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Death, Depression, Disability, and Dementia Associated With Self-reported Hearing Problems: A 25-Year Study.

Hélène Amieva et al.

The Journals of Gerontology, Series A, January 2018.

The relation between hearing loss and cognition is a very popular research topic these days, and we see more and more evidence being published. The unique aspect of this study, is that they followed a very large cohort (3777 participants) for 25 years. Furthermore this study explored the long-term evolution of subjects without self-reported hearing loss, with self-reported hearing loss, but non hearing aid users and subjects using hearing aids. In this publication the association with Death, Depression, Disability (Independence) and Dementia was evaluated.

Depression *was assessed with the "Centre for Epidemiological Studies Depression Scale (CES-D) and the criteria to considered as having depressive symptoms was >= 23 for women and >= 17 for men.*
Disability (Independence) *was assessed with both the ADL test (Activities of Daily Living – bathing, dressing, toileting, moving from bed to chair and eating) and the IADL test (Instrumental ALD – using telephone, manage medication & money, use public transport, shopping etc …)*
Dementia *diagnosis was based on interviews, neurological evaluation, a psychological checklist and if positive a consult by Neurologist or Geriatrician and further the data were reviewed by an independent panel of neurologists.*
Hearing status *was based on a short questionnaire on self-perceived hearing problems and the information on the fact that were using hearing aids or not.*

All ***subjects*** *were followed up on average every 2 years over a total of 25 years, since baseline and all assessments were conducted by a trained psychologist at the subject's home. In total 3777 subjects participated in this study, average age at baseline 75 years, 58% female, 64% reported no hearing problems, 31% reported hearing loss – but did not use hearing aids and 5% reported hearing loss and used hearing aids.*

Results *– Subjects not reporting hearing loss (NH) versus subjects reporting hearing loss – no hearing aid (HL-NO) and subject reporting hearing loss – using hearing aids (HL-HA).*
Disability (Independence – ADL)*: The group with hearing loss and no hearing aids had a significantly increased hazard ratio (HR) of 1,28 (or an increased risk of 28%), while the group with hearing loss using hearing aids had no significant risk (HR 0,81) compared to the group not reporting hearing loss.*
Disability (Independence – IADL)*: The group with hearing loss and no hearing aids had a significantly increased hazard ratio (HR) of 1,13 (or an increased risk of 13%), while the group with hearing loss using hearing aids had no significant risk (HR 1,09) compared to group not reporting hearing loss.*
Dementia*: The group with hearing loss and no hearing aids had a significantly increased hazard ratio (HR) of 1,21 (or an increased risk of 21%), while the group with hearing loss using hearing aids had no significant risk (HR 0,86) compared to the group not reporting hearing loss.*
For Death and Depression there were no significant differences between these groups, but when specifically looking for ***Depression in the male group****, there was a higher risk for men reporting hearing loss but not using hearing aids. The male group with hearing loss and no hearing aids had a significantly increased hazard ratio (HR) of 1,43 (or an increased risk of 43%), while the group with hearing loss using hearing aids had no significant risk (HR 1,21) compared to the male group not reporting hearing loss.*

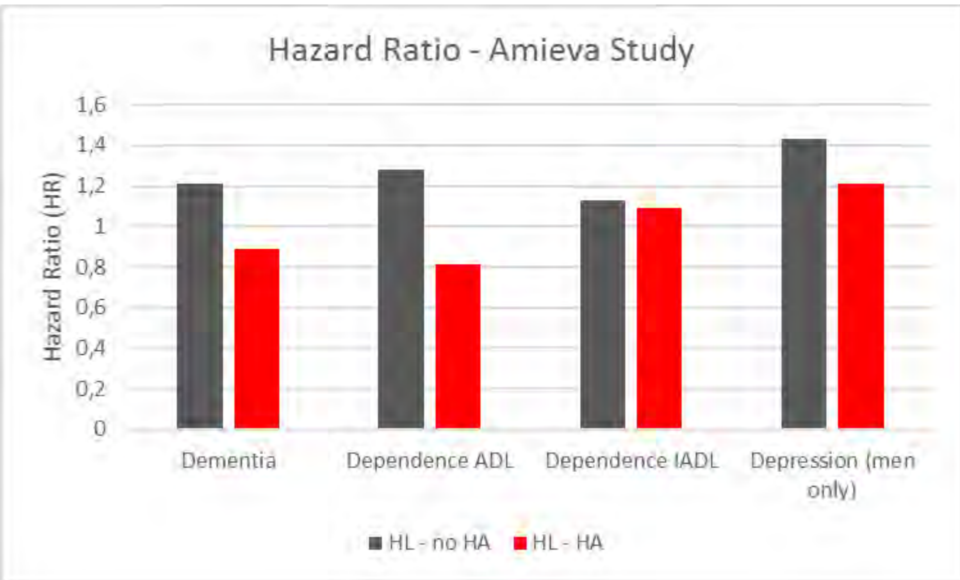

Fig: Hazard Ratio for the different dimensions, the group reporting hearing loss but not using hearing aids (HL-noHA) grey bars have a higher risk (Hazard Ratio) then the group reporting hearing loss and using hearing aids (HL-HA) red bars. Notice that for depression, only the male subjects are represented in this graph.

In conclusion , subjects reporting hearing loss but not using hearing aids, run a significantly higher risk in developing dementia (21%), to be more dependent regarding both Activities of Daily Living (28%) and Instrumental Activities of Daily Living (13%) compared to subjects not reporting hearing problems or subjects reporting hearing problems but using hearing aids. Men reporting hearing loss but not using hearing aids, run a significantly higher risk in developing depressive symptoms (43%) compared men not reporting hearing problems or men reporting hearing problems but using hearing aids.

The strong aspect of this study is the large cohort, the 25 years of follow up, the fact that a trained psychologist assessed the subjects at their home and the fact that validated instruments were used to assess Dementia, Depression, Disability (Independence – IADL) and (Independence – ADL). The weak aspect of this study is that hearing loss was only based on self-report and that hearing aid use was not evaluated in detail. The findings of this study, support us in the fact that hearing aid use is associated with a lower risk of developing Dementia, Dependence and Depression (for men). Hearing care can be associated with preventing the consequences of untreated hearing loss. That is why the theme for the World Hearing Day 2018 by the joined European Associations (AEA-EFHOH-EHIMA-Age Platform Europe) is "Hear the Future" … "Hearing Care to keep you Independent".

Impact of Hearing Aid Technology on Outcomes in Daily Life III: Localization.

Jani Johnson, Jingjing Xu & Robyn Cox.

Ear & Hearing, Vol. 38, N°. 6 (2017), 746–759.

This is the third of a series of articles on the evidence base of hearing aid technology level related to; (1) The Patients' Perspective, (2) Speech Understanding and Listening Effort and this time (3) to Localization.
On the Patients' Perspective, the conclusion was that all hearing aids were helpful, but there was no significant difference between basic and high-end hearing aids.
On Speech Understanding and Listening Effort, the conclusion was that all hearing aids improved speech understanding and listening effort in daily life, but basic and high-end hearing aids were equivalent.
For Localisation, earlier studies on the added value of directional microphone technology concluded that adaptive directional technology leads to poorer localisation compared to the unaided condition and that directional technology that mimics the function of the pinna (PES – Pinna Effect Simulation) results in better front-back localisation than omnidirectional microphone technology.

In this study, basic technology hearing aids were compared to premium technology hearing aids in function of localization in a laboratory environment in four conditions;

- *Low Frequency speech in Quiet*
- *High Frequency Speech in Quiet*
- *LF speech in noise*
- *HF speech in noise.*

And in everyday life (SSQ – Speech, Spatial and Qualities of Hearing Scale).

Subjects: 45 older adults (Avg. 70 years) with symmetrical mild to moderate hearing loss.
Hearing aids: two hearing aid brands, sets of mini behind the ear fitted with thin tubes in both basic technology and premium technology for both brands (so 4 sets in total). In this study, the premium technology hearing aids, had next to multiband adaptive directionality also PES (Pinna Effect Simulation) directionality as one of the options, while this was not the case for the basic technology hearing aids.

Results:
There was no difference between Aided and Unaided (level correction for audibility) Localisation in the four lab conditions was not significant (this was tested after 1 month of experience with the hearing aids). But the SSQ questionnaire showed better localisation performance in the aided versus the unaided condition in daily life.

The subjects performed better with Premium technology versus Basic technology hearing aids in one of the four lab conditions (HF speech in quiet). The was no difference in the other lab conditions and in daily life (SSQ).

Overall a very interesting study, demonstrating the need to be very selective in activating features in hearing aids in order to preserve localisation cues. In this study, all features of the hearing aids were turned on in the default mode and they were tested in three different programmes (1) Automatic – default program, (2) strongest fixed front facing directionality and (3) the best feature set to detect signals from all directions. The consequence is that a mix of different feature could influence localisation ability. The positive aspect of this study is that subjects could get used to the set of hearing aids for one month, before the localisation tests were performed. On the other hand, since there were four sets of hearing aids that were each tried out during one month, it is doubtful that the SQQ questionnaire would give a reliable comparison, since subjects needed to compare to the performance a month earlier.

Use of Noise Cancellation Earphones in Out-of-booth Audiometric Evaluations

Clark JG, Brady M, Earl BR, Scheifele PM, Snyder L, & Clark SD.

International Journal of Audiology, 2017; Vol 56 (12), 989-996.

Introduction

A significant proportion of the population with a disabling hearing loss do not have access to audiological examination and rehabilitation. One way around this is via recent advancements in tele-health, where telecommunications technology is utilised to deliver off-site, remote care for patients with difficult access to these services. Another way to improve access is for the clinician to physically provide off-site audiological services to nearby rural communities who lack access to the audiological care. Both of these alternatives however lack a sound-treated booth, and so diagnostic audiology is completed in the quietest room available, in order to minimise ambient noise levels in the testing room.

Noise Cancelling Earphones (NCE) uses a 180° out-of-phase active noise cancelling mechanism for incoming sounds, theoretically removing all external sounds coming via air-conduction. This would remove all ambient noise in the room, allowing for accurate air-conduction testing. Previous studies have shown the validity of using NCE for air-conduction audiometry (Bromwich et al., 2008; Lo & McPherson, 2013). However, the actual noise reduction properties of the NCE of the external environment was not quantified. Therefore, the first objective of this study was to investigate whether NCE will reduce ambient noise to below to those set by the American Standards Institute (ANSI, 1999).

In order to validate the use of NCE in the wider field (other than just an air-conduction screening), bone conduction audiometry must also be put to the test. The circumaural fit of the NCE may contribute to an occlusion effect, potentially enhancing low frequency bone conduction thresholds. The extent of this caused by the NCE has not been investigated before and hence was the second objective of this study.

Methods

To investigate the sound reduction properties of the NCE, a real ear measurement system (Verifit) was used to measure the SPL of the tympanic membrane with and without the NCE in place from 0.25-6kHz (as the Verifit cannot assess frequencies greater than 6kHz). This value was then subtracted from a typical clinic office room with no acoustic treatment and compared to the allowable ambient noise levels as stated by ANSI (1999). Sound-field audiometric testing in a test booth was also conducted, measuring warble-tone thresholds with and without the NCE in 1dB increments.

To assess the influence of NCE on the occlusion effect, measurements were performed on twenty participants with normal hearing (thresholds <20dB HL). Air conduction thresholds were measured with and without NCE. Bone conduction thresholds (forehead placement) were measured with and without a contralateral insert (to simulate masking conditions), in combination with wearing the NCE on top of this as well.

Results

Subtracting the noise cancelling properties of the NCE from the typical clinic office room, as well as the sound-field audiometric testing gave results that suggest the NCE provided sufficient sound reduction of the room noise to below the ANSI (1999) standards for all frequencies (0.25-6kHz) when testing using inserts, or for frequencies greater than 1kHz when testing without inserts (i.e. bone *conduction audiometry). These results are in concordance with previous studies (Bromwich et al., 2008). This suggests the validity of using NCE to reduce ambient room noise levels in the case where a sound treated environment is not available.*

There was no statistically significant threshold shift for frequencies greater than 1kHz when using inserts or NCE for bone conduction measurements, suggesting the absence of any occlusion effect for these frequencies. For frequencies below 1kHz, when using the NCE for bone conduction measurements, there was an occlusion effect present that was lesser in magnitude than when using inserts. The occlusion effect from the NCE was greatest at the lower frequencies (i.e. 0.25kHz) showing a maximal threshold shift of 5dB, which is within the test-retest variability measures taken in current clinical practice. The authors note that current use of correction factors when masking can be utilised to overcome the occlusion effect, and also the fact that 0.25kHz bone-conduction measurements are frequently omitted in usual clinical practice.

In this study, bone conduction measurements were completed using the forehead placement to prevent dampening of the bone conduction with the NCE. However in clinical practice, the mastoid is the preferred placement among audiologists. Hence future research should help to validate the use of NCE by the wider community by using the mastoid placement alternative to bone conduction audiometry.
Furthermore, testing a variety of NCE from multiple manufacturers, as well as an assessment of speech testing may help encourage their use by audiology clinics.
Overall, this study, in combination of the studies mentioned above, provides a strong argument for the use of NCE in tele-audiology and/or in off-site rural communities where external ambient noise is often difficult to control for.

American National Standards Institute. 1999. Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms. (ANSI S3.1-1999). New York: ANSI.

Bromwich M, Parsa V, Lanthier N, Yoo J, & Parnes L (2008). Active Noise Reduction Audiometry: A Prospective Analysis of a New Approach to Noise Management in Audiometric Testing. Laryngoscope 118, 104-109.
Lo AH & McPherson B (2013). Hearing Screening for School Children: Utility of Noise-cancelling Headphones. BMC Ear Nose and Throat Disorders 13(6), 1-10.

Soft Tissue Conduction: Review, Mechanisms, and Implications.

Sohmer H.

Trends in Hearing Dec 2017, Volume 21: 1-8.

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Introduction
Soft tissue conduction (STC) is defined as "the hearing induced when vibratory stimuli reach skin and soft tissue sites not directly overlying skull bone such as the head, neck, thorax, and body".

This is different to air conduction hearing, where oscillatory movement of the stapes footplate causes a pressure difference across the basilar membrane, causing a passive travelling wave.
It is also contrasted with bone conduction hearing, where vibration of the temporal-petrous bone causes secondary vibrations of the outer, middle and inner ear, resulting in inner ear fluid inertia, compression of inner ear bone, ossicular chain inertia, and occlusion effect. This culminates to a pressure difference along the basilar membrane, again initiating a passive travelling wave in the cochlea.

A demonstration of STC can be shown by occluding the ear canal with a finger whilst gently stroking the ipsilateral cheek. Occluding the ear canal rules out air-conduction pathways and the gentle stroking would not be sufficient to cause vibrations of the skull needed for bone-conduction. Thus the sound that is heard is presumed to be induced by vibrations of the soft tissue which activate the inner ear.

Mechanism
The proposed mechanism of STC results from a multitude of experimental evidence that point to another mode of sound stimulation whilst at the same time rules out the possibility of both air- and bone-conduction pathways.
To rule out the possibility of air-conduction stimulation, the use of hearing protection devices and custom-made ear plugs were used, and in experimental conditions, the canal filled with fluid.
To rule out the possibility of bone-conduction stimulation, sub-threshold levels of bone conduction as stimuli. Air borne sounds are transmitted to soft tissues more effectively than to bone, as the acoustic impedance mismatch between air and soft tissues is smaller than that between air and bone. Given a strong enough stimulus, the air-borne sound would eventually cause skull vibrations and activate the bone-conduction pathway.

The proposed pathway of STC is as follows. Firstly, intrinsic (vocalization, cardiovascular system) or extrinsic vibrations (direct or indirect -,water or air-, contact) causes vibrations of the soft tissue in the body such as the head, neck and thorax. Studies show that the STC pathway is more efficient in sound transfer at the lower frequencies.
The vibrations are then transmitted along soft tissues with similar acoustical impedances, reaching the ear to elicit hearing. The vibrations that enter the inner ear cause vibrations of the inner ear fluid, causing fluid pressure waves which activate the outer hair cells and in turn the inner hair cells.
This mode of conduction stands in contrast to both air- and bone-conduction pathways, in which the hair cells of the cochlea are stimulated by a passive travelling wave.

Implications
Although STC wouldn't contribute a significant amount to everyday hearing (as this would be dominated by air-conduction hearing), the authors posit that STC may be able to explain some low level auditory phenomena, which may have previously been attributed to bone-conduction stimulation. These are and not limited to: STC of the amniotic fluid to elicit hearing in the fetus in

utero, a speaker's own voice being modulated via STC rather than bone-conduction, and pulsatile tinnitus caused by STC of the heart and arteries to the ear (De Ridder, Vanneste, & Menovsky, 2013).

The clinical usefulness of STC is most likely to be minimal in the field of diagnostic and rehabilitative audiology; however, its knowledge may be utilised by audiologists in various situations. STC may explain the reason that hearing protection devices can only produce a limited amount of attenuation (Chordekar et al., 2015), or how patients with superior canal dehiscence may hear ankle-elicited bone stimulation (Brantberg, Verrecchia, & Westin, 2016). However, much like the usefulness of cartilage conduction in the designing of prototypes for cartilage conduction earphones and even hearing aids, the practical utilization of STC is yet to be fully revealed.

Brantberg K, Verrecchia L, & Westin M (2016). Enhanced auditory sensitivity to body vibrations in superior canal dehiscence syndrome. Audiology and Neurotology, 21, 365–371.

Chordekar S, Adelman C, Sohmer H, & Kishon-Rabin L (2016). Soft tissue conduction as a possible contributor to the limited attenuation provided by hearing protection devices. Noise and Health, 18, 274–279.

De Ridder D, Vanneste S, & Menovsky T (2013). Pulsatile tinnitus due to a tortuous siphon-like internal carotid artery successfully treated by arterial remodeling. Case Reports in Otolaryngology, 2013, 938787..

Listening Into 2030 Workshop: An Experiment in Envisioning the Future of Hearing and Communication Science.

Simon Carlile et al.

Trends in Hearing Dec 2017, Volume 21: 1-11.

The two-day workshop focused on communication and hearing in the future, in which several researchers brainstormed together on what future technology can do to improve communication and hearing. The purpose of this workshop was to focus on keeping the "end in mind", and search for solutions for the real-life problems of the end user. That's the reason why "Design Thinking", a dynamic methodology, was used; it encourages to observe the problem from different perspectives with the consumer at its centre.

The first step after brainstorming was the creation of seven different personas in need of some communication improvement. Some of them had a hearing disability. Each persona was analysed to reveal communication problems and barriers in order to list the main problem areas where more research is needed. The researchers discovered that a lot of key problems were similar, despite the fact that each persona was very different. Finally, the revealed problems were grouped into nine themes on which research should focus.

Three of the nine themes were very technically focused: measuring brain activity, display of auditory and multimodal information, and analysis of the auditory scene.
Speech and communication are very complex and current devices can only cover a certain amount of these domains. Some information is sent with difficulty from the sender to the receiver because of the presence of substantial background information. Technology could filter this information to improve the message transfer. But a realistic danger is that important information can be filtered away, which can have a negative influence on, for example, safety. We also do not yet know what the brain is doing with this extra information in the longer term. It can be stored and 'reused' in other circumstances. The incidental learning could be affected by filtering background information.

Two other themes were focused on health and well-being: holistic approaches to wellness and health management, and biological intervention for hearing dysfunction.
The first team handled the holistic approach where the cochlea should be seen as a part of a whole biological structure in which a dysfunction influences the whole system, rather than a separate subsystem. The cochlea is a complex structure and has been very difficult for surgery and resurrection. In most cases a hearing loss is difficult to remedy except with hearing aids. But lately, there are promising new directions, including in gene therapy.
The second theme talked about the "Invasiveness" of technology with the human body and brain. If future devices become capable of reading and analysing thoughts and emotions, this can be regarded as a great invasion of privacy. The original goal is to simplify communication by clarifying the message and transferring this information to the receiver more easily. However, an incorrect use of technology can be very dangerous for our privacy and may reduce our human interactions with a resulting impairment of our own social abilities as a possible consequence.

The other four themes focused on psychological and sociological elements: communication in a social context, social good, psychological interactions with technology, and security and privacy. Social interaction through human communication is highly complex and not easily replaced by technology. The auditory part is easy to transfer by technology but the non-verbal communication – which remains the overall part in our communication - is much more difficult to encode.

Another rather practical question for the future is how we will be able to have enough hardware and software to create low-cost, high-performance adaptive devices that will provide long-lasting benefit and that can get in the hands of those who need it.

The social aspect of communication was a subject that often came back during the discussions of the workshop. Technology to improve communication can already be very helpful, but the human and sociological aspect of communication seems very particular and difficult to be replaced by technology.
Privacy is another big and sensitive topic. The more we use new technologies and devices – which are very helpful –, the more we give up our privacy. Should we give up all our privacy and security, and build up a trust with invasive auditory technology in exchange for convenience? Or should we live in a Faraday cage? How we should use technology and devices in the future is a difficult but real and important question, for which there is no clear answer yet.

There has been extensive research on how to improve technology and our devices, but never with a focus on the end user himself. Understanding this need of the customer is the key in remaining relevant towards them. Secondly, it is good that this study placed attention on the consequences of the technological evolution upon our social life, human communication and privacy. We are giving up our privacy progressively, which is a trend in all types of technology with no way turning back. The future of this technology does not seem reassuring.

Counselling users of hearing technology: a comprehensive literature review

Alex Meibos, Karen Muñoz, Jared Schultz, Tanner Price, John J. Whicker, Ana Caballero & Laurel Graham.

International Journal of Audiology, 2017; Vol 56 (12), 903-908.

The overall aim of this study is to overview the scope of peer-reviewed empirical research on counselling individuals ('old' adults) with hearing technology.
Counselling in audiology can be divided in two categories: informational counselling and adjustment counselling. Informational counselling refers to education and sharing information with a patient or family to help them understand
- *the impact of hearing loss*
- *the role of amplification or other technologies in treating hearing loss*
- *how these technologies work.*

Adjustment counselling can be described as
- *addressing internal challenges or barriers patients and families may experience (psychosocial concerns)*
- *assisting them in finding solutions to achieve effective self-management*

In the past audiologists focused mainly on informational counselling. Singh et al 2016 stated that equally important are the cognitive, emotional, motivational, social and adjustment factors that influence treatment outcomes.
Recently audiology is shifting from a biomedical to a biopsychosocial approach. This is a more patient or family centred approach that can be accomplished by applying counselling.

Results
In the 18 articles included in this review different themes are identified.
The first theme is the audiologists' perspective on counselling. 79% of the audiologists provide informational counselling, but only 52% routinely provide adjustment counselling. Audiologists continue to report that adjustment counselling and especially addressing patients and family emotions are a big challenge and there is a need for more training on this subject.
Most audiologists prefer a patient-centred approach and agree that shared-decision making should be included in their services.

The second theme is audiologist-patient communication. Most of the communication contains information sharing. Audiologists tend to dominate conversations and often are multitasking while they are speaking.

The third theme is counselling interventions in audiology. Patient outcomes in pre-fitting counselling show that no significant change occurs due to counselling apart from an increase in average hours of hearing aid use. In post-fitting counselling patients indicate having learned something new about their hearing loss, while no significant change in behaviour is found.

Professional training outcomes indicate that after training in counselling audiologists are more likely to respond to personal adjustment concerns and show a significantly decrease in verbal dominance. Audiologists desire more training to improve communication skills in supporting patients and their family.

A consensus definition of clinical counselling in audiology is needed.

The research included in this review contains studies that are more than 30 years old. Both hearing aid technology and education of the audiologists have changed enormously since 1985. I find it difficult to define gaps in research, while taking into account studies that do not represent the current situation in 2017.
Why not first analyse the way adjustment counselling is included in education of audiologists around the world? Why not analyse current adjustment counselling given by experienced audiologists in practices around the world? Would this not provide more information to start from in order to conduct new research to provide evidence-based guidelines on this subject?

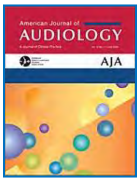
79% of the audiologists report that they routinely give informational counselling. What about the other 21%: a colleague provides the counselling in these cases that I would hope for?

Audiologists in general are modest: audiologists always feel the need to perform better in the future and are aware of their weaknesses. This is an important attitude in audiology, as technology and the working procedures change very fast over the years.

Differences in hearing aid technology (differences between brands of hearing aids, with or without accessories, use of apps, high-end versus low-end, etc) must be taken into account while conducting research on counselling effects as these factors also have an impact on internal challenges or barriers patients and families may experience, such as for example hours of use, quality of life, etc ...

In this review the focus is mainly on ‘old’ adults. Counselling 18-65-year-old hearing aid users can be very different than counselling children and their parents and then counselling older adults. In my opinion counselling this population (18-65y) is an important challenge for audiologists as it also has an impact on the professional activities of the hearing aid user.

Relation Between Listening Effort and Speech Intelligibility in Noise.



Melanie Krueger, Michael Schulte, Melanie Zokoll, Kirsten Wagener, Markus Meis, Thomas Brand & Inga Holube..

American Journal of Audiology, October 2017, Vol. 26, 378-392.

Purpose:

Previous research showed that adding subjective ratings of listening effort may be able to estimate hearing difficulties and benefit of hearing aids even at signal-to-noise ratios (SNRs) at which speech intelligibility scores are near 100% (near or at ceiling).
Hence, ratings of listening effort were compared with speech intelligibility scores at different SNRs, and the benefit of hearing aids was evaluated.

Methodology:

Speech materials

- *Listening effort was assessed using an adaptive version of the ACALES. The ACALES quantifies subjective listening effort for sentences in a background masker with different SNRs on a 14-point categorical scale.*
- *For the speech intelligibility measurements, an adaptive speech-in-noise test was used with the OLSA sentences and a constant masker of 65 dBSPL.*

Masker materials:
The listening effort ratings as well as the speech intelligibility tests were performed in four different maskers:

- *the fluctuating maskers were the International Female Fluctuating Masker and the Icra5-250*
- *the stationary maskers were the 'Olnoise' and the 'Cafeteria' noise.*

Test subjects

- *The first group: 15 listeners with normal hearing (mean age = 25)*
- *The second group, 15 listeners with hearing impairment (mean age = 68), with mean PTA4 of 42 dB HL.*

These subjects were experienced HA users and wore their own HAs (receiver-in-the-canal HAs) with their customary settings. All HAs had an automatic program, which was used in this study. No special speech-in-noise program was used.

Results:

Listening Effort for Listeners With NH and HI:

- *Listeners with hearing impairment showed higher rated listening effort compared with listeners with normal hearing.*

Differences due to Masker in Speech Intelligibility and Listening Effort:

- *The discrimination functions of the fluctuating and stationary maskers differed by approximately 11 dB SNR at SRT for listeners with Normal hearing.*
- *This distance was nearly four times smaller for unaided listeners with HI (approximately 3 dB SNR).*
- *Similar results were found for listening effort ratings. At lower SNR values, the listening effort was rated less effortful in a fluctuating masker in comparison with a stationary masker.*
- *This difference vanished with increasing SNR and was absent for the rating category no effort.*
- *In the fluctuating maskers, the benefit of the gaps might have been transformed into a disadvantage of the masker's peaks.*

- *At −0.6 dB SNR, speech intelligibility scores reached 95% for listeners with NH and became saturated for further increasing SNR. The SNR required for speech intelligibility scores of 95% shifted to positive SNR values (3 dB SNR) for unaided listeners with HI.*
- *A similar pattern was seen for the listening effort results: It was noticeable that, at a speech intelligibility of*
- *95%, perception of listening effort differed between maskers.*
- *The SNR values at which a speech intelligibility score of 95% was reached differed between listeners with NH and unaided listeners with HI. Nevertheless, despite the high speech intelligibility scores, the listeners experienced great listening effort. With increasing SNR, listening effort ratings decreased, whereas speech recognition remained at 100%.*
- *For listeners with NH, the rating category no effort was used at an SNR value between 4 dB SNR and 7 dB SNR and for unaided listeners with HI between 8 dB SNR and 10 dB SNR, depending on the masker. This SNR range could be used to evaluate the perception of speech in ecologically valid situations similar to typical daily life (Smeds et al., 2015).*

Relationship Between Speech Intelligibility and Listening Effort

- *At lower SNRs, subjective listening effort ratings depended more on objectively measured intelligibility than at higher SNRs.*
- *At higher SNRs, listening effort might be related to other, yet unknown, factors.*

Relation to Hearing Loss:

- *Higher hearing loss was related to higher SRT values. Higher PTA4 led to more effort. This effect was stronger in speech related maskers.*
- *In general, the correlation between the PTA4 and the SRT was higher than the correlation between the PTA4 and the listening effort categories no effort and extreme effort. This supports the assumption that other mental functions might have an impact on the perception of listening effort. It is noteworthy that the subjects with NH were younger than the subjects with HI. Thus, possible cognitive decline might have influenced the results.*

Benefit of HAs Assessed by ACALES
In the averaged results, the benefit of HAs on listening effort was not significant for the stationary and fluctuating maskers.

- *To some extent, the benefit was even negative at positive SNR values, especially when speech was used as a masker (IFFM).*
- *For low SNRs, where intelligibility is clearly below 100%, an average benefit is evident for all maskers.*

Conclusion:
The adaptive procedure for rating subjective listening effort yields information beyond using speech intelligibility to estimate hearing difficulties and to evaluate hearing aids.

Critical note from the authors:
As the cognitive status of the subjects was not addressed in this design in future research, individual factors, such as cognition, should be addressed to minimize possible confounding factors.

Interesting study with important potential applications in daily hearing fitting practice. Given that adding subjective ratings of listening effort can help us to gain more insight into how people actually function with their hearing aids (especially in communication situation close to everyday life). The study would probably have been even more interesting, if a normal hearing test population was used with a mean age closer to that of the hearing-impaired group.

How directional microphones affect speech recognition, listening effort and localisation for listeners with moderate-to-severe hearing loss

Erin M. Picou & Todd A. Ricketts.

International Journal of Audiology, 2017; Vol 56 (12), 909-918.

Much of the work investigating directional benefits in the laboratory has focused on listeners with mild to moderately severe hearing loss. The few studies that have explicitly evaluated the potential directional benefits for listeners with more severe hearing loss generally suggest that these listeners are likely to benefit from directional microphones, but the expected benefits are smaller than for listeners with milder losses.

This study evaluates the effect of directional microphone use on sentence recognition, listening effort and localisation. Three hearing aid conditions were evaluated: bilateral omnidirectional, bilateral directional and asymmetric microphones.

Eighteen adults with, moderately severe, symmetrical sensorineural hearing loss participated. They were bilaterally fitted with the same model of super-power, BTE hearing aids with custom earmolds and standard tubing. Sentence recognition in noise was evaluated using the Connected Speech Test (CST). Pairs of sentences were presented from a loudspeaker 1,5 m directly in front at 68 dB SPL. The background noise consisted of recorded samples of 4 females reading passages from the CST., 3,5 m from the participant, at 45°, 135°, 225° and 315°. Listening effort was evaluated using a dual-task paradigm: monosyllable word recognition as primary task, word categorisation (noun or not) as secondary task. To evaluate gross localisation, the Spatial Test Requiring Effortful Speech Recognition (STRESR) was used. The speech stimuli now originated from one of four loudspeakers placed at –60°, -45°, +45° and +60°. Participants were permitted to move their heads during testing.

Results
Directional microphones improved sentence recognition in noise, regardless of whether one or both hearing aids were in the directional setting.
Also, during the dual-task paradigm, word recognition performance and response times were improved with directional microphones, regardless of whether one or both hearing aids were in the directional setting.

In contrast, neither loudspeaker location nor hearing aid microphone setting affected performance on the STRESR. This is somewhat surprising, earlier work suggests that directional microphones can impair localisation for signals originating away from the midline. This may be an explanation, the largest directional localisation detriments were at ≥60°, in this study the largest eccentricity was ±60°. Also, participants were permitted to move their heads during testing. Third, the STRESR provides a gross measure of localisation ability. The results of this study suggest that the use of directional technology is expected to have little, if any, effect on localisation performance in similar real-world situations.

Another difference with earlier work is that the directional benefit in this study is smaller, but this is consistent with previous reports which included direct comparisons of participants with different degrees of hearing loss: smaller benefits for listeners with moderate-to-severe hearing loss than for participants with mild-to-moderate hearing loss.

The findings of the present study confirm and extend previous findings that asymmetric directional configuration can be as beneficial as a symmetric directional configuration.

The use of directional microphones for listeners with moderate-to-severe hearing loss is supported for the conditions evaluated (speech front and noise surround); there is a directional benefit for speech recognition and listening effort.
There was no effect of directional microphone use, either positive or negative, on a measure of gross localisation in the frontal plane, when loudspeakers were placed at ±45° and ±60°.

Exploring Hearing Aid Problems: Perspectives of Hearing Aid Owners and clinicians.

Rebecca Bennett, Ariane Laplante-Lévesque, Carly Meyer & Robert Eikelboom.

Ear & Hearing, Vol. 38, N°. 6 (2017), 172-187.

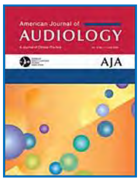
The aim of this study was to gather information regarding the problems that hearing aid (HA) owners are facing after the HA fitting and to understand how they are addressing those problems. The researches explored this topic from the point of view of both HA users and audiologists in order to generate a conceptual framework that will help to identify those problems and improve the fitting process. This article is referring to the first part of the objectives of the study identifying the problems).
17 Australian HA owners and 21 hearing healthcare clinicians participated in this study. The researchers used concept mapping technique that had 4 steps: 1. Brainstorming; 2. Grouping and rating; 3. Data analysis; 4. Interpretation.
Two main themes of HA related problems (each contain 2 types of problems) were identified from both HA owner's and clinician's responses:

1. *Problems related to HA: HA management; HA sound quality and preference.*
2. *Problems related to HA owner's experience and interaction with the clinic and clinicians: feelings, thoughts & behaviours; information and training.*

Although the results gathered from the clinicians and the HA owners were similar, the clinicians thought that the problems that were identified as having a greater negative influence on the success of the HA fitting process then the HA owners. Moreover, the HA owners indicated that the clinicians are responsible for the prevention and resolution of those problems while according to the clinicians' perception this responsibility is of the HA owners. Analysing the 4 types of problems showed a greater concentration of problems regarding HA management as compared to the other 3 types and that those problems have a greater impact on the HA success.

This study emphasizes the similarities and differences between clinicians' and HA users' perceptions and defines the different types of problems that the patients are confronted with through their rehabilitation journey. The question that comes into my mind is whether the findings in this study are global or whether there are differences related to the local healthcare system, local regulations, culture, clinicians/audiologists academic programs etc. It is important that during the different sessions we share with our patients starting from the counselling and throughout the rehabilitation journey that we will give our patients all the information they need in an accessible manner and spend time to really understand the problems that they have by asking leading questions and listing to them without providing them answers that are our own interpretations. .

The ALFA4Hearing Model (At-a-Glance Labeling for Features of Apps for Hearing Health Care) to Characterize Mobile Apps for Hearing Health Care.



Alessia Paglialonga, Francesco Pinciroli, and Gabriella Tognola.

American Journal of Audiology, October 2017, Vol. 26, 408–425.

At-a-Glance Labeling for Features of Apps for Hearing Health Care (ALFA4) is a model developed to describe 29 apps features, organizing them into an easy to use graphical representation. With increased use of mobile health (m-health - the WHO term for the provision of health services and information via mobile technologies) in audiology and hearing health care (HHC) a quick comparison of apps before downloading should prove a useful tool for audiologists, hearing professionals and end users. While hearing HHC has been slower to adopt m-Health than other medical areas such as cardiology, diabetes management and emergency medicine, there has recently been growth in some application areas such as self-fitting/fine tuning of hearing aids, smart-phone based listening tools, hearing screening, professional education and end user guides/information. With widespread adoption of smartphone apps there are few indicators to ensure app quality and suitability for the end user despite there being increasing interest in development of standards for app certification. The ALFA4 model does not consider subjective app quality but does aim to accurately describe the contents of the app before committing to download / purchase.

The five main components that are assessed by the ALFA4 model are:
Promoters (who promoted the app?) Characterizes the type of entity that developed or support the app.
Services (which services are provided by the app?) Characterizes the main apps service
Implementation (how is the app implemented?) input/output of text, video, audio and interactions with the user or other apps, devices, or transducers
Users (to whom is the app targeted?) target group(s) of the app
Descriptive Information (what are the general user-orientated features?) general features of the app that are relevant for the user

The model also uses incorporates a colour coded system with green indicating the feature is relevant, yellow = partially relevant and white = not relevant.

This study looked at 120 HHC apps, 60 android and 60 iOS, in April 2016 available in the Italian and US app stores using the keywords hearing, audiology, audio, auditory, hearing screening, speech, language, tinnitus, hearing loss, noise, hearing aid, hearing system, cochlear implant, implantable device, auditory training, hearing rehabilitation, hearing consultation, and assistive technology/tool/device. The devices used for accessing the app were an iPad 2 (Apple Inc., Model A1396, 64 Gb) on iOS 9.2 and a Samsung Galaxy Tab 10.1 3G (Samsung Electronics Co., Ltd., Model GT-P7500, 32 Gb) on Android 5.1.1.

A schematic of the ALFA4 model assessing an app "Audiogram Mobile" for iOS, an app for professional hearing testing that performs pure-tone audiometry (air and bone conduction, manual and automated testing, and noise masking) by using professional, calibrated headphones is below showing each of the sub-components.

In the Promoters Component HHC apps were found to be largely promoted by hardware/software companies and independent developers, little involvement from drug companies, public health, professional, scientific and educational institutions was found.

Interestingly in the Services Component for all apps in the study sample only one application area was green. Further research into whether developing multi-service apps are viable, useful and effective to better support HHC patients.

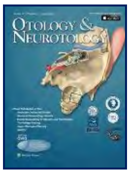
The Implementation Component highlighted that audio playback was the most important feature in HHC as majority of the apps deliver sounds. There is still more to be done and further research needed into producing reliably calibrated output levels on mobile devices. Improvements in calibration will open up additional benefits particularly in the use of apps in non-clinical remote locations to help service the HHC needs of people in isolated areas. 42% of apps in this study interacted with the user, this highlights the need for easy to understand instructions, easy to read apps as HHC users will typically be of older age group.

The Users Component found that 71 of the 120 apps studied were specifically developed for patients, 42 were aimed for people not yet diagnosed with hearing loss, with an additional 22 developed for professional use. Only 12 apps involved families or significant others, the researchers in this study anticipate that there will be growth in apps targeting professionals as well as significant others/caregivers in the quest to improve patient outcomes in.

The Descriptive Information analysis with the ALFA4 model found that 57 of the 120 apps did not provide any description, with 48 having no user manual and 47 having no support. Given recent research into the need for high readability, and ease of use for patient based information and interaction, this is an area HHC app developers could continue to improve.

Overall the ALFA4 model is a useful tool for providing a quick glance overview of HHC apps. In the future, specific app functions e.g. hearing screening app or parent/caregiver app for supporting child with hearing loss this could be identified quickly in the app store using a model such as this. As this study was conducted on tablets with the increasing number of people using apps on mobile devices it would be useful to use smartphones for analysis moving forward in future studies. Similarly, some evaluation of app quality should be integrated into assessment tool which the researchers of this study propose to do in this ongoing study. Ultimately it would be hugely beneficial for end users to have a model such as this integrated into the app store so that each of the components could be viewed. It would be even better to have these components linked to the search function within the app store so that best suited apps would appear at the top of the results list.

Prospective Evaluation of Patients Undergoing Translabyrinthine Excision of Vestibular Schwannoma with Concurrent Cochlear Implantation.



Rooth MA, Dillon MT, Brown KD.

Otology & Neurotology, Vol 38 (December 2017) p 1512-1516

This study looked at concurrent cochlear implantation at the time of Translabyrinthine (TL) Vestibular Schwannoma (VS) resection. VS are proliferative lesions of schwann cells that develop on the vestibular nerves, they are benign tumours with an incidence rate of approximately 1 per 100,000 person years. Unilateral hearing loss is a common symptom of VS meaning patients also commonly suffer from reduced ability to localize to sound, degraded speech understanding in noise and the perception of tinnitus. While it is possible to place a bone-conduction hearing aid or contralateral routing of signal (CROS) device on these patients, neither of these devices can improve localization abilities to the same degree as a cochlear implant (CI).

The seven participants in this FDA approved single site feasibility study had small tumours under 1.5cm at their most recent MRI scan. Individuals with these small VS typically have the option to monitor / observe, radiosurgery, or tumour removal. Often with small non-growing VS hearing loss is the only symptom meaning surgical removal is not particularly beneficial. Offering hearing improvement at the same time as tumour removal however may give more cause for an individual to proceed with surgery. Five of the seven study participants met cochlear implant criteria with consonant nucleus consonant (CNC scores) under 60% pre-surgery; one participant fluctuated in/out of criteria the other had terrible vertigo - both elected to proceed with implantation. To be implanted the patient needed to have an intact cochlear nerve post TL VS resection as assessed by the operating surgeon. It was found during surgery that two of the participants tumours had grown to be in excess of 2cm, however, as total resection was accomplished and anatomic integrity of the cochlear nerve was maintained they were still included in the study. A Medel standard electrode was inserted via standard round window insertion with placement verified by intraoperative x-ray, all subjects had complete electrode insertion. 3 to 4 weeks post-surgery activation occurred with Medel Sonnet audio processor using FS4 or HDCIS coding strategy.

Five of the seven participants had auditory perception at the time of activation, the two participants who could not detect sound were excluded from further testing.

Results were recorded at 1, 3, and 6 months post switch on for sound localization, CNC in quiet, AzBio sentences in noise, Tinnitus Handicap Inventory (THI). Pre- surgery scores were also obtained for THI and CNC word lists.

Localisation was assessed by measuring the root mean square (RMS) error, the root mean square deviation of the perceived response from the target location, produced by 11 speaker array spanning +/- 90 degrees. Data showed substantial sustained benefit in the implant on (38 degrees RMS error by 6 months) vs implant off (average 78-degree RMS error) condition.

Speech perception scores in quiet and in noise were variable. CNC word scores in quiet averaged 35% unaided pre-operatively, however, post-surgery with implant on scores were poorer with averages of 24%, 19% and 20% recorded at 1,3 and 6 months respectively. AzBio sentence in noise scores with the implant on were 22% vs 12% implant off in at one month, 12% vs 7% at 3 months and 18% compared with 8% at 6 months showing benefit with the implant in noisy situations when listening to speech.

Tinnitus scores were significantly better following cochlear implantation with a reduction in THI scores which averaged 23 pre-surgery, by 1 month scored averaged 7, by 6 months the average THI score was only 3. For THI lower score is better.

This study shows that concurrent cochlear implant in VS patients does not offer as great an improvement in hearing ability compared with those implanted with a CI due to idiopathic hearing loss. There is still merit in placing an implant if the patient has an intact auditory nerve post VS resection as improvements in spatial localization and decreased tinnitus severity were observed.

Interestingly despite the modest hearing benefits achieved overall, at 6 months post activation the participants in the study averaged 10 hours of CI use of per day. This combined with the reduction of tinnitus and improved localization ability does support implantation at the time of VS resection.

While concurrent CI implantation offers the benefit of only a single surgery / GA required) it was disappointing to see that CNC word recognition scores in quiet post CI activation were poorer than pre-surgery results. It could be that even though the cochlear nerve was visually intact, significant trauma / damage occurred during tumour removal causing this reduction in hearing benefit. Alternative studies placing implants without resection of the VS may show improved hearing benefit due to reduced nerve trauma/damage.

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More to Lose? Noise-Risk Perceptions of Young Adults with Hearing Impairment.

Lyndal Carter, Deborah Black.

Seminars in Hearing, 38 (2017), 319-331.

This study investigated the attitudes and behaviours of young adults with hearing impairment (HI) in relation to leisure noise.
The authors hypothesized that the sense of personal risk of noise injury would be greater for participants with HI than those with normal hearing (NH).
Data from 79 HI participants and 131 NH participants aged 18 to 24 was collected (from the extensive data set of a larger study). Questionnaires were developed specifically for the research aims. The questionnaires included detailed sections about the history of ear and hearing problems, general health, leisure and work activity participation, attitudes to noise and protective behaviours. For participants with HI, wearing hearing aids switched off during noisy activities was accepted as a form of personal hearing protectors (PHP).

The results of the study:
Less than one-third of participants believed themselves to be at risk for leisure-related noise injury. In contrast, the majority of participants believed their peer group to be at risk, in general terms. A significant difference was observed for the questions about the perceived likelihood of their hearing change in future. 35,9 % of the HI group expected no future change in their hearing compared to 9,2 % in the NH group.
Reported use of hearing protectors (or switching off hearing aids) was low among both groups. Among the HI group, use of hearing aids (switched on) in a range of noisy situations was quite frequently reported. Sometimes the hearing aids were worn with earmuffs.
Half of the respondents report that they avoid loud activities. But this was not primarily related to concern about noise injury. A range of other factors was relevant: physical discomfort, difficulty communicating, dislike of the social environment, tinnitus and vocal strain. Participants of the HI group reported also feeling "self-conscious" or feeling "dumb".

The hypothesis that young adults with HI have a greater sense of personal risk of noise injury than their peers with NH was not confirmed by that study. Both groups similarly rated their own noise-injury risk as lower than that of others their own age. Since more than a third of the HI group expected no future change in their hearing compared with just under one-tenth of the NH group, it is suggested that a proportion of young people may have limited knowledge of the likely prognosis of their HI.

Summary of the authors: Despite awareness that leisure noise can pose a risk to hearing health, few participants reported PHP use and many participants in the HI group reported wearing hearing aids during noisy activities.

Considerable effort was made to ensure a representative participant sample (country, regional, urban), but the participation rate for individuals with HI was relatively low. The test-retest reliability of the questionnaire was unknown at the time of the analysis.

Attitudes, Risk Behavior, and Noise Exposure among Young Adults with Hearing Problems: Identifying a Typology.

Abby Hunter.

Seminars in Hearing, 38 (2017), 331-347.

This study explored attitudes toward leisure noise, use of hearing protection and perceived susceptibility to leisure-noise damage in young adults with hearing problems. Interviews were done with twelve participants aged 18 to 35. Six people had tinnitus only, three people had hearing loss only, and three people had tinnitus and hearing loss.
During the interview the participants were asked to discuss their experience and views on their hearing problems, venues they visit where is loud music, attitudes toward noise levels of music, benefits and barriers associated with hearing protection and perceived severity of, and susceptibility to, further hearing problems.

The study identified 4 types of people.
Type 1: No concern about noise damage and no change in behaviour. Participants (tinnitus or hearing loss) cope well with their condition, are not concerned about leisure noise damage and do not engage in protective behaviours or change in lifestyle (Four of twelve).
Type 2: Cautious and positive behaviour change. Those with tinnitus (who may also have hearing loss) who cope well with their condition but are concerned about further leisure noise damage so they engage in protective behaviours such as using earplugs so they can still enjoy going to loud venues (Four of twelve).
Type 3: Poor coping and negative behaviour change. Those with tinnitus (who also might have hearing loss) who struggle to cope with their hearing problems, may have depression as a result, are concerned about further leisure noise damage, and avoid loud venues for fear of making their tinnitus worse (Two of twelve).
Type 4: Concerned about communication difficulties only and not noise damage. Those with hearing loss who are able to cope with their condition and are not concerned about leisure noise damage but do engage in avoidance of loud venues due to communication difficulties (Two of twelve).

Some participants engaged in protective behaviours (moving to the back, leaving early or taking breaks), when the music was too loud, but the reported use of earplugs was low.

The study was only done with 12 participants from one university. So, it is only a small qualitive study and is not representative of young adults in general.