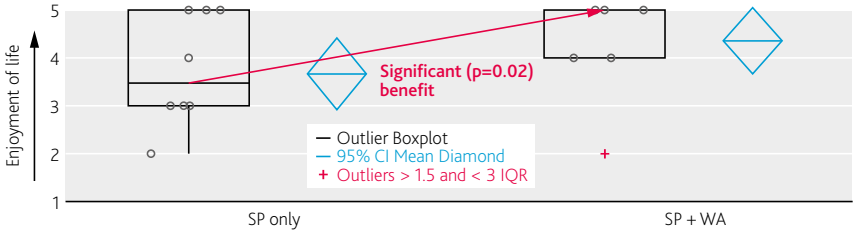


Figure 1 SSQ revealed significant improvements in subjective speech understanding and quality of speech understanding without the Mini Microphone (without WA) and with Mini Microphone (with WA)



Considering everything, how much has your present CI/CI plus Wireless Accessory changed your enjoyment of life?
1 = worse, 2 = no change, 3 = slightly better, 4 = quite a lot better, 5 = very much better

Figure 2 Significant (p=0.02) benefit in enjoyment of life with the Mini Microphone in addition to the recipient's sound processor (SP+WA) versus baseline with the sound processor only (SP only) is shown with the IOI-HA results. Even though baseline with the CP900 Series Sound Processor was already rated high, the improvement in enjoyment of life further increased with the use of the Mini Microphone.

CONCLUSION AND CLINICAL RECOMMENDATION

1. While most of the recipients were able to hear well with the sound processor alone, the Mini Microphone provided additional benefit in difficult listening situations.
2. The IOI-HA showed significant subjective improvement in listening abilities with the Mini Microphone versus without Mini Microphone.
3. The enjoyment of life increased significantly with the Mini Microphone.
4. The SSQ data demonstrated significant benefit of the Mini Microphone in different types of conversations compared to the no Mini Microphone condition.

Cochlear™ SCAN and Cochlear Wireless Mini Microphone improve speech understanding in noise with the Nucleus® CP900 Series Sound Processor.

Geert De Ceulaer[1], **David Pascoal**[1], **Filiep Vanpoucke**[2] **and Paul Govaerts**[1]
[1] The Eargroup, Antwerp, Belgium | [2] Cochlear Technology Centre Europe (CTCE), Mechelen, Belgium

STUDY AIM

The Nucleus® CP900 Series Sound Processor has two new options to improve speech in noise perception:

1. the use of the adaptive directional microphone in the SCAN mode, and
2. the use of the Wireless Mini Microphone microphone.

SUBJECTS AND PROCEDURE

13 Nucleus CP900 Series Sound Processor recipients were tested with an adaptive speech in noise test (sentences in uncorrelated diffuse multitalker babble noise).

This was done in three conditions: using the patient's Clinical Map *(Figure 1)*, using SCAN mode *(Figure 2)* and using the Mini Microphone *(Figure 3)*. Performance in these three conditions was assessed for three different distances between loudspeakers and CI recipient: 1, 2 and 3 meters. The sentences were presented from a frontal loudspeaker at a target level of 65 dB SPL.

KEY OUTCOMES

Speech in Noise improves with the use of SCAN but even more with use of the Mini Microphone.

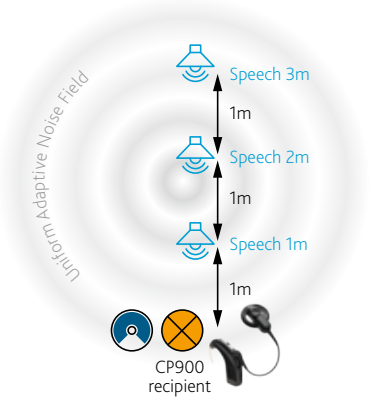


Figure 1 Using the patient's Clinical Map-omnidirectional microphone

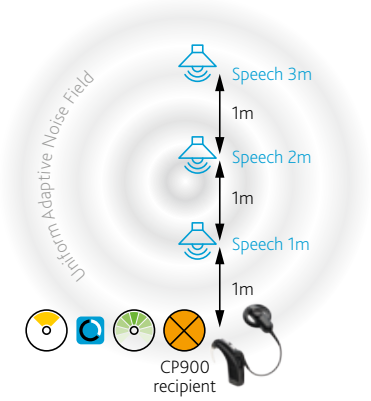


Figure 2 Using SCAN mode

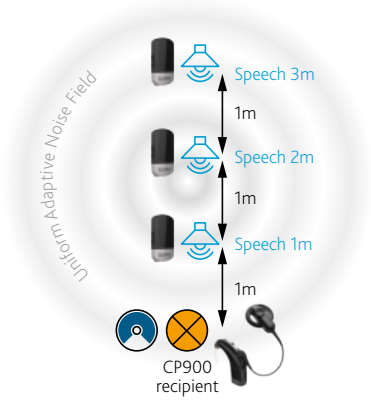


Figure 3 Using the Mini Microphone

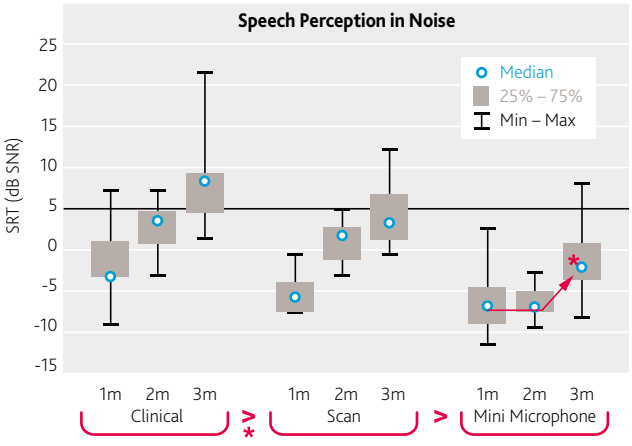


Figure 4 SRT group data for all nine test-situations

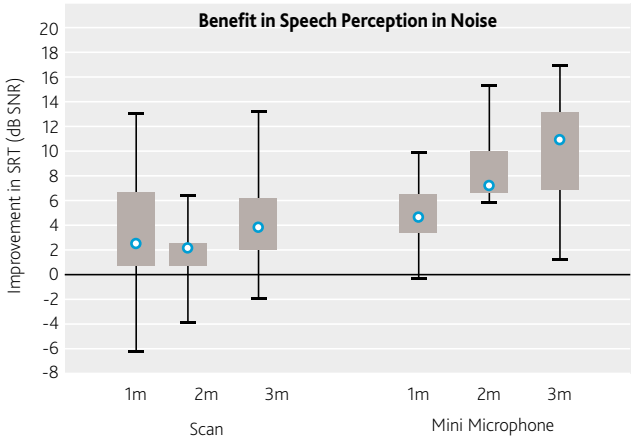


Figure 5 Calculated benefit of use of SCAN and Mini Microphone over omnidirectional microphone as a function of distance from speaker

CONCLUSION AND CLINICAL RECOMMENDATION

1. The use of SCAN and the Mini Microphone significantly improves Speech in Noise performance compared to Omnidirectional microphone.
2. The advantage at 1 m distance for SCAN is +3 dB and for the Mini Microphone it is +5 dB.
3. The advantage at 3 m distance for SCAN is +4 dB and for the Mini Microphone it is +11 dB.
4. The Mini Microphone is considered very comfortable and user-friendly.

Evaluation of sentence recognition in quiet and noise with and without the Cochlear™ Wireless Mini Microphone.

Mila Duke and Jace Wolfe
Hearts for Hearing, Oklahoma City, United States of America

STUDY AIM

To evaluate the benefit obtained from the use of remote microphone hearing assistance technology that transmits directly to a cochlear implant sound processor via audio streaming (digital radio transmission).

SUBJECTS AND PROCEDURE

16 adult Nucleus® CP900 Series Sound Processor recipients participated in this study. These participants had an average of 6.5 years of cochlear implant use. We measured sentence recognition in quiet and in varying uncorrelated classroom noise levels (at 50, 55, 60, 65, 70, 75 dB) using AzBio sentences with and without use of the Cochlear™ Mini Microphone. The sentence presentation level was 65 dB SPL at the location of the participant and 85 dB SPL at the location of the Mini Microphone.

KEY OUTCOMES

Sentence recognition was significantly better in quiet and significantly better in noise with use of the Mini Microphone compared to when the Nucleus CP900 Series Sound Processor was used alone. Sentence recognition in quiet was better than speech recognition in noise. Participants saw approximately 65% improvement in sentence recognition at a signal to noise ratio of +5 dB.

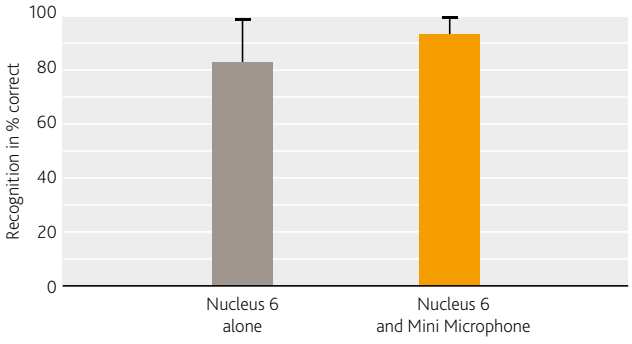


Figure 1 Word Recognition in Quiet (p=0.0002)

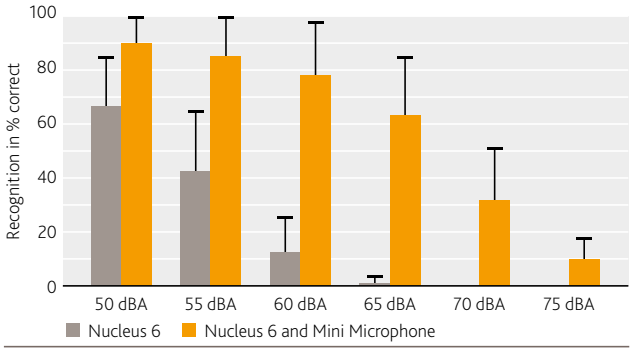


Figure 2 Word Recognition in Noise (p<0.05)

CONCLUSION AND CLINICAL RECOMMENDATION

1. Use of the Mini Microphone resulted in better word recognition in quiet and in noise.
2. Although not formally measured:
   - **a.** Subjects responded favorably to the sound quality of and improvement in speech recognition provided by the Mini Microphone.
   - **b.** Subjects reported that signal integrity was excellent.
   - **c.** No subjects reported signal dropout or interference.
   - **d.** Adjusting mixing ratio may be desirable depending on situations.
   - **e.** Clinicians should prepare to spend time orienting recipients to the use of the Mini Microphone.

Efficiency of a wireless microphone for experienced cochlear implant children in classroom situations.

Marine Parodi, Clara Legendre, Aude de Lamaze, Isabelle Prang, Vincent Couloigner, Noel Garabedian and Natalie Loundon
Necker Hôpital Universitaire, Paris, France

STUDY AIM

The purpose of this study was to assess subjective listening benefit and usability of the Cochlear™ Wireless Mini Microphone in challenging listening environments in implanted children using Nucleus® CP900 Series Sound Processors.

SUBJECTS AND PROCEDURE

18 children aged 7 to 14 years old, implanted with cochlear implants for more than five years, were enrolled in this prospective study. Children were instructed how to use the Mini Microphone and it was recommended to be worn in the classroom. The LIFE-UK self-assessment questionnaire was administrated at the beginning of the study and then again after a six week Mini Microphone trial, in order to evaluate the benefit and usability (score 0 to 10) of the Mini Microphone in a classroom situation. To complete the evaluation, speech audiometry in noise was tested with and without the Mini Microphone. The HINT test was used with the speech signal coming from the front and noise coming from both sides. Speech and noise was presented at 65 dB, meaning a Signal-to-Noise-Ratio (SNR) of 0 dB.

KEY OUTCOMES

92% of patients reported the usability of the Mini Microphone a 7 out of 10 or higher. The mean usability score was 8.6. *Figure 1 to 3* shows the results of intra-individual comparisons of the subjects for the HINT and LIFE-UK results labelled by patient initials.

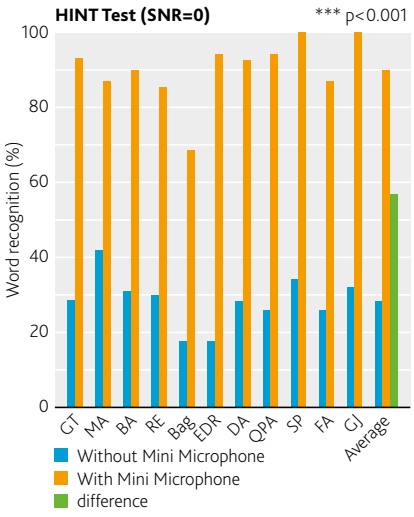


Figure 1 Individual and average percent correct HINT word recognition scores in noise measured at 0 dB SNR show a highly significant improvement of almost 60 % with Mini Microphone versus without Mini Microphone.

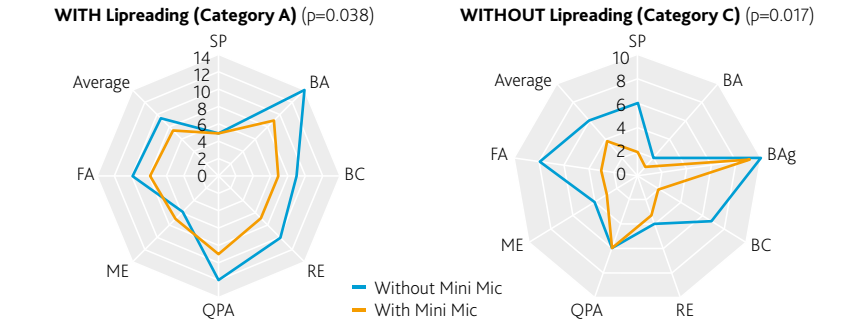


Figure 2 The results of the LIFE-UK questionnaire show a significant improvement when using the Mini Microphone with a recipient's sound processor for teacher-child interactions in noise, with and without lipreading. (Lower values indicate better performance)

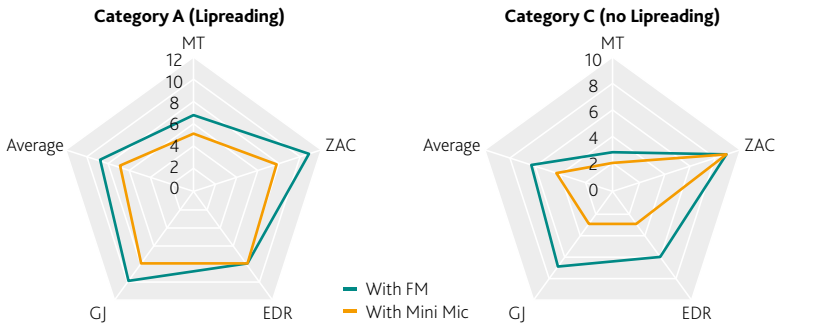


Figure 3 The comparison of Mini Microphone versus FM System with the LIFE-UK shows a tendency towards improved listening performance with the Mini Microphone for teacher-child interactions in noise. Subjectively, it was reported that listening skills and feelings are better with the Mini Microphone than with FM systems. (Lower values indicate better performance)

CONCLUSION AND CLINICAL RECOMMENDATION

1. This study found a significant improvement in subjective listening abilities in child-teacher interactions, in quiet and in noisy environments.
2. HINT scores showed a significant difference in favour of the Mini Microphone.
3. Ease of use of the Mini Microphone has been rated favourably.
4. The Mini Microphone seems to be a usable accessory for children age 7 years and older, to improve listening conditions in the classroom.

Speech intelligibility with the Cochlear™ Wireless Mini Microphone in experienced cochlear implant recipients.

Merve Batuk[1], **Filiz Aslan**[1], **Gonca Sennaroğlu**[1], **Ayça Çiprut**[2], **Ufuk Derinsu**[2], **Sıdıka Cesur**[2]
[1] Hacettepe University Medical School, Ankara, Turkey | [2] Marmara University Medical School, Istanbul, Turkey

STUDY AIM

To assess hearing performance in experienced cochlear implant recipients with and without the Cochlear™ Wireless Mini Microphone.

SUBJECTS AND PROCEDURE

20 unilateral cochlear implant recipients, all fit with Nucleus® CP900 Series Sound Processors, participated in this study. Duration of cochlear implant use was at least one year. The recipients used the Mini Microphone in their daily lives for eight weeks. Speech recognition in quiet and in noise (SNR +5 dB) was then assessed with and without the use of Mini Microphone at different intensity levels (50 dB HL, 60 dB HL and 70 dB HL) and with two different mixing ratios (2:1 and accessory only). Recipients were seated 1 meter from the loud speakers in a S45/N45 configuration. The Mini Microphone was positioned 20 cm away from the loudspeaker used to present the target signal. The International Outcome Inventory for Hearing Aids (IOI-HA) and Speech Spatial Qualities (SSQ) questionnaires were administered pre and post Mini Microphone use to all recipients. Datalogging records were examined for all participants.

KEY OUTCOMES

Use of the Mini Microphone with Nucleus CP900 Series Sound Processors improved speech recognition in noise with a +5 dB signal-to-noise ratio with the 2:1 mixing ratio and to a further extent with the accessory only mixing ratio over the sound processor only condition. All patients preferred using the Mini Microphone in daily life situations. The SSQ results shown in *Figure 1 to 3* demonstrate significant improvement with the Mini Microphone.

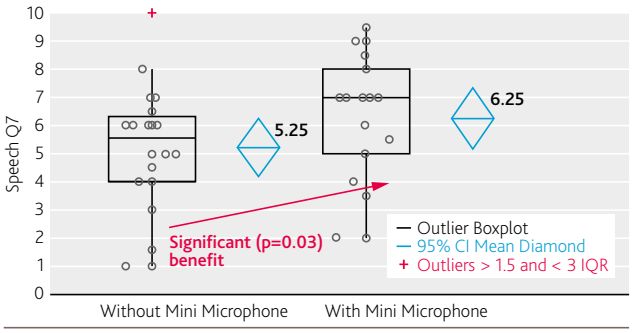


Figure 1 SSQ (speech Q7): You are talking to someone in a place where there are a lot of echoes, such as a church or railway terminus building. Can you follow what the other person says?

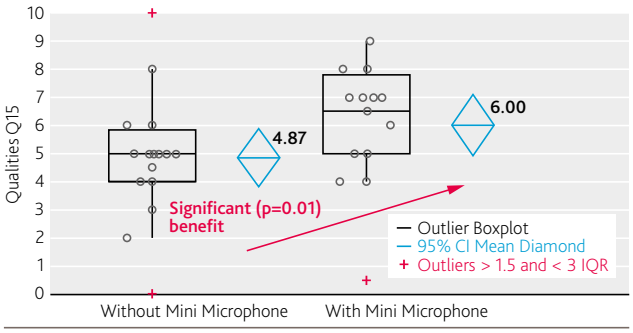


Figure 2 SSQ (qualities Q15): Do you have to put in a lot of effort to hear what is being said in conversations with others?

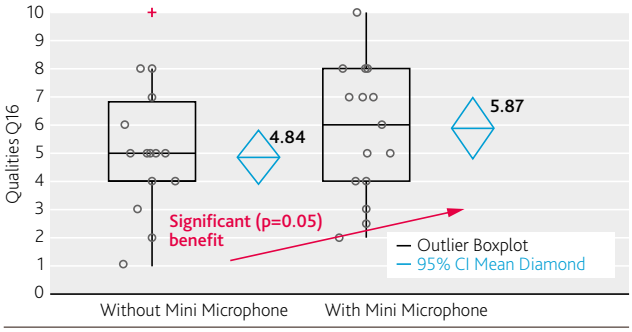


Figure 3 SSQ (qualities Q16): When you are the driver in a car can you easily hear what someone is saying who is sitting alongside you?

CONCLUSION AND CLINICAL RECOMMENDATION

1. SSQ data revealed significant improvement with the Mini Microphone compared to the sound processor only as baseline in reverberant environments.
2. The Mini Microphone significantly reduced listening effort compared to the sound processor only condition.
3. Ease of listening in a car was significantly improved with the Mini Microphone versus sound processor only.
4. Nucleus CP900 Series Sound Processor recipients achieved a speech understanding benefit with the Mini Microphone in noise versus sound processor only condition. The "accessory only" mixing ratio seems to provide further improvement over the 2:1 mixing ratio in difficult noisy listening environments.

Evaluation of benefit provided by the Cochlear™ Wireless Phone Clip.

Mathieu Robier[1,2], **David Bakhos**[1], **Thierry Pawelczyk**[3] **and Emmanuel Lescanne**[1]
[1] CHRU Tours, Tours, France | [2] AUDILAB Hearing aid Laboratory, Orleans, France | [3] Cochlear France, Toulouse, France

STUDY AIM

Benefit from cochlear implants is no longer questioned; however, many recipients still experience difficulty when using the phone[1,2]. A relationship between phone use and quality of life has been demonstrated[3]. The aim of this study was to evaluate the benefit provided by a hands-free connection to the sound processor using the Cochlear™ Wireless Phone Clip.

SUBJECTS AND PROCEDURE

Nine cochlear implant recipients (mean age 47 years, range 9–87 years) participated in the study. All recipients were fit with a Nucleus CP900 Series Sound Processor allowing for a hands-free phone connection with the Phone Clip. Speech understanding was accessed as well as Quality of Life using the Kepler[4] questionnaire. Speech understanding was tested under four conditions: in quiet and in noise, both with use of the Phone Clip and without (phone positioned close to the processor microphone input). HINT lists (Hearing In Noise Test), which were previously recorded as a message on the answering machine of the cell phone, were played back via cell phone to assess speech understanding. Cocktail party noise was presented at 65 dB SPL from a speaker positioned 1 meter in front of the recipient. The Kepler questionnaire was administered twice, with the Phone Clip and without. The questionnaire was administered before and after experience with the Phone Clip.

KEY OUTCOMES

Speech understanding scores were better with the Phone Clip in both quiet (p=0.001) and noise (p=0.001) conditions *(Figure 1)*. Overall, Kepler scores were better with use of the Phone Clip, with 2 questions (Q16 and 19) showing significant improvement (p=0.02 and 0.06 respectively) *(Figure 2)*.

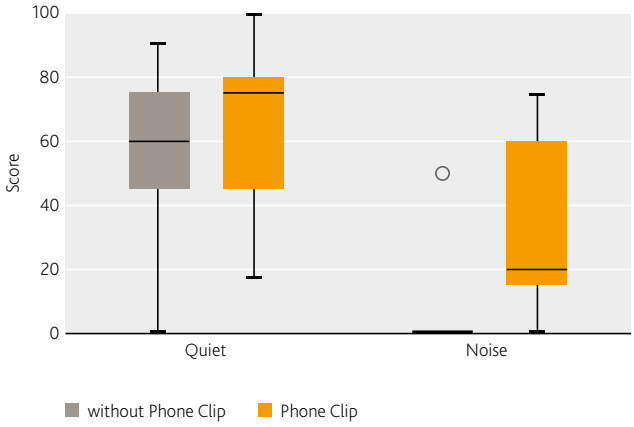


Figure 1 Speech Audiometry – without Phone Clip vs. Phone Clip

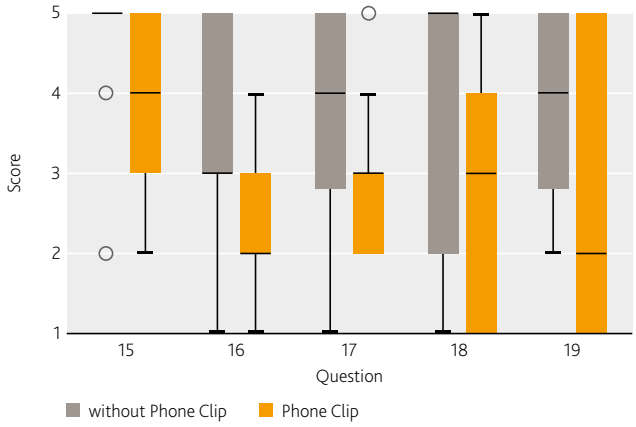


Figure 2 Kepler Questionnaire

Boxes represent the first and third quartile with whiskers showing the minimum and maximum values. The solid lines represent the median. Open circles represent identified outliers.

CONCLUSION AND CLINICAL RECOMMENDATION

The Phone Clip, which provides a wireless hands-free connection between the phone and sound processor, enables better understanding in noise and quiet. Speech understanding results were confirmed subjectively with the Quality of Life Questionnaire (Kepler) showing significant improvements in specific contexts. Although preliminary, these results suggest improved resistance to noise with this type of hands-free accessory.

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Telephone speech recognition improvement in a noisy environment: use of a Bluetooth accessory.

Zuriñe Martinez Basterra[1], **Mercedes Fernández de Pinedo**[1] **and Xabier Altuna Mariexcurrena**[1]
Supported by: Chrystelle Coudert-Koall[2], **Beatriz Pradel**[3] **and her team**
[1] Hospital Universitario Donostia, San-Sebastian, Spain | [2] Cochlear EMEA, Basel, Switzerland | [3] Gaes Headquarter, Barcelona, Spain

STUDY AIM

To access speech recognition ability in noise and user satisfaction with the Cochlear™ Wireless Phone Clip in experienced cochlear implant recipients.

SUBJECTS AND PROCEDURE

30 experienced cochlear implant users (> 6 months experience; aged 14–65 years) were enrolled in the study. Subjects were seated in a sound booth. Spanish cocktail noise was presented continuously (65 dB SPL) from four loudspeakers placed at 45, 135, 225 and 315 degrees azimuth. Bi-syllabic word lists were presented through the clinic landline telephone to the subject's mobile telephone. Speech recognition was evaluated without use of the Phone Clip (subjects held the mobile telephone receiver next to their CP900 Sound Processor microphone) and with the Phone Clip paired to the CP910 at various mixing ratio (2:1, 4:1, and accessory only). Subjects completed the Kepler[1] questionnaire to investigate phone use and the Kim & Chung[2] questionnaire to access subjective satisfaction on a Visual Analogue Scale from -5 (bad) to 5 (good).

KEY OUTCOMES

The Keppler questionnaire *(Figure 1)* showed that at the baseline, without any accessory to improve telephone conversations, 53.3% of subjects described themselves as highly or greatly affected by their deafness for telephone use and 80% were moderately to greatly affected. Therefore action has to be taken and the Phone Clip seems to be the accessory of choice, because significant (P<0,001) improvement in speech recognition performance was found with use of the Phone Clip versus baseline *(Figure 2)*. The Kim & Chung[2] questionnaire *(Figure 3)* showed significant differences (P<0,001) in subjective satisfaction with the Phone Clip compared to the conventional mode (no Phone Clip) for sound quality, noise interference and sound accuracy.

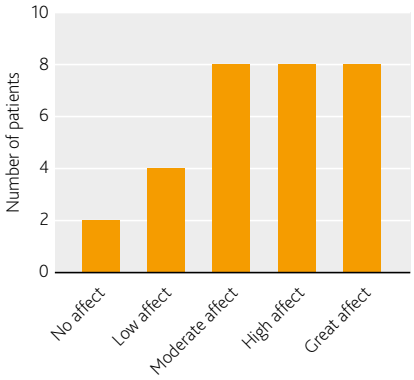

Figure 1 Baseline evaluation of impact of hearing disability on telephone conservations without wireless accessory

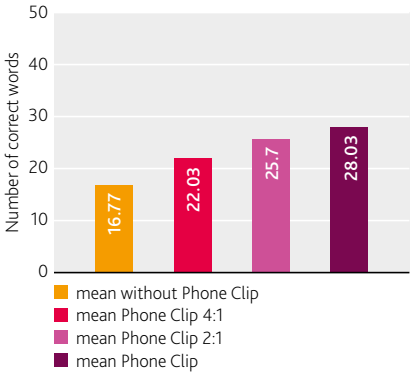

Figure 2 N=30, mean Bi-syllabic word recognition in noise without the Phone Clip and with the Phone Clip at the various mixing ratios.

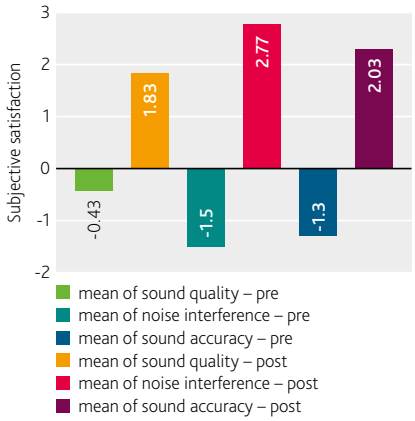

Figure 3 Subjective satisfaction score after acute Phone Clip usage: score given on Visual Analog Scale scale from -5 to 5

CONCLUSION AND CLINICAL RECOMMENDATION

1. The majority of cochlear implant recipients reported their hearing disability impacts their telephone usage negatively and the Phone Clip seems to be the method of choice to overcome this.
2. Adjusting the mixing ratio can improve speech understanding and proper counselling is necessary to adapt to individual user needs.
3. Significant (P<0.001) improvement of speech recognition ability was found using the Phone Clip in noise.
4. Significant improvements (P<0.001) were observed in subjective satisfaction of sound quality, noise interference and sound accuracy.

The Wireless Phone Clip is a step forward for cochlear implant users, which may impact their quality of life as well as their efficiency at work.

References

1 Kepler LJ, Terry M, Sweetman RH. Telephone usage in the hearing-impaired population. Ear and Hearing, Vol13, Nº5,311-318, 1992

2 Effect of a Bluetooth-Implemented Hearing Aid on Speech Recognition Performance: Subjective and Objective Measurement Min-Beom Kim, MD, Won-Ho Chung, MD, PhD, Jeesun Choi, MD, Sung Hwa Hong, MD, PhD, Yang-Sun Cho, MD, PhD, Gyuseok Park, MS3, and Sangmin Lee, PhD Choi, MD, Sung Hwa Hong, MD, PhD, Yang-Sun Cho, MD, PhD, Gyuseok Park, MS, and Sangmin Lee, PhD

Wireless streaming with the Cochlear™ Wireless Phone Clip improves speech understanding and reduces listening effort during telephone use in noise.

Steven C Marcrum
University Hospital Regensburg, Regensburg, Germany

STUDY AIM

The purpose of this study was to investigate how telephone-to-cochlear implant (CI) coupling methods affect speech understanding and reported listening effort during telephone use in a noisy environment.

SUBJECTS AND PROCEDURE

20 Nucleus® CP910 Sound Processor recipients with ≥ 1 year CI experience participated in the study. Telephone based speech understanding (HSM Sentence Test) was assessed in a noisy background (+15 dB SNR) in five listening conditions: acoustic (omni), acoustic (directional plus noise reduction (NR)), telecoil (3:1 mixing ratio), Wireless Phone Clip streaming (2:1 mixing ratio), and Wireless Phone Clip streaming (100% mixing ratio). Additionally, a 100 point visual analogue scale was used to assess the degree of perceived effort required to achieve that level of performance.

KEY OUTCOMES

Speech understanding and listening effort were significantly improved for the two Wireless Phone Clip streaming conditions when compared to the non-streaming conditions. No significant differences were identified between the two wireless streaming conditions. No significant differences were identified when comparing acoustic and inductive coupling conditions.

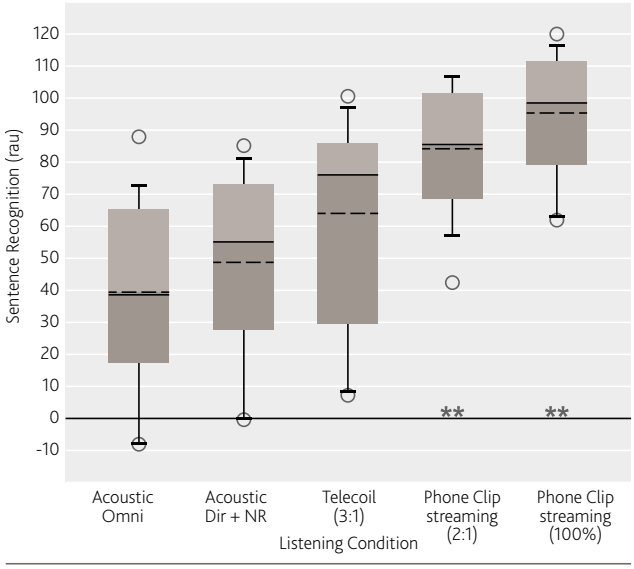

Figure 1 Sentence recognition in noise results (rau) for all listening conditions. Sentence recognition for both streaming conditions was significantly higher ($p < .001$) than for all non-streaming conditions. No other significant relationships were identified.

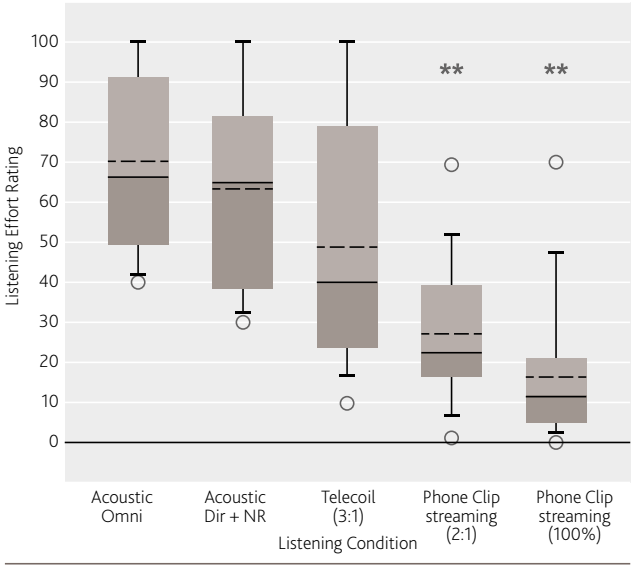

Figure 2 Perceived listening effort ratings for all test conditions. Perceived listening effort for both streaming conditions was significantly lower ($p < .001$) than for all non-streaming conditions. No other significant relationships were identified.

Solid box and whisker plot lines represent 25th (lower), 50th (middle), and 75th (upper) percentiles. Whiskers represent 10th (lower) and 90th (upper) percentiles. Dashed lines represent mean performance. Open circles represent identified outliers.

CONCLUSION AND CLINICAL RECOMMENDATION

1. Significant improvements in speech understanding and significant reductions in listening effort can be achieved by using Wireless Phone Clip streaming technology for telephone use in a noisy environment.
2. A 100% streaming mixing ratio did not lead to any significant improvements in speech recognition or reduction in listening effort when compared to a 2:1 mixing ratio. As the 100% streaming ratio has the disadvantage of making the CI user's own voice inaudible, a 2:1 mixing ratio can be recommended.

Hearing inventory with the Cochlear™ Wireless Phone Clip in experienced adult cochlear implant recipients at work and during daily life.

Bülent Gündüz[1], **Çağıl Gökdoğan**[1], **Elçin Orçan**[1], **M.Fikret Çetik**[2], **Ülkü Tuncer**[2] **and Süleyman Özdemiroğlu**[2]
[1] Gazi University Medical School, Ankara, Turkey | [2] Çukurova University Medical School, Adana, Turkey

STUDY AIM

To evaluate subjective benefit of the Cochlear™ Wireless Phone Clip in cochlear implant recipients in situations where no visual cues are available such as talking on the phone.

SUBJECTS AND PROCEDURE

20 cochlear implant recipients, with at least three months experience with Nucleus® CP900 Series Sound Processors, were evaluated with their sound processor alone at baseline and again with the Phone Clip after six weeks take-home experience. All 20 subjects had bilateral severe to profound hearing loss. The International Outcome Inventory for Hearing Aids (IOI-HA), Speech Spatial Qualities (SSQ) questionnaire, Kepler telephone questionnaire[1], and Phone Clip diary were completed at baseline and after six weeks experience with the Phone Clip. The Kepler[1] questionnaire evaluates telephone usage and communication over the phone in hearing impaired populations.

KEY OUTCOMES

The IOI-HA was affected by ceiling effects in half of the questionnaire, but the remaining part of the questionnaire showed significant benefits. The SSQ (categories: speech and qualities) showed significant benefits with the Phone Clip versus sound processor only in easy and difficult listening situations. The results of the Kepler[1] questionnaire show significant subjective benefits as shown in *Figures 1–4*.

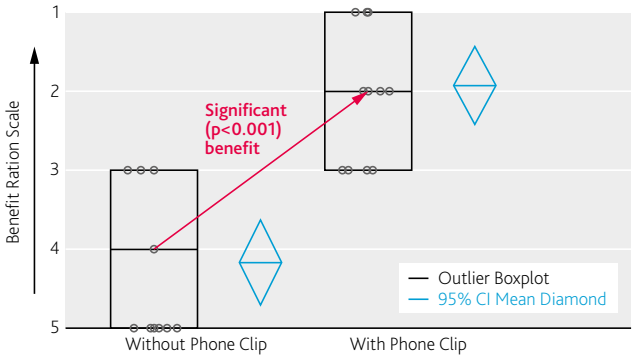

Figure 1 How much has your hearing impairment affected your use of the telephone? 1 = No affect … 5 = Great affect

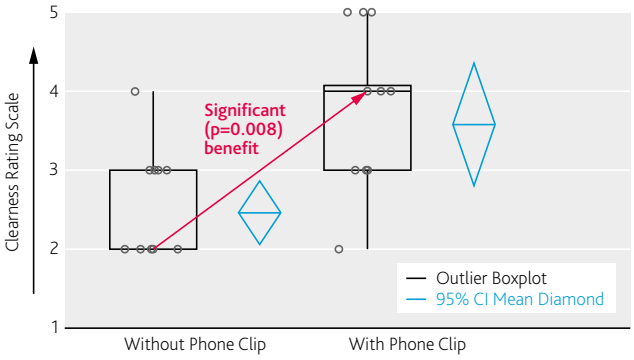

Figure 2 Generally, I feel that speech over the phone is: 1 = Never clear … 5 = Always clear

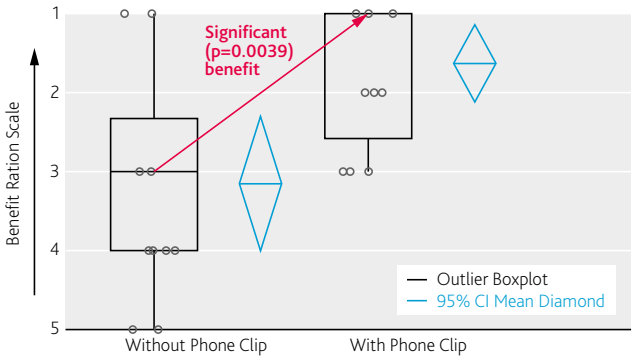

Figure 3 How often do you have to end the phone call before the conversation is complete specifically because you have difficulty hearing? 1 = Never … 5 = Often

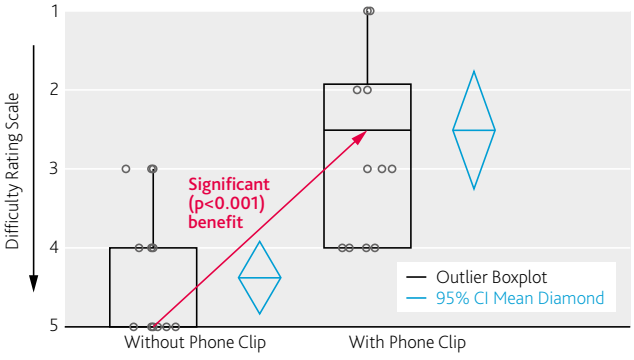

Figure 4 When using the phone and there is a great amount of noise in the room around you, how much difficulty do you have hearing the person on the phone: 1 = No difficulty … 5 = Great difficulty

CONCLUSION AND CLINICAL RECOMMENDATION

1. The Phone Clip provides Nucleus CP900 Series Sound Processor recipients improved subjective speech intelligibility over the phone in noisy surroundings.
2. The Phone Clip brings significant subjective advantages in telephone communication, such as improvement of the overall listening quality on the phone.

Reference
1 Kepler LJ, Terry M, Sweetman RH. Telephone usage in the hearing-impaired population. Ear Hear. 1992 Oct;13(5):311-9.

Evaluation of speech recognition over the telephone with and without the Cochlear™ Wireless Phone Clip.

Mila Duke and Jace Wolfe
Hearts for Hearing, Oklahoma City, United States of America

STUDY AIM

To evaluate speech recognition ability over the mobile telephone for a group of cochlear implant users. Also, we wanted to evaluate the benefit obtained from use of wireless hearing assistance technology that streams audio directly (digital radio transmission) from the mobile telephone to a Nucleus® Sound Processor.

SUBJECTS AND PROCEDURE

16 adult Nucleus CP900 Series Sound Processor recipients participated in this study. These participants had an average of 6.5 years of cochlear implant use. We measured word recognition in quiet and in uncorrelated classroom noise (65 dBA) using CNC Words presented over a mobile telephone with and without Cochlear™ Wireless Phone Clip.

KEY OUTCOMES

Word recognition was significantly better in quiet and significantly better in noise with use of the Phone Clip compared to when the Nucleus CP900 Series Sound Processor was used alone. Word recognition in quiet was better than speech recognition in noise. The decrease in speech recognition observed between quiet and noise was greater without the use of the Phone Clip.

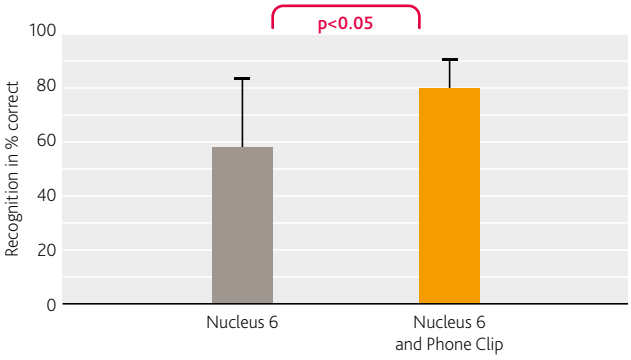

Figure 1 Word Recognition in Quiet

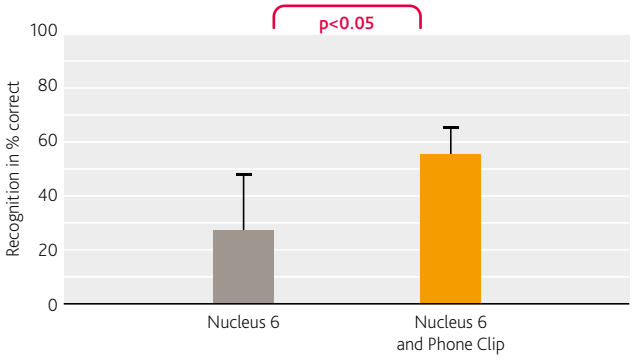

Figure 2 Word Recognition in Noise

CONCLUSION AND CLINICAL RECOMMENDATION

1. Use of the Phone Clip resulted in better word recognition in quiet and in noise.
2. Although not formally measured:
   - **a.** Subjects responded favorably to the sound quality of and improvement in speech recognition provided by the Phone Clip.
   - **b.** Subjects reported that signal integrity was excellent.
   - **c.** No subjects reported signal dropout or interference.
   - **d.** Adjusting mixing ratio may be desirable depending on situations.
   - **e.** Clinicians should prepare to spend time orienting recipients to the use of the Phone Clip.

Speech intelligibility with the Cochlear™ Wireless Phone Clip in experienced cochlear implant recipients.

Ayca Çiprut[1], Ufuk Derinsu[1], Sıdıka Cesur[1],Betül Çiçek[2], Burcu Özkan[2] and Esra Yücel[2]
[1] Marmara University Medical School, Istanbul, Turkey | [2] Hacettepe University Medical School, Ankara, Turkey

STUDY AIM

To evaluate the effect of using the Cochlear™ Wireless Phone Clip on speech intelligibility over the telephone.

SUBJECTS AND PROCEDURE

22 Nucleus® CP900 Series Sound Processor recipients with ≥ 1 year experience with a cochlear implant (CI) participated in the study. Speech intelligibility over the telephone was assessed with Turkish monosyllabic words spoken by an experienced audiologist via a telephone at a normal conversational level (60–65 dB A). The monosyllabic word test was conducted in six conditions:

- Nucleus CP900 alone in quiet and in noise **(SP)**
- Nucleus CP900 + Phone Clip in quiet and in noise (accessory mixing 2:1 condition) **(2:1)**
- Nucleus CP900 + Phone Clip in quiet and in noise (accessory only condition) **(WA only)**

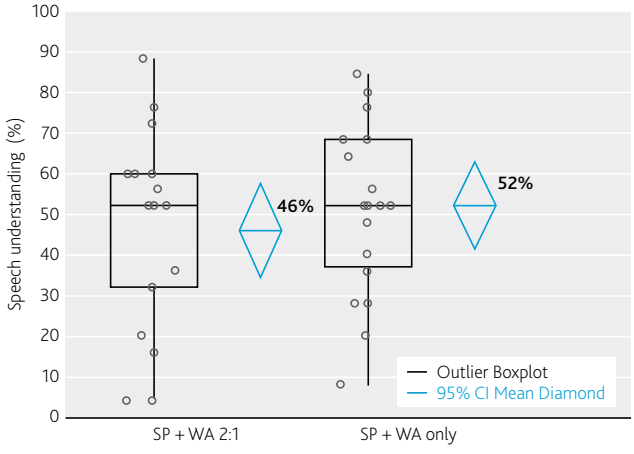

Figure 1 Speech Understanding with Phone Clip in Noise (N=19), p=0.04

KEY OUTCOMES

14 recipients completed all test conditions. The Phone Clip did not show any effect on speech understanding in quiet likely due to its design to improve performance in difficult listening situations. When comparing speech understanding in noise, recipients achieved the lowest (poorest) scores with their speech processor alone, scores increased in the accessory mixing 2:1 condition, and the highest (best) scores were obtained in the accessory only condition (SP vs. 2:1 (p=0.09) & SP vs. WA only (p=0.01)). There was a significant (p=0.04) difference between the two Phone Clip conditions, with the speech understanding scores being significantly higher with the Phone Clip in accessory only mode versus accessory mixing 2:1 condition *(Figure 1)*. The recipients added the following comments after finishing the trial: "I used my phone more often than before", "the Phone Clip helped me to understand better", and "the Phone Clip was very helpful especially when talking in noisy areas". Recipients indicated preference of using the Phone Clip over their sound processor alone for phone calls and reported a high level of satisfaction with the Phone Clip.

CONCLUSION AND CLINICAL RECOMMENDATION

1. The Phone Clip improved word recognition in noise over a mobile phone compared to using the phone with the Nucleus CP900 Series Sound Processor alone.
2. Patients reported a high level of satisfaction with the usability of the Phone Clip.
3. Patients preferred using the Phone Clip when talking on the telephone.

Evaluation of speech recognition over the television with and without the Cochlear™ Wireless TV Streamer.

Mila Duke and Jace Wolfe
Hearts for Hearing, Oklahoma City, United States of America

STUDY AIM

To evaluate sentence recognition ability over the television for a group of cochlear implant (CI) users. Also, we wanted to evaluate the benefit obtained from using wireless hearing assistance technology that streams audio directly (digital radio transmission) from the television to a CI sound processor.

SUBJECTS AND PROCEDURE

16 adult Nucleus® CP900 Series Sound Processor recipients participated in this study. These participants had an average of 6.5 years of cochlear implant use. We measured sentence recognition using CASPER-SENT 3.7 sentences over a television with and without the Cochlear™ Wireless TV Streamer. Testing was conducted in quiet at 65 dB SPL and in an uncorrelated classroom noise level of 65 dB A.

KEY OUTCOMES

Sentence recognition was significantly better in quiet and significantly better in noise with use of the TV Streamer compared to when the Nucleus CP900 Series Sound Processor was used alone. Sentence recognition in quiet was better than speech recognition in noise. The decrease in speech recognition observed between quiet and noise was greater without the use of the TV Streamer.

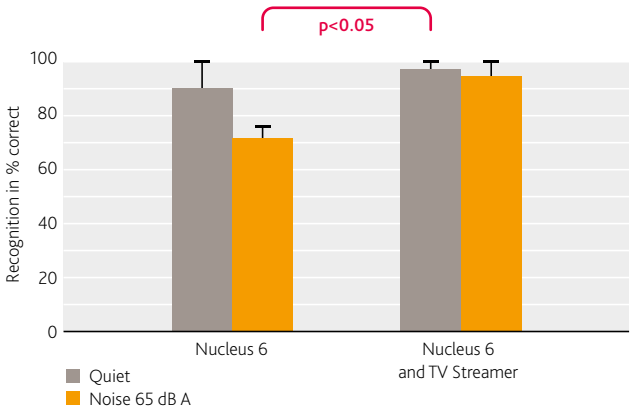

Figure 1 Sentence Recognition in Quiet and Noise

CONCLUSION AND CLINICAL RECOMMENDATION

1. Use of the TV Streamer resulted in significantly better sentence recognition in quiet and in noise.
2. Although not formally measured:
   - **a.** All subjects responded favorably to the sound quality and improvement in speech recognition provided by the TV Streamer.
   - **b.** Subjects reported that signal integrity was excellent.
   - **c.** No subjects reported signal dropout or interference.
   - **d.** Adjusting mixing ratio may be desirable depending on situations.

The Cochlear™ Wireless TV Streamer improves watching TV and is easy to use.

Nicole Neben
Cochlear Germany, Hanover, Germany

STUDY AIM

This First Experience Program was initiated to establish a unified approach to describe user experience with the Cochlear™ Wireless TV Streamer.

SUBJECTS AND PROCEDURE

25 Nucleus® CP900 Series Sound Processor recipients with ≥ 1 year CI experience participated in this investigation. A seven point Likert scale questionnaire on satisfaction was administered to evaluate subjective user experience while watching TV with the TV Streamer as compared to the recipient's own sound processor as baseline.

KEY OUTCOMES

Subjects used their TV Steamers for an average of 16 hours during the six day take-home trial. Almost all test subjects were completely satisfied with connecting the TV Streamer to the TV, with pairing the sound processor with the TV Streamer, with the reliability of the connection when leaving the room, and with activating and disabling the connection after the six day take-home trial. All recipients but one were very likely to recommend the TV Streamer to a friend or colleague. The one recipient who was unlikely to recommend the TV Streamer did not have enough plugs to connect both the TV Streamer and DVD player at the same time.

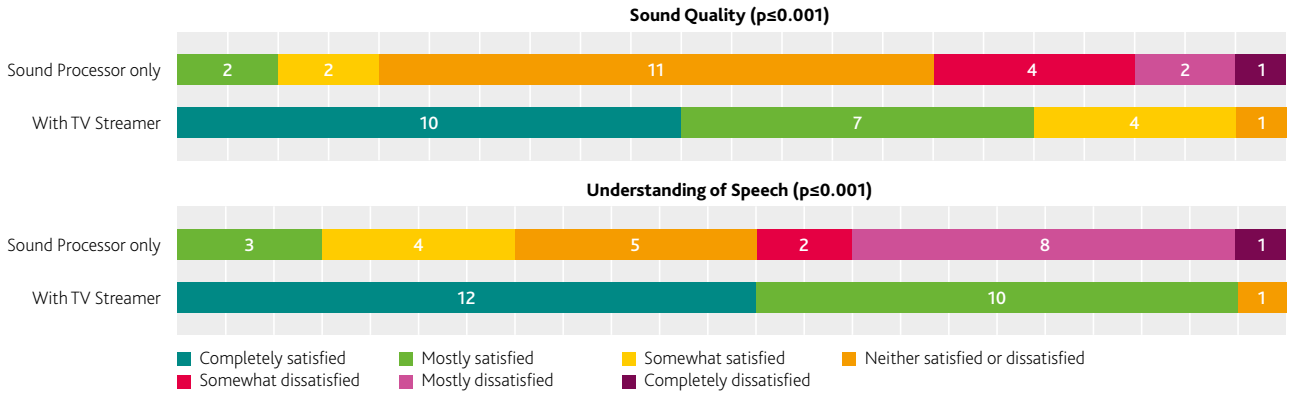

Figure 1 Compared to listening with the sound processor only, sound quality and subjective speech understanding improved significantly when using the TV Streamer

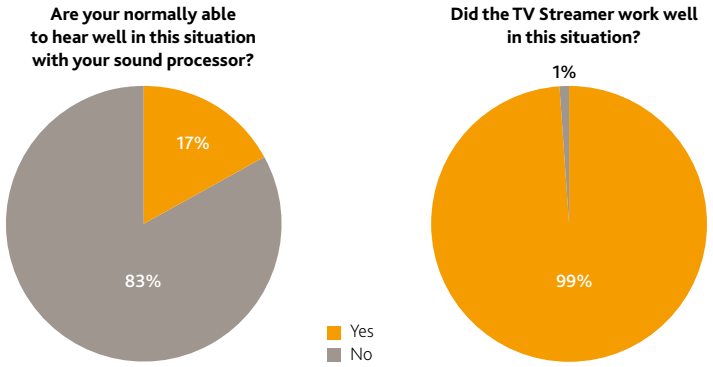

Figure 2 The percentage of listening situations in which recipients were able to hear the TV signal well improved from 17% with the sound processor to 99% with the TV Streamer

CONCLUSION AND CLINICAL RECOMMENDATION

1. Significant improvement of subjective TV listening abilities were seen with use of the TV Steamer.
2. High satisfaction ratings were found for the handling and usability of the TV Streamer.
3. Mixing ratio adjustments with the CR230 Remote Assistant should be better communicated to Nucleus CP900 Series Sound Processor recipients to potentially improve their hearing ability for the signal of interest.
4. The benefits of the TV Streamer potentially apply to stereo streaming of the TV signal for both bimodal and bilateral cochlear implant recipients, as well as school children with a cochlear implant watching educational videos. This presents an opportunity to extend the current research.

Use of take home diaries to gain insights with use of Cochlear™ Wireless Accessories

Marian Jones
Cochlear Limited, Sydney, Australia

STUDY AIM

To evaluate the subjective benefit, acceptance and use of Cochlear™ Wireless Accessories by cochlear implant recipients.

SUBJECTS AND PROCEDURE

18 subjects completed a baseline questionnaire.
15 participants from the Australian Controlled Market Release were also added to this evaluation as they completed the same diaries. The type of Cochlear Wireless Accessory selected for the take-home trial was based on discussion of individual listening needs and which accessory would be most useful. In order to capture how subjects were using the accessories in their personal lives, they were asked to complete a diary/questionnaire during the trial period. Diary questions varied depending on the type of accessory.

The diaries were returned and analysed, and Custom Sound® Datalogging information on hours of use of the accessory were used to support clinical/recipient guidance.

KEY OUTCOMES BASED ON DIARY ENTRIES

Cochlear™ Wireless Mini Microphone

- Improved hearing and conversations while in the car.
- Resumed attendance at meetings and easier conversations at a noisy cafe.

Cochlear™ Wireless Phone Clip

- Enabled for more confidence in making and receiving calls.
- Made calls with their mobile phone for the first time rather than just sending text messages.
- Were able to pair with Bluetooth devices via the Phone Clip to wirelessly watch movies and listen to music.

Cochlear™ Wireless TV Streamer

- Easy to set up and sound quality was reported to be very good.
- Less reliance on using subtitles, and were able to adjust their volume without impacting others.

CONCLUSION AND CLINICAL RECOMMENDATION

1. Great insights were obtained regarding real life use of Wireless Accessories.
2. Recommending Cochlear Wireless Accessories to a recipient should not be guided by their existing experience with wired accessories.
3. Only 7 subjects used wired accessories prior to the clinical study, but all eighteen indicated they would purchase and actively continue using Cochlear Wireless Accessories.
4. The benefits extended beyond the pure convenience of no wires, with many thrilled at the unexpected performance benefit they received from the accessories and on the phone.

The use of take home diaries on adult CI recipients to determine best practice for paediatric CI recipients.

Susan Johnston[1], **Arlene O'Malley**[1], **Agnes Allen**[1], **Lisa DeBold**[2] **and Jill Honeyman**[2]
[1] Scottish cochlear implant programme, Kilmarnock, United Kingdom | [2] Cochlear UK, Addlestone, Surrey, United Kingdom

STUDY AIM

To gain subjective information through patient diaries from adult Nucleus® CP900 Series Sound Processor recipients using Wireless Accessories and applying those outcomes to our paediatric practice.

SUBJECTS AND PROCEDURE

34 experienced adult Nucleus CP900 Series Sound Processor recipients were fitted with a Cochlear™ Wireless Accessory of their choice (five TV Streamers, 15 Mini Microphones, 14 Phone Clips). The recipients were issued with a diary and questionnaire (including baseline questions), and asked to complete them over a six week period. The recipients were instructed to use the Wireless Accessories in a range of listening environments and then record their experiences.

KEY OUTCOMES

TV Streamer: Four out of five recipients using the TV Streamer felt it worked well. Two recipients reported they did not need subtitles with use of the TV streamer.
Mini Microphone: 15 recipients were asked to try the Mini Microphone in 11 different environments. Prior to use of the Mini Microphone, 84/131 responses on the baseline questionnaire indicated that recipients could not hear well normally in their self-defined test environments. After six weeks use of the Mini Microphone, 117/131 questionnaire responses indicated that subjects could hear in the specified environment with the Mini Microphone.
Phone Clip: 14 recipients were asked to report three different uses with their phone. Prior to use of the Phone Clip, 34/42 responses on the baseline questionnaire indicated that recipients could not hear well normally in their self-defined test situations, however, after six weeks use of the Phone Clip, 38/42 responses indicated subjects could hear well in the self-defined situations with use of the Phone Clip. 13/14 recipients would purchase the Phone Clip if necessary. A majority of the negative feedback was based on patients not understanding they can adjust the mixing ratio of the microphone on the wireless accessories or not using the accessories in the correct way or in appropriate situations.

Phone Clip testimonial of one test recipient: "Thank you for putting me in this trial. I shall be using this Phone Clip every day to make my life so much easier. As far as I'm concerned it's the best thing since sliced bread!"

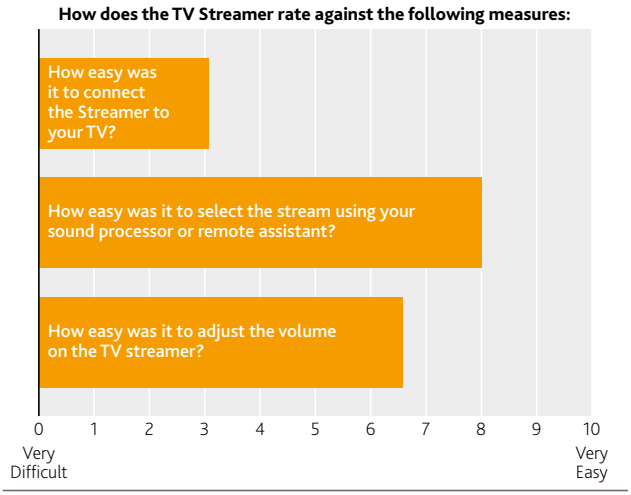

Figure 1 Average ease of use with the TV Streamer

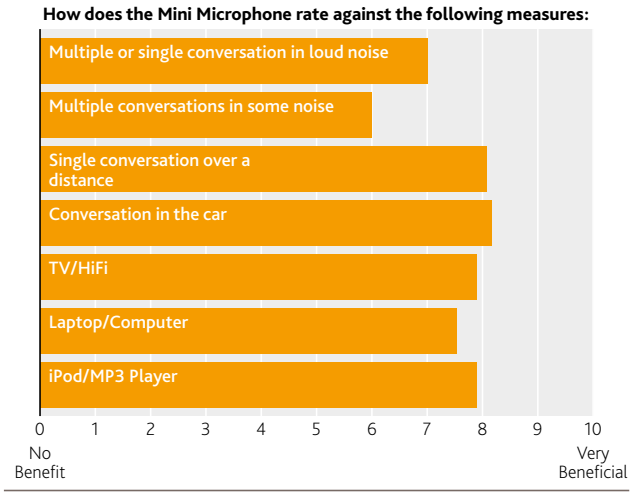

Figure2 Average benefit of Mini Microphone in various environments

CONCLUSION AND CLINICAL RECOMMENDATION

1. The ability to try these new products on adults is a valuable tool to assess the usage of products on a paediatric population including appropriate counselling of parents and child caregivers.
2. The data gathered allowed us to understand accessory usage in various environments, prompting us to create a guidance protocol on instructing patients how to mixing ratios and appropriately use the accessories. Counselling is key to gaining a positive outcome.
3. A large majority of patients demonstrated hearing improvements in challenging environments with use of their wireless accessory. They appreciated the freedom the Cochlear Wireless Accessories gave them as they could be used without wires and other associated devices. The Cochlear Wireless Accessories are simple, relatively low cost accessories which improved patients confidence and performance in various environments.

Hear now. And always

As the global leader in implantable hearing solutions, Cochlear is dedicated to bringing the gift of sound to people with moderate to profound hearing loss. We have helped over 400,000 people of all ages live full and active lives by reconnecting them with family, friends and community.

We give our recipients the best lifelong hearing experience and access to innovative future technologies. For our professional partners, we offer the industry's largest clinical, research and support networks.

That's why more people choose Cochlear than any other hearing implant company.

www.cochlear.com

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Please read the instructions for use provided with each device prior to use.

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