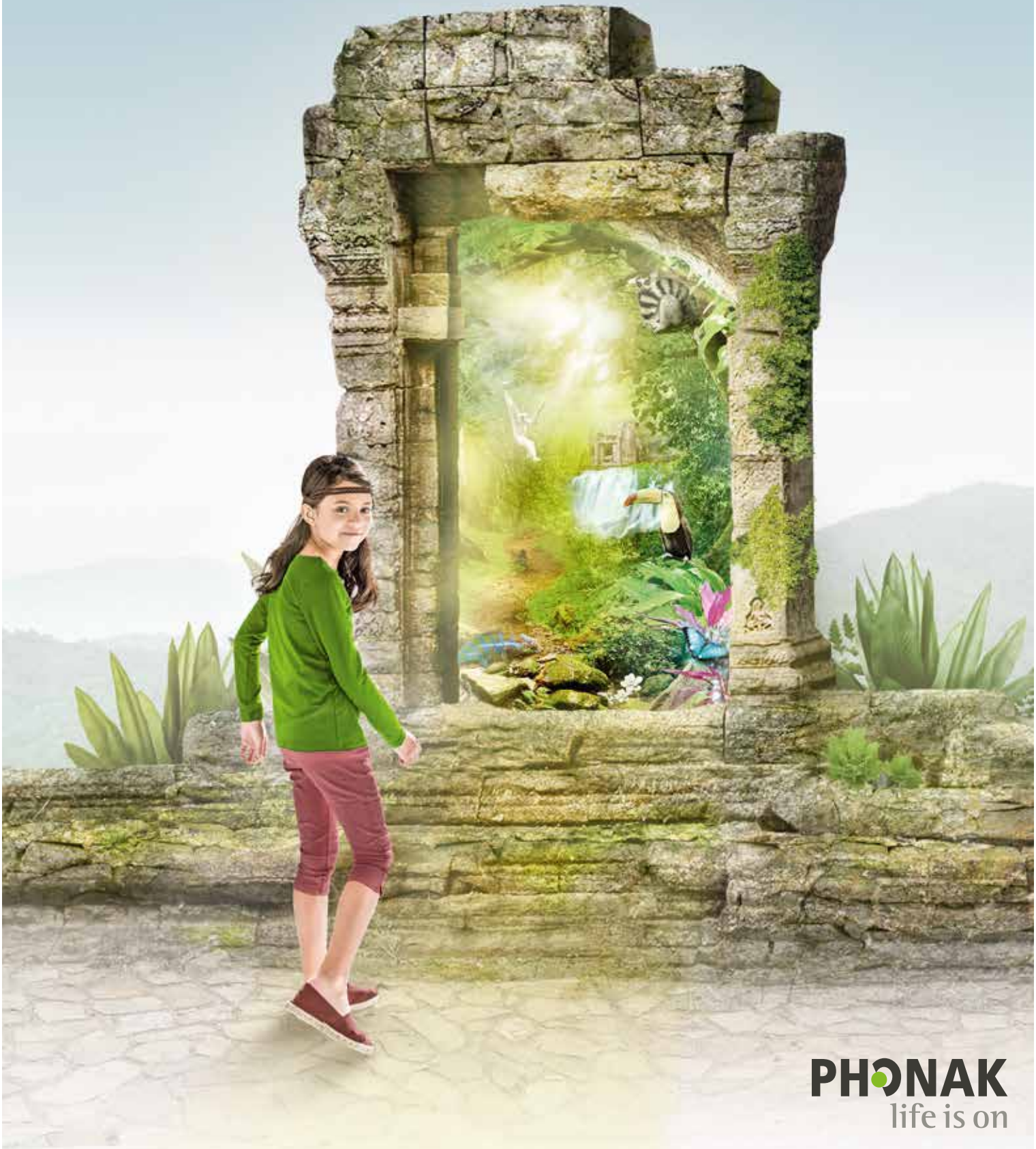
Phonak Research Pack



PHONAK
life is on

Phonak puts evidence-based research at the core of every new product and feature. You don't have to just take our word for it, we've compiled both Phonak, and independent third party studies so that you can learn the science behind our technologies.

Phonak, products created by the NHS, for the NHS.

AutoSense & Directionality

Phonak Studies:

AutoSense

Noise Technologies: What do kids need and what do they want?

Author: Wolfe, J., Rakita, L., Jones, C (2018)

Source: Phonak Field Study News

Abstract: This study describes school-age children's performance with and preference for a variety of different types of noise management technologies. Phonak Sky™ V90-P behind-the-ear hearing aids were fitted for 14 children with moderate to moderately-severe hearing loss.

> "Adaptive directional microphone mode resulted in a significant improvement in sentence recognition"

Conclusion: Use of the adaptive directional microphone mode resulted in a significant improvement in sentence recognition when speech arrived from the front (mean improvement of 24% relative to the omnidirectional condition. Compared to performance in the omnidirectional condition, use of Real Ear Sound provided an 8% improvement in sentence recognition when the signal arrived from in front of the child and essentially identical sentence recognition when the speech signal arrived from behind the child. Use of Real Ear Sound provided the best performance in the localization assessment. Finally, children expressed a strong preference for the collective use of each of the noise management technologies (i.e., noise gain-frequency response, adaptive directional mode, and noise reduction activated) both when speech arrived from the front and when speech arrived from behind.

Automatic and Directional for Kids

Author: Feilner, M., Rich, S., Jones, C

Source: Phonak Insight (2016)

Abstract: Children spend their time in a variety of listening situations throughout their day at home, outdoors and at school. Particularly, many school situations are noisy and it can be very challenging for a child to hear, understand and perform well in the classroom (even when a Roger system is routinely used by the teacher). The benefits of automatic programs and directional microphones have been clearly established for adults in noisy environments.

An in-depth analysis of multiple classrooms with children who have hearing loss, across multiple countries, revealed that as much as 1/3 of a child's school day is spent in situations where it is difficult to understand and fully participate. This analysis resulted in the development and implementation of two innovative functionalities in Phonak Sky V hearing instruments: AutoSense Sky OS, the new paediatric automatic operating system and the new 'Roger and directional' setting offering an adaptively activated fixed beamformer in the Roger programme with and without an active Roger microphone.

Conclusion: McCreery and colleagues (2012) completed an evidence based systematic review that included qualified studies examining the efficacy of directional microphones for school-aged children with hearing loss. Evidence-based systematic reviews utilise strict criteria for including studies in the body of evidence (see the original paper for those criteria). The authors reported results from seven studies published between 1981 and 2011 that met the criteria for the systematic review. From those studies, they reported the following outcomes:

- Speech recognition of directional microphones were more effective than omnidirectional microphones when speech was directly in front and noise directly behind listeners. Omnidirectional microphones were more effective when speech was not directly in front of listeners.
- Self- or parent-report of children preferred directional microphones over omnidirectional microphones for the majority of situations in one study, but there were no differences between the two microphone types in another study, as reported by children or their parents.

Following their evidence-based review, the authors concluded: "Given the number of potential acoustic environments that a school-age child might experience in home, academic, and social situations, directional microphones may be beneficial in some situations and equivocal or detrimental in others." (p. 309)

Third Party Studies:

AutoSense

An Evidence-based systematic review of directional microphones and digital noise reduction hearing aids in school-age children with hearing loss.

Author: McCreery, R., Venediktov, R., Coleman, J., & Leech, H.

Source: American Journal of Audiology (2012), 21, 295-312

Abstract: The purpose of this evidence-based systematic review was to evaluate the efficacy of digital noise reduction and directional microphones for outcome measures of audibility, speech recognition, speech and language, and self- or parent-report in paediatric hearing aid users.

Conclusion: On the basis of a moderate level of evidence, digital noise reduction was not found to improve or degrade speech understanding. Additional research is needed before conclusions can be drawn regarding the impact of digital noise reduction on important speech, language, hearing, and satisfaction outcomes. Moderate evidence also indicates that directional microphones resulted in improved speech recognition in controlled optimal settings; however, additional research is needed to determine the effectiveness of directional microphones in actual everyday listening environments.

> “Directional microphones resulted in improved speech recognition”

Clinical Practice Guidelines on Pediatric Amplification

Source: American Academy of Audiology (2013)

Abstract: AAA guidelines (2013) provide an evidence base that can be used by clinicians to make decisions related to amplification for the paediatric population. In these guidelines, both research evidence and clinical expertise were used to develop recommendations. Directional microphones are addressed in the section on hearing aid audio signal processing. The references in the evidence base include studies of adults as well as children.

Conclusion: From the studies focus on Paediatrics, the following outcomes are reported:

- Directional microphones provided benefit when a school environment was simulated if the child faced the target signal but resulted in greater difficulty when the target signal was behind the listener. The benefits from a directional microphone were smaller than those obtained with FM remote microphone hearing assistance technology. Based on review of the evidence, the following recommendations were made:
- Do not use directional microphones full-time.
    - Directional microphones may be recommended for children for some environments, with the understanding that they may reduce the audibility of off-axis talkers.
    - Technology that automatically switches the microphone between directional and omnidirectional modes of operation should be considered, with the caveat that the professional is responsible for understanding how the adaptive program functions as well as environments where it will be appropriate. In addition, omnidirectional mode might be preferred over automatic switching in some cases.
- Remote microphone systems will provide SNR improvements equal to or greater than directional microphones in hearing aids when those systems are prescribed/used appropriately.

Efficacy of an Adaptive Directional Microphone and a Noise Reduction System for School-Aged Children

Author: Auriemmo, J., Kuk, F., Lau, C., et al. (2009)

Source: Journal of Educational Audiology, 15, 15-27

Abstract: A non-randomised, experimental study utilising double-blinding was implemented to investigate differences in word recognition performance of school-aged children utilising adaptive directional microphone and noise reduction (NR) features. Children from two educational facilities participated in this study. Signal-to-Noise Ratio (SNR) benefit of the adaptive directional system was estimated to be 7.6 dB. No SNR benefit was measured for the NR feature; however, no decrease in performance was observed either. Subjective difficulty for desired sounds originating from various azimuths was not significantly greater in either the adaptive directional or NR modes.

Conclusion: Results indicate that for the purposes of improving SNR, adaptive directional microphone systems, but not NR systems, are potentially efficacious hearing aid fitting options for school-aged children.

Evaluation of Adaptive Noise Management Technologies for School-Aged Children with Hearing Loss

Author: Wolfe, J., Duke, M., Schfer, E. et al (2017)

Source: Journal of the American Academy of Audiology (2017) 28(5):415-435

Abstract: Children with hearing loss experience significant difficulty understanding speech in noisy and reverberant situations. Adaptive noise management technologies, such as fully adaptive directional microphones and digital noise reduction, have the potential to improve communication in noise for children with hearing aids. However, there are no published studies evaluating the potential benefits children receive from the use of adaptive noise management technologies in simulated real-world environments as well as in daily situations. The objective of this study was to compare speech recognition, speech intelligibility ratings (SIRs), and sound preferences of children using hearing aids equipped with and without adaptive noise management technologies. A single-group, repeated measures design was used to evaluate performance differences obtained in four simulated environments. In each simulated environment, participants were tested in a basic listening programme with minimal noise management features, a manual program designed for that scene, and the hearing instruments' adaptive operating system that steered hearing instrument parameterisation based on the characteristics of the environment. Twelve children with mild to moderately severe sensorineural hearing loss. Speech recognition and SIRs were evaluated in three hearing aid programmes with and without noise management technologies across two different test sessions and various listening environments. Also, the participants' perceptual hearing performance in daily real-world listening situations with two of the hearing aid programmes was evaluated during a four- six week field trial that took place between the two laboratory sessions.

Conclusion: On average, the use of adaptive noise management technology improved sentence recognition in noise for speech presented in front of the participant but resulted in a decrement in performance for signals arriving from behind when the participant was facing forward. However, the improvement with adaptive noise management exceeded the decrement obtained when the signal arrived from behind. Most participants reported better subjective SIRs when using adaptive noise management technologies, particularly when the signal of interest arrived from in front of the listener. In addition, most participants reported a preference for the technology with an automatically switching, adaptive directional microphone and adaptive noise reduction in real-world listening situations when compared to conventional, omnidirectional microphone use with minimal noise reduction processing. Use of the adaptive noise management technologies evaluated in this study improves school-age children's speech recognition in noise for signals arriving from the front. Although a small decrement in speech recognition in noise was observed for signals arriving from behind the listener, most participants reported a preference for use of noise management technology both when the signal arrived from in front and from behind the child. The results of this study suggest that adaptive noise management technologies should be considered for use with school-age children when listening in academic and social situations.

> **"Adaptive noise management technologies should be considered for use with school- age children"**

Directional benefit in simulated classroom environments

Author: Ricketts, T., Glaster, J., & Tharpe, A. (2007)

Source: Journal of Audiology, 16, 130-143

Abstract: To examine speech recognition performance and subjective ratings for directional and omnidirectional microphone modes across a variety of simulated classroom environments. Speech recognition was measured in a group of 26 children age 10-17 years in up to eight listening environments.

Conclusion: Although these data support the use of directional hearing aids in some noisy school environments, they also suggest that use of the directional mode should be limited to situations in which all talkers of interest are located in the front hemisphere. These results highlight the importance of appropriate switching between microphone modes in the school-age population.

Children's speech recognition in noise using omni-directional and dual-microphone hearing aid technology

Author: Gravel, J., Fausel, N., Liskow, C., and Chobot, J. (1999)

Source: Ear & Hearing, 20(1), 1-11

Abstract: The purpose of this study was to examine children's speech recognition abilities for words and sentences presented in background noise when the children used omni-directional and dual-microphone hearing aid technology.

Conclusion: Under the specific test conditions used in this investigation, dual-microphone hearing aid technology provided a significant listening advantage in background competition over conventional omni-directional microphones for children with mild to severe cochlear hearing loss for both word and sentence test materials.

> "Dual-microphone hearing aid technology provided a significant listening advantage"

Hearing Impaired Children's Preference for, and Performance with, Four Combinations of Directional Microphone and Digital Noise Reduction Technology

Author: Pittman, A. & Hiipakka, M. (2013)

Source: Journal of the American Academy of Audiology, 24, 832-44

Abstract: Before advanced noise-management features can be recommended for use in children with hearing loss, evidence regarding their ability to use these features to optimise speech perception is necessary.

> "Children's preference appeared to be goverened by listening comfort"

The purpose of this study was to examine the relation between children's preference for, and performance with, four combinations of noise-management features in noisy listening environments. Fifteen children between the ages of 8 and 12 with moderate, bilateral hearing loss, were asked to repeat short sentences presented in steady-state noise or in multitalker babble while wearing ear-level hearing aids. The aids were programmed with four memories having an orthogonal arrangement of two noise-management features. The children were also asked to indicate the hearing aid memory that they preferred in each of the listening conditions both initially and after a short period of use.
Results: The children's preference for noise management aligned well with their performance for at least three of the four listening conditions. The configuration of noise-management features had little effect on speech perception with the exception of reduced performance for speech originating from behind the child while in a directional hearing aid setting. Additionally, the children's preference appeared to be governed by listening comfort, even under conditions for which a benefit was not expected such as the use of digital noise reduction in the multitalker babble conditions.

Conclusion: The results serve as evidence in support of the use of noise-management features in grade-school children as young as eight years of age.

Head Angle and Elevation in Classroom Envrionments: Implications for Amplification

Author: Ricketts, A., Glaster, J., (2008)

Source: Journal of Speech, Language and Hearing Research, 51, 516-525

Abstract: The purpose of this study was to examine children's head orientation relative to the arrival angle of competing signals and the sound source of interest in actual school settings. These data were gathered to provide information relative to the potential for directional benefit.

Conclusion: These data are consistent with the hypothesised association between hearing loss and increased visual monitoring. In addition, these results suggest that age does not limit the potential for signal-to-noise improvements from directivity-based interventions in noisy environments.

Speech Recognition for bilateral asymmetric and symmetric hearing aid microphone modes in simulate classroom environments.

Author: Ricketts, T., & Picou, E. (2013)

Source: Ear and Hearing, 34, 601-609

Abstract: This study aimed to evaluate the potential utility of asymmetrical and symmetrical directional hearing aid fittings for school-age children in simulated classroom environments. This study also aimed to evaluate speech recognition performance of children with normal hearing in the same listening environments.

Conclusion: Bilateral directional microphones can be effective in improving speech recognition performance for children in the classroom, as long as the child is facing the talker of interest. Bilateral directional microphones, however, can impair performance if the signal originates from behind a listener. However, these data suggest that the magnitude of decrement is not predictable from an individual's benefit. The results re-emphasise the importance of appropriate switching between microphone modes so children can take full advantage of directional benefits without being hurt by directional decrements. An asymmetric fitting limits decrements, but does not lead to maximum speech recognition scores when compared with the optimal symmetrical fitting. Therefore, the asymmetric mode may not be the best option as a default fitting for children in a classroom environment. While directional microphones improve performance for children with hearing loss, their performance in most conditions continues to be impaired relative to their normal-hearing peers, particularly when the signals of interest originate from behind or from an unpredictable location.

Phonak Sky™ Marvel

Combining world's first technological innovations and child-specific designs to support children of all ages, introducing Sky Marvel.

Sky M-M Sky M-SP

What makes Marvel even more marvellous

AutoSense OS 3.0

The newest generation of the proprietary Phonak technology recognises and automatically adapts to precisely match more listening situations than ever before. With the new AutoSense OS 3.0 only Phonak Marvel can automatically classify streamed speech and streamed music signals for an enhanced listening experience. It seamlessly adapts and applies a calculated gain to different hearing situations and environments for an optimised listening experience.

- Identifies even more listening situations
- Classifies streamed signals for optimal speech and music experience
- Top rated streamed sound quality[1]

Binaural VoiceStream Technology™

This unique technology allows Phonak Marvel hearing aids to stream the full audio bandwidth in real-time and bi-directionally between both hearing aids. This enables programs and features such as Speech in loud noise, Speech in 360° and DuoPhone and leads to improved sound quality and unmatched speech understanding. Binaural VoiceStream Technology can be facilitated during the counselling process to allow the client to experience the benefit of binaural features.

- Better speech understanding in noise[2]
- Less listening effort in noise[3]

1 Legarth, S., Latzel, M. & Rodrigues, T. (2018). Media streaming: The sound quality wearers prefer, Phonak Field Study News, retrieved from www. phonakpro.com/evidence, accessed October 17th, 2018.

2 Stewart, E., Rakita, L. & Drexler, J. (2019). StereoZoom Part 1: The benefit of wirelessly connected narrow directionality in Phonak hearing aids for speech intelligibility. Phonak Compendium, retrieved from www.phonakpro.com/evidence, accessed August 19th, 2019.

3 Winneke, A., Latzel, M. & Appleton-Huber (2018). Less listening- and memory effort in noisy situations with StereoZoom, Phonak Field Study News, retrieved from www. phonakpro.com/evidence, accessed October 17th, 2018.

Use of a Digital Hearing Aid with Directional Microphones in School-aged Children

Author: Kuk, F., Kollofski, C., Brown, S., et al.

Source: Journal of the American Academy of Audiology (1999) 10: 535-548

Abstract: The efficacy of a digital hearing aid with a directional microphone was examined in a school-aged population . Twenty children (9 with a mild-to-moderately-severe hearing loss and 11 with a moderate-to-severe hearing loss) between $7^{1}/_{2}$ and $13^{2}/_{3}$ years of age wore the study hearing aids binaurally for 30 days prior to the evaluation . The testing protocol included speech recognition tests using the CID W-22 word lists presented at 72 dB SPL, 65 dB SPL, and 52 dB SPL (at 0° azimuth) in the presence of a 65 dB SPL party noise (180° azimuth) . Subjective rating of hearing aid efficacy in the classroom was examined using the Listening Inventory For Education (LIFE) questionnaire . Parental impression on hearing aid efficacy was also collected at the end of the study.

Conclusion: The results showed improved speech recognition in noise with the digital directional hearing aid at all presentation levels. Preference for the digital directional hearing aids over the subjects' own omnidirectional analoge hearing aids was also seen on the LIFE questionnaire and parental impression. The degree of hearing loss did not seem to have affected the benefits offered by the digital directional hearing aids . These results were compared to results from other studies on the use of directional microphones in hearing aids.

An exploration of nonquiet listening at school

Author: Cruckley, J., Scollie, S., & Parsa, V.

Source: Journal of Educational Audiology (2011) 17, 23-35

Abstract: The first goal of this study was to describe acoustic properties across an entire day in each of three educational environments: daycare (pre-kindergarten), a primary school (kindergarten to year 6), and a high school (years 7 through 11). Instructional and non-instructional listening situations were included in this description. Second, we classified the various listening situations experienced by the cohorts at each school. Three sites participated in this study. At each site, empty room measurements were obtained, including noise floor and reverberation levels, across the various rooms frequently occupied by the participating cohorts of children. Next, the first author followed the cohorts throughout their regular school routines, recording sound level data with a dosimeter and documenting observations of the types of listening situations encountered by the children. Noise floor, reverberation, and sound levels were compared to classroom standards and large scale classroom studies. The cohorts in this study encountered highly variable acoustic environments throughout the day, for signal levels, noise sources, and reverberation properties.

Conclusion: These results have implications for digital signal processing and hearing instrument fitting approaches for school-age children. Furthermore, the results of this exploratory study may impact on future research on classroom acoustics.

> "Improved speech recognition in noise with the digital directional hearing aid"

Directional Effects on Infants and Young Children in Real Life: Implications for Amplification

Author: Ching, T., O'Brien, A., Dillion, H., et al.

Source: Journal of Speech, Language and Hearing Research (2009) 52(5), 1241-1254

Abstract: his study examined the head orientation of young children in naturalistic settings and the acoustics of their everyday environments for quantifying the potential effects of directionality.

Conclusion: The findings suggest that directional microphones in personal hearing devices for young children are not detrimental and have much potential for benefits in real life. The benefits may be enhanced by fitting directionality early and by counselling caregivers on ways to maximise benefits in everyday situations.

Effects of digital noise reduction technology on speech perception for children with hearing loss

Author: Stelmachowiz, R., et al

Source: Ear and Hearing, (2010) 31(3), 345-355

Abstract: Stelmachowicz et al. (2010) evaluated the potential benefits and limitations of noise reduction in a group of 16 children with hearing loss and found no difference in speech recognition in noise in both the noise reduction 'on' and 'off' conditions.

Conclusion: Although noise reduction technology provided no improvement in speech recognition in noise, Stelmachowicz and colleagues concluded that noise reduction technology may still be beneficial for children because it may potentially improve listening comfort and reduce cognitive load and fatigue.

SoundRecover

Phonak Studies:

SoundRecover

SoundRecover2 for Pediatrics: Audibility where it matters most

Author: Wolfe, J

Source: Phonak Field Study News

Abstract: The potential benefit of a new adaptive version of non-linear frequency compression (NLFC) that permits the use of lower compression ratios and higher cut-off frequencies was evaluated in a study with children. This study compared hearing performance, including audibility and speech recognition, to outcomes obtained with the original NLFC algorithm. The findings suggest that the new adaptive version of NLFC results in improved access to high-frequency speech sounds and improved recognition of speech sounds and monosyllabic CVC words without detriment to speech recognition. This new adaptive NLFC processing, termed NLFC-2, constitutes the basis of SoundRecover2 from Phonak, introduced in 2016.

Conclusion: NLFC-2, the base algorithm for the adaptive SoundRecover2 processing scheme, was compared to NLFC-1, the original SoundRecover frequency lowering algorithm, to evaluate audibility and speech recognition associated with the use of an adaptive non-linear frequency compression in children. The results show that when compared to performance of the original version of NLFC (e.g. SoundRecover), the use of adaptive NLFC: - improves access to high-frequency speech sounds - improves the recognition of monosyllabic CVC words - does not result in detriment in speech recognition In addition, long-term users of conventional NLFC (e.g. original SoundRecover) were able to successfully switch to adaptive NLFC without a long period of acclimatisation.

Third Party Studies:

SoundRecover

Evaluation of non-linear frequency compression for school-age children with moderate to moderately-severe hearing loss.

Author: Wolfe, J., John, A., Schafer, E., Nyfeller, M., Boretzki, M., Caraway, T.

Source: Journal of the American Academy of Audiology (2010) 21(10) 618-628

Abstract: Previous research has indicated that children with moderate hearing loss experience difficulty with recognition of high-frequency speech sounds, such as fricatives and affricates. Conventional behind-the-ear (BTE) amplification typically does not provide ample output in the high frequencies (4000 Hz and beyond) to ensure optimal audibility for these sounds.

Conclusions: These results indicate that NLFC improves audibility for and recognition of high-frequency speech sounds for children with moderate to moderately severe hearing loss in quiet listening situations.

> "NLFC improves audibility for and recognition of high-frequency speech sounds"

Long-term effects of non-linear frequency compression for children with moderate hearing loss

Author: Wolfe, J., John, A., Schafer, E., et al

Source: International Journal of Audiology (2011) 50, 396-404

Abstract: The study aims to evaluate non-linear frequency compression (NLFC) as a means to improve speech recognition for children with moderate to moderately-severe hearing loss following a six-month acclimatization period. Study Sample: Fifteen children, ages 5 to 13 years, with moderate to moderately-severe high-frequency sensorineural hearing loss were fitted with Phonak Nios, micro-sized, BTE hearing aids and evaluated after two six-week intervals with and without NLFC and again after a six-month period of consecutive NLFC use. Using repeated measures analyses, the six-month results were compared to data that was collected following six-week trials with and without NLFC hearing aids. Improvements seen with NLFC in the initial study were maintained or significantly increased in the present study. When compared to the six-week data, aided non-sense syllable speech recognition thresholds in quiet and speech recognition in noise were significantly better at the six-month interval.

Conclusions: These results suggest that NLFC improves audibility for and recognition of high-frequency speech sounds for children with moderate to moderately-severe hearing loss. In many cases, improvements found with NLFC increased with a longer period of acclimatisation to the technology.

A Comparison of Performance in Children with Non-linear Frequency Compression Systems

Author: Glista D. Scollie S. Polonenko M. Sulkers J.

Source: Hearing Review (2009) Published November 3rd

Abstract: As found in a previous study, children with lower speech recognition/ detection scores using hearing aids without nonlinear frequency compression (NFC) benefited most when NFC was made available. NFC benefit was significantly correlated with higher levels of hearing loss. However, some children show the additional effect of continued improvement over time, due to maturation, acclimatization effects, or both.

Conclusion: Overall, the results of this study indicate that the benefit from NFC reported by Glista et al generalised successfully from prototypes to commercially released hearing aids. Individual factors in outcome may include the fitting approach (all children in this work received individualized and verified fittings), as well as the audiometric profile of each child. Individualized assessment of the need for NFC, as for any signal processing feature, is encouraged.

> "Individual assessment of the need for NFC is encouraged"

The influence of audibility on speech recognition with nonlinear frequency compression for children and adults with hearing loss

Author: McCreery, R., Alexander, J., Brennan, M et al

Source: Ear and Hearing (2014) 35(4): 440-447

Abstract: The primary goal of nonlinear frequency compression (NFC) and other frequency lowering strategies is to increase the audibility of high-frequency sounds that are not otherwise audible with conventional hearing-aid processing due to the degree of hearing loss, limited hearing aid bandwidth or a combination of both factors. The aim of the current study was to compare estimates of speech audibility processed by NFC to improvements in speech recognition for a group of children and adults with high-frequency hearing loss.

Conclusion: Word recognition with NFC was higher than CP for children and adults with mild to severe hearing loss. The average improvement in speech recognition with NFC (7%) was consistent with the modified SII, which indicated that listeners experienced an increase in audibility with NFC compared to CP. Further studies are necessary to determine if changes in audibility with NFC are related to speech recognition with NFC for listeners with greater degrees of hearing loss, with a greater variety of compression settings, and using auditory training.

Nonlinear Frequency Compression for Children with Moderate Hearing Loss

Author: Jace Wolfe

Source: A Sound Foundation Through Early Amplifcation. Chapter 17 pgs 217-225

Objective: Previous research has indicated that children with moderate hearing loss experience difficulty with recognition of high frequency speech sounds, such as fricatives and affricates. Conventional BTE amplification typically does not provide ample output in the high frequencies (4000 Hz and beyond) to ensure optimal audibility for these sounds. Through this study, the aim was to evaluate nonlinear frequency compression (NLFC) as a means to improve speech recognition for children with moderate to moderately severe hearing loss.

Conclusion: Aided thresholds for high-frequency stimuli were significantly better when NLFC was enabled, and used of NLFC resulted in significantly better speech recognition in quiet for the UWO Plural Test and for the phonemes /d/ and /s/ on the Phonak Logatome test. There was not a statistically significant difference in performance on the BKB-SIN test between the NLFC enabled and disabled conditions. These results indicated that NLFC improves audibility for and recognition of high-frequency speech sounds for children with moderate to moderately severe hearing loss in quiet listening situations.

Case Study Outcomes of Hearing Impaired Listeners Using Nonlinear Frequency Compression Technology

Author: Bagatto M., Scollie S., Glista D., Pasa V., Seewald R.

Source: Audiology Online, 17th March 2008

Abstract: These case studies illustrate the effects of a prototype NFC hearing aid relative to the same hearing aid fitting without NFC. The NFC technology was evaluated using both objective and subjective measures. The subjects presented here had severe to profound high-frequency hearing loss and the NFC parameters were set similarly. Both showed significant improvement on at least one speech recognition task when NFC was enabled. What is of interest when comparing the two subjects reported here is that the adult subject did not report a preference for NFC technology even though his performance improved. This was not the case for the child. NFC was preferred by the child when compared to Conventional technology. There is literature to suggest that children need more high-frequency audibility compared to adults for speech and language development to be consistent, and this could be the focus of future research (Stelmachowicz, Pittman, Hoover, Lewis, & Moeller, 2001).

Conclusion: NFC technology provided significant benefit for both the adult and child listener when compared to Conventional technology. However, the adult subject did not report a preference for NFC technology while the child subject did.

Evaluation of nonlinear frequency compression: Clinical outcomes

Author: Glista, D., Scollie, S., et al

Source: International Journal of Audiology (2009) 48(9) 632-644

Abstract: This study evaluated prototype multichannel nonlinear frequency compression (NFC) signal processing on listeners with high-frequency hearing loss. This signal processor applies NFC above a cut-off frequency. The participants were hearing-impaired adults (13) and children (11) with sloping, high-frequency hearing loss. Multiple outcome measures were repeated using a modified withdrawal design. These included speech sound detection, speech recognition, and self-reported preference measures. Group level results provide evidence of significant improvement of consonant and plural recognition when NFC was enabled. Vowel recognition did not change significantly. Analysis of individual results allowed for exploration of individual factors contributing to benefit received from NFC processing.

Conclusion: Findings suggest that NFC processing can improve high frequency speech detection and speech recognition ability for adult and child listeners. Variability in individual outcomes related to factors such as degree and configuration of hearing loss, age of participant, and type of outcome measure.

An Evidence-based Systematic Review of Frequency Lowering in Hearing Aids for School-Age Children with Hearing Loss.

Author: McCreery, R., Venediktov, R., Coleman, J., Leech, H.

Source: American Journal of Audiology (2012) 12

Abstract: Authors developed one clinical question for this review, which addressed the comparison of hearing aids using frequency lowering compared to conventional processing amplification for outcomes of audibility, speech recognition, speech and language, and self- or parent-report for children with hearing loss.

Conclusions: Whereas methodological limitations of the included studies preclude the formulation of strong conclusions, findings were generally positive across frequency-lowering strategies and outcomes. Additional high-quality research is needed in this area.

Study suggests that non-linear frequency compression helps children with moderate loss

Author: Wolfe, J., Caraway, T., et al

Source: The Hearing Journal (2009) 62(9) 32-37

Abstract: The preliminary findings of this study suggest that non-linear frequency compression has the potential to substantially improve acquisition and identification of high-frequency speech signals and environmental sounds compared to conventional high-end digital amplification. This type of full-time access to inputs across the entire speech range is critical for developing age-appropriate speech, language, and auditory skills. It is possible that using NLFC can enable young children to overcome many of the deficits that have been found in children with mild to moderate hearing loss.

Conclusion: In the future, we will compare performance with the study aid between the NLFC enabled and disabled conditions and we will seek to identify parameters that influence the benefit children with moderate hearing loss receive from NLFC. For now, we conclude that NLFC should be considered as an option for children with mild to moderately severe hearing loss.

> “NFC should be considered as an option for children”

> “Adaptive test procedures showed small but significant improvements in the detection and recognition of the phonemes /s/ and /sh/ with NLFC condition”

Evaluation of wideband frequency responses and non-linear frequency compression for children with mild to moderate high-frequency hearing loss

Author: Wolfe, J, John, A., Scollie, S., et al.

Source: International Journal of Audiology (2015) 54(3), 170-181

Abstract: The study aims to evaluate wideband amplification and non-linear frequency compression (NLFC) as a means to improve speech recognition for children with mild/moderate hearing loss*. Design: Randomised within-subject design with repeated measures across test conditions. (Eleven children with mild to moderate hearing loss were evaluated with: (1) Phonak BTE without NLFC, (2) Phonak BTE with NLFC, and (3) Oticon BTE with wideband response extending to 8000 Hz). Results: Use of NLFC provided better detection and recognition of high-frequency stimuli (e.g. /sh/ and /s/). No difference in performance between conditions was observed for speech recognition when measured with the University of Western Ontario (UWO) plurals test and the UWO distinctive features difference test. Finally, there were no differences between conditions on the BKB-SIN test.

Conclusions: Children with mild to moderate hearing loss have good access to high-frequency phonemes presented at fixed levels (e.g. 50 to 60 dBA) with both wideband and NLFC technology. Similarly, sentence recognition in noise was similar with wideband and NLFC. Adaptive test procedures that probe performance at lower input levels showed small but significant improvements in the detection and recognition of the phonemes /s/ and /sh/ with NLFC condition when compared to the NLFC Off and wideband conditions.

*Sampling eleven children with mild to moderate

Nonlinear Frequency Compression: Effects on Sound Quality Ratings of Speech and Music

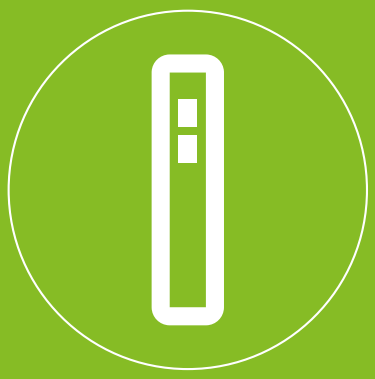
Author: Parsa, V., Scollie, S., Glista, D., et al

Source: Sage Journals (2013)

Abstract: Frequency lowering technologies offer an alternative amplification solution for severe to profound high frequency hearing losses. While frequency lowering technologies may improve audibility of high frequency sounds, the very nature of this processing can affect the perceived sound quality. This article reports the results from two studies that investigated the impact of a nonlinear frequency compression (NFC) algorithm on perceived sound quality. In the first study, the cut off frequency and compression ratio parameters of the NFC algorithm were varied, and their effect on the speech quality was measured subjectively with 12 normal hearing adults, 12 normal hearing children, 13 hearing impaired adults, and 9 hearing impaired children. In the second study, 12 normal hearing and 8 hearing impaired adult listeners rated the quality of speech in quiet, speech in noise, and music after processing with a different set of NFC parameters.

Conclusion: Results showed that the cut off frequency parameter had more impact on sound quality ratings than the compression ratio, and that the hearing impaired adults were more tolerant to increased frequency compression than normal hearing adults. No statistically significant differences were found in the sound quality ratings of speech-in-noise and music stimuli processed through various NFC settings by hearing impaired listeners. These findings suggest that there may be an acceptable range of NFC settings for hearing impaired individuals where sound quality is not adversely affected. These results may assist an Audiologist in clinical NFC hearing aid fittings for achieving a balance between high frequency audibility and sound quality.

Roger



Third Party Studies:

Roger

A powerful noise-fighting duo: Roger™ and Phonak directionality

Author: Christine Jones, Lori Rakita

Source: Field Study News 2016

Abstract: The use of a remote microphone is an effective solution for improving access to a talker in noise. However, it has always been implemented at the cost of directional processing for the hearing aid inputs. Phonak has for the first time implemented directional microphone settings within the Roger+Mic programme of the paediatric portfolio, Phonak Sky V. The Phonak Audiology Research Centre (PARC) worked in collaboration with Jace Wolfe, Ph.D. to evaluate the benefit of this feature for speech understanding of peers in quiet and noise. The results indicate that the use of an adaptively-activated fixed beamformer in the Roger+Mic programme improves near field speech in noise performance by 26%, preserves hearing from all directions and maintains the strong Roger benefit for understanding speech from a distance, either in the classroom, home or outdoors using a remote microphone.

Conclusion: The results of this investigation demonstrate the near-field benefit of adaptively activating a hearing aid directional microphone in combination with a Roger remote microphone. In noise, the Roger+Mic directional allows listeners to hear both a primary speaker and environmental input without compromise. This feature is especially relevant in dynamic classroom situations requiring students to follow teacher instruction and discuss or collaborate with peers. For children who might only have access to a Roger+Mic programme, this innovation offers not only improved hearing in noise with Roger, but also the additional advantage of adaptive activation of the directional microphone when Roger is not in use. As the adaptive activation of the fixed beamformer is based on noise level and the presence of speech, the chance of any undesirable suppression of important signals from behind is minimised in the absence of background noise. This new Phonak innovation offers listeners the best of both worlds for the first time – the established benefit of far-field hearing performance with Roger, now with the near-field hearing performance of a directional microphone.

Teens and technology Use and disuse of remote microphones explored in survey of students

Author: Christine Jones

Source: Field Study News March 2017

Abstract: The use of remote microphones has proven benefits for children in classroom environments. However, there is a steady decline in use of these systems as children approach high school. To understand the reasons for use and disuse of these systems, a survey was administered to 83 students aged 13 to 18. Findings showed that students who continue to use remote microphone (RM) systems acknowledged the benefit in classroom situations and take responsibility for using the systems, showing strong self-advocacy skills. Non-users conversely reported less perceived benefit, dislike for the cosmetics of the system and an aversion to handing the microphone to the teacher. These responses highlight the potential to increase remote microphone use in teens by improving performance with additional use cases and improving designs with inconspicuous products and less obtrusive handling.

Conclusion: The results of this survey indicate that a majority of teens in this suburban school district are successful and willing users of RM systems. On the other hand, opportunities continue to exist for the roughly one quarter of high school students who chose to stop using RM systems primarily for cosmetics and poor perceived benefit. All of the primary reasons cited point to the possibility that future RM innovations can better meet the demands of this population. Details pertaining to how cosmetics could be improved were not explored, but presumably smaller ear level devices and transmitters that are beneficial without being handed to the teacher would be appealing. Technologies such as the Roger Touchscreen Mic can adapt microphone behavior to the use case based on the position of the device and effectively broadcast input from peers working together in groups. The applicability of these adaptive behaviors should be further explored for classroom applications. Finally, since it was shown that successful teen RM users do so based on their perceived benefit and of their own volition, continued exploration of the needs and preferences of this group would support future innovation and potentially maintain more teens as RM users.

Reduced physiologic stress in children with autism using Roger™ technology

Author: Philippa James, Professor Gary Rance

Source: Field Study News August 2017

Abstract: It is established that children with Autism Spectrum Disorder (ASD) have greater difficulties processing speech in the presence of background noise compared to their peers. Research has shown that wireless communication systems that significantly improve the auditory signal delivered to the ear are beneficial to these children. In a research study conducted at the University of Melbourne, Australia, listening-related stress in children with ASD was examined with and without the use of either Roger Focus receivers or Roger DigiMaster 5000 soundfield amplification systems installed in classrooms. Results of the study show significantly improved listening, communication, and social interaction, as well as reduction in physiologic stress levels (salivary cortisol concentration) during structured listening tasks.

Conclusion: The outcomes of this study are congruent with the results of previous studies highlighting the audiologic benefits of wireless remote microphone technology in children diagnosed with ASD. Use of Roger Focus receivers resulted in significantly improved speech perception in background noise and fewer reported listening and communication challenges in this group of children. This study is the first to demonstrate a reduced physiologic stress response with use of Roger technology. Relative salivary cortisol levels were significantly lower during participation in complex one-on-one and group listening tasks with use of Roger technology compared to without. Given that communication difficulties are a core feature and major source of anxiety in individuals with ASD, the results of this study have important implications for the general health and well-being of children affected by ASD.

> “Use of Roger focus results in significantly improved speech perception in background noise”

Life is on

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