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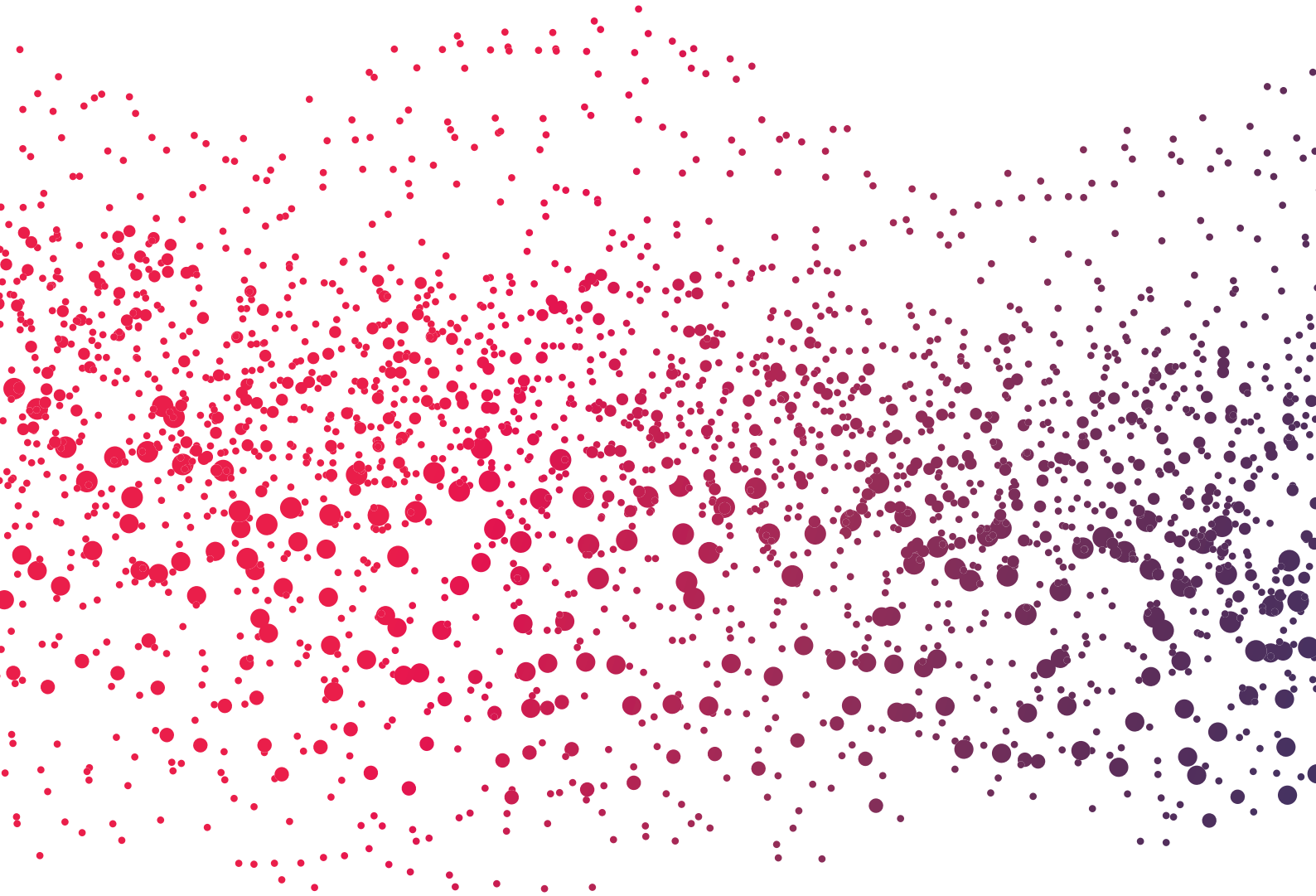

The WHO - World Report on Hearing

Association of the Use of Hearing Aids with the Conversion from Mild Cognitive Impairment to Dementia and Progression of Dementia

The Effect of Cognition on the Aided Benefit in Terms of Speech Understanding and Listening Effort Obtained with Digital Hearing Aids

CONTENT

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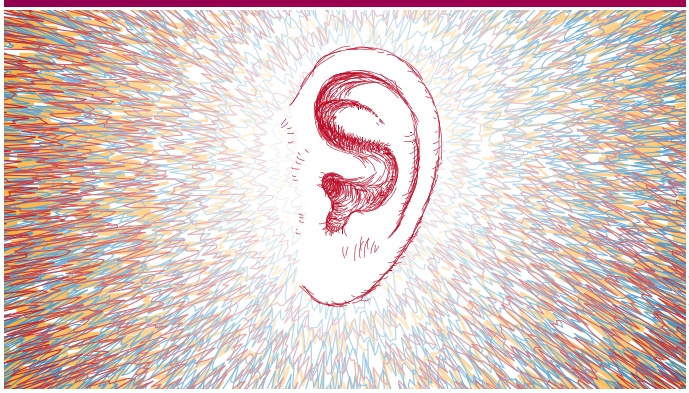
EDITORIAL



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Amidst the repeated waves of COVID-19, we are pleased to bring you this edition of our journal to help our readers stay up-to-date. This quarter saw the celebration of one of the loudest ever World Hearing Days, on 3 March, 2021. The World Health Organization (WHO) saw an overwhelming response from hearing healthcare professionals around the world, who embraced the day as a direct celebration of their work and their contribution to the world.

This issue includes a special feature on the first ever *World Report on Hearing* [WHR], which was also launched on March 3, 2021.

In addition, this issue offers summaries and reviews by our experts of 10 important articles published in the first quarter of 2021. We would like to draw your particular attention to two articles that studied hearing loss and its links to cognition. This issue also offers a range of interesting articles on a wide variety of topics, ranging from pharma treatment options for noise-induced hearing loss to sudden deafness and Hyperbaric Oxygen Therapy, cochlear implant as a treatment option for Single Sided Deafness and the use of Evoked Response Potentials and Mismatch Negativity as predictors of hearing aid/cochlear implant benefit. Of particular interest to clinicians, are the articles that focus on evidence for the use of hearing aid features and the impact of various cognitive parameters; and patient-related aspects leading to tinnitus loudness. There is also an extensive survey on hearing loss related to the use of headphones.

Our team worked hard in putting this issue together. We certainly hope you will enjoy reading it.

Reddy Sivaprasad
Country Retail Excellence Manager, India

THE FIRST-EVER WHO *WORLD REPORT ON HEARING* (WRH)

World Health Organization (2021)

hiips://www.who.int/health-topics/hearing-loss

For this report, the World Health Organization (WHO) set itself the task of presenting the global landscape of hearing loss. Years of efforts on the part of multiple partners and stakeholders culminated in the release of the first-ever *World Report on Hearing* (WRH) on the 3 March 2021. The report documents statistical data and projections on hearing loss (HL) across all Member States by means of evidence-based framework. Though global in its approach, the WRH does call for specific actions to support low- and middle-income (LMI) countries, as HL is poised to become an economic burden for the governments of these countries and threatens the livelihood of the sufferers.
The WRH is divided up into four sections, each of which provides relevant and high-quality data and facts which will prove helpful for planning national policies on ear and hearing care. While the intended audience is policy makers, the report provides interesting insights for all hearing healthcare professionals, who have an important role in advocating for ear and hearing healthcare.

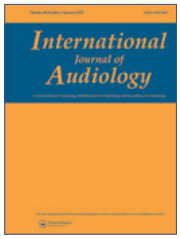
Section 1, "The Importance of Hearing Across the Life-Course", lays out the vital role communication (and therefore hearing) plays at all stages of life. In particular, it delineates the role which hearing plays throughout a person's life in the cognitive, psychological, and social domains. The report further details protective and preventive factors affecting HL at different stages of life. This section also addresses the negative impact (in terms of economic, emotional and sociological burden) of HL on the individual and on society. Current estimates revealed that globally, unaddressed hearing issues cost society close to 980 billion USD every year.

Section 2, "Solutions Across the Life Course: Hearing Loss Can Be Addressed", lists available options and the actions that need to be implemented in order to arrest the onset and mitigate the impact of HL. Among other measures, emphasis is placed on the role of early identification at all ages by promoting ear disease awareness, and management through suitable ear examination and hearing assessment.

Section 3, "Challenges Facing Ear and Hearing Care", points out that globally 1.5 billion people live with HL, and approximately 80% of people with HL live in LMI countries. The report goes on to list barriers to hearing healthcare, such as accessibility and affordability. The report further establishes that less than 20% of those who actually need hearing aids (HAs) do use such devices. This section, as the title indicates, maps out three key types of challenges to better hearing care: demographic; educational; and health system design challenges. These pave the way to identifying possible action strategies.

Section 4, "Designing the Way Forward: A Public Health Framework for Ear and Hearing Care", outlines the Vision of WHO's overall approach to Hearing Care. This last chapter develops the foundations and benefits of a toolkit the WHO designed: H.E.A.R.I.N.G (**H**earing Screening and Intervention; **E**ar Disease Prevention and Management; Access to Technologies; **R**ehabilitation Services; **I**mproved Communication; **N**oise Reduction; **G**reater Community Engagement) to promote ear and hearing care, with several practical examples. •

PERSONAL LISTENING DEVICE USAGE AMONG CANADIANS AND AUDIOMETRIC OUTCOMES AMONG 6–29 YEAR OLDS



Feder K., McNamee J., Marro L., et al.
International Journal of Audiology (2021): 1–16. DOI: 10.1080/14992027.2021.1878398

By Angela Ryall – Canada

The researchers investigated the usage of personal listening devices in Canadians aged 6–79 and specifically compared self-reported usage to audiometric thresholds of those aged 6–29. Hearing thresholds were elevated for participants with five or more years of personal listening device use compared to participants with less than five years of usage.

There is wide concern that listening to loud music for an extended period may cause hearing loss (HL). This type of noise exposure is unique in that the user has control over the volume and duration of the exposure. This study investigated personal listening device (PLD) usage patterns across Canadians, aged 6–79, and focused more specifically on PLD usage patterns with various sociodemographic variables and audiometric thresholds for participants aged 6–29 years old.

Using the 2012-2015 Canadian Health Measures Survey (CHMS) data, which was gathered from across the country, participants answered both general demographic questions (age, gender, household income, and education level) and questions regarding any possible noise exposure (NE). The latter focused on the sources of recreational and occupational loud NE, and their corresponding duration and frequency, over the past year. Participants then went to a mobile examination centre where otoscopy, tympanometry, and pure tone audiometry (0.5, 1,2,3,4,6, and 8 kHz) tests were conducted. Any participants who had been exposed to noise within 24 hours prior to the audiological assessment were excluded from the study.

Participants were divided into groups based on their PLD usage: non-PLD user; non-loud PLD user, who used a PLD but not at loud volumes; and loud PLD user, who use PLDs at a loud volume. Users from this third group were further divided into high, medium, and low categories based on their noise exposure (compared to the occupational limit of equivalent to or above 85 dBA over 40 hours or more per week).
Approximately 19% of Canadians reported using PLD at loud volumes and the highest prevalence was reported for teenagers (12–19 years old; 44%) and young adults (20–29 years old; 36%). In terms of duration, participants aged 12–19 years old reported using their PLDs at high volumes for approximately nine hours per week; this compared to an average of six hours per week for participants aged 20–29; and three to four and a half hours for adults aged 40 or older. Loud PLD users reported being exposed to other leisure noise, such as loud amplified music or car/home stereo. The proportion of participants who listened to loud PLD volumes was similar across genders, with 36% for men, and 32% for women. Age appears to be a significant factor in loud PLD usage, with a greater number of young participants aged 6–22 using PLDs at loud volumes compared to participants aged 40 and older.

CRITICAL NOTE:
This study provides some preliminary data showing that various age groups are more likely to engage in loud PLD usage, with an observable correlating increase in thresholds across age groups. These findings can be complemented, as the authors themselves underline in their recommendations, by the use of Otoacoustic emissions or high-frequency audiometry for more insight into these phenomena.

Participants aged 20–29 had significantly higher mean thresholds at 0.5,2,3,4, and 6 kHz compared to other age groups. Participants who reported 40 hours or more of PLD usage had higher audiometric thresholds than those with less reported PLD usage hours. There were no significant differences between audiometric mean thresholds across the five PLD user groups (high, medium, low, non-loud, and non-user). Prevalence of hearing loss (HL) at any frequency was low across all age groups and PLD groups.

The authors warn that individuals who engage in unsafe listening practices at high levels for an extended period may be more likely to develop noise induced hearing loss (NIHL) over time. In addition, participants who reported using PLDs at loud volumes were more likely to be exposed to other noise sources, which may suggest that multiple sources and their combined duration of exposure may influence the development of NIHL. The study further reported that loud PLD usage may influence hearing health long-term outcomes, as participants with five years or more PLD usage were found to have higher mean audiometric thresholds than those with less than five years. •

TOWARD A NEW EVIDENCE-BASED FITTING PARADIGM FOR OVER-THE-COUNTER HEARING AIDS

Urbanski D., Hernandez H., Oleson J., et al.

American Journal of Audiology (2021): 30(1), 43–66.

By Tali Bar-Moshe – Israel

This study focused on comparing different first-fit options to individual NAL-NL2 fitting method in order to develop a good fitting paradigm for Over-the-Counter (OTC) Hearing Aids (HAs). However, the researchers did not consider the adjustments audiologists make during post-fitting sessions according to costumers' reports of their experience with the HA, their daily needs, and requests.

Developing a legislative framework for promoting the use of Over-the-Counter (OTC) Hearing Aids (HA) has been a public health priority in the USA. The goal is to increase HA use by older adults with mild to moderate hearing loss (HL) by making HAs more accessible and affordable. This study focuses on developing new fitting configurations for OTCs. The authors structured their research in two parts.

PART I

The aim was to develop a limited set of preconfigured gain-frequency responses for OTCs that would meet the needs of a considerable percentage of the target population of older adults with mild to moderate HL. The researchers used the audiometry data of 267 adults with bilateral mild to moderate sensorineural HL from the National Health and Nutrition Examination Survey (NHANES) database. Using this audiometry data and the NAL-NL2 fitting formula, they created a set of four preconfigured gain-frequency responses that can provide appropriate amplification for bilateral and unilateral OTC fitting for 68% of the study population.

CRITICAL NOTE:

This study focused on comparing different first-fit options to individual NAL-NL2 fitting method in order to develop a good fitting paradigm for OTC HAs. However, the researchers did not consider the adjustments audiologists make during post-fitting sessions according to costumers' reports of their experience with the HA, their daily needs, and requests. By basing their work on the premise that adults with HL are to purchase OTC HAs by themselves without any professional guidance, the authors failed to address any consideration of the value of counselling, expectation matching, training, problem solving, etc. and failed to address this as an essential part of professional hearing care.

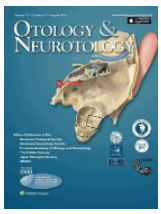
PART II

The purpose of this part was to develop a suitable method that adults with HL could use in order to select the most effective amplification from the set of four

preconfigured gain-frequency responses identified in the first phase of the study. A total of 37 adults with bilateral mild to moderate sensorineural HL tried five methods for selecting the right gain-frequency responses from among the four options that were programmed in open-fit basic-level BTE HA: 1. Select-by-audiogram (audiometric threshold); 2. Select-by self-hearing test; 3. Select-by-trying (listening); 4. Select-by-questioner (self-assessment); 5. Random assignment. The HAs were also fitted to all participants using their NAL-NL2 REAR (real-ear aided response). All participants completed speech recognition tests and sound quality rating in quiet and noise for all five fitting configurations. The results showed that three of these methods produced similar outcomes to the NAL-NL2 method: select-by-audiogram; select-by-self-test; select-by-trying. Statistically the select-by-self-test produced the outcomes most similar to the individual outcomes of the NAL-NL2 method.

These findings illustrate that, when presented with a set of four preset gain-frequency responses, adults with mild to moderate HL are able to select suitable amplification on their own, thereby demonstrating the effectiveness of a new OTC fitting paradigm. •

WHAT MAKES TINNITUS LOUD?



Yukanina N. & Nam Eui-Cheol.

Otology and Neurotology (2021): 42(2), 235–41.

By Majda Basheikh – Canada

This study examined factors that can influence the loudness of perceived tinnitus.

Tinnitus is a symptom commonly reported in individuals with hearing loss (HL). It presents as an audible sound in the absence of an actual external stimulus. Most individuals report tinnitus to be very bothersome due an intense degree of loudness that can interfere with overall hearing ability and focus on daily tasks. In this study, the authors analysed the various factors that can contribute to tinnitus loudness.

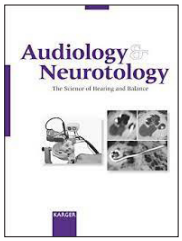
A total of 299 subjects with chronic tinnitus for at least three consecutive months were evaluated in this study. Measures included: tinnitus loudness matching; pitch matching; and Minimum Masking Level (MML) to completely mask tinnitus. Alongside these, subjective measures were also carried out, including: Tinnitus Handicap Inventory (THI); Patient Health Questionnaire-9, to evaluate depression; and Visual Analog Scales (VAS). The latter were used to measure such tinnitus-related factors as annoyance, daily duration, disturbance, and subjective loudness. A total of 178 subjects in this study reported unilateral tinnitus, while the remaining 121 reported bilateral tinnitus.
Subjective measures of tinnitus loudness (i.e. VAS loudness) did not present a strong correlation with objective measures (i.e. matched loudness or MML). However, a rather strong correlation was found between the former and measures of tinnitus-related distress (THI, daily duration, annoyance, depression). Moreover, the authors identified that factors affecting MML and matched loudness are highly associated with overall hearing ability, indicated by a strong correlation with PTA. Bilateral tinnitus sufferers displayed higher levels of VAS loudness,

CRITICAL NOTE:
This study demonstrates the differences between subjective and objective measures of tinnitus loudness. Objective measures were highly correlated with hearing-related elements such as PTA and tinnitus pitch. This would indicate that treatment methods focusing on hearing improvement can potentially reduce objective measures of tinnitus loudness. On the other hand, subjective tinnitus measures were highly correlated with psycho-emotional factors, such as tinnitus-related distress and disturbance. Treatment focusing on psycho-emotional management of tinnitus could therefore potentially contribute to reducing subjective measures of tinnitus loudness.

further supporting previous studies that bilateral tinnitus is more aggravating than unilateral tinnitus.
Females measured higher in all groups for VAS loudness, whereas males measured higher in all groups for matched loudness. This could be explained by the fact that more men are employed in occupations that are noisy, which, in turn, would also explain the more significant HL issue among males. In addition, the fact that they are more accustomed to loud noises could make them less likely to be bothered by them. The findings further suggested that females were more likely to report higher levels of VAS loudness due to gender differences in coping with tinnitus-related distress, as other studies have demonstrated.

In summary, perceived loudness of tinnitus can be obtained from self-reported data (i.e. questionnaires), or psychoacoustic measures during audiometric testing. The authors discovered that the numerical value at which a subject rates loudness of perceived tinnitus has no bearing on psychoacoustic measures of tinnitus loudness. Therefore, the two outcomes should be addressed independently during treatment. •

COMPARISON OF THERAPEUTIC RESULTS WITH/WITHOUT ADDITIONAL HYPERBARIC OXYGEN THERAPY IN IDIOPATHIC SUDDEN SENSORINEURAL HEARING LOSS: A RANDOMIZED PROSPECTIVE STUDY



Tong B., Niu K., Ku W., et al.

Audiology & Neurotology (2021): 26(1), 11–6.

By Sayanatanee Saikia – Australia

The authors of this study offer an assessment of the efficacy of a combined approach of hyperbaric Oxygen (HBO) and pharmacological treatment in patients with idiopathic sudden sensorineural hearing loss (ISSNHL) and delineate patients for HBO therapy.

CRITICAL NOTE:
The use of hyperbaric oxygen therapy (HBO) for the treatment of idiopathic sudden sensorineural hearing loss (ISSNHL) is frequently often criticized and yet at the same time recommended. There is a shortage of randomised control studies demonstrating a controlled prospective analysis for its use. This paper, with a well-designed randomized protocol, offers evidence of the benefit of HBO in conjunction with pharmacological treatment, and also identifies patient groups most likely to benefit from such an approach. As the authors highlight, one of the limitations of this paper is the absence of long-term follow-up. In addition, the study does not take the subjects' socioeconomic status into account, even though this variable might have an influence on the etiology of ISSHNL.

Idiopathic sudden sensorineural hearing loss (ISSNHL) is a condition defined as a significant reduction of hearing (full or partial) in a very short timeframe. Several treatment modalities are used, one of the most common being hyperbaric oxygen (HBO). Steroid therapy is also used, however, there is limited evidence as to the clinical benefits of treating ISSNHL with steroids, whether alone or in conjunction with HBO. The paper under review used

a randomised study design to evaluate the effect of a pharmacological treatment with and without a follow-up HBO therapy.

The subjects of the study were patients (n= 136) aged 18 or over, presenting with unilateral ISSNHL. As per the protocol, subject enrolment in the study and start of treatment was initiated no more than 30 days from the onset of symptoms. Subjects were randomly divided into two groups – Pharmacological treatment (P) and HBO and pharmacological treatment (HBO+P) – all subjects had their hearing assessed with tonal audiometry (PTA) and Auditory Brainstem Responses (ABR). The patients were further classified at three scales of hearing impairments: PTA ≤60 dBHL, less severe; 60 < PTA ≤90 dBHL severe; PTA > 91 dBHL, profound.

Patients from the P group were given oral prednisone, flunarizine tablets, vitamin A, vitamin E, intramuscular injection of vitamin B1, mouse nerve growth factor, intravenous mecobalamin, and a traditional Chinese drug intended to prevent blood clots. Patients from the HBO+P group were administered the same pharmacological treatment as the P group, in addition to 17 HBO sessions. Two weeks after the beginning of the treatment, tonal audiometry was performed.

The overall success rate (i.e. in terms of hearing recovery outcomes) of the HBO+P group was 61%, against 43% for the P group. Further analysis of the outcomes per subgroup revealed that patients with mild-moderate baseline HL had higher success rates than the P group. These findings indicate that pharmacological treatment combined with HBO result in a significantly higher chance of hearing recovery compared to the pharmacological treatment without HBO. The authors conclude that HBO treatment should be routinely used in cases of ISSNHL. Furthermore, chances of recovery with HBO+P are all the greater for those patients with mild-moderate baseline hearing loss, as well as individuals aged 50 or younger when HBO treatment is initiated within 14 days of onset. •

THE EFFECT OF COGNITION ON THE AIDED BENEFIT IN TERMS OF SPEECH UNDERSTANDING AND LISTENING EFFORT OBTAINED WITH DIGITAL HEARING AIDS:

A SYSTEMATIC REVIEW

Kestens K., Degeest S. & Keppler H.

American Journal of Audiology (2021): 30(1), 190–210.

By Sofie Peeters – Belgium

Hearing Aid (HA) users' working memory and cognitive function had no effect on the aided improvements on a speech-in-noise test. A smaller self-perceived improvement was observed for HA users with a larger working memory capacity. The aided benefit in listening effort did not seem to be influenced by working memory.

In recent years, increasing attention has been given to the role of cognitive functions in explaining the individual differences in speech understanding in HA users. The main goal of the systematic review (of 16 studies) presented by the authors was to examine how individual differences in cognitive functions can determine HA benefit in terms of speech understanding (12 studies) and listening effort (four studies). This was obtained by using different digital processing techniques. Four different cognitive functions were examined: working

memory; processing speed; selective attention; and executive functions.

All the studies measured speech understanding by means of a speech-in-noise test; whereas listening effort was assessed using a range of methods, which were classified into the following three categories: objective (i.e., pupillometry); behavioural (i.e. dual-task paradigms); subjective (i.e. visual analogue scale, VAS).

Results in general showed that HA users' working memory performance and general cognitive function had no effect on the improvements on a speech-in-noise test. However, a smaller self-perceived improvement was observed for HA users with a larger working memory capacity compared to HA users with a smaller working memory capacity. In terms of behavioural listening effort, the aided benefit did not seem to be influenced by working memory. On the other hand, HA users with a slower processing speed had more aided benefit in listening effort compared to those with a faster processing speed. Four digital HA features were explored: microphone directionality; noise reduction; amplitude compression; and frequency compression. •

CRITICAL NOTE:
The findings brought to light by this paper should be interpreted with a certain degree of caution for a number of reasons. Firstly, the sample covered by the systemic review is very small. Moreover, in addition to the lack of consensus on the topic, there is a lack of standardisation in the literature: no definition of what constitutes good or poor cognitive function; HA characteristics (type, brand, technology level, prescriptions for amplification, etc.) varied greatly among studies; most studies did not account for patients' acclimatisation period to the different HA settings. As a result, it is not possible to extrapolate a direct correlation between cognitive function and the aided speech benefit from a directional microphone, amplitude compression or frequency compression.

Digital HA features	Cognitive functions **Speech understanding**	Cognitive functions **Listening effort**
Microphone directionality	HA users with poor auditory **selective attention** benefited more from a directional microphone compared to an omnidirectional microphone. **Working memory, processing speed** and **executive functions** did not provide insight into directional benefit.	
Noise reduction (NR)	A higher **working memory** score and a faster **processing speed** were related to a larger aided benefit from NR. HA users with poor **executive functions** strongly dislike inactive NR and tend to prefer strong NR **Working memory** had no influence on a HA user's preference for NR.	No relation was found between behavioural listening effort benefit obtained with NR and **working memory**. No correlation between **processing speed** and behavioural listening effort benefit from NR was found.
Compression Speed	Higher **working memory** scores or normal cognitive scores in HA users result in better performance with both fast-acting as well as with slow-acting compression. Subjects with better (faster **processing speed**) show better performance with fast-acting compression	
Frequency compression	No effect of **working memory** and **processing speed** was observed on speech understanding benefit obtained from nonlinear frequency compression.	**Working memory** does not predict behavioural listening effort with frequency compression (on-off comparison).

ASSOCIATION OF THE USE OF HEARING AIDS WITH THE CONVERSION FROM MILD COGNITIVE IMPAIRMENT TO DEMENTIA AND PROGRESSION OF DEMENTIA:

A LONGITUDINAL RETROSPECTIVE STUDY

Buchloc M., McClean P., Bauermeister S., et al.

Alzheimer's Dement (2021): 7(1). DOI: 10.1002/trc2.12122

By Thomas Zacharia – Australia

The authors highlight the importance of early identification and management of hearing loss, as hearing aid usage significantly slows down the transition from mild cognitive impairment to incident dementia

Hearing loss (HL) and dementia are two of the most common conditions among the elderly population, which is compounded by the fact that these conditions often coexist. There is extensive literature on the effect of exercise, diet, and certain medical conditions (e.g. diabetes and heart diseases) on cognitive decline. However, there is a lack of research on the effect of HL on cognitive decline. For instance, it has been established that individuals with HL who do not wear hearing aids (HAs) suffer from depression, anxiety and other psychosocial disorders. It is also posited that HL is associated with a high risk of incident dementia.

Understanding the relationship between HL and cognitive function and dementia, as the authors highlight, could have a significant impact on the burden of cognitive decline and dementia on public health: HAs are minimally invasive, cost effective, and some studies have even reported that approximately 9% of dementia cases could be prevented with appropriate HL management.

The objective of the current study was twofold. First, to examine the effect of HA use on the risk of subjects with mild cognitive impairment (MCI) patients, to develop dementia and the risk of death. Second, to understand how HA use can affect the speed of the decline in cognitive functions, compared to the non-use.

This retrospective study analysed data from a sample of 2,114 participants. These were divided into two categories. Group 1 included participants diagnosed with mild cognitive impairment (MCI) at baseline; Group 2 included participants who were clinically diagnosed with dementia. Only participants who reported having HL and consistently wearing HAs were included for the analysis. No information on hours of hearing aid use, type of hearing aids was documented.

CRITICAL NOTE:
Hearing aid usage helps with lowering the chance of incident dementia. Cognitive decline is slower in hearing aid users when compared to non-hearing aid users. Resource reallocation and long-term auditory deprivation seem to be a key factor for cognitive decline in hearing impaired individuals.

The results of the study are as follows

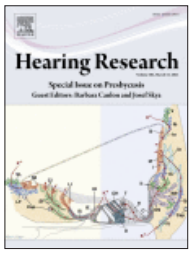
- For non-HA users, the median time between MCI and dementia was two years. For HA-users, the mean time reached four years.
- The number of subjects progressing from MCI to dementia after five years (from time of diagnosis of MCI) was 81% for the non-HA users and 67% for the HA-users.
- Mortality risk in dementia participants was six years from the initial diagnosis for non-HA users, and seven years for HA users

Possible mechanisms that would explain the correlation between HL and cognitive decline are

- Reallocation of cognitive resources to auditory processing
- Cognitive deterioration due to long-term auditory deprivation
- Social isolation caused by both sensory and cognitive loss

To conclude, there is a slower conversion from mild cognitive impairment to dementia among HA users. This highlights the critical importance of identifying and rehabilitating individuals with HL as early as possible. •

DOES HEARING LOSS LEAD TO DEMENTIA? A REVIEW OF THE LITERATURE



Nadhimi Y. & Llano DA.

Hearing Research (2021): 402. DOI: 10.1016/j.heares.2020.108038

By Reddy Sivaprasad – India

This systematic review of animal studies takes a shot at answering the complex question of the causal relationship between Alzheimer's Disease (AD) and age-related hearing loss. Though evidence does suggest that hearing loss can alter non-auditory cognition, the paper falls short of suggesting that this is a gradual degeneration. The authors posit that an additional second trigger ("hit") might be responsible for the damage leading to AD.

Epidemiological studies with a multi-national and multi-cultural span have demonstrated that Alzheimer's disease (AD) and ageing-related hearing loss (ARHL) are closely corelated. Among the population in their seventh decade of life, more than 50% have ARHL and 10-15% have AD, and these prevalence rates are growing every year. The next stage in addressing the relationship between these two phenomena is understanding whether they have common risk factors or whether there is a causal relationship between ARHL and AD or vice-versa.

For this study, the authors reviewed existing literature on animal studies concerning the link between induced HL and non-auditory cognition, reflected as the hippocampal damage and dysfunction. Cognition performance was checked on three maze tasks (Morris Water Mawe, radical-arm maze and object recognition) after an acute (single session) and subacute (30-day exposure) noise-induced HL.

- Acute noise exposure in animals showed lowered activity of the hippocampus. Ability to learn and memorise (except for spatial memory) declined. This was associated with rapid and wide changes in plasticity and functioning of the hippocampus and changes in spontaneous activity of the auditory cortex.
- Acute noise exposure significantly diminished the ability of the hippocampus to generate new neurons and establish new synaptic connections. This potentially limited the animals' ability to learn and respond to changing environmental demands.

CRITICAL NOTE:
The study was based on a well-planned construct, designed to address the complex question of the causal relationship between AD and ARHL. It provides a reference to excellent literature on this subject. Though no statistical analysis was attempted, the inferences drawn by the authors are flawless in terms of their. This study provides a possible pathway connecting the auditory system and the hippocampus based on published literature.

- Subacute (prolonged) noise exposure on animals has resulted in decline in spatial learning and memory. Neurotransmitter levels reduced significantly in the hippocampus and overall, as a result of this type of exposure, the hippocampus was damaged and the auditory cortex was intact.
- Subacute exposures are shown to diminish the generation of hippocampal neurons significantly. However, some aspects of cognition improved slightly beyond a timeline post exposure.

The hypothesis proposed by the authors is that the mechanisms might play a role in the link between noise and hippocampal damage:

- Increased oxidative stress reduces cell function as it happens at hair cell level
- Noise damage in the inner ear triggers an inflammation in tissues that spreads all the way to the hippocampus
- The amount of dB threshold elevation was shown to be directly proportional to the amount of reduction in the hippocampus. Therefore, auditory input is a significant driver of the hippocampal health.
- Noise exposure can alter sleep activity thereby damaging the hippocampal activity

The authors concluded that while noise exposure itself is a traumatic experience and can temporarily diminish cognitive activity, the studies analysed show no evidence suggesting a link between HL and the onset of a gradual degenerative condition like AD. The authors proposed that a second triggering factor, a "second hit", such as ageing for example, is needed to set off the gradual degeneration leading to AD. The authors further outline a possible research model to assess this theory. •

AUDITORY EVENT-RELATED POTENTIALS AND MISMATCH NEGATIVITY IN CHILDREN WITH HEARING LOSS USING HEARING AIDS OR COCHLEAR IMPLANTS – A THREE-YEAR FOLLOW-UP STUDY

Engström E., Kallioinen P., Nakeva von Mentzer C., et al.

International Journal of Pediatric Otorhinolaryngology (2021): 140. DOI: 10.1016/j.ijporl.2020.110519

By Reddy Sivaprasad – India

This study is based on a follow-up design, assessing a population of children using cochlear implants (CI) and hearing aids (HAs) at a three-year interval. The maturation of the central auditory system was studied using Event-related potentials (ERP) and Mismatch Negativity (MMN). It was found that while hearing aid users showed a gradual improvement, cochlear implant kids showed an atypical pattern.

Event-related potentials (ERPs) are late latency auditory potentials which originate from the sub-cortical and cortical areas in response to sound stimuli. ERPs use a number of components, such as P1, N1, P2 and N2, which reflect positive and negative peaks in that order of latencies. Mismatch Negativity (MMN) is an auditory potential which reflects perception of change/discrimination of sounds. MMN is obtained by deducting

recordings for repetitive presentation of a standard sound from that of a rare (or deviant) sound. ERPs and MMN change in latency, amplitude and resolution as the central auditory system matures gradually up to 10 years of age. Since ERPs and MMN are objective, non-invasive and recording them requires a passive state, these measures are very useful in tracking central auditory maturation in children with hearing aids (HA) or cochlear implants (CI). Several studies have used these potentials to study the changes in the auditory system. The article under review offers a follow-up study to assess whether ERPs and MMN record differently in CI and HA users, and also to study their development across three years of usage.

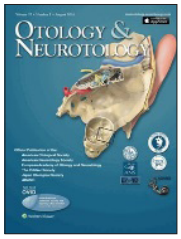
The study population consisted of six CI users (mean age six y/o), seven HA users (mean age five y/o) and 10 control subjects with normal hearing (NH, mean age seven y/o). Once recruited, they underwent a first battery of tests, and then were invited to a follow-up study three years later. Using the Optimum-1 protocol, ERPs and MMN were measured for harmonic sinusoid sounds. MMN was recorded for a deviant with one of the changes: 10dB intensity difference or with a 7ms silent gap in it or with a 10% pitch deviation or with interaural intensity difference of 800micro seconds. The amplitude and latency of all ERPs and MMN were compared at baseline vs three years later.

- The amplitude of all ERPs increased compared to baseline recordings in HA users. No difference was seen in the NH group. At the baseline, mean amplitude of all ERPs in the HA group was lower compared to the NH group, and this difference disappeared in the follow-up evaluation. This suggests a gradual improvement of plasticity in HA users.
- The mean ERP amplitude in the CI group was similar to that of the NH group. However, it reduced in the follow-up recording. A possible explanation would be reduced plasticity around seven years of age.
- There was no change in MMN amplitude in any of the groups after three years. Even at the baseline, there was no difference found between groups in terms of MMN amplitude. This indicates that MMN is a mature response.
- One exception was found in HA users: MMN amplitude for duration deviants increased after three years of HA usage. This suggests a gradual improvement in discrimination of sound duration, possibly reflecting the phonological difficulties faced by children.

CRITICAL NOTE:
Thought the sample for this study was small, it revealed significant findings, particularly the differences in central auditory maturation in CI and HA users. Another strength of the study lies in its follow-up design. The authors statistical analysis was extensive enough to find the interaction effects between the main variables.

The authors argue that some of the differences between their findings and previous studies could be explained by the excessive focus on the latency of ERPs and MMN, rather than on the amplitude of these responses. The different pattern seen in CI children may also be because they were all implanted around two years of age (i.e. after the critical age of first birthday). •

PHARMACOLOGICAL PREVENTION OF NOISE-INDUCED HEARING LOSS: A SYSTEMATIC REVIEW



Gupta A., Koochakzadeh S., Nguyen SA., et al.

Otology and Neurotology (2021): 42. DOI: 10.1097/MAO.0000000000002858

By Reddy Sivaprasad – India

This systematic review examined 72 studies and found that four pharmacological agents can reduce or reverse effects of noise-induced hearing loss by restoring hearing thresholds. The authors also detail the possible mode of implementation.

It is estimated that 5% of the world population is suffering from noise-induced hearing loss (NIHL). Though the effect of some factors on the resulting degree and severity of hearing loss (HL) is understood, what is still unclear is how this health hazard should be managed and treated. As a result, the focus has remained on prevention. Different classes of drugs have been tested in both animal studies and on human subjects and found to be effective to various degrees in preventing NIHL: anti-inflammatory drugs; minerals; vitamins; calcium supplements; hemo dilution agents, etc. This study was designed to provide a systematic review of human trials using drugs for the prevention of NIHL.

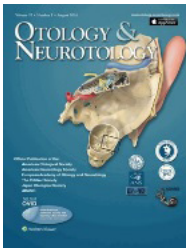
The authors searched several online databases (cut-off date: 6 February, 2020). This yielded a total of 72 articles which met the search criteria, and 11 of these underwent a qualitative analysis. These studies originated from various countries, and covered a total of 701 young to middle aged male subjects.

- The pharmacological agents used were: alpha-lipoic acid (ALA); ambient oxygen; beta-carotene; carbogen; ebselen; Mg-aspartate; NAC; and vitamins C, E and B12.
- Of these, only four agents (Mg-aspartate, vitamin B12, ALA and carbogen) resulted in statistically significant differences as reported in seven studies. Two studies administered carbogen and ebselen post-exposure, which resulted in a significant reduction in the 4 kHz notch.
- Quality of evidence ranged from two to four (four being the best); the risk of bias in these publications was rated as low.

CRITICAL NOTE:
This study provides a good amount of evidence that four pharma agents can arrest/ reverse NIHL effects. The level of detail of the analysis on the level of risk was impressive.

The authors noted that the four pharmacologic agents are known to reduce the damage caused by free radical species generation due to excessive noise through one of the modes: free radical scavenging; more oxygen supply; accelerate cell repair; or stabilization of hair cells. They further stressed that, despite of some evidence proving the efficiency of these drugs in preventing NIHL, the clinical application of these drugs has not yet been approved by the US FDA. This, the authors argue, highlights the need for better research designs, in order to be able to compare the effects of one drug over another. •

COCHLEAR IMPLANTATION IN ADULTS WITH SINGLE-SIDED DEAFNESS: OUTCOMES AND DEVICE USE.



Deep NL., Spitzer ER., Shapiro WH., et al.

Otol Neurotol (2021): 42, 414–23.

By Reddy Sivaprasad – India

In this retrospective study of 53 cochlear implant (CI) users with single-sided deafness (SSD), the authors found significant improvements in speech understanding in quiet and noise tests. In spite of having normal hearing in one ear, most of the subjects showed longer CI usage in the ear with SSD.

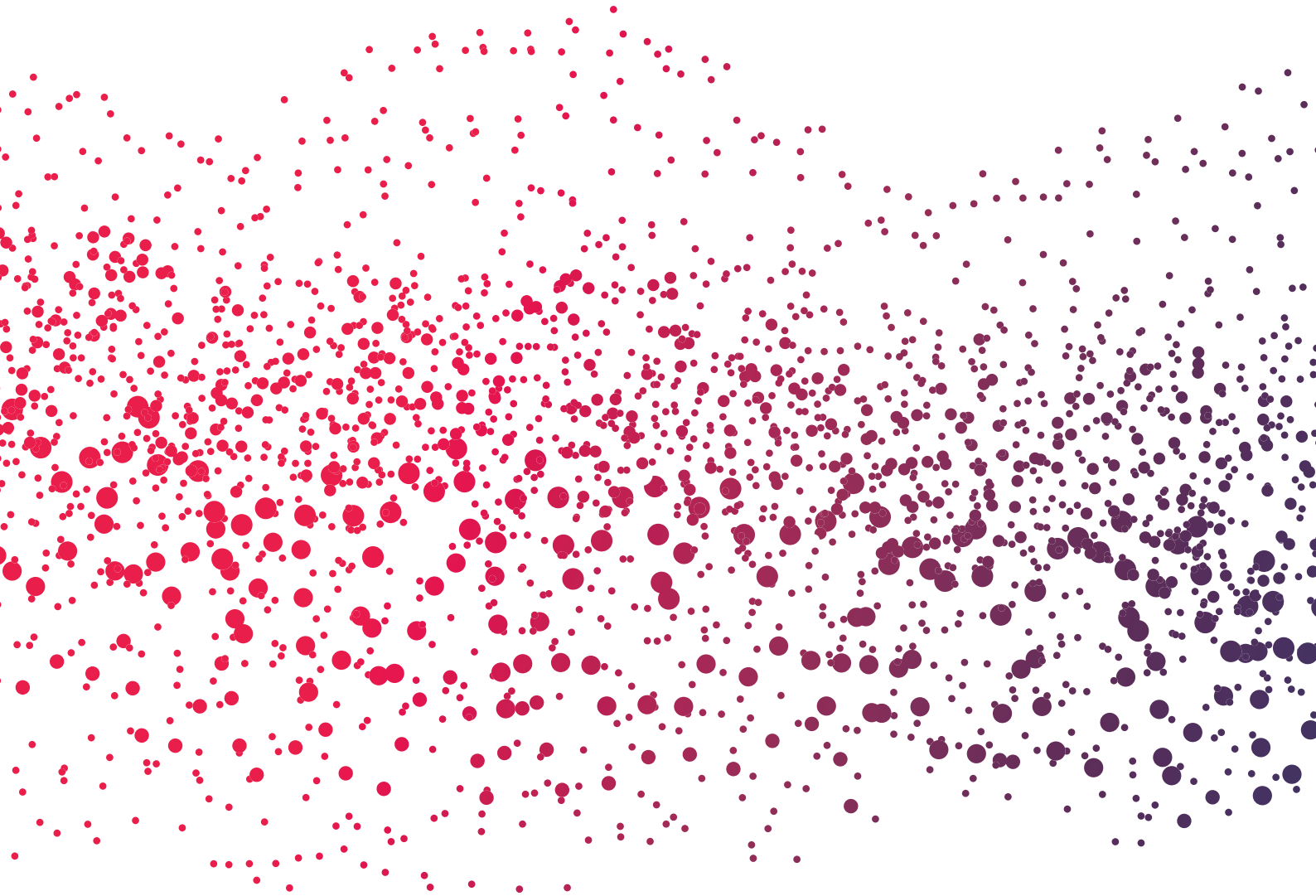
Single Sided Deafness (SSD) is a type of sensorineural hearing loss (HL) characterised by near normal hearing in one ear and severe to profound HL in the other. SSD impacts lives in different ways, depending on the particular need of the subject for spatial hearing, though it reduces the binaural hearing benefits significantly in all patients. Traditionally a CROS device or a bone conduction device (BCD) is fitted to alleviate the speech-in-noise deficits SSD is known to cause. Just as for the level of handicap, the benefit of these devices is also variable. Cochlear Implantation (CI) was initiated as a treatment option for tinnitus in SSD patients. It has now also shown benefits in certain speech-in-noise conditions. Studies have shown that in general, CI shows better benefits compared to those offered by CROS/ BCD. In this article, the authors reflect on and share their ten-years of experience of using CI in SSD patients.

The authors identified 53 adults (30 female and 23 male) who presented with SSD and who received an implant. The age of the subjects ranged from 18–75, and the duration of hearing loss from 1–50 years. Of these, 18 patients had used CROS, and four had used BCD and later chose CI. Most subjects had a history of sudden onset SSD. Some, however, had a history of retrocochlear pathology, labyrinthitis etc. Word recognition in the better ear ranged from 90–100%. A series of speech-in-quiet and speech-in-noise tests were administered pre- and post-implantation.

CRITICAL NOTE:
The scope of this retrospective, with such a large selection of data, provides more confidence in the use of CI with people suffering from SSD. The authors' choice of tests and statistical analyses were both excellent. Further explanations or research is needed to explain the variability in results.

- Participants' top three motivations for getting a CI: Tinnitus; speech-in-noise performance; localisation difficulties
- Word recognition scores improved in the implanted ear from 8% to 60% over a two-year period
- When noise was presented on the normal-hearing side ($S0N^{NH}$), the signal-to-noise ratio (SNR) improved significantly by about 2.5 dB in the binaural condition, and was greater than that offered by the CROS
- The improvement was due to the summation effect, the squelch effect, and the head shadow effect, though the largest contribution came from the head shadow effect
- When noise and speech were presented on both sides (S0N0), no improvement over unaided condition was seen
- Datalogs showed the range of device usage was from 90 min to 15 hours per day, with an average of over eight hours

As a conclusion, the authors highlight the importance of subject selection and counselling on expectation building in a positive outcome of cochlear implantation for SSD. •



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