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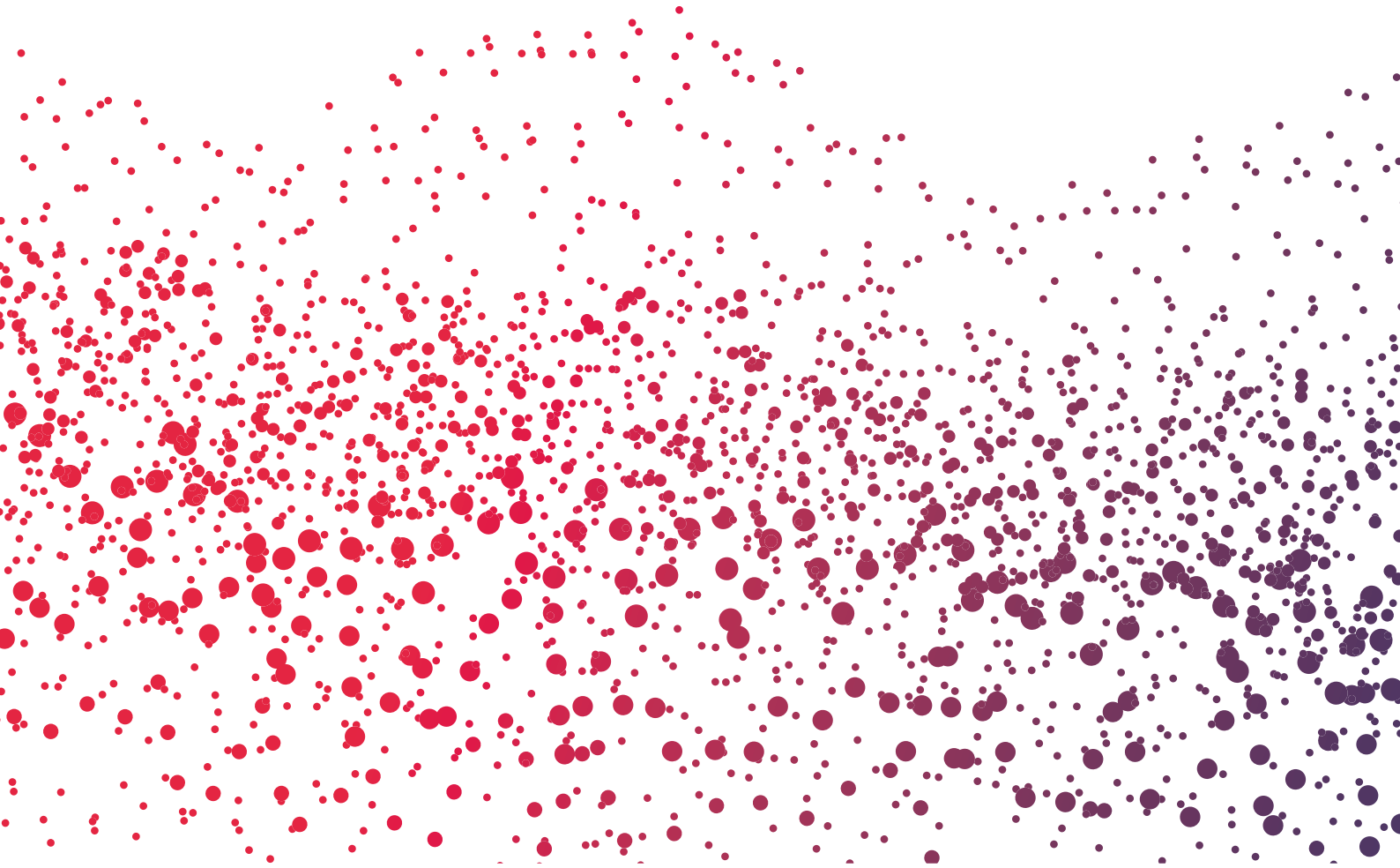

Consistent hearing aid use is associated with lower fall prevalence and risk in older adults with hearing loss.

The Extent of Hearing Input Affects the Plasticity of the Auditory Cortex in Children With Hearing Loss.

Comparing Hearing Aid Outcomes in Adults Using Over-the-Counter and Hearing Care Professional Service Delivery Models.

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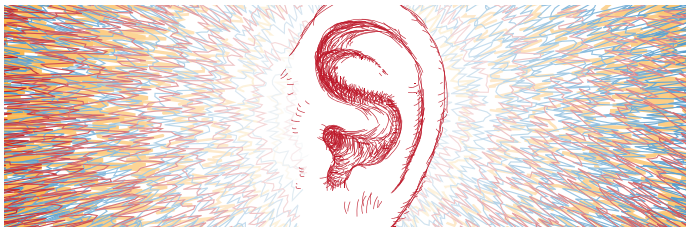
EDITORIAL



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Dear Reader, the Amplifon Centre for Research and Studies, CRS, houses one of the finest private libraries in the field of audiology and otorhinolaryngology, offering the sector's most important international journals. Every quarter, a team of Amplifon Audiologists from around the globe select the most relevant publications in the field of Otology and Audiology and make a comprehensive review. The Amplifon Centre for Research and Studies coordinates the development of this quarterly review. We are happy to share these new reviews with you. For this issue, our team reviewed 11 interesting articles published in the second quarter of 2023.

The first review handles the relation between hearing loss and fall prevalence and the association with hearing aid use. Then an article evaluates whether spatial resolution and auditory memory for speech are better with binaural fitting of Bone-Anchored Hearing Systems, compared to unilateral.
Two reviews focus on paediatric patients: one demonstrates that greater and longer acoustic stimulation, results in a larger grey matter ratio; the other assesses the effect of different types of technology such as air and bone conduction CROS and remote microphone systems on speech understanding in noise for children with severe-to-profound unilateral hearing loss.
A very interesting article evaluating the differences in auditory environments and hearing aid feature activation between younger listeners with normal hearing and older listeners with hearing loss in urban and rural locations, demonstrates the importance of taking into account demographics when selecting and fitting hearing aid features.
Also of particular interest, considering noise reduction is somewhat of a controversial feature, this issue features an article on evolutions of deep-learning based noise reduction over time.
Our selection also features an article on the key topic of hearing aid benefit and satisfaction. More specifically, it addresses the extent to which it is influenced by sound quality, fit/comfort, and battery life, highlighting the importance for both manufacturers and audiologists of systematically evaluating such features.
Since OTC hearing aids are a hot topic these days, we also included a recent article evaluating the outcomes of these devices compared to hearing aids fitted by audiologists.
Another booming aspect of our profession is telecare. We propose an article on the value a telecare tool can add before and after the initial hearing assessment appointment.
One of our contributors offered a critical review of a recently-published systematic review and meta-analysis on the prevalence of hearing loss in COVID-19 patients. Lastly, this issue concludes on an innovative paper on an automated segmentation tool for estimating the volume of vestibular schwannomas.
We hope you enjoy this issue of our *CRS Scientific Journal*.

Mark Laureyns
Global International CRS
& Medical Scientific Research Manager

CONSISTENT HEARING AID USE IS ASSOCIATED WITH LOWER FALL PREVALENCE AND RISK IN OLDER ADULTS WITH HEARING LOSS

Campos L., Prochazka A., Anderson M., et al
J Am Geriatr Soc. (2023): 1–9.
doi: 10.1111/jgs.18461. PMID: 37314100
By Carrie Meyer – US

This survey-based research evaluated the effect of hearing aid use on falls and fall risk in older adults with hearing loss.

Introduction: Falls are a leading cause of injury and death in older adults. The prevalence of hearing loss (HL) in adults over 60 years of age is estimated to be between 33 and 40%. Adults with HL are 2.4 times more likely to fall than normal hearing (NH).
While HL is a known risk factor for falls, existing research evaluating the impact of hearing aids (HAs) on improving balance function and reducing fall risk has hitherto remained inconclusive. The authors of this study argue that previous research compared adults with HL with NH peers rather than adults with untreated HL with HA users. Existing literature, as the researchers further highlight, also fails to factor in the recency or frequency of HA use.

Methodology: This project surveyed adults aged 60 years or older with bilateral sensorineural hearing loss (SNHL) treated at the University of Colorado Hospital Audiology Clinic. The survey consisted of the standardised Fall Risk Questionnaire (FRQ), which was complemented with additional questions on demographics and health comorbidities. In addition, respondents were asked to specify: whether they suffered from HL; wore HAs; experienced positional dizziness; how long (in years) and how often (hours/day) they wore their HAs.

Data Analysis: A total of 299 responses were analysed. Participants were divided into three groups based on HA usage: consistent users (four hours of HA use/day for at least one year); inconsistent users (less than four hours/day or less than one year of use); and non-users. The data analysis showed significantly reduced risk of falling for HA users compared to non-users. Consistent HA users had the greatest reduction in falls risk. Overall, HA use, regardless of recency or frequency, was associated with a 64% reduction of the risk of falls, compared to the control group (not using HAs); this number rose to 68% for consistent HA use and persisted after adjusting for age, medication use and HL severity.

CRITICAL NOTE
The link between hearing loss and falls is well established, yet the effect of hearing aid use on fall risk remains unclear. This study compares HA users to non-HA users rather than normal hearing adults. The researchers further delineate hearing aid use by recency and frequency of use. This more narrowly defined analysis of hearing aid use shows the significant, positive impact that amplification has on fall risk. This study finds an over 50% reduction in reported falls for consistent hearing aid users, information clinicians can use in daily practice to counsel patients about hearing loss, hearing aids and the benefits of hearing aid use to reduce fall risk.

Discussion:
Independent of the model or procedure of data analysis, the data consistently indicated that HA users had significantly lower odds of experiencing either fall outcome. While all types of HA were significantly associated with lower fall outcomes, this positive correlation was strongest for consistent HA users.
Current physiological mechanisms believed to affect hearing and balance are aging, increased cognitive load, and reduction in auditory spatial cues. The authors stress that the findings of their study, i.e. the positive correlation between HA use and reduced fall risk and falling odds, could suggest that HA use also play a key role in reducing cognitive load and improving access to environmental spatial cues.

Study Limitations: Because of the cross-sectional study design, the study only identifies that HA use is correlated with falls, but does not enable to draw causal effects. In addition, because this population was drawn from an ENT/ Audiology clinic, it is likely this group has higher HA use than the general population. Moreover, the survey responses are based on self-reported HA use and self-reported falls, implying recall bias may affect response accuracy.

Conclusions: This survey of older adults with HL indicates that consistent HA use is associated with reduced fall risk, which drop significantly for subjects using their hearing aids four hours or more per day. In order to strengthen study findings and determine causality, the authors propose further research using randomised controlled trials so as to definitively establish that consistent HA use reduces fall prevalence and lessens fall risk. •

EVALUATION OF THE BENEFITS OF BILATERAL FITTING IN BONE-ANCHORED HEARING SYSTEM USERS: SPATIAL RESOLUTION AND MEMORY FOR SPEECH

Brassington W., Parker R. & Bianchi F.
Ear and Hearing (2023): 44(3), 530–43
doi: 10.1097/AUD.0000000000001297
By Connie Loi - New Zealand

The authors explore the positive outcomes of bilateral fitting of bone-anchored hearing system (BAHS) in relation to spatial resolution and auditory memory for speech.

BAHS (bone-anchored hearing systems) are hearing devices, which are implanted and transmit the sound by bone vibration. They are intended for patients with a conductive or mixed hearing loss (HL), chronic middle ear infections, malformations of the outer ear, etc. The efficacy of BAHS fitting has been studied extensively, however there is a lack of research on the potential additional benefits of binaural BAHS compared to unilateral BAHS. This study aims to explore whether, in addition to benefiting binaural hearing, binaural BAHS could also support higher-level cognitive functions such as memory for speech.

The findings from this study highlight the positive outcomes of bilateral BAHS in spatial resolution. However, it also lays bare that bilateral BAHS users continue to face challenges in sound localisation and judging sound distance in daily life. Further research is therefore required for supporting bilateral BAHS treatment.

Participants:
- A total of 29 participants were recruited, of whom 24 completed the study.
- The study population was comprised of 12 females and 12 males; mean age: 55 years old (between 18 and 75 years)
- Adult BAHS users who were fitted with bilateral BAHS and had been using Ponto sound processors daily for six months
- All participants had either bilateral conductive (N=8) or mixed (N=16) HL as well as BC thresholds within the fitting range of test device (Ponto 3 SuperPower)

Study Setup:
The study included two visits per participant. During the first visit, each patient underwent a full diagnostic audiometry. The devices were first fitted bilaterally and then unilaterally, based on a special version of the NAL-NL1 fitting rule for BAHS, as implemented in the fitting software, where the unilateral fitting provided 3 dB more gain, compared to the

bilateral fitting to compensate for the summation effect. Features such as directionality and noise reduction were deactivated. No fine tuning was performed.

During the second visit, subjects underwent a series of three outcome measures:

- Spatial Resolution: MAA test
  - This test was used to estimate patients' spatial resolution by measuring the minimum audible angle (MAA) to 80% correct performance (identifying if the signal came from the left or right side, ranging from +/−5° to +/−90° angle).
- Memory for speech: Sentence-final Word Identification and Recall (SWIR) procedure
  - Test for memory processing of speech – to evaluate participants' recall ability when speech is presented at high intelligibility levels.
  - Speech-in-noise test
  - SWIR training
  - SWIR test
- Self-reported performance: SSQ12 – to reflect the perceived performance in speech intelligibility, spatial abilities and sound quality in everyday life.

Results:

- Spatial Resolution: MAA test

In the binaural condition, the average correct performance was higher than 80% at all angles; while this result was not achieved at any angle in the unilateral condition.

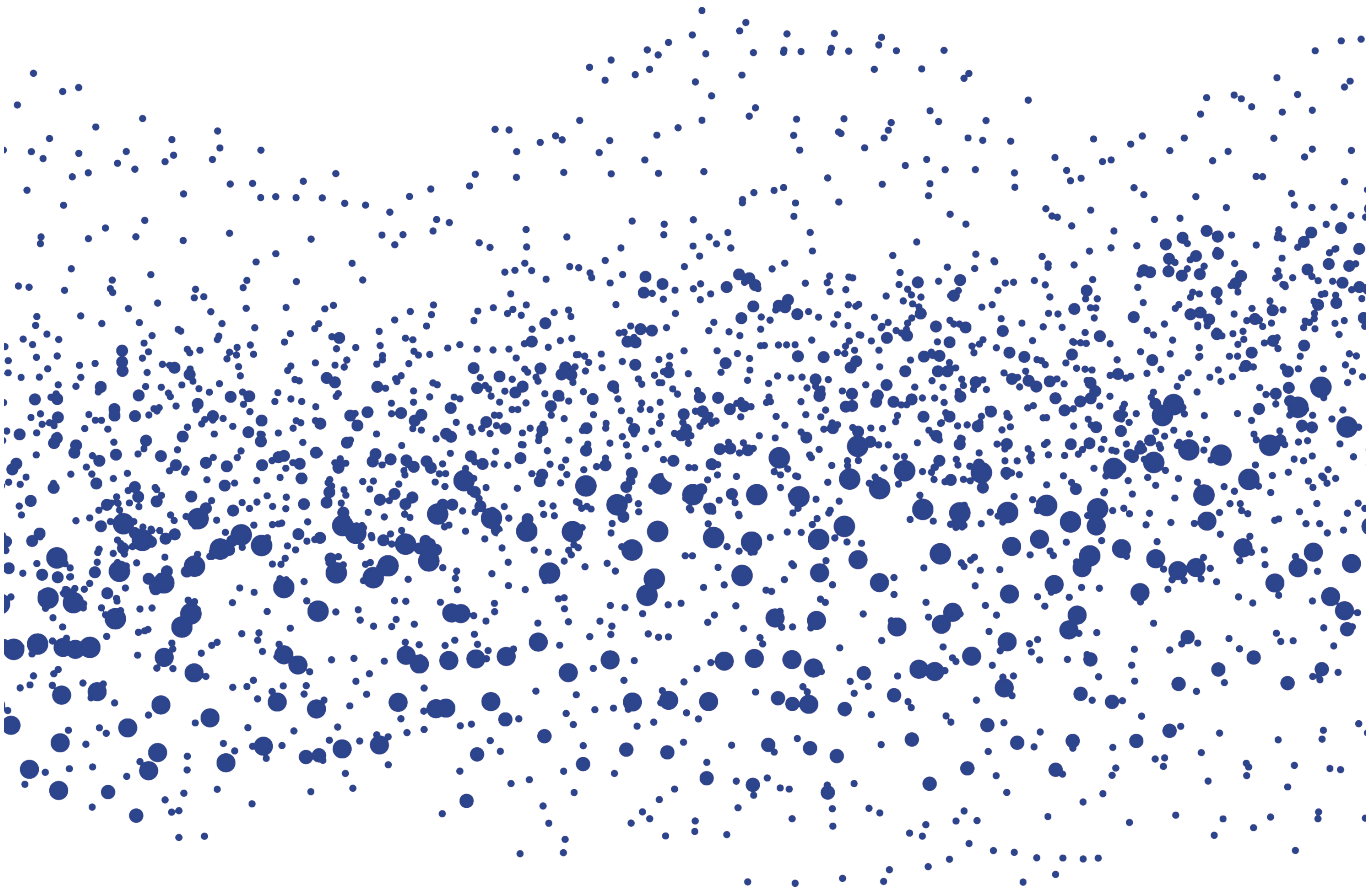
- Memory for Speech: SWIR test
  - The SNR was individually adjusted during the SWIR trial, in order to reach 80% sentence in noise recognition.
  - There was no significant effect of the condition (bilateral versus unilateral) on auditory memory for speech.
- Self-reported Performance: SSQ12
  - On a scale of 0 to 10, with higher scores indicated greater self-reported performance, the results for bilateral BAHS were on average: 4.4 for speech; 3.7 for spatial; and 5.1 for qualities of hearing.

Conclusions:

Significant benefit in terms of spatial resolution was found among bilateral BAHS users in the laboratory setting. However, participants' self-reported performance in everyday life was fairly low, particularly for the spatial criterion.

No overall benefit of bilateral fitting was found on memory for speech.

Greater performance in the SWIR test was correlated with greater self-reported performance in real-life. •



THE EXTENT OF HEARING INPUT AFFECTS THE PLASTICITY OF THE AUDITORY CORTEX IN CHILDREN

WITH HEARING LOSS: A PRELIMINARY STUDY

Yuan D., Ng IH., Feng G., et al.
Am. J. Audiol. (2023): 32(2), 379–90
doi: 10.1044/2023_AJA-22-00172.
By Pierre Devos – France

Cerebral plasticity is widely recognised today, meaning that early audibility and speech inputs lead to good prognosis in terms of language development. In this study, the authors highlight the lack of knowledge regarding the link between residual hearing levels and neuroanatomical tissue development.

Cerebral plasticity is a well-known principle whereby the brain structure can be modified by its environment. That is why it is so critical that any hearing loss (HL) be corrected as early on as possible. This is particularly true for children, who should be fitted and trained in very early childhood. In this innovative study, the authors propose to investigate the relationship between residual hearing and the volume (ratio) of grey matter in several brain regions of interest (based on a 2018 study by Feng, et al.). They also analyse the consequences of exploiting residual hearing on these brain structures.

They formulated two hypotheses:
- Children with less residual hearing benefit more from hearing aid (HA) use than children with better residual hearing. In other words, due to more significant changes in audibility, children with less residual hearing wearing HAs will show more differences in brain organisation than children with better residual hearing.
- Children with better residual hearing receive greater benefit from their HAs than their peers with poorer inputs, leading to greater differences in their brain organisation to preserve auditory cortex. This was posited to be due to limits of amplification capabilities and a lack of audibility especially in high frequency spoken language components.

A total of 21 children with bilateral severe-to-profound congenital HL, aged from 6 to 67 months, were enrolled in the study. All of them were CI candidates; 15 of whom were bilateral HA users (from 1 to 39 months); and six were not HA users. Residual hearing was calculated bilaterally and divided in low frequency residual hearing (250 + 500 + 1000 Hz thresholds / 3) and high frequency residual hearing (2000 + 4000 + 8000 Hz thresholds / 3). An MRI was performed approximately at the same time to assess grey matter volume by the voxel-based morphology analysis, in four brain regions of interest, in order to evaluate the relationship between:
- Residual hearing (low and high frequencies) and grey matter ratio (GMR)
- Effect of HA use on GMR
- HA time of use on GMR

CRITICAL NOTE
This study is the first to explore the topic of the effects of acoustic stimulations and audibility on brain structures. These preliminary findings support once more the importance of early intervention in children with hearing disorders, optimising HA fittings prior to cochlear implantation and promoting longer HA wear time as much as possible.

Results:
"Only the regression equation using high-frequency PTA to predict the GMR of the left Heschl's gyrus was significant, suggesting that children with less high-frequency residual hearing showed a smaller GMR of the left Heschl's gyrus." The study design also included HA users in the analysis and the data suggested that the GMR was larger for children who wear their HAs for longer periods of time, i.e. the effect of poorer inputs (lower residual hearing) is moderated by HA use and duration of use.

These findings support the second hypothesis.

In sum: the better the residual hearing in high frequencies, the greater the GMR in the brain organisation so as to

preserve auditory cortex in children using HAs. Additionally, the longer the HAs are worn, the greater the GMR.

The authors stress that wearing HAs helps to maintain the "natural" tonotopic organisation from peripheral to central structures. Poor hearing inputs (or low residual hearing) tend to modify central tonotopy, affecting, for example, high-frequency characteristic brain areas to lower ones because of the lack of audibility.

These findings support the importance of timely amplification for infants and young children with residual hearing so as to preserve the auditory cortex as much as possible prior to cochlear implantation. They further highlight: "Children with little residual hearing are disadvantaged and are particularly in need of early auditory input, and early CI should be a priority."

This preliminary study calls for further research, namely to mitigate the bias of the current paper, i.e. the limited number of subjects, the focus on the severe to profound HL population, the non-investigation of additional comorbidities and, last but not least, in the field of profound HL, the preferred communication used by each child (spoken input skills versus visual ones / sign language). This may affect MRI observations in the studied brain regions! •

EFFECT OF HEARING DEVICE USE ON SPEECH-IN-NOISE PERFORMANCE IN CHILDREN

WITH SEVERE-TO-PROFOUND UNILATERAL HEARING LOSS

Griffin AM., Atri A., Licameli G., et al.
Ear and Hearing (2023): 44(3), 588–602
doi: 10.1097/AUD.0000000000001310
By Pierre Devos – France

The authors investigate non-surgical hearing solutions available for children suffering from unilateral severe-to-profound hearing loss. Cochlear Implantation can be an option, however, 48% of children with this condition show cochlear nerve deficiency, which is a contraindication for this surgery. Therefore, audiology professionals need indications for choosing the best non-surgical treatment options for this population.

To date, there are many studies on non-surgical equipment for unilateral hearing losses (UHL), however, they all introduce bias, such as: non-differentiation of HL degrees; relying non-ecological speech understanding protocols; or evaluating only one particular solution as opposed to no solution.

In this study, the authors provide a detailed assessment of four of the most common non-surgical devices against unaided hearing, in an acoustically ecological (yet controlled) challenging environment. These four devices are:
- AC CROS System (Phonak CROS B13 / Phonak Sky B90-P)
- BC CROS alone system fitted on a soft band (Cochlear BAHA 5 Power)
- BC CROS + MiniMic 2+

CRITICAL NOTE:
This fascinating study has convinced me to reconsider fitting options for unilateral severe to profound hearing loss paediatric patients. Despite some limitations, the study highlights the possibility to mix several approaches and the need to avoid a rigid "specific hearing profile / specific solution" approach to their care, failing to take account of the unique circumstances, environment and capabilities of the child.

RM HAT system – Remote Microphone Hearing Assistance Technology (Phonak RogerTouchscreen Mic + Roger Focus). All devices were fitted according to international

recommendations: open fit / CROS transparency probe tube verification with insertion gain 0 for AC CROS and RM HAT; MPO probe-tube verification; in-situ bone conduction thresholds fitted with DSL-BCD targets verified on Verifit² artificial mastoid for BC CROS. Default Phonak Easy gain was kept for RM HAT system and standard 50/50 audio mixing was fitted for BC CROS + MiniMic2+ configuration.

The study enrolled 36 severe-to-profound UHL non-HA users and 36 normal hearing children, all aged from 7 to 18 years. All were tested in an acoustically controlled environment, made up of eight loudspeakers located around them. The signal (BKB Sentences) was proposed successively to the normal-hearing and the hearing-impaired ear at an angle of 45°; concurrently, a noisy "restaurant" environment was sent through the remaining seven loudspeakers (R-SPACE sound system).

No age effect was statistically highlighted.

Effect of the target speech position:
All UHL participants had a better SNR score when target speech was oriented to the normal ear. In all conditions (unaided, AC and BC CROS, RM HAT), "there was on average an 8,5 dB improvement in SNR-50 by simply orienting the normal ear toward the target signal". This is without a doubt one of the most important takeaways for counselling patients suffering from UHL. It is also important to note that when the target was directed to participants' normal ear, performance did not significantly differ between the normal hearing and unaided severe-to-profound UHL groups.

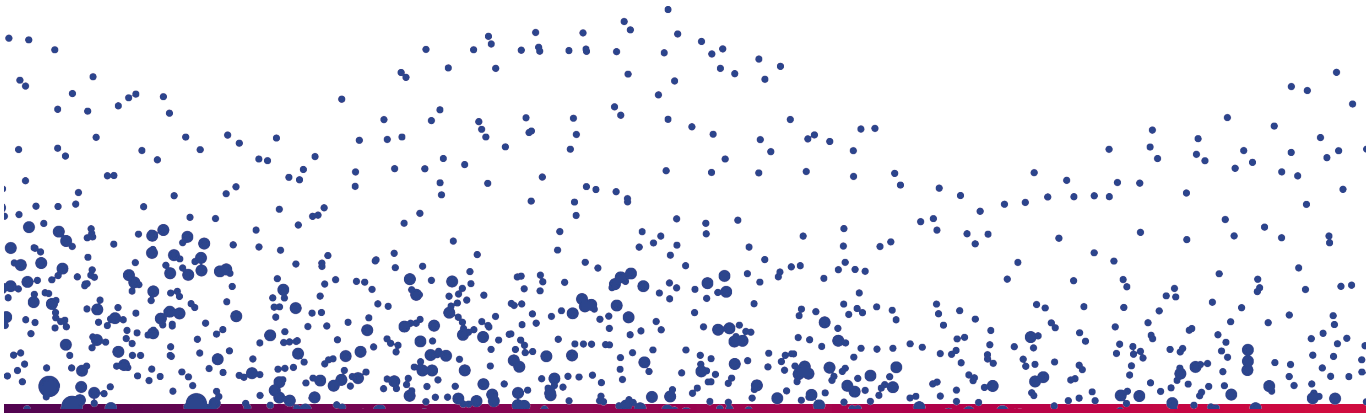
Effect of hearing device:
All devices showed a significant gain in SNR compared to the unaided situation when the signal was proposed to the impaired ear. The larger gain was observed for the RM HAT equipment (-9 dB SNR), followed by AC CROS (-2 dB SNR), BC CROS and BC CROS + RM (-1 dB SNR), these last three devices giving statistically the same result.

When target speech signal was sent to the normal hearing ear, AC CROS appears to reduce statistically the SNR score by an amount of 1,23 dB SNR compared to the unaided condition.

In this study, a 1 dB SNR difference was calculated as a 12% change in auditory performance, which indicates that the AC CROS could reduce speech discrimination by an amount of nearly 15% when the signal is sent to the good ear. This was not the case for BC CROS (with or without RM), for which there was no significant difference between conditions. This suggests that BC CROS does not improve nor hinder speech discrimination in this particular listening situation. The high-quality bandwidth of the AC CROS (compared to the BC CROS) is what enables it to reduce audibility in noise, which can potentially pass along a more fully represented interfering noise, creating a poorer SNR in the normal hearing ear. This must be taken into account when fitting AC CROS systems. The decision to opt for CROS devices, as the American Academy of Audiology Clinical Practice Guideline for Paediatric Amplification states, must factor in the child's ability to control their environment, i.e. turning their head to optimise SNR, looking at the locutor to benefit from visual cues, and muting the CROS system during unfavourable conditions.

A key limitation of this study is that both CROS devices were susceptible to have been tested in automatic directional microphone configuration (due to noisy environment), minimising the 45° target speech audibility, depending on the angle of the directionality algorithm. In addition, the controlled testing conditions seemed to be favourable to RM HAT system devices due to the presence of one single locutor which is the very best for that device.

Disregarding these biases, the study's main conclusion holds: in optimal conditions (one single locutor), RM HAT yields the best results. However, each child deserves an individual approach, based on their age and developmental abilities to control their environment. In many cases, a mix of CROS and remote microphones solutions would probably offer greater benefit than an isolated device. •



AUDITORY ENVIRONMENTS AND HEARING AID FEATURE ACTIVATION AMONG YOUNGER AND OLDER LISTENERS IN AN URBAN AND RURAL AREA

Jorgensen E., Xu J., Chipara O., et al.
Ear and Hearing (2023): 44(3), 603–18
doi: 10.1097/AUD.0000000000001308
By Gian Carlo Gozzelino – Italy

The authors explore the impact of auditory environments on hearing aid feature activation, between younger listeners with normal hearing and older listeners with hearing loss from both urban and rural settings.

This study set out to explore the impact of auditory environments on hearing aid (HA) feature activation, among groups of younger and older users from both rural and urban environments. The study population included 46 participants: 21 young normal hearing adults (YNH), with a mean age of 26 y/o; and 25 older adults with hearing loss (OHL), with a mean age of 66 y/o. Each group was further subdivided into two groups: Urban (U), for which the researchers chose the Iowa City, Iowa (USA); and Rural (R), for which the researchers chose Berkeley, California (USA), each city being considered representative of the rural and urban acoustic environment, respectively. The research design relied on a cross-sectional approach with repeated measures. In addition, participants listening environments were logged, and they used an app on a dedicated smartphone for a week, on which they needed to complete a survey every +/- 40 min. while using the HAs, for the ecological momentary assessments (EMAs).

The data demonstrated that YNH-U were exposed to significantly higher broadband sound pressure levels than the OHL groups. Furthermore, the automatic directional microphone activation in the HAs (based on the presence and the sound level of noise) occurred more frequently for the YNH-U group than for the OHL groups. Conversely, the changes in sound levels were significantly smaller for the OHL-R group compared to the YNL-U group. Consequently the automatic directional microphone activation occurred significantly less frequently for the OHL-R group, compared to both YNH groups. For the YNH-R group, sound levels fell between the YNH-U and OHL groups (all environments). No other significant differences were found as compared to other groups.

CRITICAL NOTE:
This study provides a solid foundation for future investigations in the field of audiology and highlights the relevance of living environments in understanding hearing-related outcomes.

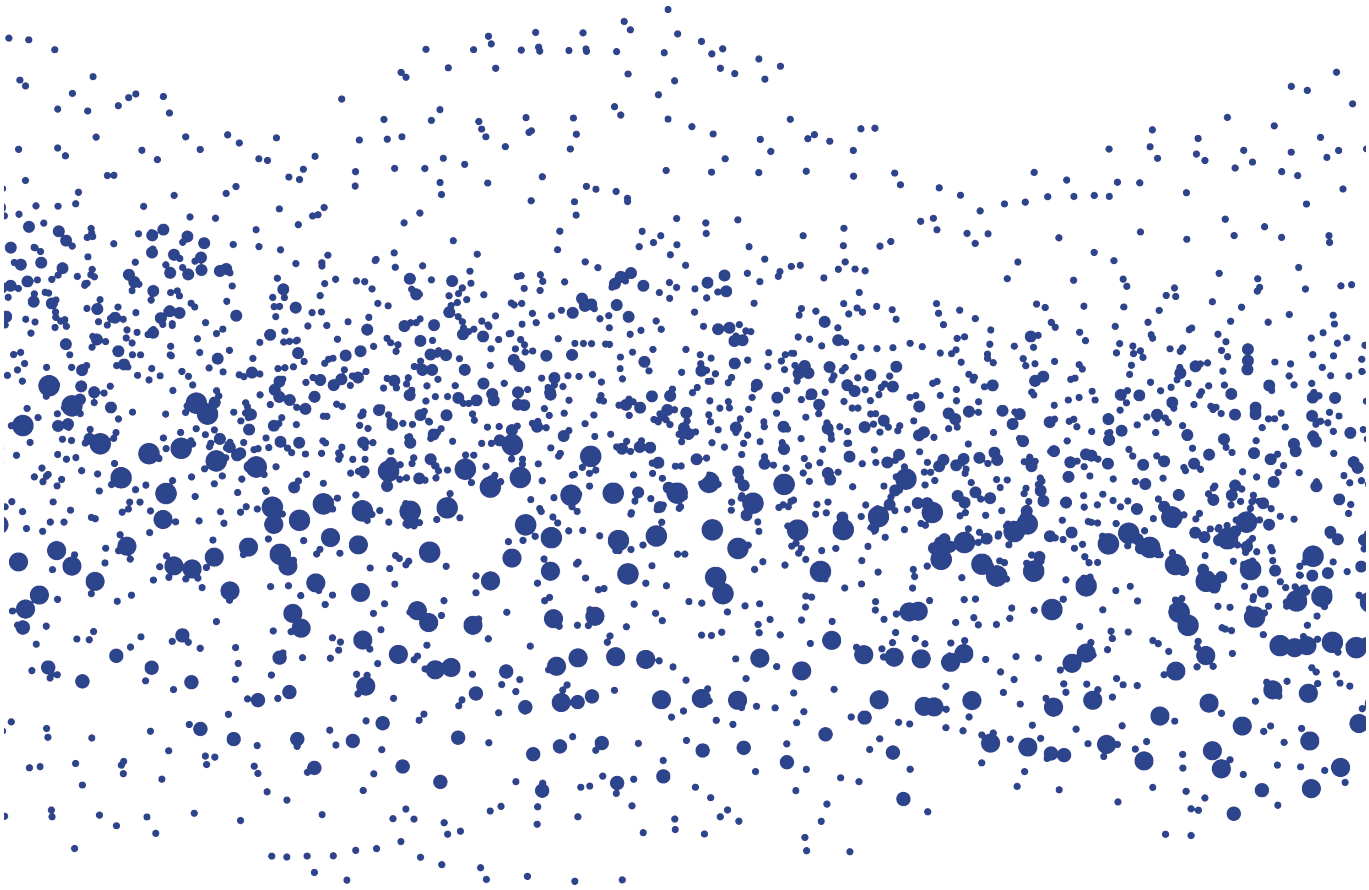
These findings demonstrate the extent to which demographics, such as age and location, influence hearers' experience of acoustic environments and, by corollary, HA automatic directional microphone activation. HA automatic directional microphone activation occurred significantly more frequently for the young subjects living in an urban area, which is likely due to the changing and more challenging acoustic soundscapes to which they are exposed. Conversely, older subjects with HL living in a rural areas functioned in more constant and less challenging soundscapes, resulting in significantly less frequent automatic directional microphone activation. Consequently, the authors stress the importance of taking into account the habitual environment of listeners in future studies and of factoring in real-world auditory environments in audiology interventions.

The article provides a comprehensive review of relevant literature on auditory environments, HAs, and their impact on HA preferences and effectiveness. In order to assess auditory environments, the researchers utilised objective and subjective measures, including: sound pressure levels; sound classification; and EMAs. The inclusion of multiple variables and measurements enhances the study's findings and strengthens the validity of the conclusions.

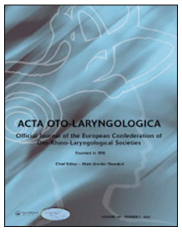
The research methodology employed mixed-effects models and statistical analyses to identify differences across groups. Appropriate corrections were applied to address multiple comparisons. The article presents clear and concise descriptions of the procedures, facilitating readers' understanding of the study design and data collection methods.

One potential limitation of the study is the relatively small sample size, particularly within each subgroup. While the sample was matched for age and hearing loss, a larger sample size would have increased the statistical power. Moreover, the study focused on specific locations, which may limit the generalisability of the findings.

This article provides valuable insights into the differences in auditory environments and HA feature activation among younger listeners with normal hearing and older listeners with HL in both urban and rural locations. The findings suggest that demographics, such as age and location, play a significant role in shaping auditory environments and HA use. The article underscores the importance of considering these factors in audiology interventions and emphasises the need for further research in real-world auditory environments. •



PREVALENCE OF HEARING LOSS IN COVID-19 PATIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS



Tang M., Wang J. & Zhang Q.
Acta Otolaryngol. (2023): 143(5), 416–22
doi: 10.1080/00016489.2023.2204909
By Sofie Peeters – Belgium

This systematic review analysed the data of 22 studies involving 14,281 patients with COVID-19 in order to identify the potential prevalence of hearing loss among these patients.

This study set out to assess potential hearing loss (HL) in relation to infection with COVID-19. The researchers used average pure tone hearing threshold values at 500, 1000 and 2000 Hz to determine the degree of HL; the grade of HL was assessed by means of the WHO-classification. Of the 14,281 COVID-19 patients included in the review, 482 presented varying degrees of HL. The overall prevalence of HL was 8.2%; prevalence was significantly higher among older patients, as shown in table 1.

Table 1: *Prevalence of hearing loss (%)*

Subgroup Age	30–40 years	40–50 years	50–60 years	+ 60 years
Prevalence of hearing loss	4.9%	6.0%	20.6%	14.8%

The authors concluded that HL is one of the clinical symptoms of COVID-19, stressing the importance for clinicians (and researchers) to take this into account when examining COVID-19 positive patients. •

CRITICAL NOTE:

The review is very superficial in analysing the data and the conclusion lacks critical foresight.

The article provides insufficient information on the degree of hearing among the 482 COVID-19 patients with hearing loss. The study design states the WHO classification was used to determine the grade of hearing loss. However, the article provides no further information, using vague terms such as 'hearing loss' and 'varying degrees of hearing loss' and offering no insight into the type of hearing loss (sensorineural, conductive or mixed).

A summary of the characteristics of the studies shows that most studies were retrospective, that there are significant differences across studies in terms of both the mean age and the prevalence of hearing loss. The studies failed to use control groups, and in 10 of the studies reviewed by the authors, there was no information regarding the origin of the data (country).

In addition, the greater prevalence of hearing loss in COVID-19 patients among the subgroups aged +50 years could also be attributed to age and the normal degeneration process of the body (see The WHO World report on hearing, 2021).

To date, there is no clear explanation regarding the pathogenesis of hearing loss related to COVID-19. More research, with heterogenous groups including a large sample size and the use of control groups, is necessary.

Nevertheless, it is very important to raise awareness of the prevalence of hearing loss in all cases to promote early diagnosis and treatment, and also to improve the quality of life of hearing loss sufferers.

COMPARING HEARING AID OUTCOMES IN ADULTS USING OVER-THE-COUNTER AND HEARING CARE PROFESSIONAL SERVICE DELIVERY MODELS:

A REVIEW

Swanepoel DW., Oosthuizen I., Graham MA., et al.
Am. J. Audiol. (2023): 32(2), 314–22
doi: 10.1044/2022_AJA-22-00130
By Thomas Tedeschi – US

This article aims to provide a comprehensive review of hearing aid outcomes in adults in two service delivery models: over-the-counter (OTC) and the traditional hearing care professional (HCP).

With the emergence of over-the-counter (OTC) hearing aids, it is crucial to assess their effectiveness as compared to the traditional hearing care professional (HCP) model. The review examines various aspects of hearing aid (HA) outcomes, including user satisfaction, device performance, and quality of life measures. By evaluating existing studies, this review offers valuable insights into the strengths and limitations of each service delivery models, and the implications of these shortcomings for adults with hearing loss (HL).

The cross-sectional survey designed by the authors enabled comparison between self-reported HA outcomes for a pool of OTC users against users who used a conventional HCP model selected from the databases of the Hearing Tracker Website and the Lexie US Database. The authors followed a Consensus-Based Checklist for Reporting of Survey Studies. They applied specific selection criteria in order to identify relevant studies, specified which databases were searched as well as the data extraction processes used. This ensures transparency and reproducibility of the review process. A total of 656 individuals responded to the survey, of whom 406 were from the traditional HCP model and 250 were from the OTC (Lexie) model. The International Outcome Inventory for Hearing Aids (IOI-HA) was utilised to determine subjective hearing aid benefits.

The review examined user satisfaction as a primary outcome measure, comparing OTC and HCP service delivery models. It analysed user-reported experiences, preferences, and subjective ratings of satisfaction with HAs obtained through each model. In the past, user satisfaction with HAs has been measured in terms of duration of daily use. This study revealed a significant difference in wear time at the 8 hours per day time frame between the OTC and the HA professional model, with significantly longer wear times for the latter. However, what is interesting is that the shorter the wear time, the smaller the differences. At some intervals the OTC model was even preferred. One inference drawn by the authors is that who preferred to wear HAs only in difficult listening situations preferred OTC devices. This could also indicate that individuals with more moderate to severe types of HL prefer to wear their HAs longer daily.

CRITICAL NOTE:
This study was the first of its kind to examine these models across such a large sample group. However, it presents a number of limitations. Since the researchers were looking at two completely different pools of subjects with a number of significantly different demographic differences, caution should be exercised in interpreting these findings. In addition, the study incorporated an OTC product delivery model which included an app-based system for adjustments, acclimatisation programs, remote support from a hearing care professional and payment options. This is very different from the majority of OTC products that are available on the market today, where clients purchase a device with no support services available. In this regard, the OTC method used by Lexie, which includes user support with a hearing care professional, could be considered a modified HCP model.

Residual activity limitations highlighted that the OTC model showed lower limitations than the HCP model. The authors were not able to definitively explain this difference. However they speculated that this may be due to individuals having immediate access to the use of smartphone applications. The OTC model used in this particular study provided phone apps enabling immediate fine-tuning changes to the HAs and immediate remote professional hearing health care support to the user.

The results of the study revealed no significant differences between the two delivery models under review. The authors suggest that the OTC model which includes remote professional support has the same potential for success as the traditional HCP method. •

CONSUMER SURVEY ON HEARING AID BENEFIT AND SATISFACTION

Bannon L., Picou EM., Bailey A., et al.
JSLHR (2023): 66(4),1410–27
doi: 10.1044/2022_JSLHR-22-00066
By Veronica Hoffman – Italy - Australia

In this paper, the authors explore the main factors influencing Hearing Aid Benefit and Satisfaction, which they reported to be: sound quality, fit/ comfort, and battery life are the most important.

There is great variability in self-reported benefit and satisfaction among hearing aid (HA) users. In order for manufacturers and clinicians to improve the services provided and hearing outcomes, there is interest in determining audiologic (e.g. type of hearing loss, HA experience) and non-audiological factors (e.g. demographic variables, device type, service delivery, cost of HAs to the user). In this study, the authors analysed the responses of 2,109 subjects, 99% of whom were from the US, who completed an e-mail survey distributed via The Hearing Loss Association of America and Hearing Tracker, an informational resource site for HA information. The authors analysed their responses on HA benefit and satisfaction ratings.This retrospective survey asked participants to answer questions about perceived HL, HA characteristics/ model, benefits, and satisfaction with HAs, as well as the costs they incurred, the service delivery model they used, and demographic information.

Hearing aid benefit is measured in terms of the improvement of auditory functionality and the ability to communicate gained thanks to the use of HAs. In clinical practice, HA benefit is often assessed using the Abbreviated Profile of Hearing Aid Benefit (APHAB), a self-report questionnaire which assesses patient experience with and without HAs in daily life using four subscales assessing: ease of communication; reverberation; background noise; and aversiveness to sounds. Interestingly, previous studies found that new wearers, fit bilaterally, with high expectations and low perception of hearing loss (HL)

CRITICAL NOTE:
Though very topical, this study does present some limitations, chief of which is the fact that the questionnaire was administered online. This immediately introduces a form of bias, as respondents need to be internet savvy. Moreover, as the study was conducted in the US, where consumers self-pay for hearing devices and services in the majority of cases (57% reported attending a private local clinic), the same survey may yield different results in other countries where hearing care is provided or subsidised by the state or insurances. The majority of respondents had high-end (54%) or mid-level (34%) HAs, which, in general, boast more advanced technology, often enabling hearing care professionals greater options in terms of programming /adjustments. Of course, this could also influence both benefit and satisfaction.

had better APHAB scores, as do those fitted with a verified prescription vs. manufacturer first fit.

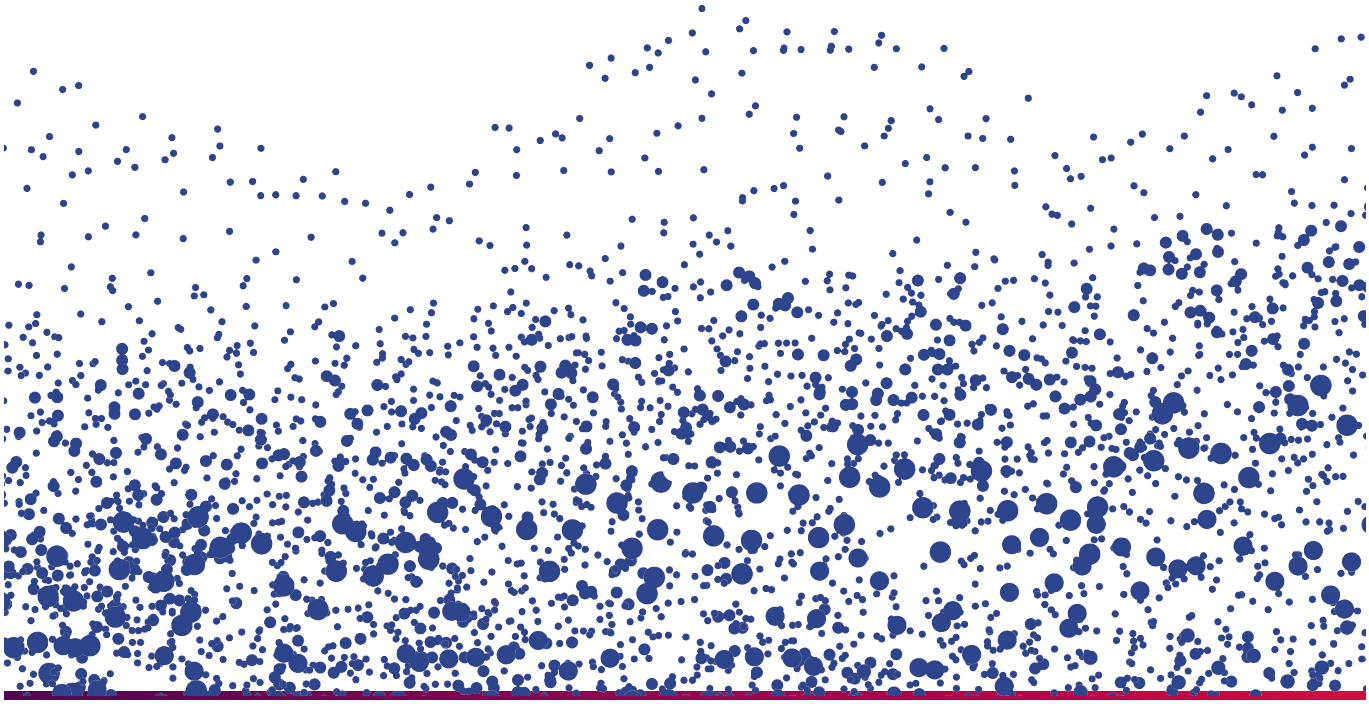
HA satisfaction is evaluated by the users rating the emotional appraisal of the experiences with HA in relation to their expectations. Clinically, HA satisfaction is often assessed using the Satisfaction with Amplification in Daily Life (SADL), a self-report inventory, also using four subscales assessing: positive effect; service and cost; negative features; and personal image. Prior studies have found speech-in-noise (SIN) ability, length of HA use, and greater levels of self-reported HL (not measured thresholds) result in higher SADL scores. In addition, the availability of social support, positive attitude, personality, and expectations toward HA have been related to greater HA satisfaction. Several studies, as highlighted by the authors, have also found a correlation between HA performance/sound quality, hearing care professional effectiveness, HA physical qualities, HA maintenance, and costs/value as determinants of HA satisfaction.

The survey used in this study consisted of approximately 50 questions covering a range of demographic, audiological background, HA characteristics, and perceived outcomes.

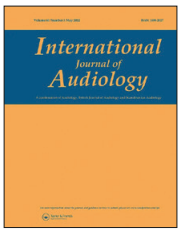
HA benefit was assessed using one key question: 'How would you rate your overall hearing with your current hearing aid(s)?' Responses ranged from maximum HA benefit described as "vast improvement in hearing ability," "good improvement in hearing ability," "fair improvement in hearing ability," "no improvement in hearing ability", and "I heard better without my hearing aid(s)" – which was taken as an indication of no HA benefit. A total of 97% of respondents reported benefit from wearing their HA; 38% reported vast improvement; 40% good benefit; 22% limited benefit (with the following breakdown: fair, 19%; no improvement, 2.4%); and 'I heard better without aids', 0.6%). The authors found that those who reported better fitting outcomes in terms of sound quality, better comfort/fit, battery life rated higher benefit. Surprisingly, those who paid more for their HAs, those with higher levels of self-reported HL, and those who had worn HA for over two years were more likely to score that they received "vast benefit" from their HA.

HA satisfaction was assessed using a 0–10 scale response to the question, "How likely is it that you would recommend your hearing aid(s) to a friend or family member?" Overall, participants reported a level of HA satisfaction, with 64% reporting "very satisfied" (score 8–10); 26% reporting being "satisfied" (score 5–7); and only 10% "not satisfied" (a score lower than 5). As found with benefit, sound quality, fit/comfort, and battery life were correlated with higher satisfaction. Interestingly, younger respondents reported greater satisfaction with their devices, as did those fitted with particular brands of devices; however, brand identity was not reported in the study outcomes.

In this study, three main determinants were found to impact both satisfaction and benefit: sound quality; fit/comfort; and battery life. It is important, as the authors remind, for hearing care professionals and manufacturers to focus on these key areas in order to enable users to achieve greater hearing and communication outcomes and satisfaction with their devices. •



A QUALITATIVE STUDY SHOWING THAT A TELECARE TOOL CAN HAVE BENEFITS BEFORE AND DURING THE INITIAL HEARING ASSESSMENT APPOINTMENT



Heffernan E., Maidment DW. & Ferguson MA.
Int. J. Audiol. (2023): 62(4), 295–303
doi: 10.1080/14992027.2022.2041740
By Tali Bar-Moshe – Israel

This article focuses on the "Why Improve My Hearing" telecare tool, developed by the renowned Ida Institute, which may improve patient-audiologist communication and can be implemented in audiological practice.

Patient-centred care is an essential approach to health care services. It may improve patients' motivation, participation, and satisfaction. There are no standards for implementing this approach in hearing rehabilitation. The Ida Institute developed Motivation tools which can guide audiologists in using patient-centred methods as part of the counselling and hearing rehabilitation process, especially with hesitant patients. Those tools help to identify patients' goals, help them understand hearing rehabilitation benefits, and motivate them to engage in the process.

One of the motivation tools is the "Why Improve My Hearing?" (WIMH) Tool. This short telecare tool was designed for adults with hearing loss (HL) who do not have hearing aids (HA). The WIMH should be completed by the patient ahead of the consultation appointment, and they are strongly encouraged to discuss it with the audiologist. In this survey, patients are asked to choose a picture of a specific listening situation, rate on a 1–10 scale how important this situation is for them, and answer two questions: "What will happen if you continue as you are today?" and "What would happen if you get a hearing aid to improve your hearing right now?" The purpose is to encourage patients to reflect on the implications of each scenario: using or not using HAs.

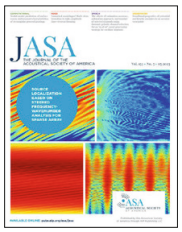
In order to assess the effectiveness of the WIMH, the researchers carried out a qualitative study which included semi-structured interviews with ten adults with HL and five audiologists. The study examined audiologists' and patients' perceptions of and experience with WIMH before and during the first hearing assessment meeting. The data collected in the interviews were analysed using thematic analysis.

CRITICAL NOTE
Patient-centred care is essential in hearing rehabilitation. As audiologists, we must always remember that it is not only two ears that enter our clinic, but see the whole person sitting in front. Implementing tools which may improve the patient-audiologist relationship and influence patients" understanding of the rehabilitation process, goals, and outcomes is important.

Three themes emerged from the data collected regarding the participants' perceptions of the impact of using WIMH tool:
- Enhanced preparation before the appointment: better understanding and greater acceptance of HL; recognition of rehabilitation goals; greater awareness of topics to be discussed during the meeting with the audiologist.
- Enriched discussion during the appointment: identifying and describing hearing difficulties more precisely; improving patient-centred communication; improving the flow and effectiveness of the meeting.
- Varied impact on outcomes following the appointment: improve patients' motivation and involvement in decision-making; individual influence on patients; less influence on additional outcomes such as HA adherence and satisfaction.

Although this research has limitations, it provides valuable information on the effects of implementing a patient-centred tool before and during the first hearing assessment meeting. The results suggest that the WIMH tool may improve patient-audiologist communication and could be beneficial to implement in audiological practice. •

PROGRESS MADE IN THE EFFICACY AND VIABILITY OF DEEP-LEARNING BASED NOISE REDUCTION



Healy EW., Johnson EM., Pandey A., et al.
J. Acoust. Soc. Am. (2023): 153(5), 2751–68
doi: 10.1121/10.0019341
By Ryan Johnson-Hunt – New Zealand

This article assesses a study on a current algorithm's benefits compared to an earlier one, showing a 51% intelligibility boost. The current algorithm's real-time operation and generalisation abilities signify substantial progress in this field.

In recent years, there have been significant advancements in deep-learning-based noise reduction, particularly benefiting individuals with hearing impairments. This study evaluates the improvements in intelligibility achieved through a current algorithm as opposed to the benefits achieved in an older algorithm, developed ten years ago by Healy, Yoho, Wang, and Wang (2013) for hearing-impaired (HI) listeners.

Both studies shared similar stimuli and procedures. However, the current study employed an attentive recurrent network, which allowed for training and testing with different noise types, talkers, and speech corpora. This enabled greater generalisation and real-time operation, unlike the initial study against which it is compared, which had limited applicability to real-world scenarios.

Remarkably, the intelligibility benefit observed for HI listeners in the newer model, across all conditions, averaged 51% points. Surprisingly, despite the additional demands placed on the current algorithm, it achieved a comparable benefit to the initial demonstration. The fact that the algorithm's performance remained strong even with various constraints removed highlights the significant progress in deep-learning-based noise reduction methods.

Method:

The study comprised two groups: 12 HI listeners with bilateral sensorineural hearing (BSNH) loss and 12 normal-hearing (NH) listeners. The HI group had varied degrees of HL across frequencies. Both groups were tested with sentences in speech-shaped noise (SSN) and babble at different signal-to-noise ratios (SNRs). An attentive recurrent network (ARN) trained on the LibriSpeech corpus was used for speech enhancement. The ARN improved speech intelligibility significantly for HI listeners across all conditions. The ARN represented an advancement over earlier algorithms by jointly enhancing magnitude and phase. The presentation level for HI listeners ranged from 81.0 to 98.6 dBA, while the level was fixed at 65 dBA for the NH listeners.

CRITICAL NOTE:
The small sample size and emerging nature of this technology require more robust studies. The integration of AI processing into hearing aids (which also have connectivity to smart devices) will mean that special considerations around privacy and personal information are needed, as the world learns to utilise AI tools while putting guardrails in place.

Results:

For the HI listeners, the algorithm significantly improved speech intelligibility in both SSN and babble, with benefit exceeding 30% points in most cases. NH listeners performed better in unprocessed conditions but still showed some benefit from the algorithm. A comparison between HI and NH listeners revealed that, in some conditions, the algorithm brought the HI "listeners' performance close to that of NH listeners. The newer algorithm showed significantly improved performance. Objective measures of intelligibility and sound quality also demonstrated improvements after algorithm processing.

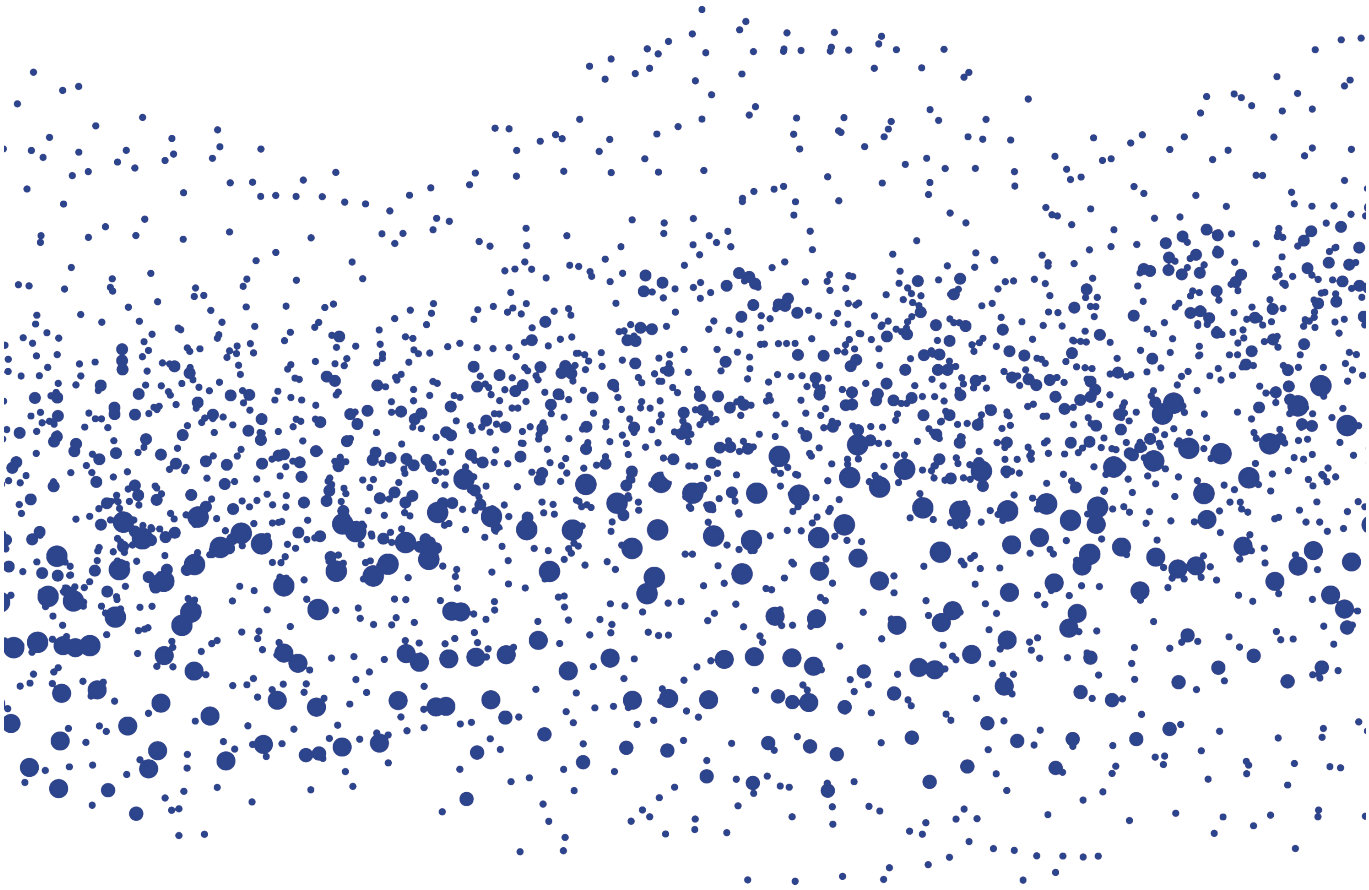
Discussion

The discussion section highlights the significant improvements achieved by state-of-the-art deep-learning-based noise reduction for both hearing-impaired (HI) and normal-hearing (NH) listeners. The algorithm demonstrated large intelligibility benefits for HI listeners, averaging 46% to 58% points across conditions, and even some benefit for NH listeners (8% to 18% points). The current

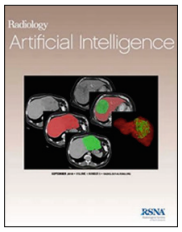
algorithm's performance was compared against the previous model, showing improvements for HI listeners and slightly lower benefit for NH listeners. This highlights the extent to which Generalisation challenges, such as cross-corpus generalisation and cross-language processing, were successfully addressed by modern networks. The discussion also emphasises the potential for real-world applications, such as bilateral HAs and commercial products with deep-learning-based noise reduction.

Conclusion

In summary, the study shows that advanced deep-learning-based noise reduction significantly improves intelligibility for both HI and NH listeners. The algorithm's current performance matches or exceeds the initial demonstration, demonstrating progress in neural network design since 2013. Different model design approaches, such as efficacy-first and viability-first, offer advantages and challenges. The study addresses issues like cross-corpus generalisation and cross-language processing, indicating effective network generalisation. Furthermore, DNN model compression can reduce the current network's size. Real-world implementations demonstrate the practical feasibility of deep-learning-based noise reduction, offering promising intelligibility improvements. •



FULLY AUTOMATED 3D VESTIBULAR SCHWANNOMA SEGMENTATION WITH AND WITHOUT GADOLINIUM-BASED CONTRAST MATERIAL: A MULTICENTER, MULTIVENDOR STUDY



Neve OM., Chen Y., Tao Q., et al.
Radiol.: Artif. Intell. (2022): 4(4), e210300
doi: 10.1148/ryai.210300
By Alex Hoetink – The Netherlands

This paper investigates the performance of an automated segmentation tool to estimate the volume of vestibular schwannomas. The results show that the tool is accurate when using contrast-enhanced T1-weighted and T2-weighted MRI scans. It performs similar to human delineation in 87%–93% of cases.

Introduction
Vestibular schwannomas are benign intracranial tumours located in the vestibular nerve. Associated symptoms are hearing loss (HL), tinnitus, and balance disorders. When tumours are small, they are not life threatening and require only surveillance with MRI. For large or growing tumours, however, radiotherapy or surgery is required. Tumour growth is measured by the extrameatal manual diameter at subsequent MRI examinations. Such two-dimensional (2D) analyses have considerable inter- and intraobserver differences (10%–40%). Three-dimensional (3D) measurements, on the other hand, are more accurate but are also more time consuming. In order to reduce imaging interpreting time, deep convolutional neural networks (CNN) can be used, particularly the U-Net architecture. In order to improve performance, hyperparameters and training strategy ought be selected carefully. The authors of this study conducted an observer study using T1-weighted MRI scans form multiple centres using different types of scanners and scanning protocols.

Materials and Methods
A total of 214 patients were included. All underwent an MRI for HL. Of these, 134 patients tested schwannoma positive, and 80 tested vestibular schwannoma negative. MRI scans were obtained from 37 different hospitals with 12 different MRI scanners from three MRI vendors. Two independent observers manually delineated the intra- and extrameatal components of the positive cases with gadolinium-enhanced T1-weighted MRI. This delineation was automatically forwarded to T2-weighted MRI. For training the no-new-U-Net framework, the dataset was divided into two sets: a training and validation set and a test set. An observer study was performed on the T1-weighted images only. The observers consisted of a head-and-neck radiologist and a skull-base otolaryngologist. They were blinded to case information and type of delineation (human or automated). They were instructed to answer two separate questions: 1) "which delineation is better?" (a, b or similar) and 2) "is the quality satisfactory" (yes or no).

CRITICAL NOTE
The model did have difficulties with tumours containing large peripheral cysts, which were sometimes partially included in the tumour by the model. Furthermore, the study used retrospectively acquired MRI data, which may have introduced bias by including older MRI

Results
Sensitivity and specificity of tumour detection by the CNN achieved a performance of 100% and 99.1%, respectively. Median calculation time was 78 seconds per patient.
The performance of the model on the gadolinium-enhanced T1 weighted MRI showed that the whole tumour Hausdorff distance in the independent test set was 2.10 mm ± 3.34; it was 1.34 mm ± 0.84 and 2.18 mm ± 3.43 in the intra- and extrameatal parts, respectively. All the median Hausdorff distances were below the 2-mm threshold, which is often used in clinical practice to define

Table 1: *results questions*

	Validation set			Test set		
	Whole tumour N = 111	Intrameatel N = 106 * N = 104	Etrameatal N = 97	Whole tumour N = 23	Intrameatel N = 23	Etrameatal N = 22
Delineation CNN similar or better than human	105 (95%)	100 (94%)	83 (86%)	22 (86%)	22 (96%)	18 (82%)
CNN segmentation satisfactory	104 (94%)	100* (96%)	90 (93%)	20 (87%)	22 (96%)	18 (82%)
Human segmentation satisfactory	110 (99%)	98* (94%)	89 (92%)	22 (96%)	23 (100%)	21 (95%)

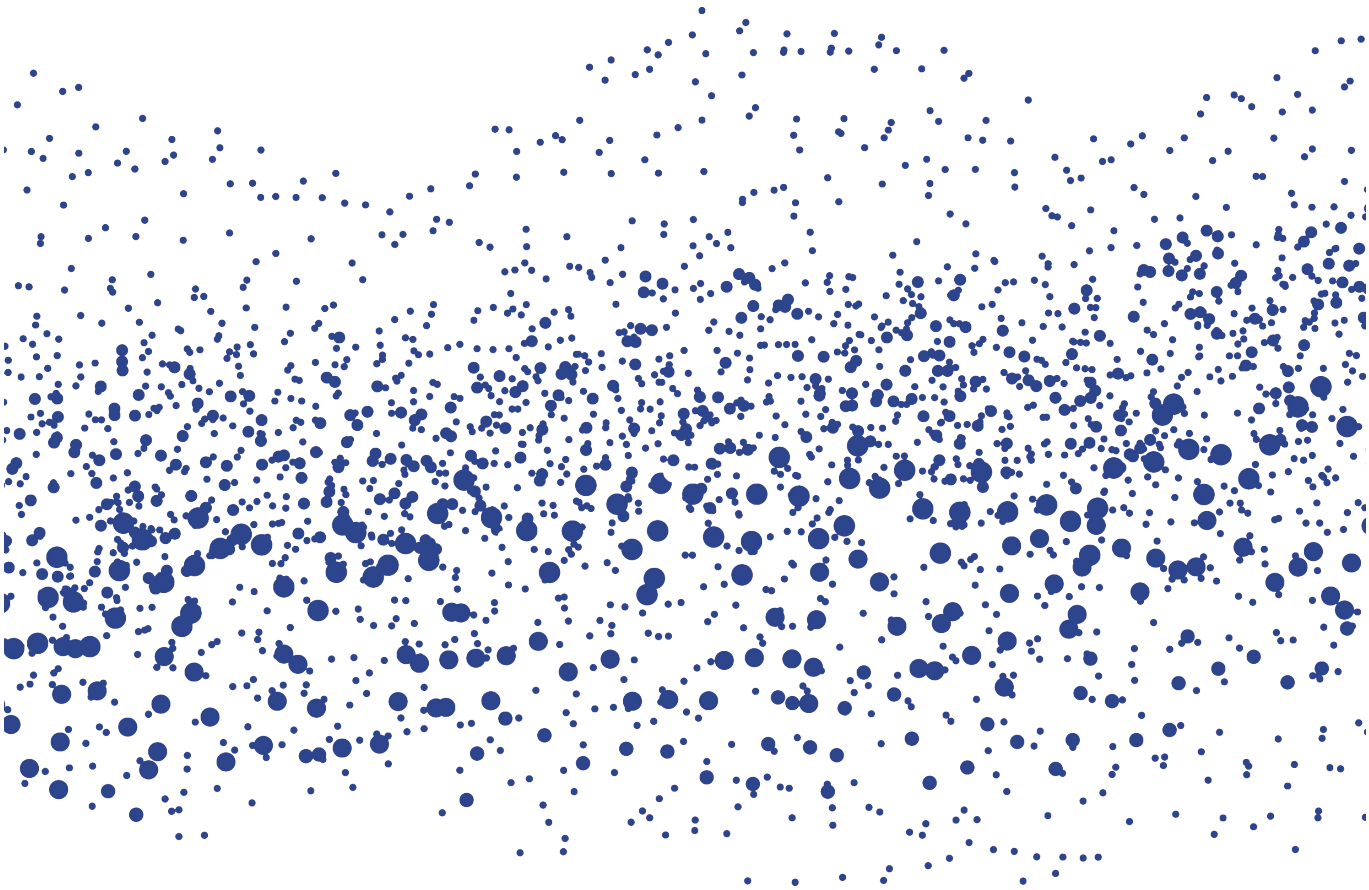
2D growth. Performance on the test set was similar to the performance on the validation set. This indicates robust external validity. The performance of the model on the T2-weighted MRI was slightly degraded, possibly because of lower contrast between the tumour and adjacent petrous bone, but still showed acceptable performance. The model performance was similar to human observer performance on all quantitative measures.

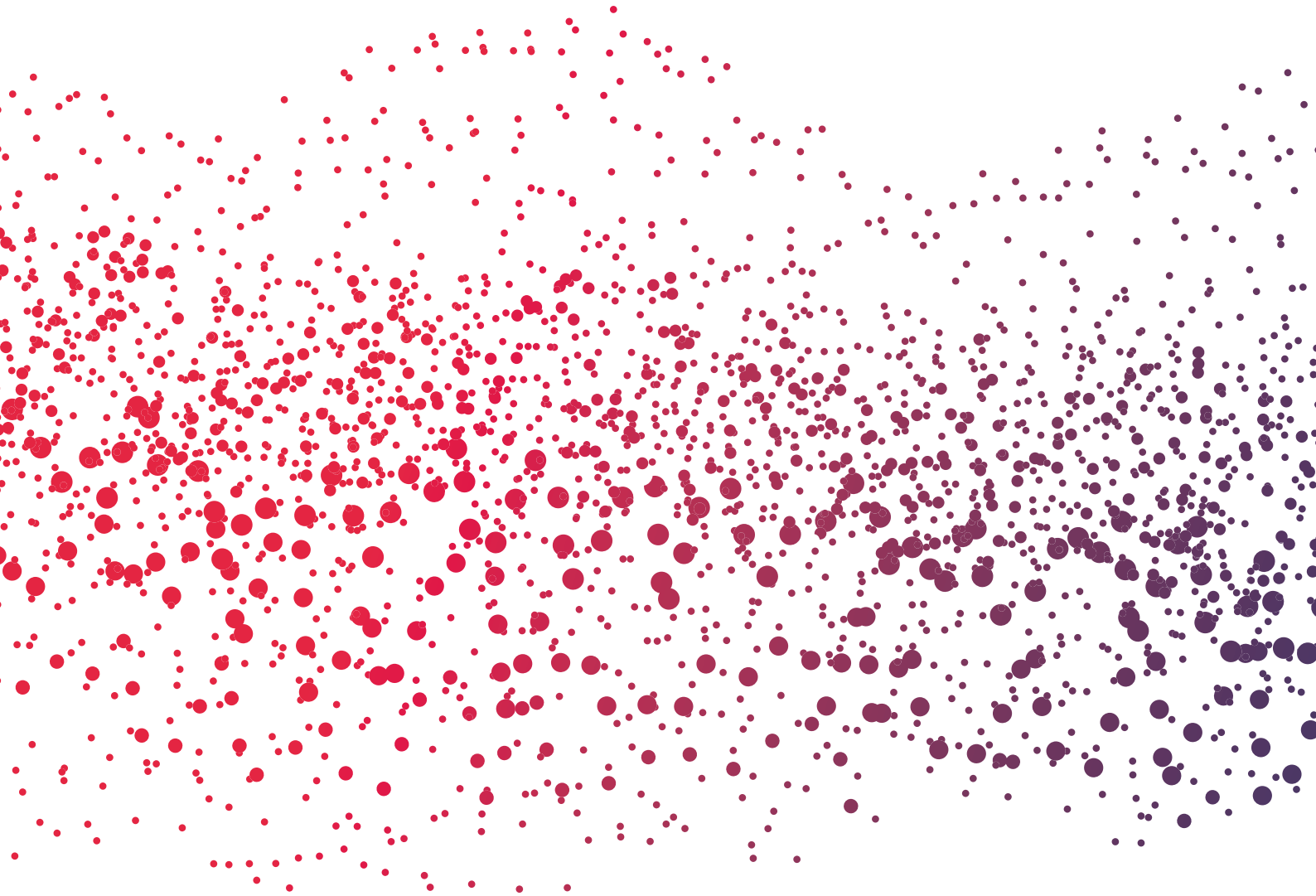
Size of tumour showed to affect performance, with better performance for larger tumours.

In 103 of 111 cases for the validation set and 20 of 23 cases for the test set, segmentations of the whole tumour by CNN were rated similar to human segmentations. In contrast, in 2 of 111 and 2 of 12 cases in the validation and test sets respectively, CNN segmentations were rated as better.

Conclusion

The results of this first multicenter and multivendor study with automated segmentation for vestibular schwannoma shows that the 3D CNN tool can measure tumour volume with a great degree if accuracy on contrast-enhanced T1 weighted MRI scans, and slightly less accurate T2-weighted MRI scans. From the observer study, it may be concluded that the tool performs similar to human delineation in 87%–93% of cases. •





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